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Missing Links:

Demic Diffusion and the Development of Agriculture on the Central Iranian Plateau

Jenny Lee Marshall

Ph. D

The Department of Archaeology, Durham University

2012

Abstract

This thesis studies the development of agricultural settlements on the Central Iranian Plateau during the Neolithic and Chalcolithic periods. To date, no Early Neolithic sites (ca. 8000-6500 BC) are known on the Central Plateau. This thesis aims to establish whether there was an Early Neolithic presence on the Central Plateau through taking a combined approach involving: a review of the current information available on the Neolithic of Iran and surrounding areas; the re-calibration and chronometric hygiene evaluation of existing radiocarbon determinations for Neolithic sites in Iran and neighbouring areas in order to map the 'spread' of agriculture; and the analysis of new data from recent archaeological research the Central Iranian Plateau. In studying the development of agriculture on the Central Iranian Plateau this thesis will provide valuable information on the origins and spread of agriculture in Central and South Asia, a region which has received relatively little archaeological attention in comparison to Europe. In particular, this research will elucidate whether the prevalent model for the spread of agriculture across Europe – Ammerman and Cavalli-Sforza's (1984) 'Wave of Advance' – is equally applicable to Central Asia, as has been suggested by Renfrew (1987), but never explicitly tested. As this research utilises both new and old data and provides both temporal and spatial perspectives, it represents an original study of the prehistoric period on the Central Iranian Plateau.

Table of Contents

List of Tables vi

List of Figures vii

Chapter One: **Missing Links: Demic diffusion & the spread of Agriculture in the Central Iranian Plateau**

1.0. Introduction 1

1.1. Aims and objectives 3

1.2. Overview of research 4

1.3. Conclusion 5

Chapter Two: The Agricultural transition

2.0. Introduction 6

2.1. What's in a name? The 'Neolithic' & 'Mesolithic' defined 7

2.2. The origins of food production 9
2.2a. Plant domestication 11
2.2b. Animal domestication 18

2.3. Why did food production occur? 26
2.3a. Population pressure 29
2.3b. Climate change 32
2.3c. Coevolutionary models 35
2.3d. Social and ideological change 36

2.4. The spread of agriculture 40
2.4a. Demic diffusion 41
2.4b. Population genetics 46
2.4c. Molecular-genetic approaches 51
2.4d. Cultural diffusion 61

2.5. Conclusion 67

Chapter Three: The Neolithic of Iran & neighbouring areas

3.0. Introduction 87

3.1. The country of Iran 87

3.1a. Soils 90
3.1b. Soil factors limiting agricultural production 92
3.1c. Land use 93
3.1d. Hydrology 94
3.1e. Climate 95
3.1f. Vegetation 97
3.1g. Fauna 98

3.2. Chronological considerations 99
3.2a. Proposed chronologies for prehistoric Iran 100
3.2b.The Neolithic & Chalcolithic periods defined 105

3.3. The Iranian Neolithic 107
3.3a. Northwestern Iran 108
3.3b. Central western Iran 113
3.3c. Southwestern Iran 123

3.4. The Neolithic of surrounding areas 143
3.4a. Turkmenistan 143
3.4b. Caspian Sea Plains 147
3.4c. Afghanistan 148
3.4d. Baluchistan 149

3.5. Discussion 155

3.6. Conclusion 159

Chapter Four: Methodology

4.0. Introduction 204

4.1. Aims and objectives 205

4.2. Modeling 205

4.3. The Neolithic of Iran 210

4.4. Radiocarbon determinations 213
4.4a.The radiocarbon method 213
4.4b.Chronometric hygiene 220
4.4c.Calibration 224

4.5. Excavation & settlement survey on the Central Iranian Plateau 225

4.6. Conclusion 228

Chapter Five: Radiocarbon dating

5.0. Introduction 244

5.1. The ^{14}C determinations 241

5.2. Neolithic sites in Iran 245
5.2a. Northwestern Iran 245
5.2b. Central western Iran 249
5.2c. Southwestern Iran 261
5.2d. Central Iranian Plateau 281
5.2e. Northeastern Iran 283
5.2f. Southeastern Iran 287

5.3. Neighbouring regions 290
5.3a. Turkmenistan 290
5.3b. Afghanistan 292
5.3c. Baluchistan 293

5.4. Spatial analysis 295

5.5. Discussion 299

5.6. Conclusion 300

Chapter Six: **The Central Iranian Plateau: The Tehran, Qazvin & Kashan Plains**

6.0. Introduction 318

6.1. Geography of the Central Iranian Plateau 319

6.2. Prehistoric sites 328

6.3. The Tehran Plain 329
6.3a.History of archaeological investigation 331
6.3b.Settlement survey 332
6.3c. Archaeological sites 334
6.3d.Summary of settlement pattern on the Tehran Plain 345

6.4. The Qazvin Plain 346
6.4a. History of archaeological investigation 348
6.4b. Settlement survey 348
6.4c. Archaeological sites 348
6.4d. Summary of settlement distribution on the Qazvin Plain 359

6.5. The Kashan Plain 360

6.5a. History of archaeological investigation 361
6.5b. Settlement survey 361
6.5c. Archaeological sites 363
6.5d. Summary of the distribution of settlement on the Kashan Plain 375

6.6. Discussion 376

6.7. Conclusion 377

Chapter Seven: Discussion

7.0. Introduction 418

7.1. Radiocarbon dates for the Iranian Neolithic 418

7.2. The Central Iranian Plateau 420

7.3. The spread of agriculture in Central & South Asia 432

7.4. Conclusion 434

Chapter Eight: Conclusion and outline of further research

8.0. Introduction 442

8.1. Limitations of this research & future prospects 449

8.2. Conclusion 451

References 454

List of Tables

Table 2.0. Some suggested caused for the transition to food production 70

Table 3.0. McCown's (1942) comparative stratigraphy for Iran 157

Table 3.1. R.H. Dyson's (1965) proposed relative chronology of Iran 158

Table 3.2. Majidzadeh's (1981) relative chronology for the early prehistoric period of the Central Iranian Plateau 159

Table 3.3. Hole's (1987) relative chronology for the prehistoric period of Iran 160

Table 3.4. Voigt & Dyson's (1992) chronology for prehistoric Iran 161

Table 3.5. Proposed chronologies for the Central Plateau 162

Table 3.6. Summary of the economy & cultural attributes of the Neolithic sites mentioned in the text 163

Table 4.0: A list of radiocarbon laboratories and their laboratory codes 229

Table 5.0. The earliest ^{14}C determination (BP) & calibrated age (BC) for each site 303

Table 5.1. Sites assigned to temporal groups according to the earliest 'clean' ^{14}C date 305

Table 5.2. Sites assigned to temporal groups according to the earliest ^{14}C date, regardless of chronometric hygiene 305

Table 6.0. Monthly climatic data for Tehran 379

Table 6.1. Monthly climatic data for Qazvin 379

Table 6.2. Monthly climatic data for Qum (nearest reported station to Kashan Plain) 380

Table 6.3. Survey sites from the Tehran Plain attributed to broad chronological periods 381

Table 6.4. The occupation sequence of Neolithic to Chalcolithic period sites on the Tehran Plain 382

Table 6.5. The occupation sequence of Neolithic to Chalcolithic period sites on the Qazvin Plain 383

Table 6.6. Finds from 2009 pilot *qanat* survey 384

Table 6.7. The occupation sequence of Neolithic to Chalcolithic period sites on the Kashan Plain 385

Table 6.8: The earliest radiocarbon determination & calibrated age for each site 386

Table 7.0: Imported materials and manufactured ceramics and lithics found at sites on the Central Iranian Plateau 437

List of Figures

Figure 2.0.	The Fertile Crescent showing the position of the Earliest known village sites	71
Figure 2.1.	The origin and dispersal of domestic livestock in the Fertile Crescent	72
Figure 2.2.	Fisher's (1937) model of a population wave of advance	73
Figure 2.3.	A graphic representation of logistic & exponential growth	74
Figure 2.4.	Map showing location & dates of early farming settlements in Europe & the Near East	75
Figure. 2.5.	Isochronal map of the spread of early farming in Europe	76
Figure 2.6.	Isochronal map of the spread of the 'latest' Mesolithic occupation in Europe	77
Figure 2.7.	Map of the Rhesus negative (Rh-) gene in modern populations of Europe, Africa and western Asia	78
Figure 2.8.	Contour map of the first Principle Component of the genetic analysis of populations in Europe	79
Figure 2.9.	Contour map of the second Principle Component of the genetic analysis of populations in Europe	80
Figure 2.10.	Contour map of the third Principle Component the genetic analysis of populations in Europe	81
Figure 2.11.	Synthetic map of the first Principle Component values calculated from 95 gene frequencies in Europe	82
Figure 2.12.	Map showing the frequency & microsatellite Variance of haplogroup R1b1b2	83
Figure 2.13.	Hypothetical application of the Farmer Language Dispersal Hypothesis to the Neolithic Near East	84
Figure 2.14.	(a) The original wave of advance & (b) 'leapfrog' colonization	85

Figure 2.15. The distribution of 940 Early Neolithic sites, bounded by 250-year isochrones 86

Figure 3.0. Topographical map of Iran showing main geographical features 171

Figure 3.1. Soil map of Central Iranian Plateau 172

Figure 3.2. Distribution of Brown soils and Chestnut soils 174

Figure 3.3. Distribution of Sierozem soils 175

Figure 3.4. Distribution of Desert soils 176

Figure 3.5. Soil potentiality map for Central Iranian Plateau 177

Figure 3.6. Map showing the rivers of Iran 179

Figure 3.7. Map of River Karan 180

Figure 3.8. Mean annual amount of precipitation 1951-60 181

Figure 3.9. Mean annual range of temperature 1951-60 182

Figure 3.10. Types of vegetation 183

Figure 3.11. Design motifs from Sialk I Ware 184

Figure 3.12. Typical Sialk I 'Buff' Ware 185

Figure 3.13. Typical Cheshmeh Ali Ware 185

Figure 3.14. Design motifs from Cheshmeh Ali Ware 186

Figure 3.15. Map of Iran showing key Neolithic sites in Iran & surrounding areas 187

Figure 3.16. Contour plan of Hajji Firuz Tepe 188

Figure 3.17. Aerial view of Ganj Dareh under excavation in the 1970s 189

Figure 3.18. 1978 site plan of Tepe Abdul Hosein 190

Figure 3.19. Site plan of Ali Kosh 191

Figure 3.20. 1978 contour map of Chogha Bonut 192

Figure 3.21. View of Tol-e Baši with excavation in progress 193

Figure 3.22: Plan of Tol-e Baši & location of collection fields 194

Figure 3.23: General view of Tang-e Bolaghi 195

Figure 3.24: Satellite image of the area of TB75 & TB130 196

Figure 3.25: TB75 cave 197

Figure 3.26: Plan of TB75 198

Figure 3.27: Shelter of TB130 199

Figure 3.28 Shelter of TB130 199

Figure 3.29. Map of southern Turkmenistan 200

Figure 3.30. Sketch plan of Jeitun 201

Figure 3.31. Hotu & Belt caves as seen from the road 202

Figure 3.32. Site plan of Mehrgarh 203

Figure 3.33. Mehrgarh, areas MR 3 & MR 3/4, Periods IA-IIA 204

Figure 4.0 Childe's map of the spread of farming in Europe (Period I) 230

Figure 4.1. Childe's map of the spread of farming in Europe (Period II) 231

Figure 4.2. Map showing the spread of farming into Europe 232

Figure 4.3. Map to show the spatial distribution of Neolithic sites 233

Figure 4.4. Isochron map for the distribution of Early Neolithic sites 235

Figure 4.5. Distribution of Early Neolithic sites bounded by 250-year isochrones 236

Figure 4.6. Sites with references to (a) domestic hulled barley 10,000-6500 BC & 237
(b) domestic emmer/einkorn 10,000-6500 BC 238

Figure 4.7. General map of Eurasia showing simulated language distribution at time 0 239

Figure 4.8. Stimulated language distribution after 60 turns 240

Figure 4.9. Stimulated language distribution after 340 turns 241

Figure 4.10. Simulated language distribution after 2000 turns 242

Figure 4.11. Distribution of archaeological sites in the Mahidasht Project area containing pre-Bronze Age material 243

Figure 5.0. Distribution of sites ca. 10,000-8000 BC using 'clean' dates 306

Figure 5.1. Distribution of sites ca. 9000-8000 BC using 'clean' dates 307

Figure 5.2. Distribution of sites ca. 8000-7000 BC using 'clean' dates 308

Figure 5.3. Distribution of sites ca. 7000-6000 BC using 'clean' dates 309

Figure 5.4. Distribution of sites ca. 6000-5000 BC using 'clean' dates 310

Figure 5.5. Distribution of sites ca. 5000-4000 BC using 'clean' Dates 311

Figure 5.6. Distribution of sites ca. 10,000-9000 BC (no hygiene) 312

Figure 5.7. Distribution of sites ca. 9000-8000 BC (no hygiene) 313

Figure 5.8. Distribution of sites ca. 8000-7000 BC (no hygiene) 314

Figure 5.9. Distribution of sites ca. 7000-6000 BC (no hygiene) 315

Figure 5.10. Distribution of sites ca. 6000-5000 BC (no hygiene) 316

Figure 5.11. Distribution of sites ca. 5000-4000 BC (no hygiene) 317

Figure 6.0. Map of the Central Iranian Plateau showing sites 387

Figure 6.1. Topographic map of Fakrabad 388

Figure 6.2. Topographic map of Mafinabad 389

Figure 6.3. Topographic map of Mehedikani 390

Figure 6.4. Topographic map of Chakmahk Tepe 391

Figure 6.5. The south slope of Chesmeh Ali showing the beginning of excavation in 1934 392

Figure 6.6. Topographic plan of Cheshmeh Ali showing areas excavated by Schmidt's expedition 393

Figure 6.7. Topographic map of Cheshmeh-Ali showing areas excavated by Fazeli 394

Figure 6.8. Trenches E4-5 & H7 from the 1997 excavation at Cheshmeh Ali 395

Figure 6.9. East facing section of Cheshmeh Ali Trench H7 396

Figure 6.10. West facing section of Cheshmeh Ali Trench E4-5 397

Figure 6.11. General view of Tepe Pardis 398

Figure 6.12. Tepe Pardis, Trench I 399

Figure 6.13. Topographic drawing of the exposed north section of Tepe Pardis 400

Figure 6.14. North-south section & northern elevation of Tepe Pardis 401

Figure 6.15. Distribution of prehistoric sites on the Qazvin plain 402

Figure 6.16. Topographic map of Zagheh showing 2001 excavation areas 403

Figure 6.17. General view of Chahar Boneh 404

Figure 6.18. General view of Ebrahim Abad 405

Figure 6.19. Aerial view of Kashan Plain showing Tepe Sialk 406

Figure 6.20. Topographic map of Sialk North & South and the Sialk Rud 407

Figure 6.21. General view of Sialk North Mound 408

Figure 6.22. Contour map of Sialk North Mound 409

Figure 6.23. Cutting in Trench II, Sialk North 410

Figure 6.24a Section drawing of Sialk North, Trench 5 411

Figure 6.24b Section drawing of Sialk North, Trench 6 412

Figure 6.25. General view of part of the mudbrick 'fortification' wall 413

Figure 6.26. Map showing location of Tepe Shurabad 414

Figure 6.27. Tepe Shurabeh 415

Figure 6.28. General view of Ghabristan 416

Figure 6.29. Map of distribution of early farming settlements in Iran including the 'new' dates from the Central Plateau 417

Figure 7.0. Map of soil types of the Central Iranian Plateau showing key sites. 437

Figure 7.1. Map of source areas and prehistoric sites in Iran 439

Figure 7.2. Location of caravanserai in Central Iran 440

Figure 7.3. Distribution of caravanserai in eastern Iran 441

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Chapter One

Missing Links: Demic Diffusion and the Development of Agriculture in the Central Iranian Plateau

1.0. Introduction

The focus of this thesis, the origin and development of agriculture in the Central Iranian Plateau, has captured the imagination of innumerable scholars over the last three centuries (e.g. de Candolle 1884; Childe 1934; 1952; Braidwood 1950; Braidwood & Howe 1960; Binford 1968; Flannery 1969; Renfrew 1987; Renfrew & Bellwood 2002; Sherratt 1980; 2007; 2009; Zeder 2001; 2005; 2009). As early as 1884, Alphonse de Candolle identified southwest Asia, with Egypt, as one of the earliest centres of domestication in the world; a remarkable apt prediction considering he had no archaeological evidence with which to work. De Candolle's work heavily influenced that of later scholars, including Vere Gordon Childe (1934) who also claimed Egypt to be the homeland of agriculture; although he subsequently retracted this statement in the face of increasing evidence of early food production in the Near East (Childe 1952: 25-7). Today, it is generally accepted that agriculture first originated in the Fertile Crescent: the fertile soils and rivers that stretch in an arc from the Nile to the Tigris and Euphrates in western Asia (e.g. Brown et al. 2008; Fuller et al. 2010; Zeder & Smith 2009; Nesbitt 2002). However, where exactly and whether one or multiple domestication centres for each species were involved, remains contested (Alizadeh 2003: 10).

The prevailing model for the spread of agriculture is Ammerman and Cavalli-Sforza's (1984) 'Wave of Advance'. The 'Wave of Advance' rests on two main assumptions: that growth occurs in a logistic manner; and that migrationary activity takes place at a constant rate in time and space, and according to a random walk process (Ammerman & Cavalli-Sforza 1984: 68). From these premises, Ammerman and Cavalli-Sforza predicted that a 'wave front' would

form at the periphery of the spread of farming and keep advancing at a constant rate, which they calculated from the radiocarbon (hereafter ^{14}C) dates of early agricultural sites in Europe to be 1-kilometre per year, or 25 to 30-kilometres per generation (Ammerman & Cavalli-Sforza 1971: 685).

While Central and Western Europe has seen a deluge of archaeological research, particularly in the latter half of the twentieth century, the development of agriculture in Central and Southern Asia has received little attention. Indeed, the region has generally been portrayed as "a backwater sitting on the sidelines" (Zeder 2008b: 245). Ammerman and Cavalli-Sforza specifically applied the Wave of Advance to the western spread of agriculture across Europe, and while adaptations of the model have been applied to the eastwards spread of farming (e.g. Renfrew 1987; Renfrew & Bellwood 2002; Bellwood 2005), they have never been formally tested. Attempts to understand the development of agriculture in central and southern Asia are further complicated by the Early Neolithic (ca. 7000-5500 BC) levels at Mehrgarh, western Baluchistan (Jarrige et al. 1995), which evidence the on-site domestication of sheep, cattle and possibly goats (Meadow 1981: 152; 1984: 37-40; Meadow & Patel 2002: 396); and the presence of locally domesticated barley (Constantini 1984: 29-30; Jarrige et al. 1995: 64). Significantly, small amounts of domesticated wheat were also recovered, which were probably introduced in an already domesticated form from outside the region (Meadow 1996: 395). No precedents for Mehrgarh are known within Southern Asia; nor, does it seem possible that agriculture could have spread this quickly to the site by a Wave of Advance from the west: more than 3500 kilometres separates Baluchistan from the Fertile Crescent, a distance over which, by Ammerman and Cavalli-Sforza's (1971: 685), calculations, farming would have taken approximately 3500 years to spread. The presence of Mehrgarh, thus, presents an enigma in our current understanding of the origins and spread of agriculture.

If, as Renfrew (1989: 149) suggests, agriculture did spread to Mehrgarh from the Fertile Crescent, then the development and spread of agriculture in Iran would have played a pivotal role in this process. Early farmers would need to

have crossed, or the idea of farming would have had to of spread, over Iran to reach Baluchistan. The Iranian Neolithic, then, potentially holds the key to our understanding of the development and spread of farming in South Asia. This research focuses on the origins and development of agriculture in Iran by specifically focusing on the Central Iranian Plateau, a region that has received little archaeological attention, despite its potential importance (Hole 2004). To date, no Early Neolithic (ca. 8000-6500 BC) or Middle Neolithic (ca. 6500-6200 BC) sites are known in this region, and "one of the key archaeological problems with the Central Iranian Plateau is the lack of evidence for the…Early Neolithic period" (Fazeli et al. 2007: 7).

1.1. Aims and objectives

In view of the above lacuna, the aim of this research is to establish whether there were any Early to Middle Neolithic period (ca. 8000-6200 BC) settlements on the Central Iranian Plateau. The objectives of this research are to: (1) review models for the sequential Neolithic occupation of Iran; (2) analyse published material on the Early Neolithic (ca. 8000-6500 BC) of Iran and neighbouring regions; (3) recalibrate and evaluate the 'chronometric hygiene' (Spriggs 1989) of published ^{14}C determinations for Neolithic sites in Iran and neighbouring regions; (4) spatially plot the 'cleaned' ^{14}C determinations onto a geographic map of Iran; and (5) review the data from recent fieldwork – including my own research – on the Tehran, Qazvin and Kashan Plains. The impact of this research is that it will provide a fresh perspective on the Neolithic of Iran, and its potential influence on South Asia. Many of the ^{14}C determinations of sites in Iran were measured in the formative years of the ^{14}C process, and have not been calibrated using the latest calibration curves. The age of the ^{14}C measurements also means that many of the determinations are unacceptable by present-day standards. Indeed, Paul Pettitt (2003) advises that one should have "little confidence" (Pettitt et al. 2003: 1698) in any ^{14}C determination that was measured before 1970. Assessing the chronometric hygiene of the ^{14}C measurements used in this research, allows for the rejection of those ^{14}C dates that are unacceptable by

modern standards, whilst allowing for the inclusion of those that are reliable enough to be used without further questioning. This research also presents new data from fieldwork on the Central Iranian Plateau, including my own survey and excavation work on the Kashan Plain. Such research is essential in improving our understanding of the development and spread of agriculture in this potentially important region. With many of the archaeological sites in the region under threat from industrial and urban expansion (cf. Coningham et al. 2004), it is also of the utmost priority that this research takes place now, before this invaluable resource is destroyed. A greater knowledge of the Neolithic of the Central Plateau will also further elucidate our understanding of the possible eastwards spread of agriculture to South Asia, and to identify potential flaws in our current understanding.

1.2. Overview of research

The structure of this thesis is as follows. The purpose of this chapter was to introduce the research themes, aims and objectives of this thesis. Chapter Two investigates the history of the study of the development and spread of agriculture in Eurasia over the last three centuries, and considers the strengths and weaknesses of the prevailing theories. Chapter Three provides a background to the environmental and geographical contexts of Iran, and contains a detailed study of the key Neolithic sites in the region, which include: Hajji Firuz (Voigt 1983), northwestern Iran; Tepe Sarab, Tepe Asiab (Braidwood 1961; Braidwood et al. 1961), Ganj Dareh (Smith 1967; 1968; 1970; 1972a; 1972b; 1974; 1975; 1976) and Tepe Abdul Hosein (Pullar 1990) in the foothills of the Zagros Mountains; Ali Kosh (Hole et al. 1969) and Chogha Bonut (Alizadeh 2003) in the southwestern lowlands; Tall-e Mushki and Tall-e Jari (Alizadeh et al. 2005) on the Marv Dasht Plain; Sang-e Chakmaq (Thornton 2010), northeastern Iran; Jeitun, southern Turkmenistan (Harris et al. 2003; Harris 2010a); and Mehrgarh (Jarrige et al. 1995, 2005), western Baluchistan. Chapter Four discusses the aims and objectives of this research, and the methodology which will be used to attain them. Chapter Five contains the reanalysis of existing ^{14}C determinations for Neolithic sites

in Iran and neighbouring region. The dates are recalibrated using the latest version of the calibration software OxCal (Brook Ramsey 2009); and assessed for their chronometric hygiene, in order that only those determinations deemed "reliable enough to be used…without further questioning" (Pettitt et al. 2003: 1690) are incorporated in this research. Such an analysis has never been undertaken before for the ^{14}C dates for Iran, and is desperately needed in order to produce a database of verified determinations for the Iranian Neolithic. Chapter Six is a synthesis of the results of recent archaeological research on the Central Iranian Plateau within the Tehran, Qazvin and Kashan plains (e.g. Fazeli 2001; Coningham et al. 2004; 2006; Fazeli et al. 2004; 2005; 2009), including previously unpublished data from fieldwork on the latter. In Chapter Seven, the results from the two main focuses of this research – the re-calibration and cleaning of the ^{14}C dates for Neolithic Iran, and the findings from new fieldwork on the Central Plateau – are discussed. Chapter Eight draws together the different themes of this research and the conclusions that can be made, and outlines future research prospects.

1.3. Conclusion

In this introductory chapter, the aims and objectives of this thesis have been presented, and the range of data sources that will be used identified. These include: the analysis of existing information on the Neolithic of Iran; the re-analysis of existing ^{14}C determinations for Iranian sites through their recalibration and 'cleaning'; and the results from recent fieldwork on the Central Iranian Plateau, including previously unpublished data from the Kashan Plain. Various theoretical approaches are examined in this research, and this data will be interpreted accordingly. By the utilization of both new and old data, and temporal and spatial perspectives, this research presents an original study of the Neolithic of the Central Iranian Plateau, which is invaluable in informing us of the development and possible spread of agriculture in this hitherto poorly-studied region.

Chapter Two

The Agricultural Transition

"Food-production – the deliberate cultivation of food plants, especially cereals, and the farming, breeding, and selection of animals – was an economic revolution – the greatest in human history after the invention of fire."
(Childe 1934: 42)

2.0. Introduction

No study of the Neolithic of Iran would be complete without first considering how the origins and spread of agriculture has been perceived over time, and the prevailing theories of today. For some 85 per cent of their history, humans have subsisted on wild resources, then, at the end of the Pleistocene (ca. 8500 BC), food production emerged independently in a number of regions (Diamond 2002: 705). Since then, food production has spread, and today almost the entire world population is dependent on domesticated food resources. The questions of why and how this major transition, coined by Gordon Childe the "agricultural revolution" (1934: 74), occurred has intrigued scholars for over 300 years, and an enormous literature exists on the subject. Due to the limited archaeological research that has taken place in Iran, most of our knowledge of the origins and development of agriculture comes from the regions immediately to the west of Iran: modern-day Iraq, Syria and Turkey. This is the information, then, that is primarily utilized in this chapter, although wherever possible, reference to Iranian sites is made.

Before any models for the development and spread of agriculture are considered, it is necessary to define the terms 'domestication', 'cultivation', and 'agriculture'. In this research, 'domestication' is defined as an evolutionary process in which human cultivation/tending of plant and animal species lead

to morphological and physiological changes, that distinguish domestic taxa from their wild ancestors (Diamond 2002: 700; Zeder 2006a: 115; Purugganan & Fuller 2009: 843). This process creates an "increasingly mutual dependence between human societies and the plant and animal populations they target" (Zeder et al. 2006: 139). Cultivation itself, involves the manipulation of the soil and vegetational environment, and cycles of harvesting and storage, which exerts selective pressures for recurrent adaptations on the part of the cultivated species (Allaby et al. 2008; Fuller et al. 2010; Purugganan & Fuller 2009). It can be argued that cultivation is a human, and thus conscious, activity; whilst domestication consists of genetic and morphological changes within the taxa that people cultivate (Bellwood 2005: 13; Fuller et al. 2010: 14). Agriculture is understood as the practice of cultivating the ground, including: the harvesting of domesticated crops; the rearing and management of livestock; and the processing of agricultural produce (Bellwood 2005: 13; van der Veen 2010: 2).

2.1. What's in a name? – The 'Neolithic' and 'Mesolithic' defined

The term 'Neolithic' was originally used by Sir John Lubbock (1865: 2-3) in the mid-nineteenth century to distinguish the 'New' from the 'Old' Stone Age. Lubbock associated the Neolithic with modern fauna, cereal cultivation, animal husbandry and technical advances such as polished stone and pottery. However, it was Gordon Childe (1925) who first used the term to refer to a distinct agricultural economy. In so doing, Childe transformed the 'Neolithic' from an "explicitly chronological and evolutionary phenomenon…to a socio-economic phenomenon" (Zvelebil 1998c: 1); and it is due to Childe's legacy, that the 'Neolithic' is often perceived as synchronous with the introduction of farming. More recent scholars have also stressed the ideological significance of the Neolithic (e.g. Hodder 1990; Pluciennik 1998; Thomas 1998; Sherratt 2003), perceiving the Neolithic as a 'conceptual', rather than 'economic' phenomenon. Others have argued that there were many different 'Neolithics', and that the 'Neolithic' was not a static entity held constant in time and space (e.g. Thomas 1998; Sherratt 2003; Robb & Miracle 2007). Indeed, it is

recognized that the ‘Neolithic’ is a product of archaeological thinking, a tool for understanding and interpreting the past, which has too often solidified into something real. After all, how many people living in the Neolithic would have considered themself to be ‘Neolithic’?

The term Mesolithic arose to describe what was perceived as a hiatus between the Palaeolithic and the Neolithic (Zvelebil 1998c: 2). As a chronological period, the Mesolithic was first introduced by Hodder Westropp (1872 in Nicholson 1983) to denote the intermediate flint assemblages between the ‘Old’ and ‘New’ Stone Ages. However, it was not recognized as a distinct period until the 1930s; the reason for the reluctance to accept the term laying with its non-conformity with the prevailing social-evolutionary views (Zvelebil 1998b: 3). On a social-evolutionary scale, which should only have showed improvement, the Mesolithic was perceived as representing a period of decline. This view continued throughout the twentieth century, leading Richard Bradley to comment that, “in the literature as a whole successful farmers have social relations with one another, whilst hunter-gatherers have ecological relationships with hazelnuts” (1984: 11), and it was not until the 1980s that the importance of the Mesolithic as a period in its own right began to be recognized (e.g. Bradley 1984; Zvelebil & Rowley-Conwy 1984; Pluciennik 1998; Zvelebil 1998a).

Some scholars (e.g. Sherratt 2003; Boric 2005) have gone as far as to stress that the Mesolithic and the Neolithic were not two distinct entities at all, but a continual temporal sequence which scholars have categorized and labeled in order to better study. However, for the clarity of this research a distinction, no matter how arbitrary, needs to be drawn, for “regardless of their provisional and arbitrary invention, the terms Mesolithic and Neolithic have become the theoretical currency for debate of Mesolithic–Neolithic archaeology” (Boric 2005: 17). Due to the economic focus of this thesis the ‘Neolithic’ will be understood as a chronological phase where early food production was practiced, which developed out of – although was not a necessary outcome – of the ‘Mesolithic’, a period principally defined by a hunting and gathering

economy. However, it is recognized that the boundary between the two 'periods' was not fixed, but was fluid and permeable.

2.2. The origins of food production

One of the earliest attempts to study the origins of domestication was that of Alphonse de Candolle (1884), who identified that certain conditions were needed to make plant domestication successful including, "that such or such a plant, offering some of those advantages which all men seek, must be within reach…a not too rigorous climate; in hot countries, the moderate duration of drought; some degree of security and settlement; lastly a pressing necessity" (de Candolle 1884: 2). De Candolle's conditions were remarkably apt for their time and, indeed, can still be found echoed in the work of modern scholars. Joy McCoriston and Frank Hole, for example, advocated that, "the impetus for domestication came from the synergistic effects of climate change, anthropogenic environmental change, technological change, and social innovation" (1991: 46).

To locate the heartland of domestication, de Candolle (1884: 18) combined the available information from botany, palaeontology and historic sources, to identify Southwest Asia, with Egypt, as one of the earliest centres of domestication in the world. De Candolle's work greatly influenced that of subsequent scholars including Vere Gordon Childe (1934), who following de Candolle, proclaimed Egypt to be the homeland of agriculture; although in light of increasing evidence of the early development of food production in the Near East he was later to retract this statement (Childe 1952: 25-7).

Robert Braidwood (1960a, 1960b, 1960c, 1961; Braidwood & Braidwood 1950; Braidwood & Howe 1960) was the first archaeologist to explicitly test in the field the origins of agriculture, by excavating at Jarmo, Iraqi Kurdistan, with a multidisciplinary team of scientists for three seasons, between 1948 and 1955. His findings led him to suggest that plant domestication first occurred in the "hilly flanks" (Braidwood & Howe 1960: 131) of the Fertile

Crescent, one of the natural habitats of modern wheat and barley (Fig. 2.0). Braidwood's hypothesis has since been repudiated (Binford 1968; Higgs & Jarmon 1969; Redman 1978: 98). Higgs and Jarmon, for example, argued that it was "absurd to look for a beginning of agriculture in a particular area" (Higgs & Jarmon 1969: 40), and posited instead that domestication events occurred many times over a large area, with the Near East representing the place "where different agricultural techniques collected together and integrated"(ibid.: 40).

Lewis Binford (1968: 328) suggested that, rather than in the heart of the natural habitat zone of domesticates, domestication took place at the edge of the nuclear zone, where resources were scarcer; a view that was also held by Kent Flannery (1969; 1973). In the 'marginal zone' hypothesis, Flannery argued that farming did not begin in the optimal areas of wild cereal growth, where botanical experiments have shown that wild wheat can do as well as in a cultivated field (Zohary & Harlan 1966: 1079), but around the margins, where it was necessary to raise the food capita of the land. Flannery (1969: 74) believed that animal domestication was subsequent to that of plants, and represented a way of banking the unpredictable surpluses from cereal cultivation in live storage. The marginal zone hypothesis has been informative in focusing research, however, as Flannery himself emphasized, it is only a hypothesis and, "although it has won an almost frightening acceptance among some of my colleagues it is still unproven and highly speculative" (1973: 284). More recent work has shown that the situation was more complex than the marginal zone hypothesis allowed for. It is now known that the limit of the nuclear zone, which itself moved over time in response to climate change (Bar-Yosef & Meadow 1995: 45), originally included areas that now lie outside it, and early farming villages are distributed throughout the whole of the nuclear zone, and not just on its fringes (Bar-Yosef & Meadow 1995: 65-6; Cauvin 2000: 106). Other authorities, including Joy McCoriston and Frank Hole (1991) and A.M.T. Moore & Gordon Hillman (1992) have argued that due to the period of cooling associated with the Younger Dryas (ca. 10,000-9600 BC) climatic episode, the highlands of southwestern Iran were cold, dry and mostly uninhabited between 10,0009000 BC, and domestication took place in

the lowlands of the Levantine Corridor. McCoriston and Hole (1991: 46), for example, placed the origins of agriculture in the Jordon valley and the surrounding regions of the southern Levant, whilst Moore and Hillman (1992: 491) have argued that the development of agriculture occurred at relatively few large sites, located in areas with rich soils and ample surface water, such as Abu Hureyra.

Since then the spot light has shifted to the Fertile Crescent, especially the upper reaches of the Tigris and Euphrates Rivers, which appear to be the homeland of initial domestication of a number of founder crops, e.g. einkorn, emmer and pulses (Hillman 2000; Lev-Yadum et al. 2000); and three, if not four, livestock species (sheep, pig, cattle & possibly goat; Zeder 1995, 2005; Horwitz et al. 1999; Peters et al. 1999; Horwitz 2003).

The most recent genetic and archaeobotanical evidence (e.g. Tanno & Willcox 2006a, 2000b; Weiss & Zohary 2011; for overview see Zeder 2011) paints a much less focused, more diffuse picture of agricultural origins. The emergence of agriculture in the Near East now seems to have been a pluralistic process with initial domestication of various crops and livestock occurring, sometimes multiple times in the same species, across the entire region (Zeder 2011: 230).

2.2a. Plant domestication

Archaeological evidence

Eight plant species are generally recognized as constituting the founder crops domesticated in the Fertile Crescent: three cereals – diploid einkorn wheat (*Triticum monococcum*), tetraploid emmer wheat (*T. dicoccum*) and barley (*Hordeum vulgare*) – two pulses – lentil (*Lens culinaris*) and pea (*Pisum saivum*) – flax (*Linum usitatissimum*), bitter vetch (*Vicia ervilia*) and chickpea (*Cicer areitinum*) (Zohary 1996: 143-4). To this list possibly could be added faba bean (*Vicia faba*) (Brown et al. 2008: 105). At the turn of the last century, when archaeobotanical research in the Near East was still relatively limited, it

was generally held that the domestication of each of the Fertile Crescent founder crops occurred only once, in a limited area of the Fertile Crescent (e.g. Heun et al. 1997; Lev-Yadum et al. 2000; Gopher et al. 2002). Lev-Yadum, for example, claimed, based on the restricted distribution of modern wild chickpea, that all of the main founder crops of the Near East were domesticated within a single small area of northern Syria and northeastern Anatolia (Lev-Yadum et al. 2000: 1062-3). It was also the common contention that domestication – in terms of the development of morphological traits – was a rapid event, which was initiated and completed in the brief period that marked the Pleistocene/ Holocene transition (Blumer 1992: 101; Diamond 1997: 1243; McCoriston & Hole 1991: 58; Zohary 1992: 84). For instance, Jared Diamond advocated, "that at most a few centuries were required for the transition from hunter-gatherer villages harvesting wild plants to farming villages planting fully domesticated crops" (1997: 1244), whilst Hillman and Davies suggested, based on a computer simulation, that "…domestication could be achieved within 20-30 years" (Hillman & Davies 1990: 189, 191).

With the growth of quantitative archaeobotanical evidence in the last decade, both of these contentions have been challenged. Monophyletic models for the origin of crop domestication have been questioned by a growing body of research, that has emphasized the complexity of the processes that preceded and accompanied the development of plant domestication (Brown et al. 2008: 105; Purugganan & Fuller 2009: 845; Fuller et al. 2010: 17). 'Hard' domestication traits e.g. non-shattering in cereals and increased size and loss of germination inhabitation in seeds, are generally used as indicators of cultivation because they are the least ambiguous (Balter 2007: 1832; Brown et al. 2008: 105; Fuller et al. 2010: 14). However, archaeological remains indicate that the fixation of these morphological traits was a "slow process" (Purugganan & Fuller 2009: 843) with, for example, the fixation of non-shattering rachises perhaps taking 3000 years or more (Tanno & Willcox 2006b: 1886). Thus, instead of a starting point, we need to see these morphological changes as "a result…in what was likely a long chain of innovations that constitutes a domestication pathway' (Fuller et al. 2010: 14). Domestication, therefore, rather than the 'event' it has originally been

perceived as (e.g. Hillman & Davies 1990; Diamond 1997), should be considered to have been “a protracted and biologically complex process” (Brown et al. 2008: 104).

Arguably, the earliest evidence of plant domestication in the Near East comes from Abu Hureyra, Syria, where a few reportedly ‘domesticated’ grains of rye have been identified from Epipalaeolithic levels (ca. 11,000-10,000 cal BC) (Hillman 2000: 376). However, the domestic status of the rye is controversial (Nesbitt 2002: 120), and even if the rye were domesticated, “it does not seem to have made much of a mark on Near Eastern subsistence economies” (Zeder 2011: 224). Indeed, domesticated rye is not seen in the region again for another 2000 years, where it is found in low numbers in central Anatolia at Can Hassan II (Hillman 1978), and it was never a prominent component of the Neat Eastern cereal crops (Zeder 2011: 224).

The first securely identified and dated evidence of domesticated plants in the Near East, is not found until the Early Pre-Pottery Neolithic B (PPNB) (ca. 8,500-8,200 cal BC), where domesticated emmer (*Triticum turgidum* spp. *dicoccum*) and einkorn (*T. monoccocum*) has been reported from Navali Çori, Cafer Höyük and possible Cayönü, in the Upper Euphrates Valley (Tanno & Willcox 2006b: 1886); while the first firm evidence of domesticated barley does not occur until the Middle PPNB (ca. 8000 cal BC), at which time it is recovered from sites throughout the Fertile Crescent and Central Anatolia (Nesbit 2002). Additional evidence for the late, or at least delayed, appearance of morphologically domestic cereals in the Near East comes from Tanno and Wilcox (2006b), who document the gradual increase in the proportion of tough-rachis domestic morphotypes among wheat and barley recovered from sites in the Middle and Upper Euphrates.

Substantial quantities of lentils have been recovered from PPNA sites (ca. 8500-7600 BC) in both the southern and northern Levant. Wild lentils are not a common component of Near Eastern plant communities, and Weiss et al. (2006) and Tanno and Willcox (2006b) suggest that the hundreds of lentils found in storage bins at site such as Netiv Hagdub and Jerf el Ahmar, are

unlikely to be from wild, unmanaged plants (see also Weiss & Zohary 2011). Similarly, Tanno and Willcox (2006b) report that the large numbers of chickpeas (*Cicer* sp.) recovered from Tel el-Kerkh (ca. 8200 cal BC), northwestern Syria, represent an early stage in the cultivation of this well-known Near Eastern crop plant (Zeder 2011: 225).

Kislev et al. (2006) argue that the earliest morphologically altered plant domesticate in the Near East was neither a cereal nor a pulse but the fig. They interpret the presence of parthenocarpic figs, a mutant, infertile variety that remains on the tree longer & develops sweeter, softer fruit (Zeder 2011: 225), at the PPNA site of Gigal in the southern Levant (ca. 9400-9200 cal BC), as a clear indication of human selection. The domestication of parthenocarpic figs, they maintain, could be accomplished by replanting cut branches of trees that naturally produce these sweeter fruits.

Refinement in archaeobotanical identification criteria has provided another source of evidence for multiple domestications of the 'same' (or similar) crops, although not all of the taxa have survived (Fuller 2007: 908). It is possible on the basis of grain shape, to distinguish einkorn wheat with single-grained spikelets (*T. boeoticum* subsp. *Aegilopodes*) from einkorn with two-grained spikelets (from wild *T. b.* subsp. *thaudor* or *T. urartu*), suggesting at least two independent domestications of einkorn (ibid.). Modern domesticated einkorn (*T. monococcun*) is normally only one grained, but archaeobotanical evidence indicates the presence of two-grained forms from the Late Pleistocene at the Syrian sites of Mureybet, Jerf el Ahmar and Abu Hureyra, and later as a domesticated cereal in Syria, Turkey, and into Neolithic Europe, although it subsequently disappears from Europe (Willcox 2005: 537). This implies an additional two-grained einkorn domestication, although this crop went extinct in prehistory (Fuller 2007: 908).

Prior to the appearance of morphological traits of domestication, plants can be considered to be under 'pre-domestication' cultivation (Colledge 1998; 2002); a condition which may have lasted for hundreds, if not thousands, of years before the manifestation of morphologically indicators of plant domestication

(Piperno et al. 2004: 670; Willcox & Tanno 2006b: 1886; Balter 2007: 1831; Fuller 2009: 904; Zeder 2011: 231). For example, the presence of distinctive complexes of weedy species characteristic of fields under human cultivation, suggest that humans were actively tilling and tending wild stands of einkorn and rye at both Abu Hureyra and nearby Mureybit during the Late Epipalaeolithic (ca. 11,000-10,000 cal. BC) (Colledge 1998; 2002; Hillman 2000: 378). Increases in this weed complex at the PPNA sites of Qarmel (ca. 9500 cal BC) and Jerf el Ahmar (ca. 9000 cal BC), indicates an intensification of plant cultivation in the ensuing period (Willcox et al. 2008). The antiquity of broad-spectrum plant-exploitation stretches back even further, to at least the Late Glacial Maximum (ca. 21,000 cal BC) (Zohary 2011: 225), where it is evidenced by the remarkably well-preserved plant assemblage recovered from water-logged deposits at the Levantine site of Ohallo II, which contained a diverse array of large- and small-seeded cereals and legumes (Piperno et al. 2004).

The delayed expression of domestication-induced morphological changes in managed plants (at 8500-8000 cal BC in cereals & later still in pulses; Zeder 2011: 226) may be attributed to the frequent importation of new wild plants when cultivated crops failed (Tanno & Willcox 2006b: 1886). It is also possible that the harvesting practise of early farmers did not encourage the morphological changes in cereal dispersal mechanisms, which have traditionally been interpreted as markers of domestication (Zeder 2011: 226). For example, farmers harvesting cereals before they were fully ripe and/or collecting shattered heads of grain from the ground, might have led to the retention of the brittle rachis in cultivated cereals (Willcox & Tanno 2006: 296). Melinda Zeder suggests that the appearance of morphological change, rather than being a cutting-edge indicator of domestication, is “most likely an artefact of a change in management or harvesting practises of cultivated crops” (Zeder 2011: 226), that may occur hundreds of years after plants were first brought under human control. The total time length for which pre-domestication occurred before the appearance of morphological changes in the Near Eastern founder crops, remains unclear (Fuller et al. 2010: 17; Zeder 2011: 230). Dorian Fuller et al. (2010: 18) infer, from archaeobotanical

remains of weed flora in the Near East, an extended period of perhaps two or more millennia of cultivation prior to the start of the recognizable selection for morphological traits of domestication.

Genetic evidence

A modern crop is a relatively recent descendant from the wild populations from which it derived, thus, comparison between the genotypes of modern crop varieties and landraces of wild populations, should indicate which wild populations were ancestral to the crop (Brown et al. 2008: 106). The earliest work on the genetics of plant domestication was conducted in the 1990s, when the "genetics behind this issue [were] a little clouded" (Bellwood 2005: 49). Multilocus analysis was first applied to einkorn wheat by Heun et al. (1997) who, through the typing of 288 amplified fragment length polymorphism (AFLP) in 338 wild and cultivated accessions, were able to construct phylogenetic trees from the AFLP data, which showed domestic einkorn to be monophyletic (Heun et al. 1997: 1313), i.e. all modern crop plants shared a common descendent from a single progenitor population of early domesticates (Brown et al. 2008: 106). Based on the general similarities between the early domesticates and wild plants from the Karacadağ Mountains, Heun et al. suggested that this region was "the very probable site of einkorn domestication" (Heun et al. 1997: 1313). Heun et al.'s findings were supported by the archaeological record, as only a few kilometres from the Karacadağ Mountains lie archaeological sites (e.g. Navali Çori & Cafer Höyük) that have yielded some of the earliest evidence of single grained einkorn domestication (Zeder 2011: 288).

Subsequent study by Kilian et al. (2007), however, contends that the wild race named by Heun et al. as ancestral to all modern populations, is instead a closely related sister group. Kilian et al. maintain that this more distant relative, and the high level of genetic diversity evidence in domestic einkorn, argues against a monophyletic origin. Instead, they propose a 'dispersed specific model', in which multiple local populations of the originally more widely dispersed sister race of wild einkorn, were taken under cultivation and eventually domesticated multiple times by communities across a broad area

(Kilian et al. 2007: 256-7). This model is more in line with current archaeological evidence, which shows that multiple sites from southeastern Turkey to the Middle Euphrates were involved in a protracted process of cultivation of both local and imported wild progenitors of later crops (Zeder 2011: 288).

Earlier genetic analyses of domestic emmer were also interpreted as demonstrating the monophyletic origin of the plant, with Őzkan et al. (2002) believing the closest living wild populations of emmer to occur in the same region of the Karacadağ as Heun et al. (1997) identified as the homeland of einkorn domestication. Subsequent studies, however, suggest that at least two separate domestications occurred (Brown et al. 2008: 107), although the geographic distance and degree of cultural independence between these events is unclear (Zeder 2011: 229). More recent work by Őzkan and colleagues (Őzkan et al. 2005; see also Őzkan et al. 2010) led them to suggest that, as well as the major domestication event at Karacadağ, a secondary domestication event of a population near the Kartel Mountains, 300 kilometres to the west of Karacadağ, occurred (Őzkan et al 2005: 1058-9). There is also some indication that populations in Iran and Iraq may have contributed to the gene pool of domestic emmer (Őzkan et al. 2005: 1057). Luo et al. although concurring with Őzkan et al. (2005) that einkorn was first likely to have been domesticated in southeast Turkey, propose that there was a subsequent hybridization and introgression into domestic emmer from wild emmer in the southern Levant (Luo et al. 2007: 957).

Initial indicators of a single domestication of barley in the Jordan Valley (Badr et al. 2000) have also been revised to include a second domestication of this crop (Molina-Cano et al. 2005; Morrell & Clegg 2007). Molina-Cano et al.'s work on chloroplast-based cluster analysis indicates that modern barley landraces fall into at least two genetically and geographically distinct groups, leading them to conclude that barley was probably independently domesticated in the subregions of the Fertile Crescent, the western Mediterranean and Ethiopia (Molina-Cano et al. 2005: 617). Subsequent work by Morrell and Clegg, involving a more extensive resequencing of 18 loci

containing 684 polymorphisms, indicates that barley was probably domesticated not only in the Israel-Jordon region, but also in a region to the east of the Fertile Crescent, possibly in the western foothills of the Zagros Mountains (Morrell & Clegg 2007: 3291).This corresponds well with archaeological evidence of domesticated barley at Zagros sites at about 8000 BC (Zeder 2011: 229).

Lev Yadum et al. (2000) have proposed a model for a single centre of origin of agriculture, based on the modern-day limited distribution of chickpeas. However, chickpeas are evidenced at Early PPNB sites lying outside their area of natural distribution today (e.g. Tel el-Kerkh) suggesting that their distribution in the past was greater than that of today (Tanno & Willcox 2006a: 197). This conclusion is supported by the genetic evidence, which indicates that the modern wild chickpea populations that are genetically closest to domestic chickpeas are found growing at the far western end of the current distribution of this plant in southern Turkey, close to Tel el-Kerkh (Sudupak et al. 2004). Genetic evidence also points to the initial domestication of lentils in southeast Turkey/northern Syria (Ladizinsky 1989), where there is early evidence for the initial chickpea cultivation.

2.2b. Animal domestication

Early research on the origins of agriculture focused on the highland valleys and piedmont flanks of the Zagros Mountains, as the likely heartland of both plant and animal domestication (Braidwood & Howe 1960; Braidwood et al. 1983; Hole et al. 1969). It was demonstrated that animals were domesticated as least as early as plants in the Zagros, and perhaps slightly earlier, in the context of semi-sedentary communities centred on the intensive utilization of wild plants and animals (cf. Hole 1996). After the 1970s, the geographic focus of the study of agricultural origins in the Near East shifted to the southern and northern Levant in the western arm of the Fertile Crescent (Zeder 2008a: 245). Here, it seemed that plant domestication occurred at least 1000 years earlier than in the Zagros, and that animal domestication was a delayed and

subsequent development, occurring more than 1000 years after the initial plant domestication (Bar-Yosef & Meadow 1995: 82, 91). There is still no consensus on where initial animal domestication took place (Zeder 2008a: 245). Both the southern and northern Levant, and southeastern Anatolia have been argued as likely homelands for the domestication of different livestock species (Bar-Yosef 2000b: 195; Horwitz 2003: 20; Horwitz et al. 1999: 76-7; Legge 1996: 259; Peters et al. 1999: 43), while more recent researchers have returned to the Zagros region (e.g. Peters et al. 2005; Zeder 2001b; 2006b; 2008; 2009; Zeder & Hesse 2000).

Archaeological evidence

Until the late 1990s, archaeozoologists relied on morphological changes in target species to identify where and when wild animals were transformed into herded livestock (Zeder 2006a: 171-4; 2008b: 11597). One of the most widely accepted morphological markers of domestication was a sharp and overall rapid reduction in body size (Uerpmann 1978; Meadow 1989b: 82-7; Bar-Yosef & Meadow 1995: 86). On the basis of reduction in body size, the established consensus was that the domestication of goats occurred between the late tenth to early ninth millennium BC, while sheep were domesticated somewhat later, after the first quarter of the ninth millennium BC (Bar-Yosef & Meadow 1995: 89-90). However, the utility of size reduction, and indeed of all morphological markers of domestication, is questionable (Zeder 2006: 189). Through a comprehensive analysis of archaeological and modern collections of sheep and goat skeletal remains from the Near East, Melinda Zeder and Brian Hesse (2000) were able to show that sex and, to a lesser extent, temperature, are the most important factors affecting the body size in sheep and goats. Domestic status, on the other hand, has no effect on the size of female caprines and only a limited effect on males, manifested as a decrease in the degree of sexual dimorphism (Zeder 2001; 2005). This work has also shown that apparent evidence of domestication-induced body size reduction in Near Eastern archaeological assemblages is not, as has been assumed, the result of a morphological response to human control. Instead, the apparent shift towards smaller animals is “an artefact of the different culling strategies employed by hunters…and herders” (Zeder 2011: 226). Hunters’

aim to maximise the return of the hunt, often results in an archaeological assemblage dominated by prime-age males, while herders, who seek to maximize the long-term yield of the herd, cull younger males and females who have passed peak reproduction (Zeder 2008a: 11597). Due to various taphonomic factors and methodological practises, the herder's harvest strategy produces an archaeological assemblage dominated by smaller adult females (Zeder 2001; 2008; 2011). Zeder, thus, advocates that instead of morphological markers, harvest profiles of male and female animals should be used to document domestication (Zeder 2008a: 11597-8).

Morphologically unaltered, but clearly managed, goats are first seen in their natural habitat at the highland site of Ganj Dareh, central Zagros, around 8000 cal BC (Zeder 2008a: 265; 2011: 226), and are evidenced at lowland sites (e.g. Ali Kosh; Hole et al. 1969), outside the natural habitat of wild goats, around 500 years later (Zeder 2008a: 254). Precisely where in their natural habitat region goats were first domesticated remains hard to say, although emerging archaeological evidence strongly suggests that it took place somewhere between Nevali Cori and Ganj Dareh in the northwestern Zagros/eastern Taurus region (Zeder 2008a: 265).

Sheep domestication appears to have followed a different trajectory. Recent evidence from southeastern Anatolia suggests initial sheep domestication took place somewhere in the upper reaches of the Euphrates and Tigris valleys around 8500-8000 cal BC (Zeder 2008a: 265). However, well-documented domesticated sheep do not appear in the central Zagros until at least 1000 years later, where they are evidenced at the Early Pottery Neolithic (hereafter PNL) sites of Tepe Guran, Sarab and Jarmo ca. 5900 BC (Zeder 2008a.: 265). Earlier evidence of sheep domestication in the highlands of the Zagros Mountains is possibly represented by the unusual demographic profile of sheep from Zawi Chemi Shanidar (ca. 9000 cal BC) (Perkins 1964), but this remains contested (Zeder 2008a: 261; 2008b: 11597; 2011: 227)

Herded sheep are not evidenced at lowland sites in Iran until about 6000 cal BC, where they are seen at Farukhabad, Sharafabad, Chogha Sefid and Ali

Kosh from the PNL onwards (Zeder 2008a: fig. 9; Zeder 2011: 227). Recent analysis of the faunal remains from the sites of Tall-e Mushki, Tall-e Jari and Tall-e Bakun on the Marv Dasht Plain, Fars, also demonstrates a significant delay of the introduction of sheep into the region (Mashkour et al. 2006). A possible explanation for the delayed spread of sheep compared to goats, is that goats are generally adapted to dryer conditions, although at present there is not sufficient data to say (ibid.: 104).

The outlines of cattle (*Bos Taurus*) domestication in the Near East are still sketchy (Zeder 2011: 227). The ancestral species of modern domestic cattle was *Bos primigenius* (now extinct), and common usage gives two taxa for the domestic descendants, *Bos indicus* and *Bos taurus* (Bradley & Magee 2006: 317). *Bos taurus* cattle predominate in the temperate lands of Europe, West Africa and northern Asia, whereas *Bos indicus* are generally found in the hot-arid or semi-arid regions of South Asia and Africa.

The earliest evidence for the domestication of cattle during the eighth millennium BC, points towards the marshlands and forests of the Middle Euphrates Basin, from where Helmer et al. (2005) report evidence of a degree of sexual dimorphism at several Early and Middle PPNB including Halula and Dja'de, and to a lesser extent at Cafer Hoyuk and Aswad, which they link to an on-going process of domestication. However, the animals fall within the size range of wild aurochs (*Bos primigenius*), and cattle from contemporary sites in the same region are still highly sexually dimorphic, and thus seen as being wild (Zeder 2011: 228). Later evidence in the region for elevated female to male ratios, and the absence of older individuals within the slaughter remains (ca. 7000 BC) suggests a culling strategy and domestication (Bradley & Magee 2006: 317). Domesticated cattle spread out of this heartland of initial domestication slowly (Zeder 2011: 228), reaching the southern Zagros around 6500 cal BC (Hole et al. 1969: 303; Zeder 2008b: 11598).

It has been postulated that both *Bos taurus* and *Bos indicus* cattle were derived from the western Eurasian aurochs (*B. primigenius*) within southwest Asia during the Early Neolithic (e.g. Epstein 1971; Epstein & Mason 1984).

However, a more widely held view is that *Bos indicus* were domesticated independently or subsequently to *Bos taurus* from a biologically distinct wild progenitor within the Indian subcontinent (Bradley & Magee 2006: 317). Archaeological fieldwork at Mehrgarh, Baluchistan, has provided plausible evidence for the domestication of *Bos indicus* cattle, most probably from local *Bos primigenius namadicus* populations, ca. 5000 BC (Meadow 1993; 1996; Bökönyi 1997).

In pigs (*Sus scrofa*), a reduction in the size of molars, especially of the M3, is thought to be an early marker of domestication (Flannery 1983; Zeder 2011: 228). It is thought that pigs, similarly to dogs, entered into domestication through a commensal route, initiated when less wary individuals entered into human habitations to scavenge for food (Zeder in press; Zeder 2011: 228). It is therefore hard to know whether initial changes in the jaw and tooth morphology seen in the animals reflects true domestication, or simply an adaption to living alongside humans (Zeder 2011: 228). Redding has reported that pigs at Hallan Çemi show some evidence of tooth size reduction (Redding & Rosenburg 1998). He also interprets an increase in the number of pigs through time at the site, and data on age and sex, as indicative of a developing association between humans and wild boar (Rosenburg & Redding 2000; Rosenburg et al. 1998; Redding 2005). At nearby Çayönü, clear signs of a gradual change in tooth size, age structure and biometry, are thought to represent a gradual process in which pigs moved from a wild to a commensal to a fully domestic status (Ervynck et al. 2001). As with sheep and cattle, pigs seem to have spread slowly out of the Fertile Crescent (Zeder 2008b: 11598; 2011: 228), and although domesticated pig are identified at Jarmo in the northwestern Zagros by 7000 cal BC (Flannery 1983), morphologically altered domestic pigs are not found in lowland Iran until 6500-6000 BC (Zeder 2008b: 11598).

Genetic evidence

Genetic analysis of both modern and ancient materials has brought fresh insight into the geographical and temporal context of livestock domestication (Zeder 2008b: 11598). To trace the evolutionary ancestry of domesticates,

geneticists study neutrally evolving, noncoding loci and organellar genomes, particularly focusing on those that are specifically selected for or against by domestication (Zeder et al. 2006: 141-2). Most domesticated animals that have been subject to genetic analysis seem to have been domesticated several times (Jones & Brown 2000: 773; Luikart et al. 2001: 5929; Hiendleder et al. 2002: 901; Dobney & Larson 2006: 265; Zeder et al. 2006: 147; Zeder & Smith 2009: 684).

Hiendleder et al. (2002) conducted the first phylogenetic analysis of sheep, sequencing 63 unique control regions from wild sheep (*Ovis musimin, O. orientalis*, *O. vigne, O. ammon & O. canadenis*) and domesticated sheep (*O. aries*) from Asia, Europe and New Zealand. Their study identified two well-separated mtDNA lineages (A & B) among modern domestic sheep, with an estimated divergence time of 1.54 MyrBP or more (Hiendleder et al. 2002: 902). As this time vastly predates sheep domestication – which is unlikely to have been much before 10,000 years ago – it suggests that sheep were domesticated from two distinct wild populations, a conclusion supported by Hiendleder's earlier work (Hiendleder et al. 1998; 1999). More recent phylogenetic analysis by Pedrosa (2005) of mtDNA from local sheep breeds reared throughout Turkey, identified three major maternal lineages (B, A, C), for which the divergence times were estimated to be ca. 160,000 to 170,000 years ago for lineages A and B, and 450,000 to 700,000 years ago for lineage C (Pedrosa et al. 2005: 2216). These times greatly predate domestication, and suggest a further independent sheep domestication event, as well as the two purported by Hiendleder (Hiendleder et al. 1998; 1999; 2002).

In terms of goats, Luikart et al.'s (2001) phylogenetic analysis of modern goat breeds, revealed 3 highly divergent goat lineages, with an estimated divergence of over 200,000 years ago. As with the divergence times of sheep mtDNA clades, this divergence time greatly predates goat domestication, and "suggests that the three goat lineages arose from genetically discrete populations" (Luikart et al. 2001: 5929). From a combination of the molecular genetics and archaeological data, Luikart et al. propose that goats were first domesticated in the southern Turkish region of the Euphrates valley, ca. 9000

BC, as evidenced at Nevali Cori, with secondary, independent, domestication events occurring in the Zagros Mountains of modern Iran and Iraq ca. 8000 BC (as evidenced by the archaeological site of Ganj Dareh); and in the Indus Basin at the site of Mehrgarh, Baluchistan, ca. 7000 BC (Luikart et al. 2001: 5930), however this remains controversial.

The maternal lineages of modern cattle also show a polyphyletic signature. The primary feature of the analysis of both mtDNA and microsatellite genetic distances of both modern and ancient cow populations is the marked dichotomy between *Bos taurus* and *B. indicus* (Bradley & Magee 2006: 319, 321). The divergence between *B. taurus* and *B. indicus* has consistently been estimated to have a time depth of hundreds of thousands of years (e.g. Loftus et al. 1994; Bradley et al. 1996), meaning that the diversity between the two could not have arisen within the purported 10,000-year history of animal herding (Bradley & Magge 2006: 321). Y-chromosomes also show a strict dichotomy (Bradley et al. 2004). This supports a domestication of *Bos taurus* in the Near East, as traditionally identified, and a different centre for the domestication of *Bos indicus* (Bradley & Magge 2006: 325), possibly in Baluchistan, where Mehrgarh has yielded archaeological evidence pertaining to the domestication of *B. indicus*, possibly as early as 7000 BC (Meadow 1993).

Within the *Bos taurus* clade, five main lineages are recognized (T, T1, T2, T3 & T4/J5). The lineages are geographically distributed with three, possibly four likely to be from domestication events in the Fertile Crescent (Bradley & Magge 2006: 323). The lineages, thus, are consistent with a history of cattle domestication in the Near East and subsequent population expansion (ibid.; Zeder 2011: 230).

Near Eastern wild boar matrilines are not represented among modern domestic swine, as they were replaced by those of domestic swine with maternal origins from European wild boar by about 4000 BC (Larson et al. 2005), however, ancient-DNA analysis points to at least four different lineages of Near Eastern domestic pigs (Larson et al. 2007).

To summarize, advancements in archaeological techniques and the use of genetic evidence are increasingly suggesting that different species were initially brought under domestication several times, in different parts of the Fertile Crescent, from where they spread (Fig. 2.1) (Fuller 2007:; Fuller et al. 2010; Allaby et al. 2008; Brown et al. 2008; Fuller et al. 2010; Zeder 2008a; 2009; 2011; Zeder & Smith 2009). Plants and animals were domesticated at the same time – or animals even earlier – in the eastern arc of the Fertile Crescent around 11,000-10,500 years ago (Zeder 2008a: 243). In contrast, in the southern and northern Levant (the western arc of the Fertile Crescent) plant domestication seems to have occurred at least 1000 years earlier (Nesbitt 2002: 122), and animal domestication seems to have been a "delayed, somewhat subsidiary development" (Zeder 2008a: 245). Sheep were probably domesticated in the eastern Taurus Mountains at the apex of the Fertile Crescent, the genetic evidence suggesting at least twice (Hiendleder et al. 1998; 1999; 2002); while the archaeological record indicates that goats were domesticated in its eastern arm, in the northwest or Central Zagros; the natural homeland of wild goats (Zeder 2008: 265). Where precisely within this region goats were domesticated is unclear from the current archaeological evidence, but the genetic data points to between three to five genetically independent domestication events (Luikart et al. 2006: 304). As regards cereals, the archaeobotanical evidence implies geographically independent domestication events for each species (Tanno & Willcox 2006a: 1886; Brown et al. 2008: 206; Zeder 2009: 14), a scenario supported by the genetic evidence (Willcox 2005: 540; Fuller 2007: 907; Brown et al. 2008: 107). Einkorn domestication was probably restricted to southeastern Anatolia (Kilian et al. 2007: 265-7); emmer wheat may have been independently domesticated in both the southern and northern Levant (Ozkan et al. 2005: 1058-9; Luo et al. 2007: 957); and barley domesticated in the southern Levant and western Zagros (Molina-Cano et al. 2005: 617; Morrell & Clegg 2007: 3291).

There are, then, "no easy answers to the central questions about domestication and agricultural origins" (Zeder 2006b: 115). The distribution of the wild ancestors of the future Near Eastern founder crops and livestock in

the Pleistocene-Holocene transitory period is still not known exactly, making it difficult to determine where they were originally domesticated (Zeder 2008a). The problem is further exacerbated by the gradual nature of the transition. Although Gordon Childe (1925) labelled the development of agriculture the 'Neolithic Revolution', the favoured view today is that it was a slow, not necessarily unilinear, transition (Meadow 1989b: 80; Hodder 1990: 102; Gebauer & Price 1992a: 7; Ingold 1996: 12; Brown et al. 2008: 106; Zeder 2009: 46, 2011: 231; Fuller et al. 2010: 17). It has been contended (e.g. Cohen 1977: 23; Meadow 1989b: 80; Ingold 1996: 12; Zeder 2008b: 11598) that domestic status is not a definite category, but rather part of a continuum of human-animal relations, including random hunter-gathering, intentional game cropping, herd following, animal penning and cultivation of wild cereal stands, to the breeding of genetically isolated stock, "along which humans, animals and plants became increasingly intertwined" (Meadow 1989: 80). Indeed, Zeder argues that "estimating when during this extended co-evolutionary process a plant or animal species crossed the domesticated threshold is now more a semantic issue than a substantive research question" (Zeder 2008b: 11602). Thus, while it is recognized that the Near East is one of the oldest, if not the oldest, centre of domestication in the world, and that the domestication of most plants and animals was polyphyletic; where exactly in the Near East these domestication events took place is still a matter of great controversy. Having considered the geographic origins of agriculture, it will now be considered why the agricultural transition occurred.

2.3. Why did food production occur?

> "If agriculture provides neither better diet, nor greater dietary reliability, nor greater ease, but conversely appears to provide a poorer diet, less reliably, with greater labor costs, why does anyone become a farmer?" (Cauvin 1977: 141)

Traditionally, it was believed that the advantages of food production were so great, that agriculture would be adopted automatically if available (Perry 1937:

46; Childe 1952: 23; Braidwood 1960: 134). Stemming from the work of the seventeenth century philosopher Thomas Hobbes, who described life in the state of nature as “solitary, poor, nasty, brutish and short” (Hobbes 1651: 86), food production was understood as a preferable alternative to hunting and gathering. It was an opportunity, which “opened up a richer and more reliable supply of food, brought now within man’s own control and capable of almost unlimited expansion by his unaided effort” (Childe 1953: 23). According to Braidwood, everybody practicing food production, “had a more rounded diet; they were all stronger, and there were more children…the villagers wouldn’t starve, even if the hunters and fishermen came home empty-handed...There was more time to do different things, too” (Braidwood 1951: 86). In contrast, Braidwood described hunting and gathering as, “an existence which takes nature as it finds it, which does little or nothing to modify nature - all in all, a savage’s existence, and a very tough one... [hunting & gathering] is really living just like an animal” (1951: 86), and it was generally believed that hunter-gatherers “must work much harder to live” (Lowie 1946: 13) than food producers.

Many of the initial explanations for the transition to agriculture were heavily influenced by Darwin’s notions on evolution and vitalism, with scholars (e.g. Childe 1952; Braidwood 1951, 1960) arguing that the development of agriculture was an inevitable stage in human evolution. Braidwood believed that food production emerged when it did, because “around 8000 BC the inhabitants of the fertile crescent had come to know their habitat so well that they were beginning to domesticate the plants and animals they had been hunting” (Braidwood 1960: 134), but prior to this, “culture was not yet ready to achieve it” (Braidwood & Willey 1962: 134). Such vitalistic explanations can be heavily critiqued, for, as Binford has argued, they are untestable and thus, “unacceptable as an explanation” (Binford 1968: 322). A further issue is that the timescale is wrong. Why, if as Braidwood argues, food production was the result of “the ever increasing cultural differentiation and specialization of human communities” (Braidwood 1960: 134), has it only appeared in the last 10,000 years of human history? (Richerson et al. 2001: 399).

It was not until the late 1960s, through the publication of anthropological works like Lee and Devore's (1968) *Man the Hunter*, that the hardships involved in early agricultural economies, and the relative ease of hunter-gatherer strategies, was recognized. Lee's revolutionary study of the !Kung Bushmen of semi-arid Kalahari Desert, who he describes as living "by any account a marginal environment" (Lee 1968: 30), revealed that adults on average worked (gathering or hunting food) for only two-and-a-half-days per week, with an average working day of six hours (ibid.: 38). This modest work effort provided sufficient calories to support not only the active adults, but also a large number of youngsters, middle-aged and elderly people (ibid.: 39). Indeed, a Bushmen when asked this very question replied, "why should one plant, when there are so many mongongo nuts in the world?" (ibid.: 33), calling into question why there was ever a need to undertake food production. In comparison, the Hanunoo agriculturalists of the Philippines put in around 1200-hours per year into agricultural activities alone, an average of over 3-hours-per-person per day, excluding hunting, gathering and secondary activities (Conklin 1957: 58). Lee's (1968) study also showed that the diet of the !Kung Bushmen, which consisted largely of Mongongo (mangelti) nut, was both more nutritious and more reliable than one based on cultivated foods (Lee 1968: 33).

Ethnographic studies like Lee's (1968), led Marshall Sahlins (1972) to challenge anthropologists' generally low opinion of hunter gatherers. Sahlins considered hunter gatherers to be the original affluent society, who were able to achieve affluence by, "desiring little and meeting those desires/needs with what is available to them" (Sahlins 1972: 1). Sahlins believed hunter-gatherers to have a "marvellously varied diet" (Sahlins 2005, online), based on the abundance of the local environment, and to have worked less than agriculturalists, so that "rather than a continuous travail, the food quest is intermittent, leisure abundant, and there is a greater amount of sleep in the daytime per capita than in any other condition in society" (Sahlins 1972: 14). Thus, archaeologists (e.g. Cohen 2009: 591) increasingly came to acknowledge that under normal conditions the adaptive pressures or 'pull' factors (e.g. new knowledge, invention or technology) were not strong enough

for developing an agricultural economy, and that people must have been forced or 'pushed' into food production. As Flannery succinctly put it, "people did it because they *had to*, not because they *wanted to*" (1967: 74; original emphasis). Since the 1960s an almost endless list (Table 2.0) of explanations for the development of agriculture has been suggested, although several prime mover models have dominated the debate.

2.3a. Population pressure

Proponents of population pressure models (e.g. Binford 1968; Smith & Young 1972; Cohen 1977; 2009; Redding 1988), suggest that population pressure stressed the carrying capacity of the local environment to the extent that agriculture became a viable alternative to hunter-gatherer strategies. Many population pressure models draw heavily on the work of Ester Boserup (1965), who contended that population density compelled societies to invent new technology in order to increase food production. Mark Cohen (1977; but see Cohen 2009), one of the originally advocates of population pressure, argued that the only economic benefit of agricultural over hunter-gatherer strategies was, "the ability to grow and harvest more food from a unit of space in a unit of time" (Cohen 1977: 39). He thus proposed, that agriculture would only have arisen as a result of population pressure, which he describes as "an imbalance between a population, its choice of foods, and its work standards" (ibid.: 50). Cohen suggested that the nearly simultaneous adoption of agricultural economies throughout the world at the end of the Pleistocene can, "only be accounted for by assuming that hunting and gathering populations had saturated the world approximately 10,000 years ago and had exhausted all possible (or palatable) strategies for increasing their food supply within the constraints of the hunting-gathering life-style" (Cohen 1977: 279). He proposed that plant cultivation arose in those areas where both the population pressure was the greatest, and there were plants and animals suitable for domestication. Agriculture then spread, "because the world, in effect, was saturated with hunters and gatherers" (Cohen 1977: 53). Cohen (1977: 60)

argues that animal domestication followed later, as wild meat resources declined.

Cohen's population paradigm can be queried in a number of ways. Firstly, like with Braidwood's (1960) vitalistic explanation, the timescale is wrong: why in 90,000 years of human history were so many places in the world suddenly saturated with hunter-gatherer groups around 10,000 years ago? Secondly, Cohen offers no explanation for why hunter-gatherer groups would have over stretched their resource base in the first place. Hunter-gather groups today tend to live in equilibrium with their environment (cf. Lee & Devore 1968), and there is no reason to suppose that this would have been different in the past (Binford 1968). In more recent work, Cohen has come to accept that he "clearly overestimated the effect of [Palaeolithic] growing population" (2009: 591).

Population pressure or 'packing' models have also been favoured for explaining the agricultural transition in Southwest America and Mesoamerica. Both Lewis Binford (1968) and Kent Flannery (1969) have proposed that increasing population densities among relatively sedentary fisher-forager groups during the Late Pleistocene, led to an overflow of people into marginal zones, resulting in cereal cultivation in order to increase the food supply.

Lewis Binford (1968) rejected the concept that human populations are constantly growing, and continually seeking new means of acquiring food. Rather, he argued that conditions of disequilibrium between human groups and their local area, caused either by environmental change or by groups immigrating into already settled areas, created resource stress. At the time Binford was writing, the prevailing belief was that there had been no dramatic climate change during the agricultural transition (see, for example, Charles Reed & R.J. Braidwood in Braidwood & Howe 1960: 163). Therefore, he suggested that population increase would have occurred because of the influx of people into already populated areas. Binford modelled that in such situations, a marked discrepancy would have arisen in the population growth between the two groups, with the more sedentary group experiencing a

growth in population, which would have stressed the carrying capacity of their area, eventually necessitating the emigration of people into the territory of the neighbouring group. This group in turn would have experienced population growth and resource growth, inevitably resulting in emigration into a new territory. Binford (1968: 328) argued that under these conditions, there would have been strong selective pressure favouring the development of food production for both groups. However, in more recent work, Binford (2001) has downplayed the role of population growth in the agricultural transition, and instead emphasized the impact of 'population packing', in particular the threshold limit of 9.098 people-per-100-kilometres squared, as "the universal conditioner of change in…subsistence strategy" (Binford 2001: 374).

Population pressure models, although convincing at a general level, do not explain everything, including why agriculture did not develop in all affluent hunter-gatherer societies; or why it only emerged in the last 10,000 years of human history (Richerson et al. 2001: 396; Bellwood 2002: 22). Another issue with population pressure models, is that due to the focus on a limited number of resources and heavy dependence on climate, early food production was inherently unreliable (Feynman & Ruzmaikan 2007: 299-300); as well as being more labour intensive than hunting and gathering (Lee 1968: 39; Richerson et al. 2001: 388). Population pressure is also difficult to identify in the archaeological record, and is usually identified by proxy evidence, such as sedentism, increased storage and resource intensification, giving the models a "certain tautological burden" (Zeder & Smith 2009: 683), in that population pressure causes sedentism, which is then used as evidence of population pressure. Today, it is generally recognized that population pressure did not operate alone, and was one of a number of factors that played a significant role in the agriculture transition (Bellwood 2005: 25; Cohen 2009: 592; Zeder 2006: 115; Zeder & Smith 2009: 687). Population pressure has been described as the "snowball factor" (Bellwood 2009: 625), which got things rolling and escalated the speed of the whole process. Another influential and related factor was climate change.

2.3b. Climate change

The relationship between climate change and the development of agriculture, has been widely debated for many years, by both archaeologists and the scientific community. The situation is not helped by the "complex climatic system of the Near East today [which] makes it difficult to reconstruct the patterns of the past" (Bar-Yosef & Meadow 1995: 43), nor by the conflicting nature of the climatic evidence for the Near East during the Neolithic (Lovell 2004: 18). The geologist Raphael Pumpelly (1908), was one of the earliest proponents for a climate-induced agriculture transition. He hypothesized that the warming climate of the Holocene, forced hunter gatherers to settle near drying lakes, where they domesticated plants and animals. Pumpelly's work influenced that of Gordon Childe, who posited in the 'Oasis' theory (Childe 1952; 1956) that at the termination of the Pleistocene the Near East experienced a period of desiccation which forced plants, animals and humans to congregate around oases and other areas of permanent water. Childe believed that through intensive interaction, a symbiotic relationship developed between humans and certain plants and animals (the future domesticates), that eventually culminated in their domestication (Childe 1952: 35). Childe asserted that plants were domesticated first, following which it was easier to domesticate animals, as the stubble in the harvested fields offered the animals grazing, especially in the dry season (ibid.).

Childe's model was innovative for its time, and he was the first to really consider why the transition to food production occurred. However, it suffered from a lack of archaeological evidence, that led Robert Braidwood to scathingly comment, "so far this theory is pretty much all guess-work, and there are certain questions it leaves unanswered. I will tell you quite frankly that there are times when I feel it is plain balderdash" (Braidwood 1951: 85). The Oasis theory can also be queried on the basis that similar environmental changes have occurred in the past without initiating food production (Braidwood 1950: 82; Richerson et al. 2001: 396; Feynman & Ruzmaikan 2007: 297), and for its implicit assumption that prior to 10,000 years ago, hunter-gatherers had no knowledge of plants and animals, when there is

plenty of ethnographic evidence to the contrary (see Cohen 1977: Chap. 2 for an overview; also Bellwood 2005: 25).

During the late 1950s and 1960s, there was a general acceptance that there was no major climate change during the agricultural transition (e.g. Braidwood & Reed in Braidwood & Howe 1960: 193; Binford 1968), and climate-induced models for the development of agriculture fell out of favour. However, subsequent work (e.g. Wright 1968; 1976; 1993; Roberts & Wright 1993) revealed a much closer temporal correlation between climatic change and agriculture origins than had been previously postulated. This led scholars such as Henry Wright, who had previously advocated that there was no climate change during the period of the agricultural transition (cf. Wright 1969), to argue that, "the origin of agriculture in the Near East can be attributed to the response of early people to a unique sequence of climatic events from 13,000 to 10,000 years BP" (Wright 1993: 466). More recently, Peter Richerson and colleagues (Richerson et al. 2001; Bettinger et al. 2009) have argued that agriculture was impossible during the Pleistocene, but compulsory in the Holocene. Richerson et al. (2001: 394) refer specifically to two climatic changes that occurred during the Early Holocene – an increase in atmospheric carbon dioxide, & the end of rapid fluctuations in world temperatures – which they suggest enabled the development of agriculture in many places. Richerson et al. (2001: 404) argue that agriculture was compulsory in the Holocene, because early farming groups, who made better utilization of the land, where able to outcompete local hunter gatherers, generating "a competitive ratchet favouring the origin and diffusion of agriculture" (ibid.: 389).

Joan Feynman and Alexander Ruzmaikan (2007) have also stressed the importance of climate stability in the agricultural transition, arguing that agricultural societies dependence on relatively few species compared to most hunter-gatherer societies, means that climate instability strongly inhibits agriculture (Feynman & Ruzmaikan 2007: 299-300). They estimate based on a study of prehistoric sites in the Middle East, that the transition from hunter-gather to agricultural subsistence strategies required the absence of large-

scale climate variability for a period of at least 2000 years. Climate proxy records suggest that there was probably no time span as long as this that was free of relatively large century-scale climate variation between 50,000 years ago and the Younger Dryas (ca. 10,800-9500 BC). Feynman and Ruzmaikan argue, then, that it was only possible for agricultural economies to develop in the last 10,000 years (ibid.: 300).

A number of scholars have invoked the Younger Dryas climatic episode (ca. 10,800-9500 BC) as the driving force behind the development of agriculture (Bar-Yosef & Belfer-Cohen 1991; 1998a; 1998b; Bar-Yosef & Belfer-Cohen 2002; Belfer-Cohen & Bar-Yosef 2000; McCoriston & Hole 1991; Moore & Hillman 1992; Harris 2003; Hole 2006). Over the years, Ofer Bar-Yosef has refined his argument for an association between the Younger Dryas and the origins of agriculture. Bar-Yosef's basic contention is that, "the climatic crisis of the Younger Dryas…resulted in major environmental deterioration which undoubtedly affected the subsistence strategies of the Natufian populations" (Bar-Yosef 1998b: 147). He suggests that the onset of cold and dry conditions with the Younger Dryas, reduced the yields of natural cereal stands, forcing human groups to change their food procurement strategies. This lead to "experimental planting, shifts in the location of settlement, and the clearing of land patches" (Bar-Yosef 1998a: 174), that culminated in the development of food production. Alternatively, Dow et al. (2005) argue, that the Younger Dryas downturn crowded populations, which had grown large during the preceding climatic amelioration of the Early Holocene, into a few favourable environments, in which agriculture became a viable solution to food shortages. However convincing as these arguments may sound, there is no evidence, with the possible exception of a fleeting appearance of domesticated rye at Abu Hureyra ca. 9000 BC (Hillman 2000; but see Nesbitt 2002), for agriculture during the Younger Dryas (Bellwood 2005: 24; Bettinger et al. 2009: 628; Zeder & Smith 2009: 682). Nor, is there any evidence for intensive food resources use or food stress in the Early Holocene (Munro 2003: 62). Rather, recent evidence suggests that the beginning of agriculture fell well after the Younger Dryas interstadial, during the period of climatic stability in the eighth millennium BC (Cauvin 2000: 107; Richerson et al. 2001:

388; Willcox 2005: 540). A further problem with correlating the Younger Dryas with the origins of agriculture, is that during the last 40,000 years there have been approximately 9 other similar events, but agriculture developed only after the most recent one (Richerson et al. 2001: 396; Feynman & Ruzmaikan 2007: 297). Today, it is generally accepted that climate change, like population pressure, was not the sole reason for the agricultural transition, but it was a "necessary ingredient" (Wright 1976: 385) that "set the stage" (Bettinger et al. 2009: 629; see also Bar-Yosef & Cohen 2002; Cohen 2009; Zeder & Smith 2009).

2.3c. Coevolutionary models

Eric Higgs and colleagues (e.g. Higgs & Jarmon 1969; 1972) took an alternative view of the agricultural transition, and argued that animal domestication occurred as a gradual refinement of human hunting and husbandry practices that began in the Pleistocene. David Rindos (1980; 1984; 1986) expanded on Higgs' work to propose a co-evolutionary model, in which humans and plants became increasing interdependent in an obligate relationship. Rindos believed that thousands of years of interaction between humans and plants were needed to allow for wild plants to become pre-adapted for agriculture, before domestication could occur (Rindos 1984: xiv-xv, 134-5, 142, 183). However, he did not explain why such co-evolutionary relationships would have developed in the first place, regarding the question, as "without meaning…the relationships were established as a result of the maximization of fitness in a given situation in time and space; they were neither inevitable nor desirable, but merely happened" (Rindos 1984: 141).

Rindos' paradigm is good in emphasizing the important role of the responses of target plant and animal species to increasing human intervention (Zeder & Smith 2009: 688; Zeder 2011: 11602). However, his assumption that coevolution was a "prolonged, gradual process" (Rindos 1984: 191) has come under criticism. There is no empirical support that the development of agriculture was prolonged over thousands of years (Blumer & Byrne 1991:

27), and most evolutionary biologists would favour that evolution is driven by great fluctuation, rather than long-term, gradual changes, which can often be diffuse and weak (Blumler 1996: 34-5). The model is further belied, "by the nearly synchronous appearance of domestication in many parts of the globe" (Blumler 1996.: 27) so recently in human history, and the fact that it does not address why food production only occurred in certain areas, from which it spread (Redding 1988: 60; Blumler & Byrne 1991: 35; Cohen 2009: 591; Zeder & Smith 2009: 966). Rindos (1984: 85-99, 94) denied that conscious selection or human intent played any role in the domestication of plants, an assumption which Blumler and Byrne described, as "overly progressionist…[and] a matter of semantics" (Blumler & Byrne 1991: 27). Human intent was obviously important in the agricultural transition, and it should not be "ignored in…enhancing the density and productivity of desired resources" (Zeder & Smith 2009: 966; see also Cohen 2009: 591).

2.3d. Social and ideological change

Some scholars have stressed the role of social and ideological change in the transition to agriculture (e.g. Bender 1978; Bender 1985; Hayden 1990; 1996; 2001; 2003; 2009; Cauvin 2000), in what can be loosely categorized as 'universal stress free' models (Zeder & Smith 2009: 682), in that they look to internal causes within human society and psyche in order to explain the development of agriculture (Zeder 2009: 42).

Barbara Bender (e.g. 1978) was among the first to emphasise the social aspects of the agricultural transition, claiming that the success of food production was due to an individual's ability to accumulate food surpluses, and transform them into valid items. Her work was followed by that of Brian Hayden (e.g. 1996; 2001; 2003; 2009), who, over the last 20 years, has refined a model in which agriculture arose as the outcome of competitive feasting (for a summary see Hayden 2001). Hayden's central thesis is that a range of technological innovations, which only became widespread during the Mesolithic, made it possible for some complex hunter-gatherer groups to

accumulate an abundance of food (Hayden 1996: 143; 2009: 597). Within these groups, highly-motivated individuals (Hayden's 'Accumulators') used competitive feasting as a means to develop and consolidate their power (Hayden 1990: 310; 2009: 600). Hayden argues that it was within this context food production first occurred; as Accumulators could never have too much surplus, the incentive was to produce ever more, to the extent that certain favourable species of plants and animals came to be domesticated (Hayden 1996: 143). Hayden (1990: 57-62; 1992: 13) posits that initially the production of domesticated, 'feasting' foods was too laborious for such foods to have been consumed on a daily basis, but that overtime genetic selection and technological developments made some of the labour-intensive feasting foods, such as cereals – which Hayden (1992: 13) believes were valued as feast foods because of their high carbohydrate content – cost competitive compared to wild foods.

A primary objection to Hayden's model is that it is just that, a model (Smith 2001: 220). Hayden never explains how social inequality and Accumulators first emerged, and is quite dismissive of the issue, arguing that "the ultimate and immediate reasons for the emergence of socioeconomic inequalities are not essential to document for the presence discussion" (Hayden 1990: 33). But without explaining the underlying causes of competitive feasting, Hayden fails to explain the development of agriculture, and simply describes the process (Zeder & Smith 2009: 864). Hayden's model also does not necessarily accord with the empirical record (Smith 2001: 220; Kuijt 2009: 642-4; Zeder & Smith 2009: 684), and indeed, is described by Bruce Smith as "fact free" (Smith 2001: 219). Hayden (e.g. 2009) argues that the pre-agricultural Early and Late Natufian periods were characterized by sufficient food storage and surpluses to allow for individuals to gain social power over others. However, researchers working in the Levant have found little direct evidence for food storage in the Naufian (Bar-Yosef 1998a: 164; Goring-Morris & Belfer-Cohen 1998: 80). Indeed, Bar-Yosef (1998a: 173) has argued, that the archaeological record indicates that the surpluses needed for competitive feasting only became available as an outcome of food production, and not before. Nor, does the period directly before the appearance of

domesticates, provide any clear evidence of social differentiation (Kujit 2009: 643; Smith 2001: 221). It is also unclear why Accumulators would have chosen to domesticate the initial domesticates, such as cereals and pulses, which "cannot be categorized as anything other than widely available, easily grown staples" (Zeder & Smith 2009: 684), rather than the prestige goods called for by Hayden's model (Smith 2001: 220; Zeder 2009: 43). Whether or not competitive feasting was a driver for the origins of agriculture, Hayden's feasting model has been useful in emphasizing the importance of food in the Neolithic, which despite its importance is often overlooked. Simmons, for example, argues "given that the Neolithic revolved around food in one way or another, it seems somehow appropriate that feasting be considered as reasons for its origins" (Simmons 2007: 19; see also Straus 2004: 104).

A modern school of thought has emphasised the Neolithic as an ideological phenomenon, "a new way of thinking" (Rowley-Conwy 2004: 83, citing several authors). Charles Heiser (1990) suggests that planting began in order to appease the gods after harvest of wild plants, a hypothesis which, although incapable of being tested, is "interesting none the less" (Bellwood 2005: 25, while Jaques Cauvin (2000; 2001) has cast the emergence of agriculture in terms of a reordering of symbolic material, a 'revolution of symbols' that occurred in the period immediately preceding agriculture, ca. 13,000-10,000 BC. Specifically, Cauvin (2000: 209) argues that it was the birth of divinities in human form, which he believes is evidenced in the archaeological record by female figurines (mother goddesses) and bull symbols, that created the agency and alienated sense of self that were necessary for agriculture. He does not, however, explain why this mental shift occurred (Hodder 2001: 108; Rollefson 2001: 112; Zeder 2009: 42), except for a passing reference to a "dissatisfied collective psychology" (Cauvin 2001: 65), an inadequate explanation, which essentially implies that "the imagination of the group psychology just changed, for no apparent reason" (Hodder 2001: 109).

Hodder argues that Cauvin's treatise for the primacy of ideological change over all other factors, including environmental, climatic and economic, "makes it impossible to explain the symbolic efflorescence at all" (2001: 109), and he

is not alone in voicing this view (Watkins 1997: 269; 2001: 118; Rollefson 2001: 112; Arias 2004: 99; Budja 2004: 100; Rowley-Conwy 2004: 84; Straus 2004: 103). Andrew Jones, for example, argues that economy and ecology can never be decoupled, and that "a proper study of the Neolithic requires that equal weight be given to both" (Jones 2004: 102; see also Thomas 2004: 105). Cauvin's 'revolution of symbols' also "has a hard time squaring itself with the empirical record" (Zeder & Smith 2009: 684), particularly the Younger Dryas climatic downturn, which makes it hard to accept Cauvin's 'Garden of Eden-like' scenario, for encouraging the florescence of symbols (Zeder 2009: 42).

Richerson and colleagues (Richerson et al. 2001; Bettinger et al. 2009) recognise that both external and internal factors inhibited and encouraged the development of agriculture. Bettinger et al. (2009: 629) argue that although climate change was the major external constraint, its development after the climatic amelioration of the Holocene was retarded for around 1000-2000 years by internal constraints, particularly the slow evolution of more sophisticated social organisation.

In light of the archaeological data accumulated over the past several decades, it is easy to debunk earlier models for the agricultural transition, which were based on limited fieldwork and a misunderstanding of past climatic conditions. What is not so easy is to come up with viable alternatives. There is no evidence of drastic or catastrophic climate changes at the time of the Neolithic transition to support Pumpelly (1905) and Childe's (1954) 'Oasis' theory (Richerson et al. 2001; Bettinger et al. 2009), and even if there was, similar climatic and environmental fluctuations have occurred many times in the past without initiating food production (Richerson et al. 2001: 396; Feynman & Ruzmaikan 2007). In terms of population pressure, there is little evidence from Late Palaeolithic sites of a broad-spectrum subsistence base (Simmons 2007: 26), nor can it be explained why population pressure suddenly became such a major driving force at various places around the world ca. 10,000 years ago. Models incurring population growth can also be questioned on theoretical grounds, as it is impossible to indict population growth as an

immediate cause of change (Bellwood 2005; Gebauer & Price 1992a; Price 1995; 2000), and, moreover, in times of trouble people are much less likely to experiment with new ideas (Bellwood 2005: 24). Models of social and ideological change have also not escaped criticism, for while they may have considerable merit as intellectual concepts, they are not grounded on any archaeological evidence, and fail to account for why the ideological or social changes arose when and where they did (Hodder 2001: 109; Watkins 2001: 118; Simmons 2007: 26; Smith 2001: 220; Zeder & Smith 2009: 691). Ideological and social change explanations for the origins of agriculture are also questionable, because of their implicit assumption that pre-Neolithic groups were somehow not quite fully modern in their mental capabilities, a concept that does not accord with much anthropological thought (Simmons 2007: 27).

Increasingly, it has come to be acknowledged, that the impetus for the transition to agriculture came from a complex intertwining of climate, environmental and social factors, and regional responses to them (Bellwood 2005; 2009; Bettinger et al. 2009; Richerson et al. 2001; Simmons 2007; Zeder & Smith 2009). More recent models for food production, often represent a blend of several explanatory models, which include both social and environmental factors. Peter Bellwood, for example, conjectures that agriculture could not have occurred anywhere without deliberate planting and a regular annual cycle of cultivation; a situation, he argues, which would have been unlikely to occur without the climatic stabilization of the Holocene (& its warmer and wetter climates), and social change in the form of affluent hunter gatherers, where economic wealth and feasting were combined with a shift towards sedentism (Bellwood 2005: 25).

2.4. The spread of agriculture

"[T]he significance of agriculture cannot be elucidated in terms of its origins alone, but involves a more detailed understanding of the emergent structure of its continuing spread." (Jones et al. 1996: 97)

Paradigms for the spread of agriculture generally fall into two main categories, which were defined by Albert Ammerman and Luigi Luca Cavalli-Sforza (1984: 6) as: (1) *demic diffusion*, the spread of farming through the movement of farmers themselves; and (2) *cultural diffusion,* by which cereals and farming techniques were passed among local groups, without the geographical replacement of groups. The two paradigms are not mutually exclusive, and a third model can be proposed of mixed cultural and demic diffusion, where 'intermarriage' occurs between hunter-gatherer and food-producing groups.

2.4a. Demic diffusion

The classic model of demic diffusion is the 'Wave of Advance' (Ammerman & Cavalli-Sforza 1971; 1973; 1979; 1984). Ammerman and Cavalli-Sforza (1971: 687-9) observed that substantial increases in population density often took place concurrently with the shift to agriculture, due to a range of factors that include: increased food production-per-unit of land; a greater potential for the redistribution of food resources; and changes in the pattern of reproductive behavior, including increased female fertility, reduction in infanticide, and a preference for larger families. In an agricultural society children become productive earlier, and older children actually subsidize the investment in younger ones (Shennan 2009: 341). Ammerman and Cavalli-Sforza (1984: 66) argued, that population growth can only occur in a given area for so long; until the area's carrying capacity is reached. On attaining this horizon, the population may either remain at its saturation level, in which case the growth rate falls to zero; or growth may continue to take place, in conditions where expansion to adjacent areas can occur at the same time. Ammerman and Cavalli-Sforza believed that wherever the situation permitted, the later would have occurred. To model the population expansion, Ammerman and Cavalli-Sforza adopted a variant of the geneticist R.A. Fisher's (1937) 'Wave of Advance', which he had created to predict the spread of an advantageous gene (Fig. 2.2). Fisher's original model was of the stationary form of the wave, describing a spread in a one-dimensional habitat. J.G. Skellam (1951) later

applied the ‘Wave of Advance’ to population expansion, and it was a variant of the Fisher-Skellam model that Ammerman and Cavalli-Sforza (1971; 1973; 1984) employed.

The ‘Wave of Advance’ rests on two main assumptions. Firstly, that growth occurs in a logistic or sigmoid, as opposed to exponential, manner (Fig. 2.3); and secondly, that migrationary activity takes place at a constant rate in time, and according to a random walk process (Ammerman & Cavalli-Sforza 1984: 68). From these premises, Ammerman and Cavalli-Sforza predicted that a ‘wave front’ will form at the periphery of the spread, and keep advancing at a constant rate, driving the spread of agriculture across Europe. Ammerman and Cavalli-Sforza (1979: 296-8) recognized that the ‘Wave of Advance’ relied on a number of assumptions that are divergent from real world contexts. Firstly, it assumes that movement is continuous in space and time, whereas in reality the parameters of the ‘Wave of Advance’ would have varied with location and/or with time as a result of geographic and social conditions, and the movement would have been discontinuous, with individuals, or more often small groups or families, settling within walking distance of a previous settlement (Steele 2009: 129);. Secondly, the Wave of Advance relies on a conventional, random walk process or Gaussian distribution. However, in many empirical instances of human movement, the distribution of individual displacements is not Gaussian, and exhibits higher frequencies of both short- and long-distance movements (Steele 2009: 129). Thirdly, the Wave of Advance requires that dispersal is isotropic, that is movement is equally likely in all directions, and “serves to redistribute populations to achieve uniform densities regardless of local variation” (ibid.: 130). However, in human populations, the underlying motivation for movement may involve either one of attraction or repulsion to certain places, and “in any given time and space the density would be low in ‘repulsive’ places and high in ‘attractive’ places” (Ammerman & Cavalli-Sforza 1979: 351). Fourthly, the Wave of Advance assumes all movement to have ben statistically independent, and uncorrelated with any preceding movement, but migrations are informed by earlier migrations (Anthony 1990: 902), and in the spread of early farming there was a tendency towards outward or centrifugal movement (Ammerman

& Cavalli-Sforza 1979: 351). To justify the use of the 'Wave of Advance', Ammerman and Cavalli-Sforza (1979: 351) argued that these processes would have operated over short time and space intervals, and that the 'Wave of Advance' provides a useful approximation of the spread, what Steele describes as "a general, or basic, model of human population dispersals" (2009: 126).

To test the validity of the 'Wave of Advance', Ammerman and Cavalli-Sforza 'measured' the rate of the spread of farming in Europe by expanding on Clark's (1965a; 1965b) (Fig. 2.4) map of radiocarbon (hereafter ^{14}C) dates of Neolithic sites. Ammerman and Cavalli-Sforza defined sites as 'Neolithic' by the presence of a given trait of importance to early farmers, giving particular weight to the cereal crops wheat and barley, for which there is no evidence for the indigenous domestication of in Europe (Ammerman & Cavalli-Sforza 1971: 675). Due to the limitations of the archaeological evidence at the time, at some of the sites used in the measurements, the presence of cereals was inferred by Ammerman and Cavalli-Sforza, rather than documented.

Ammerman and Cavalli-Sforza's original analysis was based on a group of 53 Neolithic sites, on which regression techniques were used for measuring the rate of spread. The results of the analysis indicated that there appeared to be a fairly regular pattern to the spread of farming over Europe, at a rate of ca. 1-kilometre-per year or 25–30-kilometres-per generation (Ammerman & Cavalli-Sforza 1971: 685). The analysis was subsequently refined in 1973–4, with the addition of a further 51 sites, and the drawing of a series of isochrones onto the map of Europe (Fig. 2.5). An advantage of this approach was that it avoided attributing centres of origin for the spread, a somewhat ambiguous process, and a necessary requirement of the regression approach (Ammerman & Cavalli-Sforza 1984: 58), as well as providing a better idea of the regional variation in the spread.

Ammerman and Cavalli-Sforza (1971: 680; 1984: 59-60) also looked at the spread of the Neolithic from the perspective of the survival of hunter-gatherer or Mesolithic populations in Europe. Using ^{14}C determinations from 62 Late

Mesolithic sites, they produced an isochronal map similar in design to that for the Neolithic sites (Fig. 2.6). Ammerman and Cavalli-Sforza believed that "a comparison of the two isochronal maps shows a good *overall* correspondence between them [Mesolithic & Neolithic sites]" (1984: 60; original emphasis), although a potential problem with this conclusion is that nearly twice as many Neolithic sites (106) compared to Mesolithic sites (62) were used in the study; an idiosyncrasy which could easily have affected the outcomes of the two maps. More recently, the ^{14}C record has been revisited by Gkiasta et al. (2003) and Pinhasi et al. (2005) using linear regression techniques on an expanded set of Neolithic sites and linear regression techniques. Both studies found an average rate of spread of the Neolithic transition in the range of 0.6-1.3-kilometres per year, which is in agreement with the Wave of Advance model (Ammerman & Cavalli-Sforza 1984).

Subsequent work since the publication of *The Neolithic Transition and the Genetics of Population Growth in Europe* (Ammerman & Cavalli-Sforza 1984), has transformed this simple picture. It has been shown mathematically that identical travelling waves for the spread of farming can be generated by demic expansion, demic diffusion, or by trait-adoption diffusion (Aoki et al. 1996: 15; Gkiasta et al. 2003: 60). The 'Wave of Advance' predicts that agriculture spread at a constant rate of one-kilometre-per year (Ammerman & Cavalli-Sforza 1971: 685) but migrations of farming populations can be, and often are, "long-distance, highly-directed processes" (Anthony 1990: 902), particularly during pioneer colonization. Thus, whilst the 'Wave of Advance' might accurately account for the generalized results of diverse population movements, averaged over great spans of time, it does not describe the dynamics of actual population movements on a human time scale (Anthony 1990: 902). The Wave of Advance rests on the assumption that each migratory movement was statistically independent, "a random walk process" (Ammerman & Cavalli-Sforza 1984: 68). However, Anthony (1990: 903) has argued migratory moves are highly dependent on previous moves, and generally proceed along well-defined routes towards a specific destination. Another common feature of long-distance migrations ignored by the 'Wave of

Advance' is 'return' migration, where a counterstream of migrants returns back to their place of origin (Anthony 1990: 904).

In terms of the empirical evidence for a Wave of Advance, archaeologists (e.g. Zvelebil & Rowley-Conwy 1984; 1986; Zvelebil & Zvelebil 1988; Zvelebil 1998a; Zvelebil 1998b; 2002; Dennell 1992; Fix 1996) have pointed out the very different rates of spread of farming in different regions of Europe; the lack of evidence for rapid population expansion in many Early Neolithic populations; and the evidence of relatively large, complex Mesolithic populations. The Wave of Advance presupposes the introduction of a 'Neolithic package' into Europe. However, with the exception of southeast and central Europe, domesticates initially appear in Europe in a variety of contexts, often with many years - Zvelebil and Zvelebil (1988: 578) speak of millennia – separating the point at which they first appeared, to when they became economic staples (Dennell 1992: 76; Zvelebil 1998b). Archaeological evidence for the development of agriculture in Europe is affected by the nature of the archaeological record itself. Due to the ephemeral nature of many hunter-gatherer sites, there is a bias against their preservation and recovery, which has often resulted in an over emphasis on permanent agricultural settlements (Zvelebil & Zvelebil 1988: 579). The same is true for faunal remains, with a bias against the preservation and recovery of wild faunal remains at archaeological sites, meaning that the contribution of transient foraging-farming communities to the development of agriculture in Europe may be routinely underestimated (ibid.).

A further problem with the Wave of Advance is the very great demographic differentials between farmers and foragers, which is required to generate a continuous wave of population spread (Fix 1996: 626). Pertinent ethnohistorical evidence reveals the potential for a wide overlap between hunter-gatherer and subsistence-farming population densities. Ethnographic studies have shown that hunter-gatherer population densities can range tremendously, from 0.02-people-per-square kilometre to up to 100 people-per-square kilometre, with coastal, more sedentary, forgers having the highest population densities (cf. Kivisild et al. 2003; Sengupta et al. 2005; Sahoo et al.

2006). Meanwhile, the population density of subsistence farmers can vary enormously, ranging from 3-people-per-square kilometre, recorded in Laos and Zimbabwe; to 30-people-per-square kilometre in the Philippines; and over 300 people in New Guinea (Hassan 1975: 40). Even though these figures are only rough approximations, they clearly show that in certain situations in the past the population densities of hunter gatherers and foragers could have been similar (Zvelebil 1998b: 413). Furthermore, it cannot be assumed that the potential for population growth that farming economies allow for, actually occurred (Zvelebil & Zvelebil 1988: 579). In many areas of Europe the size and density of farming populations does not always seem to have been enough to cause or require emigration into new areas, and even in the presumed core-area of such expansions – southeastern Europe – the saturation process was slow and incomplete (Dennell 1992: 86; Zvelebil 1998: 412; Zvelebil & Zvelebil 1988: 579).

Subsequent research has also questioned the archaeological integrity of the 'Wave of Advance'. Many of the sites defined by Ammerman and Cavalli-Sforza as 'Neolithic' have subsequently been interpreted as hunter-gatherer sites (Jordan & Zvelebil 2009; Zvelebil 1998b: 413), and improved ^{14}C-dating techniques have revealed there to be regional variation in the speed of the spread of food production, suggesting much greater variance in the rate of spread of early farmers into different areas of Europe (Gkiasta et al. 2003: 534; Pinhasi et al. 2005: 2223).

2.4b. Population genetics

Ammerman and Cavalli-Sforza (1984) sought to further test the 'Wave of Advance' using genetic evidence. Theoretically, demic and cultural diffusion should cause different genetic signatures, with demic diffusion resulting in significant changes in gene frequencies, while cultural diffusion should lead to no change (ibid.: 82-4). A combination of both forms of diffusion would be expected to generate a gradient or cline in the direction of migration, as a

result of the genes of the original farmers decreasing proportionally from southwestern Asia to northwestern Europe.

In the 1970-80s when Ammerman and Cavalli-Sforza were working, it was only possible to study the genetics of modern European populations in the form of 'classical' (i.e. non-DNA) markers, such as allele frequencies in blood groups, the tissue antigen HLA system and enzymes (Richards 2003a: 160). Initially, Ammerman and Cavalli-Sforza used A.E. Mourant's (1976) work on the Rhesus (Rh) gene. Mourant noted that the Rh negative gene, which is found almost exclusively in Caucasians (European populations are predominantly Rh positive), has its highest frequency among the Basques, who also speak a language quite distinct from the Indo-European-based languages spoken by most of Europe (Fig. 2.7). His observations led him to propose that the Basques represented the descendants of the oldest inhabitants of Europe, who mixed at a later date than the rest of Europe with immigrants from outside the region. Ammerman and Cavalli-Sforza (1984: 87) suggested that these immigrants were farming populations originally from southwest Asia. The modern distribution of the Rh gene, then, is not in disagreement with the Wave of Advance model.

Following the success of the mapping of the Rh gene, Ammerman and Cavalli-Sforza (1984: 95-7) attempted a similar study with the ABO blood system. However, each of the blood groups were found to show a different pattern, none of which were in agreement with the Wave of Advance. Ammerman and Cavalli-Sforza (1984: 97) attributed the variation to the influence of factors other than migrations, such as natural selection and climate. The failure of the mapping of the distribution of the ABO blood groups emphasized to the pair, how individual gene maps can often show considerable variation to each other, making it difficult to obtain a clear overall picture of genetic trends in populations, an issue which they combated by the using a more synthetic approach: Principle Component Analysis (hereafter PCA).

PCA allows for the combining of the information from a number of genes. Ammerman and Cavalli-Sforza (1984: 105), for example, used 39. The method detects major patterns in the combined data from the genes, separates them from each other, shows each pattern in isolation, and estimates their relative importance as a fraction of the total amount of variation (Cavalli-Sforza 1997: 385). The name 'principle' refers to the fact that the method automatically selects the most important patterns, and sorts them in order of importance, as measured by their relative contribution to the total variation (ibid.). Ammerman and Cavalli-Sforza's (1984: 105) PCA of modern European populations showed that the first Principle Component (PC) – accounting for about 27 per cent of the total variation in classical marker frequencies across Europe and the Near East – showed a southeast–northwest cline (Fig. 2.8), which supported the 'Wave of Advance', and matched the distribution of Early Neolithic sites in Europe. The second and third PCs (Figs. 2.9 & 2.10), accounting for about 22 per cent and 11 per cent of the variation respectively, showed gradients that were orientated roughly southwest-northeast and east-west. Due to their lower impact on the genetic variation, Ammerman and Cavalli-Sforza assumed them to be the result of later dispersals, and suggested that the distribution pattern of the second PC could be the result of a series of migrations from Central Asia or parts of Russia towards Europe, perhaps starting with the movement of pastoral nomads in the third millennium BC; and that the third PC may reflect the expansion of Indo-European speaking people from their homeland in the Black Sea, or the so-called 'Barbarian' invasions in Late Roman times (Ammerman & Cavalli-Sforza 1984: 107-8).

Ammerman and Cavalli-Sforza's (1984) use of synthetic gene maps to validate the demic diffusion of agriculture has been questioned. Genetic clines can be produced by multiple mechanisms of which demic diffusion is only one (Fix 1996: 626, 631, 641; Barbujani & Bartorelle 2001: 21; Gkiasta et al. 2003: 60; Currat & Excoffier 2005: 659). Sampling error and statistic artefacts are also a problem (Zvelebil 1998b: 415; Sokal et al. 1999). Thus, "the demonstration of a cline in gene frequencies…does not specify the cause of the pattern; casual explanation depends on other information" (Fix 1996: 631).

Instead, a cline may reflect adaptation to variable environmental conditions, population expansion at one moment in time, and/or continuous gene flow between groups that initially differed in allele frequency (Barbujani & Bartorelle 2001: 21). Fix (1996: 636) suggested that the genetic clines Ammerman and Cavalli-Sforza associated with the demographic spread of early farmers may have been caused by natural selection. He posited that genetic fitness changed through time, as a function of increased disease intensities associated with the spread of agriculture which, because agriculture required several thousand years to spread across Europe, generated a gradient in duration and selection. According to Fix (1996: 625), then, the gene-frequency clines in Europe may indeed be due to domestication, but are the outcome of natural selection rather than demic diffusion. The analysis of gene frequencies in extent populations, including the demonstration of clines, is therefore not sufficient to establish the mechanism which produced them. Furthermore, different genes are expected to show different modes of variation purely by chance, quite aside from the action of selective pressures upon them (Barbujani & Bartorelle 2001: 25).

A further issue with the use of PC analysis is that genetic clines have no time depth (Sampietro et al. 2007: 2161). Thus, even if a genetic cline can be associated with a specific demic diffusion process, it does not correlate that it was created at this time (Currat & Excoffier 2005: 679; Richards 2003b: 157). Ammerman and Cavalli-Sforza's interpretation of the first PCA solely in terms of a Neolithic expansion is therefore questionable, as there are currently two processes in the demographic and evolutionary history of Europe that could account for the cline: the Palaeolithic colonization of Europe starting ca. 40,000 years ago, or the Neolithic agricultural diffusion (Sampietro et al. 2007: 2161). Furthermore, Europe as a small peninsula of Eurasia has been the sink for many dispersals throughout prehistory, and the distribution of modern genetic lineages is consequently likely to represent a palimpsest of multiple dispersals (Zvelebil 1998b: 414; Richards 2003b: 143, 161; Richards et al. 1996; Richards et al. 1997). Zvelebil describes Ammerman and Cavalli-Sforza's association of the first PCA with the spread of the Neolithic, as "tenacious at best" (1998b: 414).

Genetic clines, as well as no time depth, do not have any intrinsic stratigraphic order. Thus, Ammerman and Cavalli-Sforza's (1984: 105) assumption that the first PC is older than the second and third PC cannot be proven. Indeed, more recent studies suggest that it is likely that the second PC (running from southwest to northeast) may in part be the result of Late Glacial hunter-gatherer expansions, which preceded the Neolithic by over 50,000 years (Torroni et al. 1998: 1137). The direction of movement underlying a genetic cline can also be ambiguous, and the high frequency end of a cline can either represent: the area of pre-existing substrate least affected by a migration originating far away; or the final destination of a wave of migration into a thinly populated territory, where expansion and drift have had their greatest effects (Balaresque 2010: 1).

A further problem with Ammerman and Cavalli-Sforza's PC analyses, is that they rely on the *ad hoc* assumption of pre-Neolithic homogeneity across Europe, and account for neither back migration across Europe into the Near East, nor for subsequent post-Neolithic immigrations, both of which are known to have been high from mtDNA results as well as archaeological evidence Soanes et al. 2010: 179; see also Richards 2003).

Kenichi Aoki et al. (1996: 2) have argued that a particular problem with using genetic clines to support the 'Wave of Advance' is that according to the model, by the time farming reached the northern edge of Europe, the indigenous European population would already have been completely overrun by people of Middle-Eastern origin. Aoki et al. also critique Ammerman and Cavalli-Sforza for ignoring the fate of the indigenous hunter-gatherers, and whether they went extinct, continued to exist at a lower population density or become converted to farming? (Aoki et al. 1992: 2). To describe the spread of farming into regions where indigenous hunter-gatherers already existed, and to deal explicitly with the dynamics between them and early farming groups, Aoki et al. proposed the 'Reaction-Diffusion' model. The model diverges from the 'Wave of Advance', by expecting the spread of farming to be the result of both: the intrinsic growth rate of incoming farmers and their mobility; and the conversion

rate and carrying capacity of the indigenous hunter-gatherer populations. The Reaction-Diffusion model thus predicts that the clines seen in the genetics of modern European populations "are formed by diffusive admixture of the two farming populations" (Aoki et al. 1996: 15).

2.4c. Molecular-genetic approaches

In the late 1980s, it became possible to analyse not merely the products of certain genes, as done by Ammerman and Cavalli-Sforza (1984), but to analyse DNA sequences directly, enabling the study of the two non-recombining loci in humans: mitochondrial DNA (mtDNA), which is inherited down the maternal line; and Y-chromosomal DNA, which is inherited father to son (Richards 2003b: 144). The molecular approach has the advantage over classical analyses, in that it introduces a chronological dimension, allowing for the tracing of lineages back through time, and their dating using the molecular clock (ibid.: 135; Soares et al. 2010: 174).

The earliest molecular-genetic approaches focused on spatial autocorrelation analysis. Robert Sokal et al. (1991) sampled 26 genetic systems from 3373 loci in Europe, testing the correlation between them and a hypothetical origin of agriculture. Their findings confirmed the existence of a northwest-southeast cline for gene frequencies in Europe, leading them to conclude that the spread of agriculture through Europe, "was not simply a case of cultural diffusion, but involved significant differential reproduction of the new farmers whose origins can be traced to the Near East" (Sokal et al. 1991: 144); a conclusion they were able to qualify the following year (Sokal et al. 1992: 214). Other spatial autocorrelation analyses included that of Alberto Piazza et al. (1995), who used synthetic genetic maps to claim, in agreement with Ammerman and Cavalli-Sforza (1984: 105), that a Neolithic spread through Europe from the Middle East accounted for 26 per cent of modern genetic variation (Fig. 2.11) (Piazza et al. 1995: 5387); and Chikhi's et al. (1998) study of seven hypervariable loci in Europe (4 microsatellite, 2 larger tandem-repeat loci & a sequence polymorphism), which produced a similar broad, clinal

pattern of DNA variation, in agreement with the 'Wave of Advance' (Chikhi et al. 1998: 9053).

At the same time, Martin Richards et al. (1996; 1998) were using founder analysis to date the arrival of mtDNA lineages into Europe as a whole. Their results suggested that only a small minority of lineages dated to the Neolithic, with the remainder belonging to between 15,000–50,000 years ago, and presumably Middle or Late Upper Palaeolithic dispersals (Richards et al. 1996: 185; 1998: 241). Richards et al.'s findings were tentative, due to their reliance on comparisons with a very small and inadequate sample from the Near East (Richards 2003b: 148), but were confirmed by subsequent work by Antonio Torroni et al. (1998; 2001), who, by focusing on a particular mtDNA clade (haplogroup V), were able to show that a major Palaeolithic population expansion from southwest Europe, particularly Iberia, occurred around 10,000–15,000 years ago, probably as a result of Late Glacial re-expansions (Torroni et al. 1998: 1137). Torroni (1998: 1149) suggests that these Late Glacial re-expansions could provide a plausible explanation for Ammerman and Cavalli-Sforza's (1984) ambiguous second PC, which is orientated southwest–northeast. Brian Sykes (1999; see also Sykes 2003) refinement of the mtDNA phylogeny and enlargement of the sample size produced a similar conclusion, suggesting that the overall Neolithic contribution to modern mtDNA lineages was about 20 per cent, and that "the recolonization of Europe after the Ice Age from refugia…distributed the mitochondrial ancestors of most modern Europeans", and that "this event, and not the Neolithic, that was the most significant in shaping the mitochondrial gene pool" (Sykes 1999: 137).

More recently, Richards et al. (2000) have used a greatly improved Near Eastern mtDNA database, as well as more sophisticated founder analysis, to build on their earlier work. Their findings show, that under various criteria, the putative Neolithic component in modern Europe was between 12–23 per cent, with the best estimate being ~13 per cent; the Early Upper Palaeolithic component between 2– 17 per cent, with ~7% the best estimate; and that the Late Glacial expansions, conflated with preceding Middle and Upper

Palaeolithic immigration, accounted for between about two thirds of modern lineages (Richards et al. 2000: 1272). Richards et al. also applied founder analysis at a more regional level, which showed that the highest Neolithic impact occurred in southeastern, central, northwestern and northeastern European populations, where it accounted for 15–22 per cent of modern haplogroups (Richards et al. 2000: 1267). Fewer Neolithic-derived lineages occurred along the Mediterranean and Atlantic coasts (~10%); while the Basque region, the outlier in PCA of mtDNA and classical markers, had the lowest Neolithic content of all (~7%). It appears, then, that at least on the maternal line of descent, only a minority of European ancestors were Near Eastern farmers, and that the majority were indigenous hunter gatherers who presumably adopted agriculture later on (Richards et al. 2000: 1272; Richards 2003b: 149).

Barbujani and Chikhi critiqued Richards et al.'s work, arguing that the ages of molecules cannot be equated with the ages of populations (Barbujani & Chikhi 2006: 83; but see also Barbujani et al. 1998; Chikhi et al. 1998; Barbujani & Bartorelle 2001; Chikhi et al. 2002). They believe that migrating people carry alleles and haplogroups in their genome originally from mutations that occurred before, sometimes long before, the migratory movement started, and that inferring from the former the date of the latter is never straightforward (Barbujani & Chikhi 2006: 83). Richards and colleagues responded by arguing that mtDNA can be used to establish the age of a population, and that "founder analysis was explicitly designed to get round this problem" (Richards 2003b: 151; see also Sokal et al. 2009). However, Barbujani and Chikhi's work is useful in emphasising that, like with using classical markers, there are inherent problems with mtDNA founder analysis.

Around the same time as the early mtDNA work was being conducted, similar studies were being undertaken on extant European Y-chromosome lineages. Ornello Semino et al. (1996) identified candidates for both an indigenous European clade of Y-chromosome lineages (paragroup R*), and a likely Near Eastern Neolithic component, haplogroup J. Haplogroup J showed a cline similar to Ammerman and Cavalli-Sforza's first PC for classical markers, with

the highest diversity appearing to be in the Fertile Crescent, or possibly Iran (Quintana-Murci et al. 2001: 538). In comparison, paragroup R* was most common in Western Europe and declined moving east. Subsequent studies by Semino et al. (2000; 2004) and Z.H. Rosser et al. (2000) involving a larger set of markers, have substantiated these results, identifying hg-J2 and hg-E1b1 as representing the Y-chromosome components of a Neolithic demic diffusion into Europe (see also Giacomo et al. 2004; Soares et al. 2010). The frequency of these haplogroups in modern populations, suggests that the Near Eastern contribution to Europe as a whole was about 20–25 per cent, with the remainder of the Y-chromosome gene pool (~78%) attributable to Palaeolithic expansions from glacial refugia in Iberia and the Ukraine (Semino et al. 2000: 1158). The association between Near Eastern haplogroups and a Neolithic diffusion into Europe is supported by the archaeological record. Roy King and Peter Underhill (2002: 712) have found evidence of a significant correlation between the distribution of Near Eastern Y-chromosome haplogroups (particularly Eu9), and Neolithic painted pottery of the Cardio Culture at Early Neolithic sites in Europe, supporting the demic diffusion, at least of early farming males, from the Fertile Crescent as far west as southern France (King & Underhill 2002: 713).

By the early 2000s, the Y-chromosome dataset was sufficient to study worldwide patterns. Comparison of these showed that the Y-haplogroups of European and western and central Asian populations are closely related, particularly when compared to sub-Saharan African and East Asian populations (Underhill 2004: 492). Underhill et al. propose that two of the particular haplogroups concerned (hg-III & part of hg-VI), could have spread into Europe by Neolithic expansion, supporting a model of demic diffusion with population admixture, from southeast to northwest Europe during the Neolithic (Underhill 2003: 74; Underhill et al. 2001: 59).

Lounges Chikhi et al. (2002) analysed 22 binary markers on the Y-chromosome in order to model situations of admixture, followed by genetic drift, between two ‘ideal’ populations: one using modern Near Eastern samples to represent a ‘Neolithic’ node; and the other using modern Basque

and Sardinian samples to represent a 'Palaeolithic' node. Their findings led them to conclude, that the contribution of Near Eastern Neolithic farmers to Europe as a whole was on average greater than 50 per cent (Chikhi et al. 2002: 11010). This figure is far higher than both the original estimate of Ammerman and Cavalli-Sforza (1984), and the evidence from mtDNA analysis (Richards et al. 1996, 1998, 2000) and other Y-chromosome studies (Semino et al. 2000), which have both yielded averages of under 30 per cent. The validity of Chikhi et al.'s findings can be critiqued on a number of grounds. Their approach lacks any time scale; makes no allowance for back migration into the Near East – which mtDNA data suggests was considerable (Richards et al. 2000: 1204); and assumes that Palaeolithic populations and Near Eastern populations were unitary groups (Richards 2003b: 154).

Balaresque et al.'s (2010) Y-chromosome study, the most recent to date, refutes Chikhi et al.'s claims. Balaresque et al. focused on the haplogroup-R1b1b2, which is carried by ca. 110,000,000 men in Europe, and has a southeast-northwest clining distribution, which reaches its highest frequency in Ireland (~85%) (Balaresque et al. 2010: 1) (Fig. 2.12). This cline has traditionally been interpreted as the result of a postglacial expansion. However, Balaresque et al.'s work indicates that it actually spread together with farming from the Near East, supporting the earlier work of Semino et al. (1996; 2000; 2004) and Rosser et al. (2000) on haplogroups J2 and E1b1.

Recent advances in archaeogenetics have made possible the study of ancient DNA (hereafter aDNA), offering "a powerful new means to test evolutionary models and assumptions" (Haak et al. 2005). One of the earliest aDNA studies was Haak et al.'s (2005), which sequenced the HVR1 of mtDNA from 24 Neolithic skeletons from various locations in Germany, Austria and Hungary, dating to the *Linearbandkeramik* or LBK, ca. 5500-4900 BC). Haak et al. (2005: 1017) found 25 per cent (6 out of 24) of the samples to have a distinctive rare N1a lineage of mtDNA, and that of these 5 out of 6 displayed different N1 haplotypes, and were wide spread in the LBK area. Modern Europeans have 150 times lower frequency (0.2%) of this mtDNA type, which suggested to Haak et al. (2005: 1018) that the first farmers in this region did

not have a strong impact on the genetic impact of modern European female lineages. Consequently, they propose that small pioneering farming groups carried farming into new areas of Europe, and that once the technique had taken root, indigenous hunter-gatherer populations adopted them, outnumbering the original farmers and diluting the N1a frequency to its low modern value. More recent work by Haak et al. (2010) on LBK samples, involving a considerably extended genetic data set of 42 individuals, has shown that the LBK population shared an affinity with modern Near Eastern and Anatolian. However, the LBK population also showed unique genetic features, including a distinct distribution of mtDNA haplogroup frequencies, which suggests that major-demographic events continued to take place in Europe after the Early Neolithic. aDNA from a range of Mesolithic hunter-gatherer samples from neighbouring regions to the LBK area, have been shown to be surprisingly homogenous across time and space, with an mtDNA composition almost exclusively of haplogroup U (ca. 80%), which is clearly different from the LBK dataset, as well as modern European populations (cf. Bramanti et al. 2009). The combined data from LBK and Mesolithic hunter-gatherer populations is compatible with a model of Central Europe in the Early Neolithic of indigenous populations, plus significant inputs from expanding populations in the Near East (Haak et al. 2010: 8). Haak et al. conclude that, "Overall, mtDNA haplogroup composition of the LBK would suggest the input of Neolithic farming cultures (LBK) to modern European genetic variation was much higher than that of Mesolithic populations, although some unique characteristics of the LBK sample imply that further significant genetic changes took place in Europe after the Early Neolithic" (2010: 8).

Conversely, Sampietro et al.'s phylogeographic analysis of HVR1 sequences from 11 Neolithic remains from Granollers, Catalonia, northeast Spain, dated to ca. 3500 BC, showed that the haplogroup composition of the samples was very similar to that found in modern populations from the Iberian Peninsula, "suggesting a long-time genetic continuity, at least since the Neolithic times" (2007: 2161), and that early farmers from the Near East have had little to no influence on modern genetics in the region. The contrast between Sampietro et al.'s findings and those from the LBK region, suggest that the spread of

early farming was complex. Sampietro et al. (2007: 2161), for example, propose a 'dual model' for the Neolithic spread, with acculturation occurring in Central Europe and demic diffusion in southern Europe. Clearly, more regional studies of aDNA are needed before any firm conclusions can be made, but current evidence indicates that "the Neolithic spread was neither genetically nor geographically a uniform process" (Sampietro et al. 2007: 2167).

It would appear, then, that the overall Neolithic contribution to modern European populations was somewhere between 12–23 per cent on the female side (with the most likely value 13%), and up to 22 per cent on the male side, depending on how much overwriting there has been in recent times (Richards 2003b: 154; Barbujani & Chikhi 2006: 84). A possible explanation for the disparity between the distribution of mtDNA and Y-chromosome lineages, is that it arose because of the increased and transmitted reproductive success of male farmers, compared to indigenous male hunter gatherers (i.e. male farmers 'married' female hunter gatherers, but not vice versa), without a corresponding difference between females from the two groups (Balaresque et al. 2010: 6). Perhaps, the best way of understanding the ambiguous nature of the genetic evidence, is to adopt Peter Bellwood "common sense scenario" (2005: 264), in which an early farming population spread into Europe from the southeast, but gradually disappeared in a genetic sense, as farming spread westwards across Europe. In a more refined version of Bellwood's scenario, Soares et al. (2010: R183) use a synthesis of mtDNA and Y-chromosomal results to model that, first, farming was likely dispersed into Europe by human migration, accompanied by a spread of domesticated plants and animals beyond the migrants. Second, that immigration from the Near East was minor, and there was substantial adoption of farming by indigenous groups in many parts of Europe; and third that post-Neolithic migrations may have later considerably reshaped the genetic landscape.

Colin Renfrew (1987), a staunch supporter of the Wave of Advance, contends that agriculture and the Proto-Indian European language family were introduced into Western Europe by a wave of from immigrant farmers from the

Fertile Crescent, ca. 8000 years ago. He argues that in prehistory major language replacements were only likely to occur when incomers speaking a different language moved into a new territory, and outcompeted the local population, and that the spread of agriculture was one, perhaps the only, way that this could have occurred (Renfrew 1987: 174). Similarly to Ammerman and Cavalli-Sforza (1984), Renfrew (1987: 174) argued that none of the incoming individuals need to have moved more than a few kilometres each in search for new farmland, for the gradual and cumulative effect of such displacements to result in the spread of a new population, whose descent could be traced back to the original early farming areas.

Renfrew (1987; 1989) initially ignored genetic evidence, believing geneticists to "have brought historical linguists and indeed archaeologists nothing but confusion in the past" (Renfrew 1989: 149). However, in light of the great advancement in genetic studies, Renfrew has subsequently retracted his position, in favour of the use of genetic evidence, arguing that "it is clear that a brilliant future lies ahead for DNA-based work" (1992: 471). In response to the growing volume of genetic studies that suggest that the contribution of incoming Neolithic populations to the European gene pool was low (e.g. Sykes 1999, 2003; Richards et al. 1996, 1998, 2000; Toroni et al. 1998 Richards 2003b), Renfrew proposed the Staged Population Interaction Wave of Advance (SPIWA) model. The SPIWA utilizes many of the assumptions of the original wave of advance, predicting that farming groups will outcompete hunter-gatherer groups in most territories, and that population spread will take the form of random displacement behavior. However, it differs by allowing for gene flow between incomers and indigenous populations, with asymmetry existing between male versus female, and incomer versus indigene gene flow and, thus, allowing for exponential decline in the frequency of incoming DNA with distance. Renfrew (2000: 13) argues that as time passed, genetic drift and further admixture would further have diminished frequency differences, and homogeneity would have increased. According to the SPIWA, then, in areas which were initially settled by Palaeolithic populations, the genetic frequency of Palaeolithic lineages will often be greater in magnitude than that of later ones, such as those of Neolithic farmers.

Due to their controversial nature, both the Farmer/Language Dispersal Hypothesis and the SPIWA have been heavily critiqued. At the most general level, the whole nature of the relationship between language, culture, and population assumed by the models has been questioned (Sherratt & Sherratt 1988; Zvelebil & Zvelebil 1988; Kivisild et al. 2003: 216). The Farmer/Language Dispersal Hypothesis effectively equates the Indo-European language group with people (the first farmers), and the archaeological context of the Neolithic. However, Renfrew makes no attempt to prove the association between a people, a language, and a cultural trait, and by so doing, creates a normative view of culture, language and genetics, which is "inadequate and oversimplified" (Zvelebil & Zvelebil 1988: 575). To paraphrase Kohl, conflating language, culture and race is the "cardinal sin" of molecular anthropology (Kohl in Lawler 2008). Further, the notion of a widespread distribution of Indo-European languages in prehistory is questionable, and it is probable that the present distribution is the result of more recent dispersals (Sherratt & Sherratt 1988: 376; Zvelebil & Zvelebil 1988: 576; Robb 1993). Even if Proto-Indo European did spread during the Neolithic, the idea that it spread by a single, continual process, is "highly questionable" (Zvelebil & Zvelebil 1988: 576).

Renfrew (1987; 1989; 2000) posits that both the Farmer/Language Dispersal Hypothesis and the SPIWA are equally apposite to the spread of agriculture to South Asia, proposing that "some sort of Wave of Advance operated to the south and east as well as to the north and west from primary zones in and near East Anatolia" (Renfrew 1989: 149). He advocates that the development of farming in the Near East may have been responsible for several expansions and language replacements in addition to that from Anatolia (Fig. 2.13), including to Khuzestan, "where the Deh Luran area was another focus of early farming [from which] we can predict another expansive process this time to the south and southeast" (1989: 134). In terms of where Mehrgarh fits into this model, Renfrew (1989: 134) hypothesizes that the origins of farming at the site can be situated in the Near East, with farming arriving in Pakistan by a process of demic diffusion analogous to the European case (1989: 134). Renfrew, in support of his conclusion, cites the work of Zohary and Hopf

(1988: 36) who believe the cereal species attested at Mehrgarh to be of Near Eastern origin. Peter Bellwood also supports Renfrew's thesis believing, "the spread [of agriculture] to Pakistan probably occurred through northern Iran" (Bellwood 2005: 84). However, as Renfrew admits, the application of the Wave of Advance to Central Asia is purely hypothetical, and "what works in Europe does not necessarily apply so well for the transmission of farming across or along the western flanks of the Iranian plateau" (1987: 197). The situation is further complicated by the current lack of archaeological information from Central Asia and Afghanistan, which "makes further speculation rather difficult" (Bellwood 2005: 84).

The genetic evidence of a Neolithic population dispersal from the Near East to South Asia is complex, and compared to Europe "the debate for this region is really only starting" (Bellwood 2005: 262). One of the earliest molecular-genetic studies in South Asia was that of Giuseppe Passarino et al. (1996), who found evidence for a dilution of an ancient mtDNA marker in northern India, by Caucasoid populations coming in from western Asia, which they interpreted as supporting the demic spread of Indo Europeans into India. Their work was subsequently expanded on by Lluis Quintana-Murci et al. (1999; 2001; 2004) who analyzed a set of 459 Y-chromosomes from several populations, located in key geographical positions between the Fertile Crescent and northern India. Their results suggest that there were two episodes of demic diffusion from the northwest, represented by haplogroups 9 and 3 (Quintana-Murci et al. 2001: 538). Haplogroup 9 – which has been interpreted as an indicator of the demic diffusion of farming into Europe (e.g. Semino et al. 1996) – is largely confined to Caucasoid populations, with its highest frequency occurring in Iranian populations (~30-60%), and its lowest in Pakistan (19%) and northern India (19%) (Quintana-Murci et al. 2001: 538). Quintant-Murci et al. argue that the high incidence, and global haplotype diversity, of Iranian haplogroup 9 chromosomes, suggests that Iran is the geographical origin of haplogroup 9, and that the decreasing frequency decline towards Pakistan and northern India, supports a model where farming spread by major population dispersal from Iran to India (Quintant-Murci et al. 2001: 538-9).

Haplogroup 3 has its highest frequency in Central Asia, and exhibits a decreasing frequency cline westwards into Europe, which suggests that Central Asia is the source region (Quintana-Murci 2001: 539). The distribution of hapolgroup-3 in Iran shows a marked difference between western (3%) and eastern provinces (31%), with a decreasing frequency cline towards India, which again can be interpreted as evidence of an eastern spread of early farmers (Quintana-Murci et al. 2001: 539-40). The calculated dates for the spread of haplogroups 9 and 3 are between 4000–6000 years ago, and 3500–4500 years ago, respectively (Quintana-Murci et al. 1996: table 2), leading Quintana-Murci et al. to conclude that the "geographical distributions, observed clines, and estimated ages of HG-9 and HG-3 chromosomes in southwestern Asia all support a model of demic diffusion of early farmers from southwestern Iran…into India" (Quintana-Murci et al. 2001: 541).

Other mtDNA analyses, however, present a different picture. Toomas Kivisild et al. (2003) suggest that more than 50 per cent of the maternal lineages of most present-day Indians, derive from a common ancestor, haplogroup M, which split into Indian, eastern Asian, Papuan and Australian subsets 40,000–60,000 mtDNA years ago (Kivisild et al. 2003: 215-6), and that the second major component in modern Indian mtDNA, traces back to the split of haplogroup U into Indian, western Eurasian and northern African variants, at approximately the same time. They suggest that at least 90 per cent of modern Indian maternal lineages date back to the Upper Palaaeolithic and, thus, do not support the demic diffusion of Indo-Europeans into India during the Neolithic (Kivisild et al. 2003: 220-1), although they do accept that the majority of Indian paternal lineages, do not share recent ancestor with eastern Asian populations, but stem from haplogroups common to eastern Europe or western Asian populations (ibid.: 215). However, they caution against interpreting this finding in favour of the demic diffusion of Indo-Europeans, believing that such an interpretation, "is probably caused by a phylogeographically-limited view of the Indian Y-chromosome gene pool" (Kivisild et al. 2003: 215). The genetic evidence as it currently stands for the spread of agriculture into South Asia, then, is ambiguous, and much more work is needed before any firm conclusions can be made.

2.4d. Cultural diffusion

Although no scholar would deny the introduction of farming into Europe from the Near East, profound differences in opinion exist about the rate, direction and methods of dispersal (Zvelebil & Zvelebil 1988: 576). Some scholars have stressed the evidence of Mesolithic-Neolithic continuity in some parts of Europe, particularly north-western Europe, and argued that in regions such as these, farming spread by indigenous acculturation (e.g. Sherratt & Sherratt 1988; Zvelebil & Zvelebil 1988; Zvelebil & Rowley-Conwy 1984, 1986; Dennell 1992; Zvelebil 2002; Rowley-Conwy 2004). These scholars have also emphasised how the Neolithic transition over Europe as a whole, was a "slow, gradual process, taking upwards of 3000 years to complete" (Zvelebil & Rowley-Conwy 1984: 104). Dennell (1992: 86), for example suggests that in the UK, foraging and farming coexisted for much of the fourth millennium BC.

Zvelebil and Rowley-Conwy's (1984; 1986) 'Availability' model, is perhaps the most widely-accepted model of indigenous acculturation. It describes the spread of agriculture from a farming to a non-farming group as a 'process', which passes through three phases of frontier situation (availability, substitution & consolidation), before an agricultural economy is fully implemented (Zvelebil & Rowley-Conwy 1984: 104). During the availability phase, agriculture is available to hunter gatherers, but plays little or no role in their economy; in the substitution phase, agriculture accounts for 5–50 per cent of the diet; and during the consolidation phase, agriculture accounts for over 50 per cent of the diet (ibid.: 105-7). The actual transition to agriculture, the substitution phase, is very rapid as "people depend on agriculture either to a negligible extent or heavily" (Rowley-Conwy 2004: 97). Zvelebil and Rowley-Conwy argue, that while the initial adoption of agriculture might have taken place for a multitude of reasons, the subsequent outcome of this process inevitably resulted in the demise of the hunter-gatherer economy, and "the Neolithic economy was in the end adopted because of a lack of alternative" (Zvelebil & Rowley-Conwy 1984: 124).

Robin Dennell expanded on the Availability model (Zvelebil & Rowley Conwy 1983), by proposing a number of different forms that the agricultural frontier could have taken, “ranging from static to mobile…impervious to porous” (Dennell 1985: 135). Dennell (1992: 84) argues that agricultural frontiers existed in the regions for which there is ‘diffuse’, rather than ‘crisp’, evidence for the development of agriculture. ‘Crisp’ evidence refers to sites containing evidence for the earliest local use of domesticated plants and animals, pottery and polished stone artefacts, whilst at sites with diffuse evidence the “essential background to understanding the origins of… agriculture in these areas is the local Mesolithic”. Dennell’s (1992: 92) argued that it is in the latter, that long-lasting agricultural frontiers would have existed.

In terms of how the genetic evidence may support indigenous acculturation models, Zvelebil argues that Ammerman and Cavalli-Sforza’s (1984) first PC does not necessarily have to represent the spread of Near Eastern farmers, but may instead represents a ‘starburst’ pattern, in which small communities of farmers colonized limited areas from the Near East, and then interacted with local hunter-gatherers within agricultural frontier zones (Zvelebil 1998b). Zvelebel proposes that these interactions would have involved both the transmission of cultural knowledge, including the practice of farming, and gene exchange through marriage alliances. Zvelebil argues that with the adoption of farming practices, hunter-gatherer-turned-farmer communities were able to grow and expand, “filling in niches hitherto suboptimal for hunting and gathering” (ibid.: 414). Zvelebil, thus, argues that “it was not farmers migrating from the Near East, but local hunter-gatherers-turned-farmers who were undergoing expansion after a period of contact and gene flow with earlier farming populations” (ibid.: 414-5), which spread farming across much of Europe, a pattern which Zvelebil believes better conforms with the archaeological evidence.

Increasingly, it has come to be recognized that the ‘Wave of Advance’ describes a large-scale process, and that a refined version of an agricultural advance would involve a more selective colonization of specific areas, with frequent halts in the process of expansion, and input from local hunter-

gatherer groups (van Andel & Runnels 1995; Zilhao 1993; 2000; Bogucki 2000; Zvelebil 2000b; Zvelebil et al. 2000; Sherratt 2003; Zeder & Smith 2009). The colonization is selective in that first the most fertile regions were settled, followed by a secondary colonization of suboptimal areas at a later date. Selective colonization allows for the existence of hunter-gatherer survivals in regions not initially colonized by farmers, and for the adoption of farming by local hunter-gatherer groups (Sherratt 2003: 61).

Andrew Sherratt has emphasized how the distribution of Early Neolithic sites in the Near East and Europe, was “restricted and highly selective” (Sherratt 1980: 314). They were generally associated with alluvial fans, lake edges, or other areas with high ground water, which would have been ideally suited to floodwater farming; a process which Sherratt defines as a “small-scale system of crop growing which takes advantage of seasonally wet ground, with sewing occurring after small annual inundations” (2007: 6). Floodwater farming would have idealy suited small groups of early farmers with simple technology, “as it requires less soil preparation and forest clearance than rainfall agriculture, and is more predictable than rainfall agriculture and therefore a safer economic strategy” (Sherratt 1980: 317). It also had the potential to spread widely, to wherever similar alluvial niches were to be found, resulting in a distribution pattern where sites, “although having locally high population levels, were spatially restricted with large intervening uncultivated areas between them” (ibid.: 318). Sherratt does not out rightly reject the ‘Wave of Advance’, believing it to “offer an adequate representation at low levels of spatial resolution” (2003: 61), however, he argues that higher magnification reveals a more detailed view in which a different set of patterns predominates, the modeling of which has largely been due to the work of Tjeerd van Andel and Curtis Runnels (1995).

van Andel and Runnels, whose work primarily focused on early farming sites in southeastern Europe and the Balkans, model that farming in these areas spread by salutatory jumps or discrete steps, “the length and spacing of which was dictated by geography and population growth, in each of the parent areas” (1995: 497) (Fig. 2.14). They concur with Sherratt that the optimal

areas selected by early farmers for colonization were flood plains, believing that although other areas would have permitted the survival of early farmers, it was only on the flood plains that it was possible to support populations large enough to start the next migratory move (van Andel & Runnels 1995: 497). These migratory moves did not occur in a uniform direction, but rather spread in a "pattern of interstitial penetration around and among established populations, with early farmers occupying the areas no-one else wanted" (Sherratt 2003: 60).

Following the work of van Andel and Runnels (1995) and Sherratt (1980, 2003), more complex models for the spread of early farming have been proposed, which see a more staggered 'pulse'-like rate of expansion, with long periods of stability in between, and which do not completely eradicate hunter gatherers in agricultural areas (Bellwood 2005: 277-8). Indeed, Peter Bellwood, although a firm advocate of the 'Wave of Advance', suggests that "as long as there are niches, hunters can of course survive for millennia amongst farmer" (Bellwood 2005: 84). Similarly, Peter Rowley-Conwy advocates that though "major movements of people were probably frequent…[they] were probably much slower and less directional" (Rowley-Conwy 2004: 97) than suggested by the 'Wave of Advance'. Rowley-Conwy models that farming probably spread through a range of processes including leapfrog migration, where a group or subgroup moves just beyond its neighbours into available space; trickle migration, involving the movement of individuals over periods of a generation or more; and creep migration, where migration is so slow that it may be scarcely discernible in a human generation (ibid.). Rowley-Conwy describes these processes as collectively creating a "rapid and massive socioeconomic…wave of disruption" (2004: 97).

Such models are also supported by recent re-evaluations of the ^{14}C evidence. Bocquet-Appel et al. (2009) were able to work on a more regional scale than Ammerman and Cavalli-Sforza (1984), facilitated by a 30-fold increase in ^{14}C determinations. Using a sample of 3072 calibrated ^{14}C dates from 940 georeferenced Early Neolithic sites, Bocquet-Appel et al. (2009: 809-16) reconstituted the surface expansion of Early Neolithic sites to show, that

although the general pattern of the diffusion gradient was the same as Ammerman and Cavalli-Sforza's, the expansion was not uniform or regular across Europe, but proceeded in leaps (Fig. 2.15). They conclude that "clearly, the whole does not correspond to a process of homogenous diffusion approximately steady, but a process marked by phases of geographical expansion and stasis" (Bocquet-Appel et al.: 816), and suggest that the leaps were caused by multiple obstacles including geographical, ecological, population and cultural (ibid.: 811).

John Robb and Preston Miracle (2007) question whether the polar dichotomy drawn between demic diffusion and acculturation models is useful or, indeed, relevant. They argue that neither of the paradigms is really plausible, and that although it is conventionally perceived that a fast rate of spread is representative of the spread of early farmers, and a slow spread is consistent with acculturation models, that in reality hunter-gatherer acculturation need not have been a slow process. Robb and Miracle (2007: 102) argue that hunter-gatherer groups are often highly mobile and thus, that large distances of up to 50 kilometres could have been covered by a single transmission of agriculture from one foraging group to the next, while sedentary farmers, which are generally much less mobile, would have required many more steps to cover the same distance. In terms of the other criterion used to distinguish migration from acculturation – the spread of a complete or piecemeal 'Neolithic package' – Robb and Miracle argue that there lies a double standard of logic. They argue that whilst farmers are perceived as carrying "their physical and conceptual baggage with them like a snail carrying its shell", indigenous hunter gatherers "shop at the Neolithic store", actively selecting elements to incorporate into their lifestyles (ibid.: 102). Instead, they believe that the Neolithic transmission from one group of farmers to another, would equally have been an active choice, and in areas where the transition to farming was slow (e.g. northern Europe), such a phase might have existed for several centuries. Robb and Miracle (2007: 106) also contend that farming and foraging groups were "fluid", and not the closed, static entities that classic migrationist and acculturation models (e.g. Ammerman & Cavalli-Sforza 1984; Zvelebil & Rowley-Conwy 1984, 1987) have typically perceived them as. They

argue that people are always moving and that this movement can take many forms, including that of individuals and families, multi-family groups, and entire self-sufficient societies; and that it is not always directional. For example, hunter-gather women did not always 'marry into' farming groups as some scholars (e.g. Richards 2003b; Richards et al. 2000) suggest. They further caution that many outcomes are equifinal, leaving similar archaeological patterns, which make it difficult to interpret what was taking place, and that, indeed, this may have been a deliberate move on the part of early farmers, "who were consciously seeking to reshape their ancestry" (Robb & Miracle 2007: 113).

2.5. Conclusion

It is clear, then, that while we may have a general appreciation of the processes involved in the development of agriculture, there exist several competing paradigms, and many questions remain unanswered. As Simmon's (2007) states, echoing views voiced by Flannery over three decades earlier (Flannery 1973: 272), "it is unlikely that there will ever be one broad covering law to explain this process" (Simmon 2007: 26). However, though there may exist no broad covering law, there does appear to be a core of recurring traits, which "in their general sense are relevant in many, if not all, instances of agricultural emergence" (Zeder & Smith 2009: 688). These factors include population pressure, or at least high population density; environmental and climatic factors; and social and cultural change. Other factors may have been more significant at a more regional level, such as variable responses to global climatic shift; the diversity and distribution of potential domesticates; the appropriate harvesting and processing technology; storage; sedentism and trade and communication networks (ibid.). However, the circumstances of the agricultural transition seem to have varied locally, and these traits cannot be consistently and satisfactorily applied. Furthermore, as Zeder and Smith stress, "isolating and selectively emphasizing any of these very general macrolevel overarching factors…does not explain very much about how the process unfolded on the ground in either region" (Zeder & Smith 2009: 6878).

Perhaps, as Andrew Sherratt argues, the background to the agricultural transition is best understood as, “an unusual time in an unusual place, when the elements were shaken up and reconfigured, in the presence of behaviourally modern human populations” (Sherratt 2007: 3).

There is also no universally accepted model for the spread of agriculture, and the nature of the spread appears to have varied both geographically and temporally. If we take the ‘long view’, as advocated by the historian Fernand Brandel (2001), and focus on long-term dynamics, then a ‘Wave of Advance’, similar to that originally described by Ammerman and Cavalli-Sforza (1984), can perhaps be said to apply, while a more nuanced approach reveals that the spread of agriculture involved a variety of, not mutually exclusive, mechanisms, which varied according to local environmental, social and economic conditions. These mechanisms, which have been summarized by Zvelebil (2000b), include: demic diffusion by means of a ‘Wave of Advance’ (Ammerman & Cavalli-Sforza 1984; Renfrew 1987; Bellwood & Renfrew 2002); infiltration of communities by a small number of specialists fulfilling a particular need (e.g. livestock farmers) (Zvelebil 2000b); leapfrog colonization by small groups, targeting optimal areas (Sherratt 1980; van Andel & Runnels 1995); frontier mobility or exchange between farmers and hunter gatherers at agricultural frontier zones (Zvelebil & Rowley-Conwy 1984; Dennell 1990); and regional contact involving trade and the exchange of ideas (Sherratt 2007). Thus, perhaps as Sherratt comments, “almost all of the suggested models …for the last thirty years, have some elements of truth; the challenge is to mobilize them in their appropriate contexts…rather than treating them as competing universal explanations” (Sherratt 2007: 10).

Some scholars (e.g. Bellwood 2005; Robb & Miracle 2007; Zeder & Smith 2009) question whether the use of grand-scale models such as the Wave of Advance, actually help us to understand the processes of the agricultural transition, or merely serve to mask the nuances of local migration and acculturation events. However, more commonly it is held that both macro- (e.g. Wave of Advance) and micro- (e.g. ‘leapfrog colonization’) models can be reconciled, and understood as operating at the same time, depending on the

scale of observation. Albeit, there are exceptions, where there are very clear cases for one or the other, for example the acculturation of forager groups on the Atlantic seaboard and the demic diffusion of farmers from the Near East to southeastern Europe, but, on the whole, these are in the minority.

In terms of the eastwards spread of agriculture, and the application of models for the origins and development of agriculture in Central and southern Asia, there has been relatively little progress. Colin Renfrew (1987; 1992) and Peter Bellwood (2005, 2007; Bellwood & Renfrew 2002) both propose that processes similar to the 'Wave of Advance', operated to the east, as well as to the west; but the issue has never been closely examined. It is one of the major objectives of this research to do this, by focusing on the Neolithic of Iran, and particularly that of the Central Iranian Plateau, and its implications for Central and southern Asia as a whole. In the following chapter the climatic and environmental context of Iran is described, and a summary of the key excavated Neolithic sites given.

Aliens
‘Agriculture as a drug’
Big men
Broad-spectrum adaptation
Circumscription
Climatic change
Competition
Cultural evolution
Cultural diffusion
Demic diffusion
Domesticability
Environmental degradation
Familiarity
Feasting
Geniuses
Girls’ hormones
Hormones
Intelligence
It was the ‘right time’ (i.e. humans were ready)
Kitchen gardening
Land ownership
Multi-causal
Marginal environments
Natural selection
Natural habitat
Nutritional stress
Plant migration
Population growth
Population pressure
Random genetic change
Resource concentration
Resource pressure
Rich environments
Rituals
Scheduling conflicts
Sedentism
Storage
Technological innovation
Vitalism
Water access
Zoological diversity

Table 2.0: *Some suggested causes for the transition to food production. (After Gebauer & Price 1992.)*

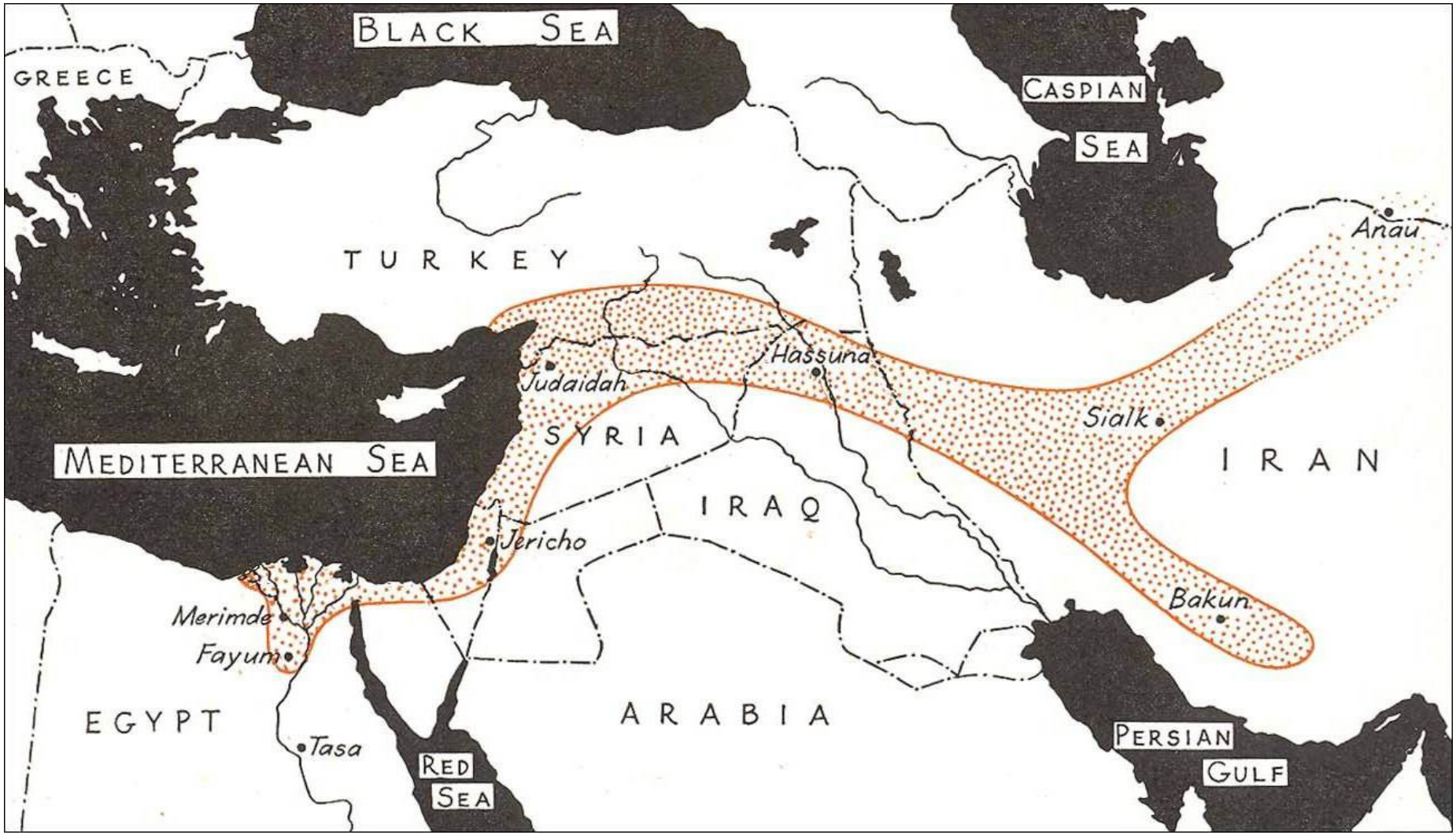


Figure 2.0: *The Fertile Crescent showing the position of the earliest known village sites. (After Braidwood 1950: 51.)*

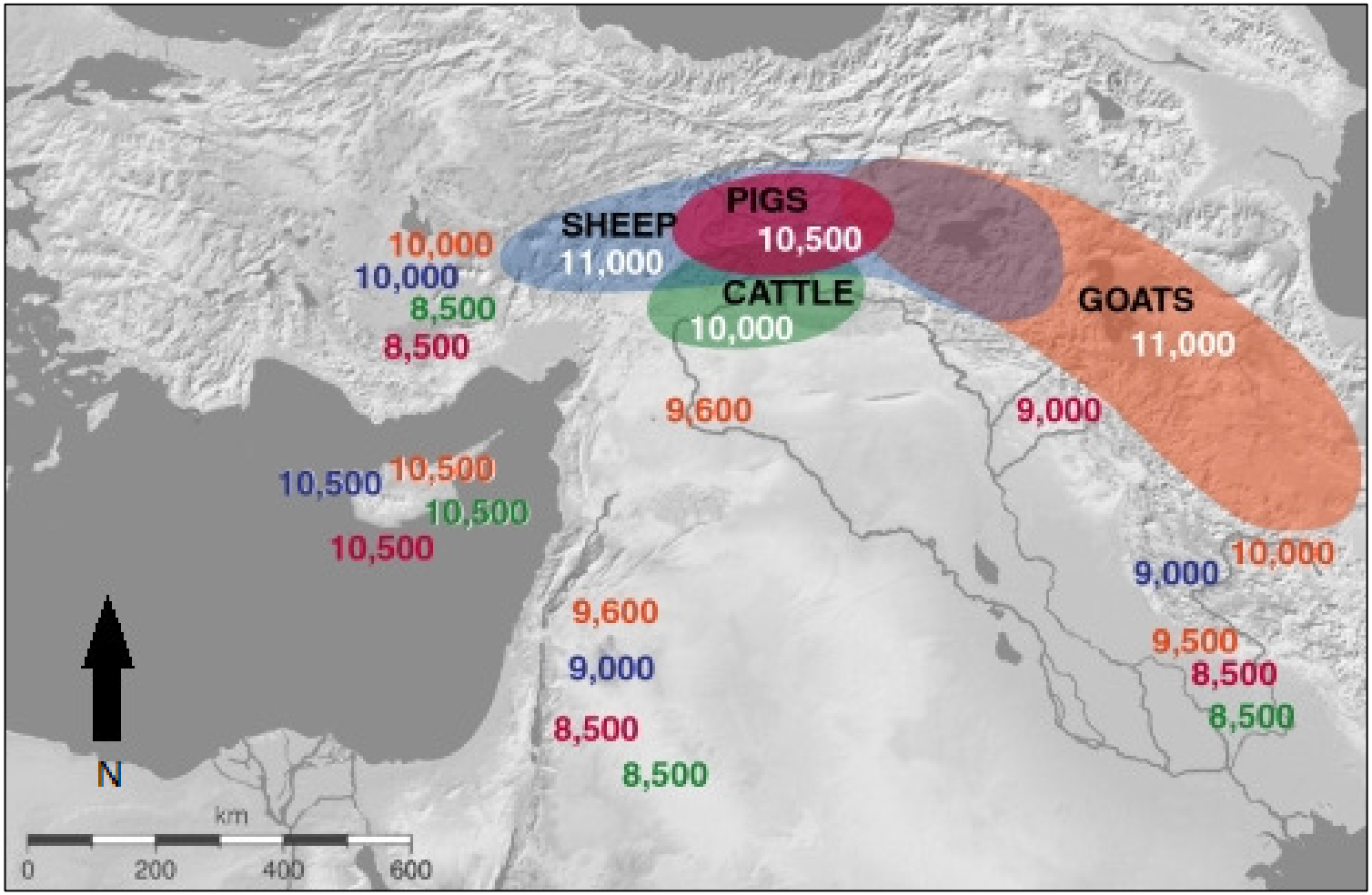


Figure 2.1: *The origin and dispersal of domestic livestock species in the Fertile Crescent. Shaded areas show the general region the approximate dates in calibrated years BP, in which initial domestication is thought to have taken place. Dates outside the shaded areas show the approximate date when the domesticate first appears in a region. (After Zeder 2008: fig. 1.)*

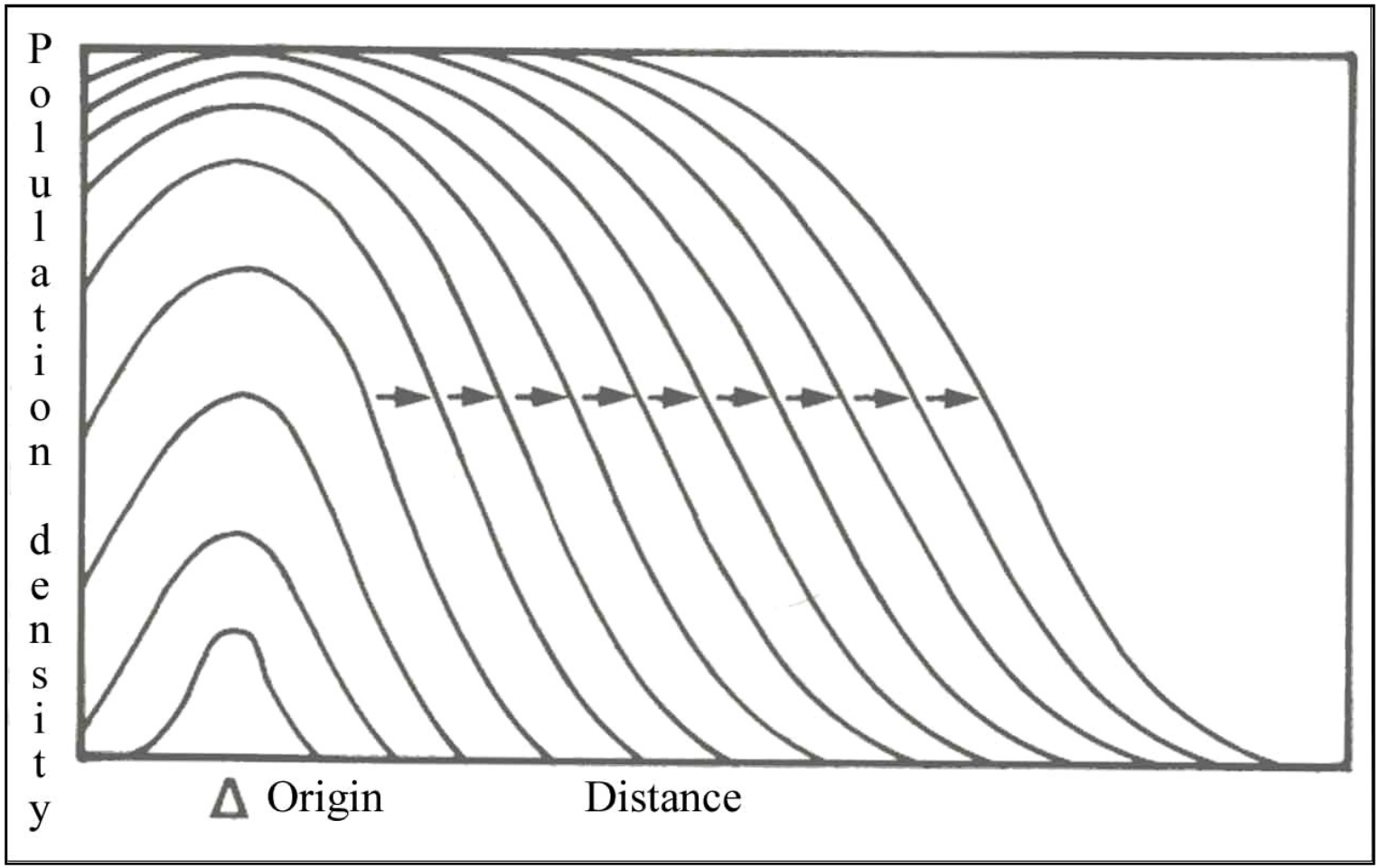


Figure 2.2: *Fisher's model of a population wave of advance: this graphic representation shows the rise in local population density expected with increasing distance from the origin as time elapses. (After Ammerman & Cavalli-Sforza 1984: 69.)*

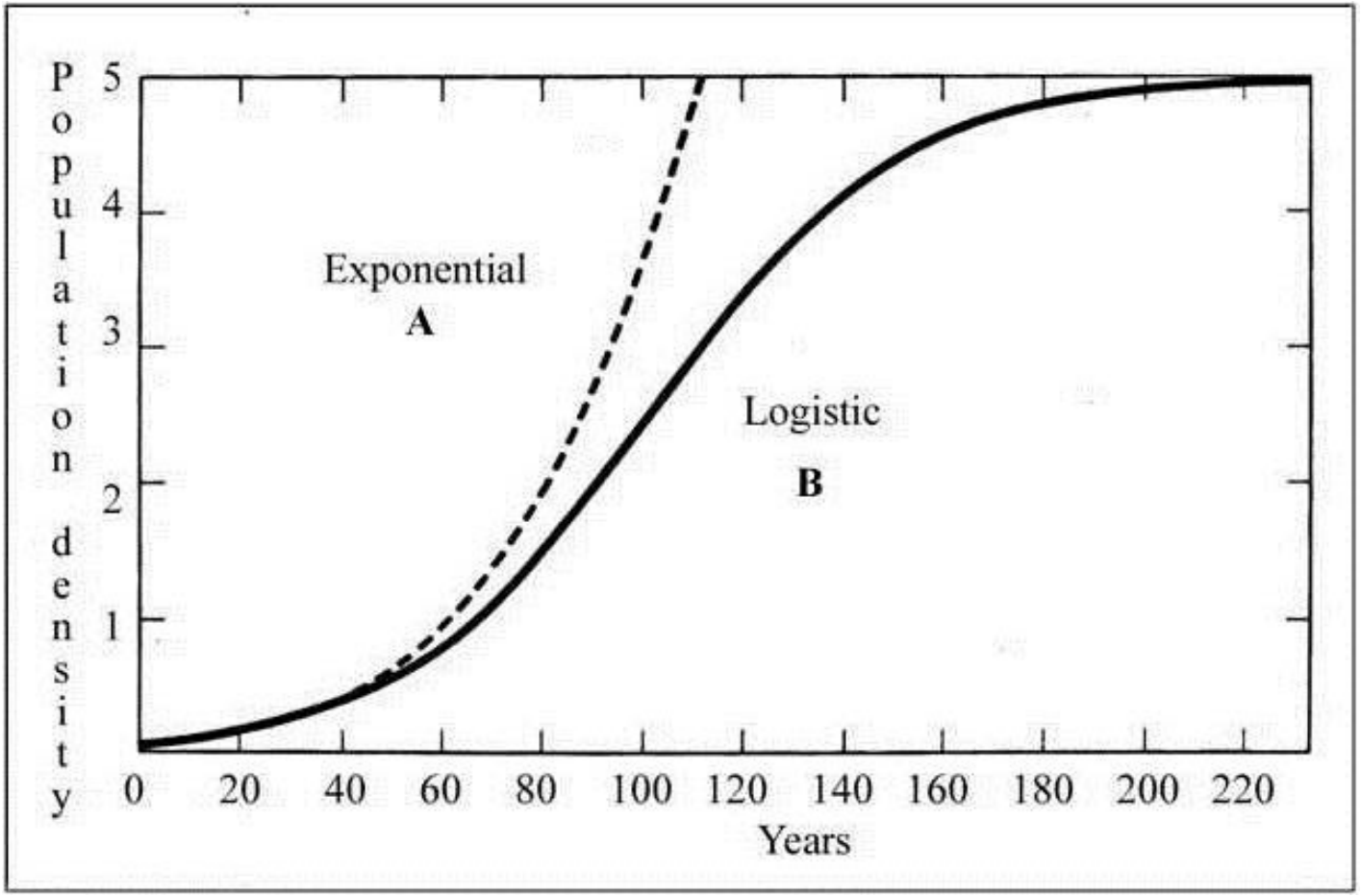


Figure 2.3: *A graphic representation of logistic and exponential growth: A - exponential growth where the same rate of growth continues indefinitely through time; and B - logistic growth where the growth rate is high at the beginning but slows down in time and eventually stops as an upper limit of population density is approached. The later is more realistic model of population growth as it allows for the growth rate to be responsive to the carrying capacity of the environment. (After Ammerman & Cavalli-Sforza 1984: 72.)*

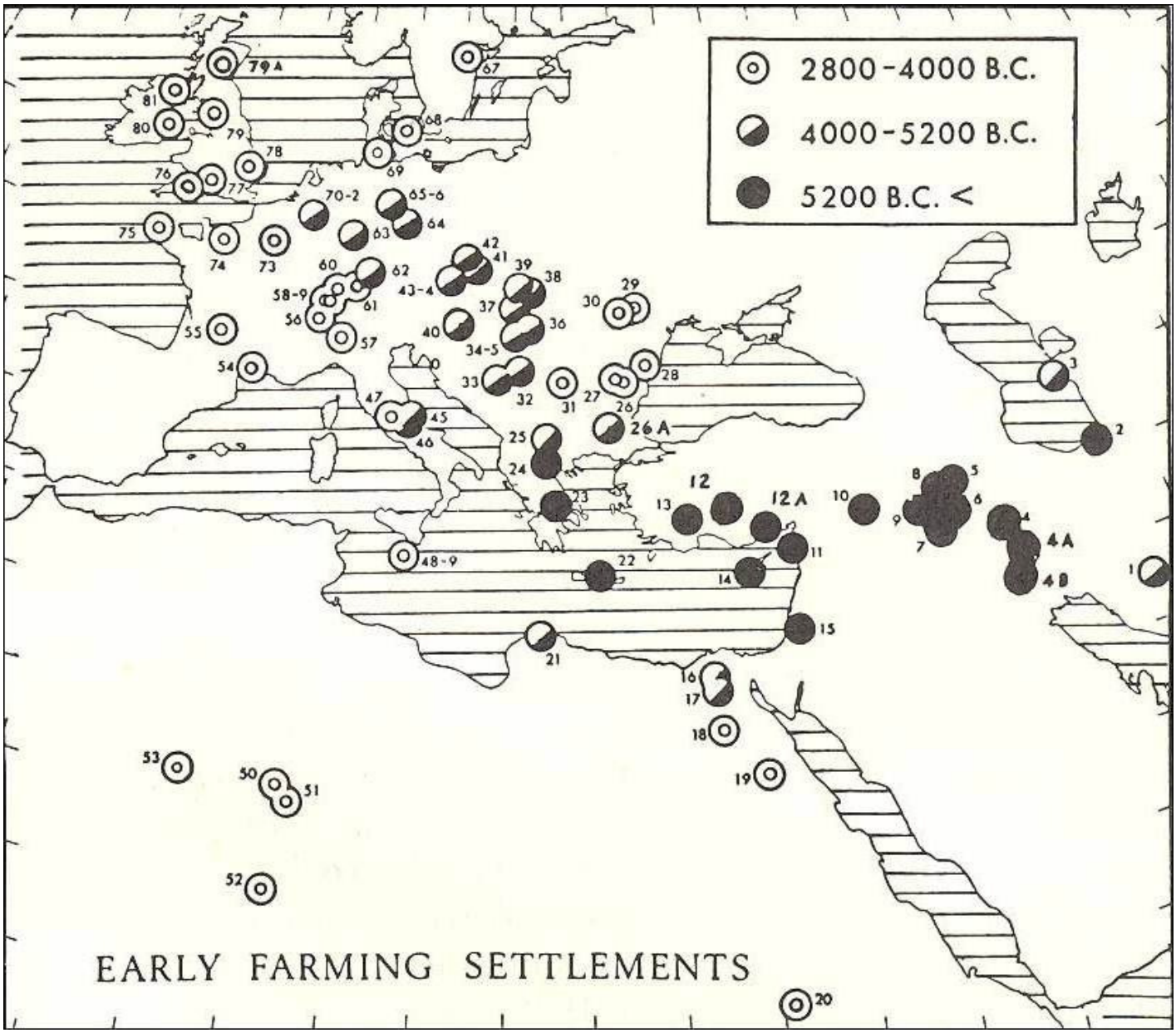


Figure 2.4: *Map showing locations and dates of early farming settlements in Europe and the Near East. (After Clark 1965a: 65.)*

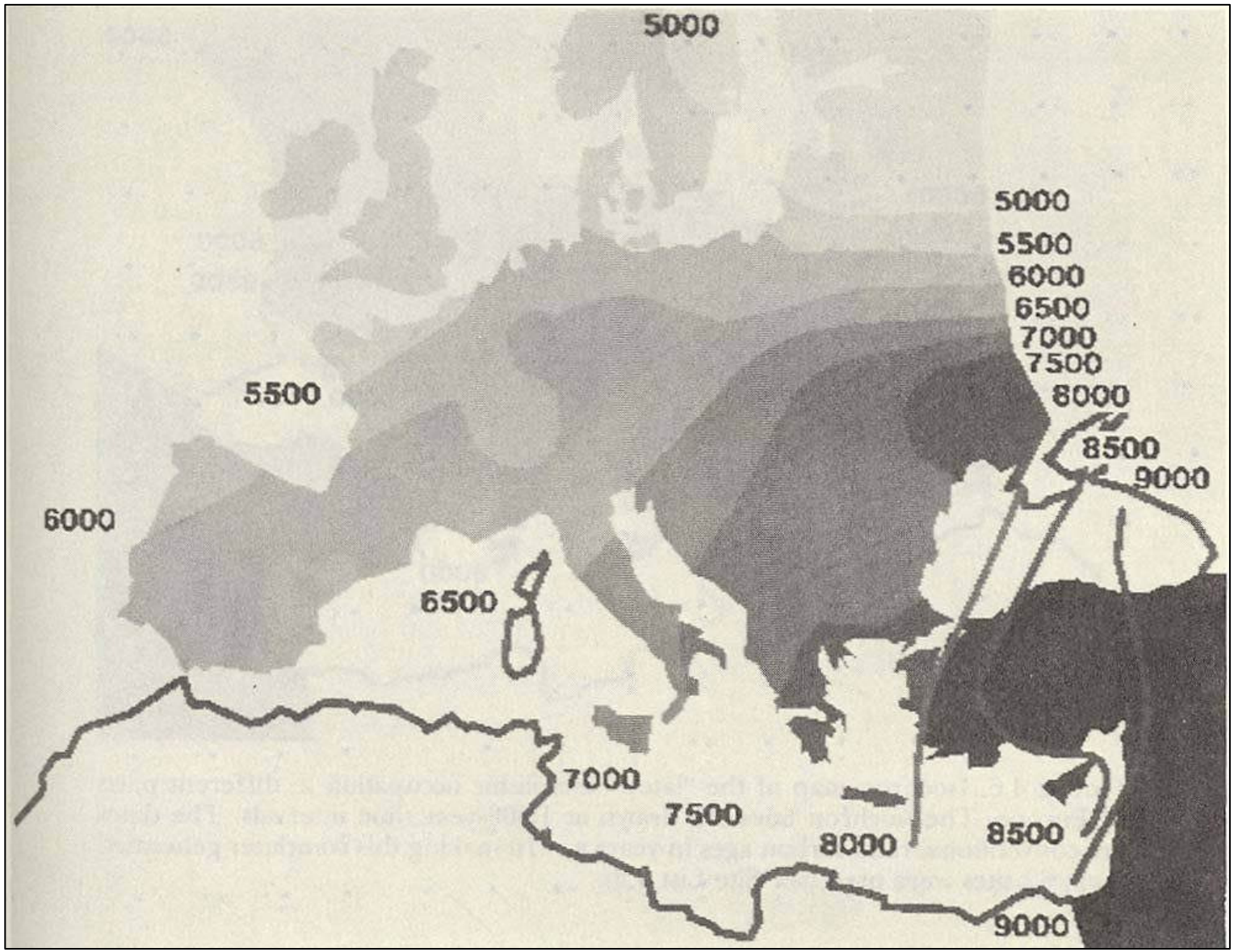


Figure 2.5: *Isochronal map of spread of early farming in Europe. The isochrones are drawn at a 500-year time interval. The dates are conventional ^{14}C ages in years BP. (After Ammerman & Cavalli-Sforza 1984: fig. 4.5.)*

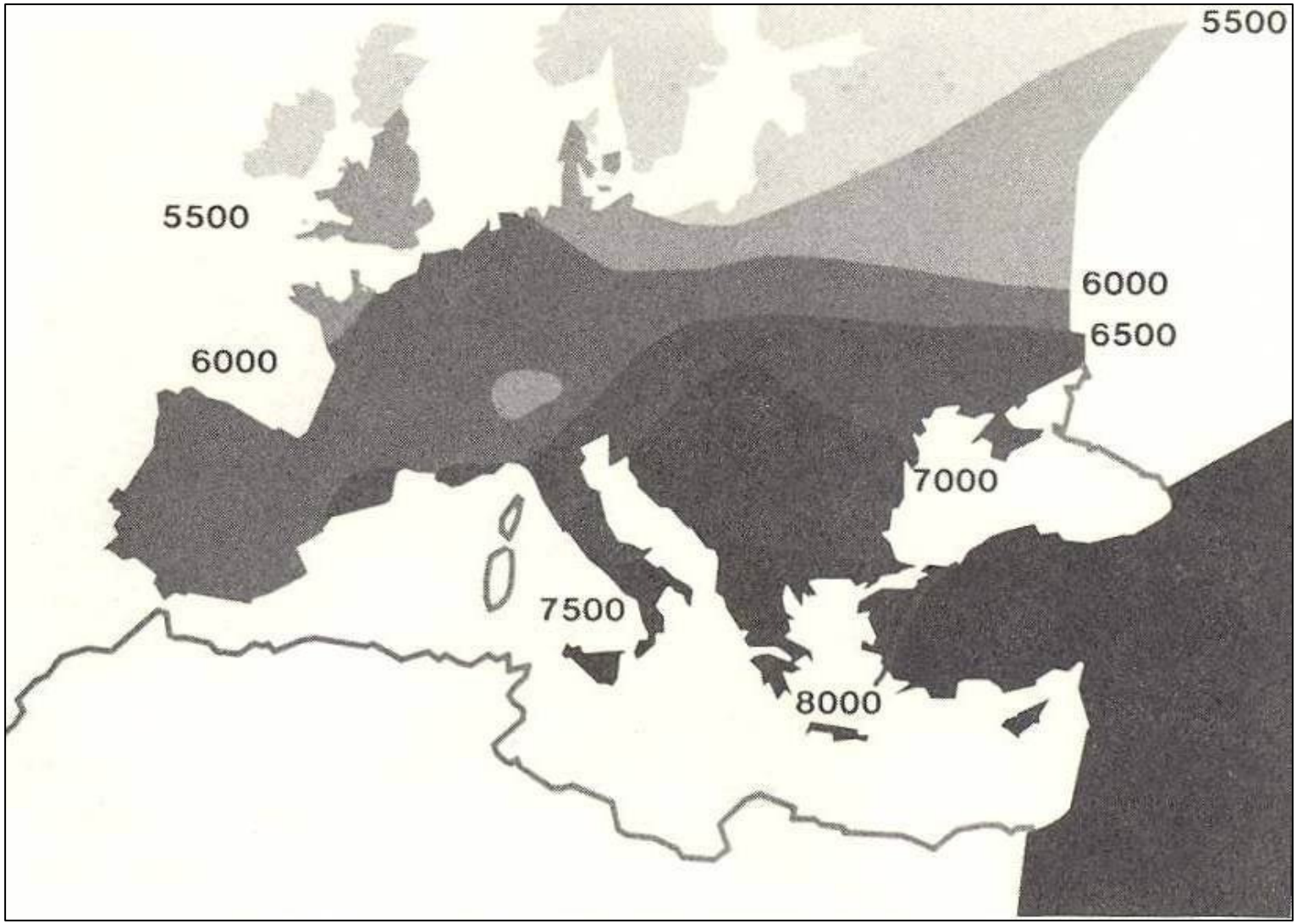


Figure 2.6: *Isochronal map of the 'latest' Mesolithic occupation in Europe. The isochrones are drawn at a 500-year time interval. The dates are conventional ^{14}C ages in years BP. (After Ammerman & Cavalli-Sforza 1984: fig. 4.6.)*

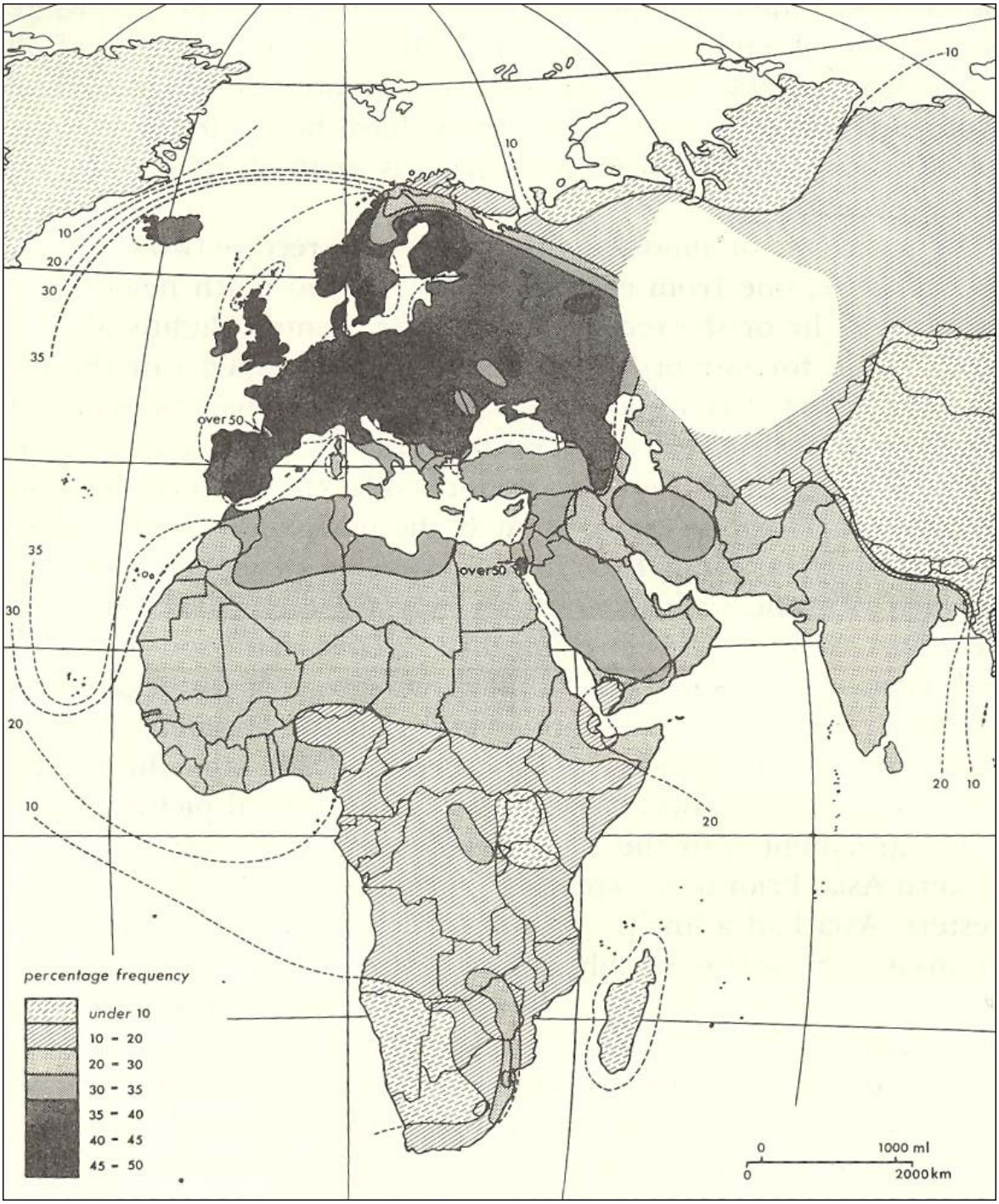


Figure 2.7: *Map of the Rhesus negative gene in the populations of Europe, Africa & western Asia. (After Mourant et al. 1976: fig. 22.)*

Figure 2.8: *Contour map of the first PC of the genetic analysis of populations in Europe. (After Ammerman & Cavalli-Sforza 1984: fig. 6.10.)*

Figure 2.9: *Contour map of the second PC of the genetic analysis of populations in Europe. (After Ammerman & Cavalli-Sforza 1984: fig. 6.11.)*

Figure 2.10: *Contour map of the third PC of the genetic analysis of populations in Europe. (After Ammerman & Cavalli-Sforza 1984: fig. 6.12.)*

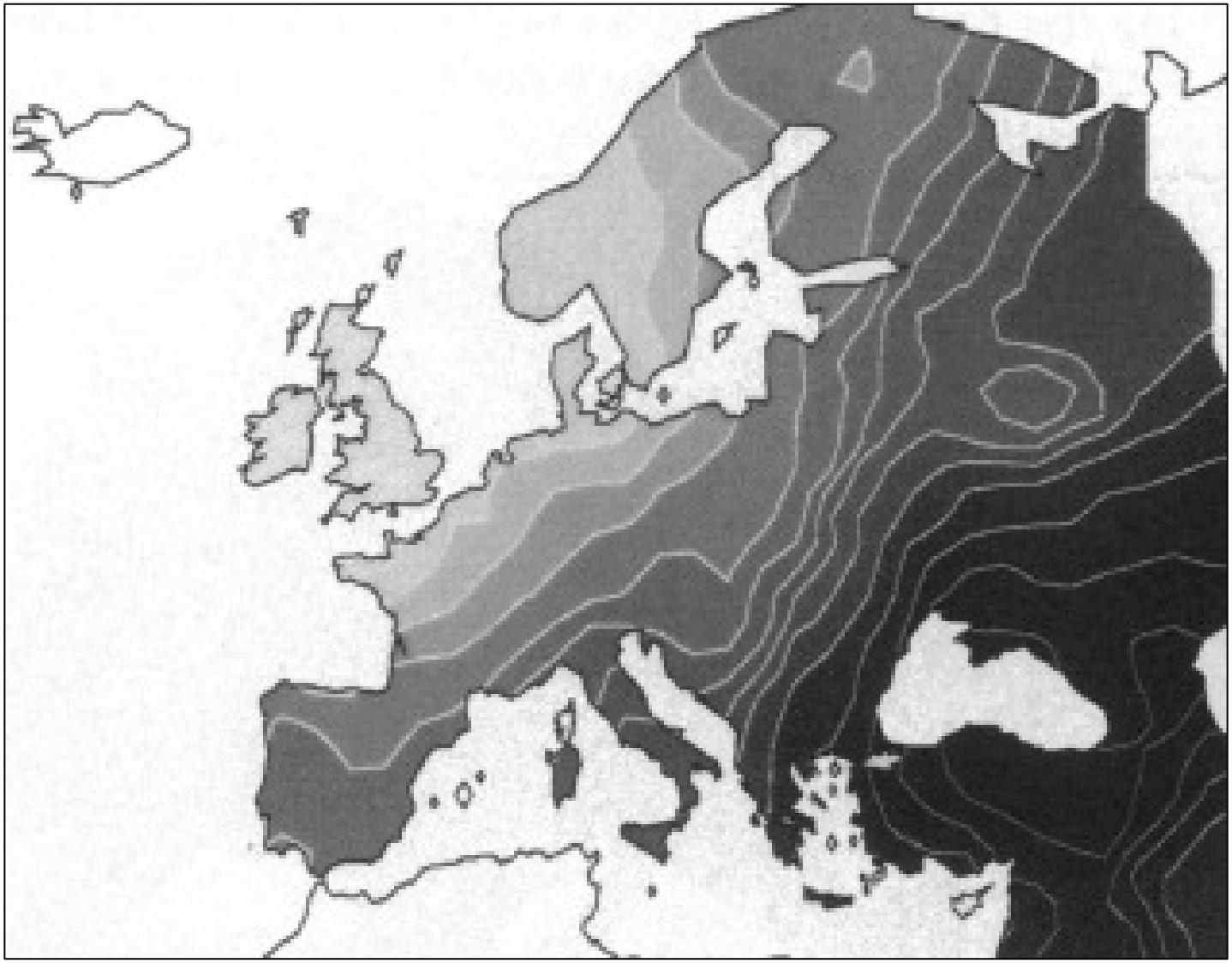


Figure 2.11: *Synthetic map of the first PC values calculated from 95 gene frequencies in Europe. The map conveys 26 per cent of the total genetic variation. (After Piazza et al. 1995: fig.1.)*

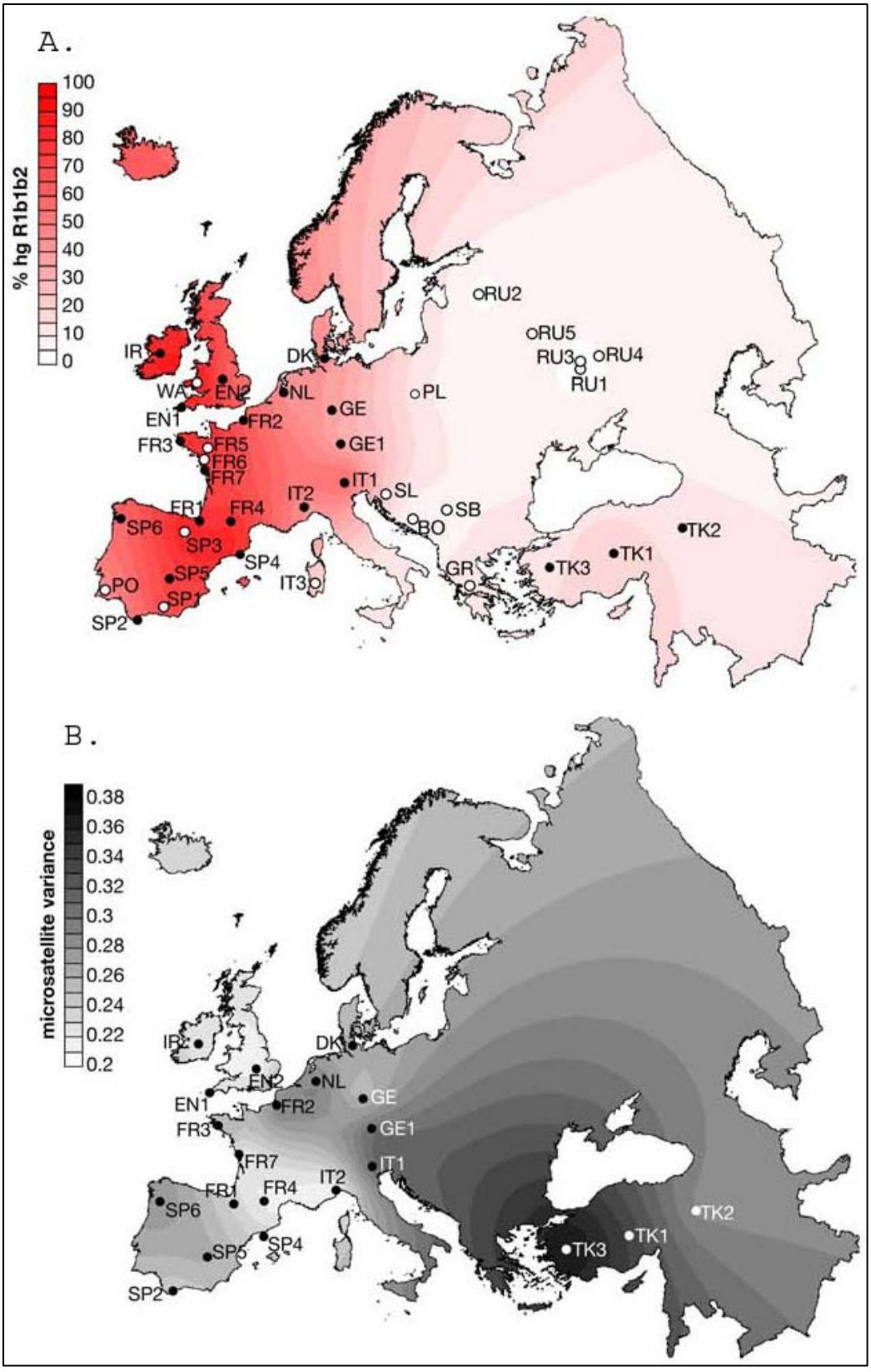


Figure 2.12: *Maps showing the frequency and microsatellite variance of haplogroup R1b1b2: (A) Geographic distribution of haplogroup frequency of hgR1b1b2; (B) Geographic distribution of mean microsatellite variance within hgR1b1b2. Both maps are shown as an interpolated spatial frequency surface. (After Balaresque et al. 2010: fig. 1.)*

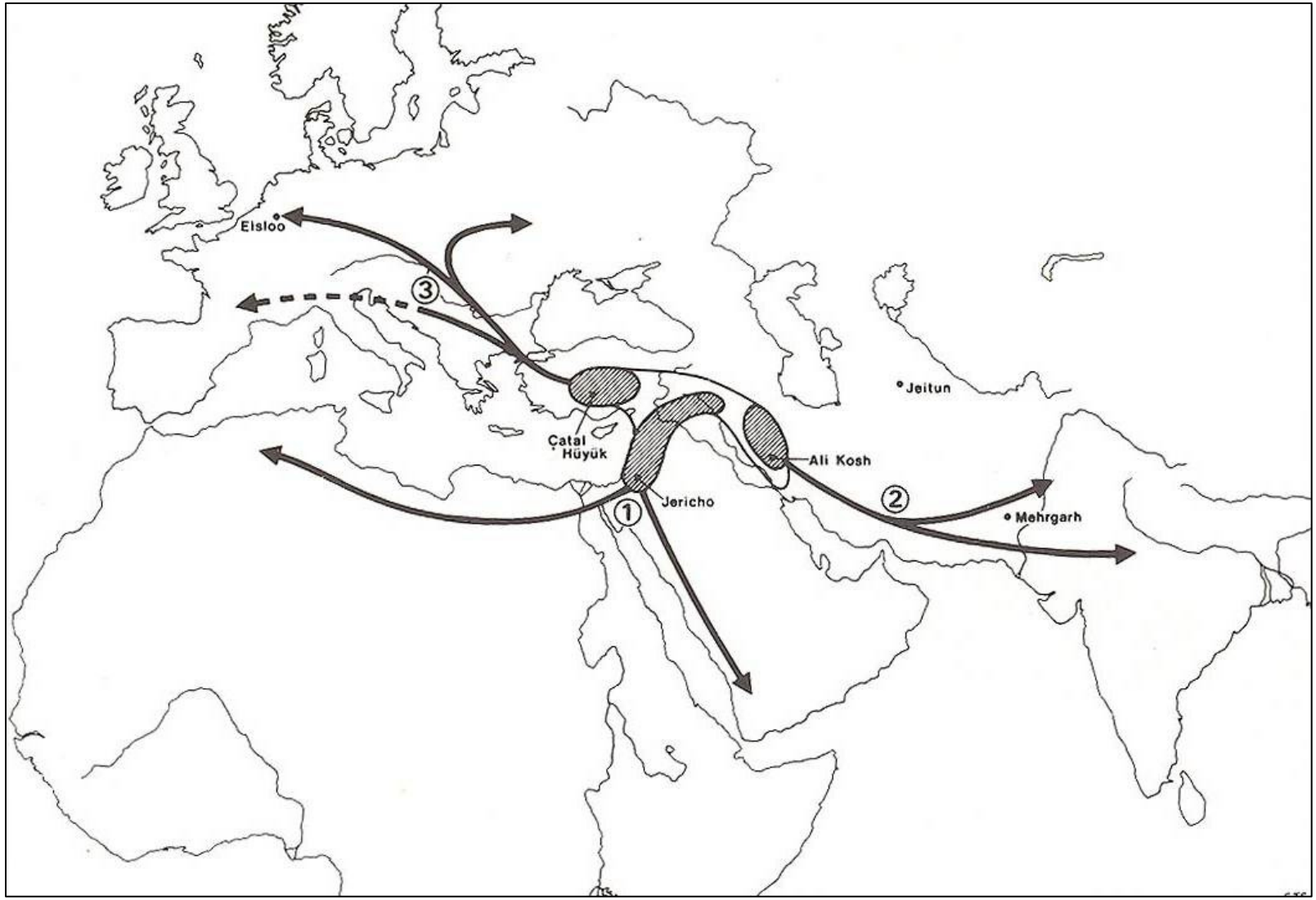


Figure 2.13: *Hypothetical application of the FLDH to the Neolithic Near East. Renfrew postulates that ca. 10,000 BC Proto-Afro-Asiatic, Proto-Elamo-Dravidian, & Proto-Indo-European languages were spoken in the Near East within the hatched areas. The early development of farming within this nuclear area may have led to agricultural dispersals & hence language replacements responsible for the early widespread distribution of: (1) Proto-Afro-Asiatic languages; (2) Proto-Elamo-Dravidian languages; & (3)Proto-Indo-European languages, possibly be 4000 BC. (After Renfrew 1989: fig. 8.)*

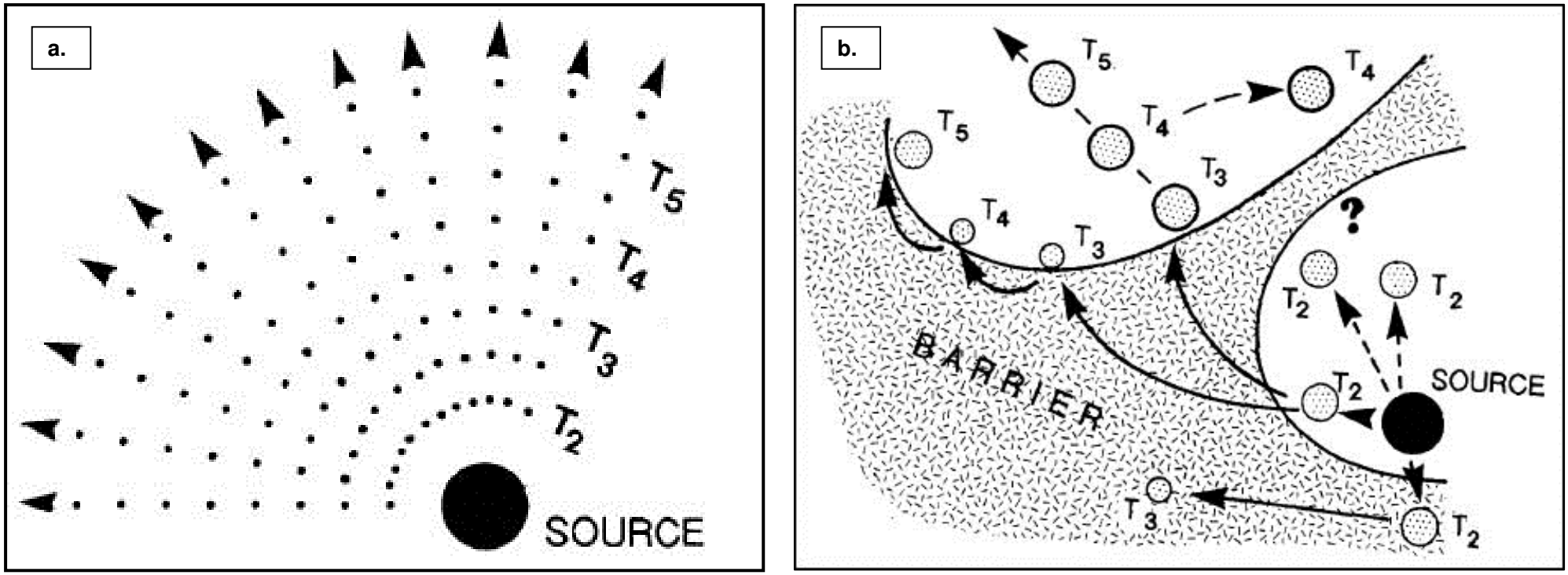


Figure 2.14: *(a) the original wave of advance model as applied by Ammerman and Cavalli-Sforza (1984); & (b) the wave of advance model modified by the addition of a barrier (e.g. sea, desert, mountain) to gradual movement, combined with a strong preference for optimal environments. (After van Andel & Runnells 1995: fig. 12.)*

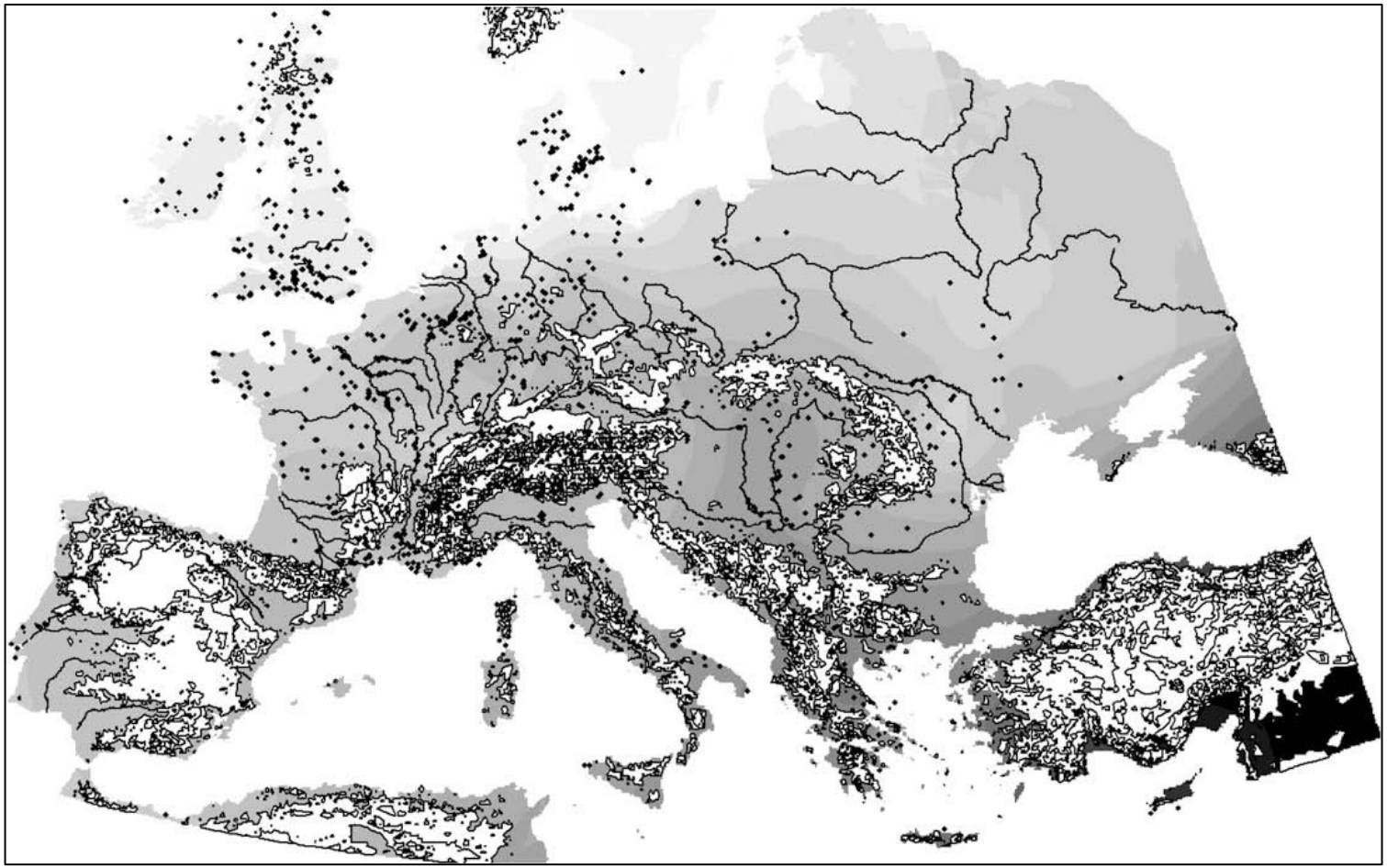


Figure 2.15: The *distribution of 940 Early Neolithic sites bounded by 250-year isochrones. Five hundred-year isochrones can be obtained by skipping one isochrone. (After Bocquet et al. 2009: fig. 5.)*

Chapter Three

The Neolithic of Iran and neighbouring areas

3.0. Introduction

Having discussed the development and spread of agriculture in the Near East in general, this chapter contextualizes the Neolithic of Iran. The first half of the chapter focuses on the geography and environment of modern Iran; an account of the palaeoclimates, zooarchaeology and palaeobotany of Iran is given in Chapter 6. The second half of the chapter deals explicitly with the Neolithic period. Compared to its westerly neighbours, the Iranian Neolithic has been subject to relatively little archaeological investigation. Only a handful of sites have been systematically excavated, and even fewer have had the findings from these investigations fully reported (Hole 2002; Alizadeh 2003). This chapter provides an overview of these sites, some of the details of which will be expanded on in subsequent chapters. Information is also given on significant Neolithic sites in the countries which neighbour modern Iran. Of particular note among these are the sites of Jeitun in southern Turkmenistan and Mehrgarh, western Baluchistan. Due to the hiatus in scientific research in Iran following the 1979 Islamic Revolution, the majority of the sources referenced in this chapter are from before 1980.

3.1. The country of Iran

Iran is located in southwest Asia, and borders the Gulf of Oman, the Persian Gulf and the Caspian Sea. It covers an area of 1,648,000 square kilometres and extends between latitude 25° and 40°N, and longitude 44° and 63°E (Fisher 1968: 3). It is the sixteenth biggest country in the world, measuring approximately three times the size of France (Brookes 1982: 191). It shares

its northern border, which extends over 2000 kilometres, with Armenia, Azerbaijan and Turkmenistan; to the west with Turkey (to the north) and Iraq (to the south); to the south the Persian Gulf and the Gulf of Oman littorals form the entire 1770 kilometres border; and to the east lie Afghanistan and Pakistan (Fisher 1968: 3).

The country is essentially bowl-like in shape, with a mountain rim surrounding lower, but not low-lying, interior basins (Fig. 3.0) (Brookes 1982: 191; Fisher 1968: 5). Indeed, the total area of land below 500-metres-above-sea level consists of only a small portion of the total land surface, and is limited to very narrow coastal plains (Fisher 1968: 5); while some 165,000 square kilometres (approximately one sixth) has an elevation exceeding 2000 metres (Dewan & Famouri 1968: 250; Ganji 1968: 220). It can be divided into four main physiographic areas, each with a distinctive character: the Zagros and Alburz Mountains, which together form a great 'V' shape; the area within the 'V', which begins as a high plateau with its own secondary ranges, and gradually levels towards the interior deserts; the low-lying plain of Khuzestan (a continuation of the Mesopotamian Plateau); and the Caspian littoral which lies below sea level and forms a separate climatic zone (Dewan 1968: 250).

Iran is bisected from northwest to southeast by the Zagros mountain chain, which occupy almost one half of the total area of the country (Fisher 1968: 6). The general elevation of the Zagros Mountains spans from 2000–3000 metres-above-sea level, with summit masses attaining heights of 3500–4500 metres (Brookes 1982: 191), and their maximum width spans 350 kilometres. The massive bulk of the Zagros provide an effective barrier to atmospheric moisture from the Mediterranean Sea, creating a rain shadow in Central Iran. The Alburz Mountains are the other principal mountain chain. They diverge from the Zagros Mountains to encircle the southern edge of the Caspian Sea, continuing eastwards to the northern highlands (*Kopet Dagh*) (Fisher 1968: 5). The Alburz rise very steeply from the Caspian lowlands to a general level of more than 3000-metres-above-sea level, and contain Iran's greatest peak: Mount Damavand (5654 metres) (Brookes 1982: 191; Fisher 1968: 38). The

Alburz also create a climatic border, obstructing precipitation from the coastal plains of the Caspian Sea, from entering the interior (Fazeli 2001: 11). The southern mountains of the Iranian Makran are lower and less massive than the Zagros and Alburz, and comprise a number of broken upland massifs with a general height of ca. 1000-2500 metres-above-sea level (Brookes 1982: 191; Fisher 1968: 60). In terms of geomorphology, the Iranian mountain chains are comprised of essentially sedimentary rocks without volcanics, and are the result of the uplifting, faulting and folding of an ancient sea floor (Harrison 1968: 127, 142).

Iran has only two expanses of lowlands: the Khuzestan Plain in the southwest; and the Caspian littoral in the north. The Khuzestan Plain, which averages ca. 160 kilometres in width, is a roughly triangular-shaped extension of the Mesopotamian Plain, much of which is covered by marshes (Fisher 1968: 33). The Caspian Plain is both longer and narrower, extending some 640-kilometres along the Caspian shore, with a maximum width of 50 kilometres and a minimum width of less than 2 kilometres (ibid.: 47).

The centre of Iran consists of a series of closed basins of irregular shape, which collectively form the high Central Iranian Plateau; a belt over 950 kilometres across at its widest (Harrison 1968: 127). The majority of the Central Plateau lies at an altitude of around 900-metres-above sea level, but there are a few regions where the lowest basins are only 300 metres or less in elevation (Fisher 1968: 90). Most of these basins are covered by colluvial and alluvial deposits brought down from the surrounding mountains by rainfall runoff and snow melt; a process that is normally vigorous due to the preponderance of steep slopes, and has resulted in high rates of denudation (Brookes 1982: 192-3; Dewan & Famouri 1968: 254). Indeed, as much as four metres of alluvium has been deposited in the lowlands and intermountain valleys since the emergence of the first villages (Brookes 1982: 192). The deposits are mainly chalky (Afary et al. 2006), and can be either arid or fertile depending on the regional climate (Schmidt & Fazeli 2006: 38). Much of the present surface of the Central Plateau was once covered by large lakes,

however, today only the lowest parts of the plateau are occupied by residual salt lakes or marshes, and the majority of the plateau is covered by two salt deserts or '*dasht*': the *Dasht-e Kavir* (Great Salt Desert) and the *Dasht-e Lut* (Fisher 1968: 90; Schmidt & Fazeli 2006: 10). Presently, and throughout much of history, with the exception of some scattered oases, these deserts are thought to have been largely uninhabited (Fisher 1968: 90).

3.1a. Soils of Iran

Due to its topographical, climatic and particularly its lithologic diversity, Iran displays a rich mosaic of soils (Fig. 3.1) (www.ecogeodb.com). Most of the soils are lithosols due to heavy erosion which does not allow for profile development. Other soils are alluvial-colluvial with steady rejuvenation of the profile. These occur in a variety of forms that can be readily distinguished from one another by vegetation. Climatically, the soils of Iran can be classed into humid, semi-humid and arid ones. From a geobotanical point of view the soils can be subdivided into regional and interregional ones. The former comprises all soil series which are definitely confined to climatic and plant geographical regions, such as forest soils and steppe soils. The latter are those that may occur in various plant geographical regions, although slightly or markedly varying in their vegetation cover in various regions. Such soils, as long as they preserve their primary pedological nature, will sharply differ in their vegetation from other soils of the region, while showing more vegetational affinity to similar soils in alien regions.

Of the regional soil groups the following should be mentioned:

a. *Forest climax soils.* These can be divided into three main types: Brown Forest soils, Chestnut soils and Rendzinas (Fig. 3.2). Brown Forest soils are confined to areas with high precipitation, part of which falls in the summer. Generally it has a well-developed profile with a humiferous A-horizon, moderately acid to alkaline. Beech and Oak

forests are the characteristic climax vegetation of the soil. Chestnut soils develop under humid climatic conditions from various parent materials such as limestone and igneous rocks (Dewan & Famouri 1964: 15). They are characterized by a dark-brown to dark greyish-brown surface horizon. It occurs in the Caspian Sea and the Zagros districts, where it supports a climax vegetation similar to that of the brown forest soil. True rendzinas, which develop from soft marly limestones, are confined to humid or semi-humid areas. They are generally characterized by their dark-colour, usually calcareous surface horizon, which sharply contrasts with the marly or chalky white parent rock. In Iran they are not uncommon in the forest areas of the mountains, but are often intermixed with other types.

b. *Alluvial soils.* These are the soils that fill the great plains and valleys. They are partly formed in situ, but largely transported from the mountains and redeposited, and thereby physically changed. There is no mature profile in these soils because of the steady rejuvenation of the upper horizons. Alluvial soils are ecologically zonal soils, because they are apt to harbour plant communities of the same regional vegetation complex as the adjacent mountains that supply the soil material, e.g. the alluvial soils of the intermountain valleys of the Zagros and Alburz Mountains support the same forest type that grows in similar altitudes of adjacent mountains.

c. *Steppe soils.* The bulk of Iran is occupied by steppe and desert, which are characterized by dwarf shrubs or herbaceous formations, the density of which is largely dependent upon the amount of rainfall. Soil types include sierozems, brown steppe, loess and loess-like soils, and hammadas (Fig. 3.3). Of these Brown steppe soils are probably the most predominant (Dewan & Famouri 1964: 15). These soils are developed in semiarid climate under grass vegetation and suffer moisture deficiency during the summer months.

Interregional soils of note include:

d. *Hydromorphic soils.* This type includes the soils of freshwater swamps and river banks. These soils are largely hydromorphous, not only by way of their transportation and deposition, but also by their pedogenesis and physical properties. In Iran types comprise river-bank soils, swamps, and alluvial soils under inundation or irrigation.

e. *Halomorphic soils*. This type comprises saline soils, both solonchaks and solonetzs. The largest part of saline soils in Iran are solonchaks, in which sodium chloride is the dominant salt. Iran has its largest concentration of salines in the Central Plateau. The salines here belong to northern continental ones of Middle and Central Asia, notably of Turan. In addition, there are also human-made salines caused by irrational irrigation.

f. *Dunes and sandy soils* (Fig. 3.4). Iran has considerable areas covered with sand and dunes. The largest of these is the *Dasht-e Lut*, on the southern fringe of the *Dasht-e Kavir*; some smaller areas are scattered in the Central Plateau and the coastal plains. Desert sand dunes and sandy soils in general, which are not in excessive movement, offer more favourable conditions for plant life than fine-textured soils. This is because of their capacity to absorb rain water without run-off and their lower evaporation rate. On the other hand, rain water accumulates here at greater depths and only deep-rooting perennials or shrubs can take foothold in this habitat. Accordingly, there is only a small number of plant communities specific to sandy soils.

3.1b. Soil factors limiting agricultural production

The soil factors which limit agriculture in Iran are several (Fig. 3.5). Soil salinity, alkalinity, and waterlogging affect large areas to the extent that they

do not support any crops or other vegetation. In Iran over 15 per cent of the land surface, or a total of about 250,000 metres squared, suffers from a combination of salinity, alkalinity and water logging (Dewan & Famouri 1964: 234). Water, or the scarcity of it, is responsible for the greater part of the accumulation of salts in the soils of the arid and semiarid parts of Iran.
Soil infertility and inadequate amounts of plant nutrients in the soils are other big limiting factors today, for increasing agricultural production. However, their role in the past is unclear, as they may be the result of centuries of over farming (Dewan & Famouri 1964: 240).

The absence of organic matter in the soils of some of the arid and semiarid areas is another deficiency responsible for low crop production. In general, about 85 to 90 per cent of the land surface in Iran, including the cultivated areas, contain inadequate organic matter (Dewan & Famouri 1964: 259). In general the soils range from almost no organic matter to about two to three per cent in some Brown and Chestnut soils or alluvial soils (ibid.).
Large areas of Iran are affected by water and wind erosion. A soil and water conservation program to control erosion is essential before such areas can be brought under efficient agriculture (Dewan & Famouri 1964: 234).

3.1c. Land use

Desert, wasteland and barren mountain ranges cover about half of Iran's total land area (www.ecogeodb.com). Of the rest in the 1980s: 11 per cent was forested; about 8 per cent was used for grazing, and about 1.5 per cent was occupied by urban or industrial developments. The remainder included land that was cultivated either permanently or on a rotation: about 14 per cent on a dry-farming basis; and 15 to 16 per cent with adequate irrigation.
In most regions the natural cover is insufficient to build up much organic soil content, and on steeper mountain slopes much of the original earth has been washed away. Although roughly half of Iran is made up of the arid Central Plateau, some of the gentler slops and the Gulf lowlands have relatively good

soils but poor drainage. In the southeast, a high wind that blows incessantly throughout the summer is strong enough to carry sand particles with it, destroying vegetation and stripping away the lighter soils of the region.
In mountain valleys and in areas where rivers descending from the mountains have formed alluvial plains, much of the soil is of medium to heavy texture and is suited to a variety of agricultural uses when brought under irrigation. Northern soils are the richest and the best watered (www.ecogeodb.com).

3.1d. Hydrology

There are no major rivers in Iran (Fig. 3.6). Of the small rivers and streams only one is navigable, the 830 kilometre long Karun, which today shallow boats can negotiate along the 180 kilometre stretch from Khorramshahr to Ahvaz (Fig. 3.7) (Oberlander 1968: 273). It originates in the southwestern Zagros and flows south to the Shatt Al-Arub (Arvand Rūd), which drains into the Persian Gulf (Afary et al. 2006). Other large rivers include the Sefid (Sefad) Rūd, which begins in the Alburz Mountains, and flows across the Gīlān Plain into the Caspian Sea, and the Zāyandeh Rūd, which is the largest river on the Central Plateau. The Zāyandeh starts in the Zagros Mountains and travels 400 kilometres eastward before ending in a seasonal salt lake, southeast of Isfahan. There are several other smaller rivers that drain into the Persian Gulf, and a number of minor rivers that originate in the northwestern Zagros or Alburz Mountains, and run into the Caspian Sea (Oberlander 1968: 273). Most of these are seasonal and variable, and spring floods can do enormous damage, while in summer many streams disappear (Afary et al. 2006). Water is also stored naturally underground, finding its outlet in springs and, since the first millennium onwards, by *qanats;* human-made underground water conduits. The largest inland body of water is Lake Urmia in the northwest, which covers an area that varies from 5200-6000 square metres depending on the season. Other lakes are principally seasonal and dry up in summer. All have a high salt content (Afary et al. 2006).

3.1e. Climate

The mostly Mediterranean climate of Iran is governed by the pressure systems of the westerly cyclones, the Siberian High and the SW Monsoon (Kehl 2009: 2). Around 75-per cent of the total land area of Iran is dominated by an arid or semiarid climate, with annual precipitation rates from ca. 350 mm to less than 50 mm. The dryness is caused by intense solar radiation and north-westerly to north-easterly winds, which transport dry air masses; and is further enhanced by the Alburz and Zagros Mountains, which prevent north-westerly and westerly depressions from the Caspian and Mediterranean Seas from entering the plateau. As a result, regional rainfall and temperatures are locally very pronounced (Fig. 3.8 & 3.9) (Kehl 2009: 2). Only the highest peaks of the Alburz and Zagros Mountain systems (e.g. Kuh-e Damavand, 5671 metres; Alam Kuh, 4850 metres; Kuh-e Savalan, 4811 metres; Zardeh Kuh 4548 metres) bear small glaciers and exhibit features of active nivation and glaciation (Bobek 1968) – or at least they did in the 1960s; unfortunately more recent information on the extent of glaciers in Iran is not available (Kehl 2009: 4-5).

Climatically, Iran experiences a marked seasonality of temperature and precipitation regimes, which is emphasized locally by the complex topography of the country, maritime influences and seasonal winds (Beaumont 1974: 418; Bobek 1968: 281; Ganji 1968: 230; Brookes 1982: 192; Stevens et al. 2001: 748; Afary et al. 2006). In general, Iranian summers are hot and dry with persistent northerly winds (Kendrew 1961: 608). July and August are the two warmest months of the year, and average daily temperatures in the hottest parts of the country e.g. Abadan, Khuzestan Province, can top 43°C (Ganji 1968: table 3). January, with the exception of the Caspian Plain, is everywhere the coldest month of the year, with mean temperatures varying from 20°C in southeast Iran to less than -10°C in Azerbaijan (Ganji 1968: 220). Officially, the lowest temperature is -36°C, recorded at Bijar, northeastern Iran, in January 1964 (ibid.: 233). To the west and the north of the Central Plateau, annual temperatures decrease under the influence of higher latitudes and also greater altitudes. Generally speaking temperatures

decrease over Iran from the southeast to the northwest (Stevens et al. 2001: 748). The northern and western parts of Iran experience four distinct seasons, whilst towards the south and east, spring and autumn become increasingly short and ultimately merge into an area of mild winters and hot summers (Afary et al. 2006).

Iran is an arid county, with water surpluses existing only in the northern and western parts, and precipitation, with the exception of the Caspian area, is a winter phenomenon (Beaumont 1974: 418; Brookes 1982: 193; Dewan 1968: 250). The mean annual precipitation for the entire country is 400 millimetres (Ganj 1968: 234), although the average distribution of moisture varies considerably throughout the region (Stevens et al. 2001: 748). Shielded by mountains, large areas of central, eastern and southeastern Iran receive less than 100 mm of precipitation annually, whilst the Caspian region enjoys some 1980 mm (Afary et al. 2006; Brookes 1982: 193). As a whole, annual precipitation generally increases to the north and east, except where the relief of the land upsets the regularity in this arrangement (Ganji 1968: 234; Stevens et al. 2001: 748). Summer is a dry season all over, with the exception of the Caspian area, and “all through the long summer clear skies are generally the rule over many places in the interior of the country, where there is no chance even of a shower” (Ganji 1968: 241). Iran is subject to disastrous floods and droughts, which repeatedly devastate city and farm communities (Melville 1984). On the one hand more than 90 per cent of the land areas in Iran are arid or semi-arid regions, whilst on the other flooding is one of the most prevalent natural disasters occurring in Iran each year (Ghayoumian et al. 2005: 493).

During the winter months, the general wind regime is governed by air pressure gradients between Siberian anticyclone and equatorial low pressure systems (Kehl 2009: 2). In the summer, a strong heat low develops over southern-central Iran (Ganji 1968), and a relatively high pressure high prevails over Eurasia, resulting in north-easterly to north-westerly winds (Kehl 2009: 2,

4). Beginning in October and ending in April westerly winds prevail, caused by depressions entering eastern Iran from the eastern Mediterranean (ibid.: 4).

3.1f. Vegetation

More than 6000 years of cultivation and intensifying human occupation has had a pronounced effect on the distribution of vegetation in Iran, and the modern vegetation pattern is thought to bear little resemblance to the original cover (Bobek 1968: 281; Dewan 1968: 250). The broad topography and varied climate of the country, has resulted in a huge diversification of vegetation cover, and more than 10,000 plant species are known from the Central Plateau alone (Bobek 1968: 280-1; Dewan 1968: 250). Most species belong to the Irano-Turanian group, which dominates the vegetation of the interior plains and uplands (Bobek 1968: 280), although the Caspian, Persian Gulf and Makran shores are characterized by species from the Euro-Siberian, the Nubo-Sindian and Sudanian groups respectively. Bobek (1968: 283) divides the types of vegetation in Iran into three main groups, each with its own geographical distribution: humid forests; semi-humid and semi-arid forests; and steppes and deserts (Fig. 3.10). To these he adds three azonal types: sand brushwoods; riparian forests; and salt-marsh brushwoods and coastal forests (Bobek 1968: 283).

The ‘Hyrcanian forest’ on the Caspian Plain is the only true humid forest in Iran, while extending across southwestern Iran lies the ‘Zagrosian forest’, a semi-humid oak forest, which floristically belongs to the Irano-Turanian complex (Bobek 1968: 284-5). On the intermediate plateau between the Hyrcanian and Zagrosian forests, “nothing but various associations of open steppe are to be found nowadays, which gradually taper out towards the deserts of the Central Iranian depressions” (ibid.: 286). Two dry forests within this area, ‘Juniper forest’, which once covered the southern slopes of the Alburz chain and the main ranges of Khurasan; and ‘Pistachio-Almond-Maple forest’ which have covered the more elevated parts of the interior plateau

(ibid.: 287). Similar, but very much thinner, stands of pistachio trees, together with shrubs of several almond and other drought-resistant species, are found combined with steppe- and even true desert-formations, at lower elevations throughout the Central Plateau. The vegetal ground cover on the latter can be zoned according to the limits of potential rainfall cultivation, which is around the 250-300 mm isohyet (Oates & Oates 1976: 111). Down to this boundary, the steppe cover is “very closely set and well developed” (Bobek 1968: 288). Within this cover lie two main groups of associations: spiny bushes or brushwood (of tragacanthic or other *astragulus* and *acantholimon* sp.) and other dwarf bushes and many grassy and herbaceous species; and artemisieta-type associations, where the scrub is composed of wormwood and other variable species of dwarf bushes, grasses and herbs. The latter generally covers areas of medium elevation, while the former association typically occupies elevated areas of 1800 metres or more (ibid.: 289). Outside the limits of potential rainfall agriculture, the steppe gradually thins out. There is an intermediate zone – the ‘desert steppe’ – where the patches of bare-ground become considerable; and finally, bare ground and the “true desert” predominates (ibid.: 289). The largest area without any vegetation is the depression of the southern Lut, which declines to around 250 metres in altitude. The Great *Kavir* of Khurasan is also devoid of vegetation, as are many other small *kavirs* all over the central part of the Plateau (ibid.: 288-9).

3.1g. Fauna

There is an abundance of fauna in Iran: 129 species of mammals have been recorded including: 15 insectiovora, 21 chiroptera, 28 carnivora, 1 pinniped, 12 ungulta, 4 lagomorpha and 48 rodents (Misonne 1968: 294). By comparison Europe, which is 4 times larger and much more varied ecologically, contains only 133 species, very few more than are found in Iran. Iranian carnivora include tiger, lion (now extinct), cats, leopards (including cheetahs), lynx, wolves, hyena and various foxes (ibid.: 295). Ungulates include onager on the edge of the central desert), red and roe deer in the

higher levels of the Caspian forest, and fallow deer in the foothills of the western Zagros. Gazelle (*Gazella subguttorisa* & *G. gazelle bennetti*) and wild goat (*Capra hircus aegagrus*) and sheep (*Ovis orientalis*) are numerous.

There are a wide variety of lagomorpha and rodents (Misonne 1968: 296). Pikas (*Ochtona rufesceus*) inhabit the mountains of central and eastern Iran, as well as eastern parts of the Alburz, and six different types of jerboas are present; although the majority of Iranian rodents (~90%) are jirds and gerbils (ibid.: 296). As regards chrioptera and insectivore, little is known, although at least 21 species of bat have been recorded, and hedgehogs are common (ibid.).

Studies made in Khuzestan Province, the Baluchistan region, and along the slopes of the Alburz and Zagros chains, have revealed the presence of a remarkably wide variety of amphibians and reptiles including toads, frogs, tortoises, salamanders, boas, racers, rat snakes (*Phytas*), cat snakes (*Tarbophis fallx*) and vipers (Anderson 1968: 306). There are approximately 450 species of birds, which can be broadly divided into residents, summer visitors, winter visitors and passage migrants (Read 1968: 372). The species are broadly similar to those found in Europe, with the addition of species from Siberia, Africa and southern Asia (ibid.). In terms of aquatic wildlife, seals (*Phoca caspica*) and 30 species of fish are known from the Caspian Sea, and some 200 varieties of fish, shrimps, lobsters and turtles live in the Persian Gulf (Misonne 1968: 295).

3.2. Chronological considerations

A plethora of chronological periodizations for the Neolithic has been proposed during the history of archaeological research in Iran (e.g. Schmidt 1935; Ghirshman 1938; McDonald 1942; Majidzadeh 1981; Hole 1987; Voigt & Dyson 1992; Malek Shahmirzadi 1995), each with its own strengths, weaknesses and terminological idiosyncrasies (Potts et al. 2006: 6), and it is

important to establish the chronology that will be used in this research. The generally excepted prehistoric sequence for Iran has been built up from the results of excavations carried out through the 1920s to 1970s, archaeological surveys (e.g. Sumner 1990), soundings and the reassessment of published material (e.g. Voigt & Dyson 1992). However, despite the compilation of these general syntheses, the relative chronology of Iran remains somewhat contested, and reinterpretations continue to be proposed (e.g. Fazeli 2001; Alizadeh 2004; Coningham et al. 2004; 2006; Potts & Roustaei 2006; Fazeli et al. 2009). The uncertainties in the relative and absolute chronology of Iran reflect a number of factors, including the size and geographical diversity of the country; the limited amount of fieldwork that has been undertaken in the region; and restriction of the country to foreign archaeologists following the 1979 Islamic Revolution (Potts et al. 2006: 6).

In recent years, a number of new research projects have commenced work in Iran, and have greatly expanded our knowledge of the archaeological material sequences and absolute chronologies of the region. Examples include: The Mamasani Archaeological Project excavation at Tal-e Nurabad and Tal-e Spid (Potts et al. 2006); the joint Oriental Institute-Iranian Cultural Heritage and Tourism Organisation (hereafter ICHTO) excavations of Tall-e Jari A and B, Tall-e Bakun A and B and Tall-e Mushki on the Marv Dasht Plain (Alizadeh 2004; 2006); the Central Zagros Archaeological Projects excavations at Sheikh-e Abad and Jani (Matthews et al. 2010); and Hassan Fazeli (2001; Fazeli et al. 2001; 2002; 2005; 2009) and Robin Coningham's work on the Central Plateau (Coningham et al. 2004; 2006).

3.2a. Proposed chronologies for the prehistoric period of Iran

Traditionally, the chronology of prehistoric Iran has been based entirely on a series of relative ceramic chronologies. The first archaeologists to propose cultural sequences for the prehistory of Iran were Erich Schmidt and Roman Ghirshman, both of who conducted archaeological investigations on the

Central Iranian Plateau. Prior to this, information relating to the study of the cultural sequences of Iran was based on surface surveys, which had been conducted by French archaeologists in southwestern Iran during the early twentieth century (Fazeli 2001: 30). Schmidt's excavations at Cheshmeh Ali on the Tehran Plain (see p. 303), led him to distinguish three cultural periods: the Islamic Period; Parthian Period; and Neolithic and Chalcolithic Period. He divided the latter into three main phases on the bases of the ceramic typology: the first phase, represented by the cultural deposits of the lowest levels at Cheshmeh Ali, yielded a crude, handmade ware, painted with simple geometric motifs; the second phase was distinguished by the appearance of black-on-red painted wares (hereafter 'Cheshmeh Ali Ware'); and the third phase was characterized by the introduction of wheel-made ceramics.

Ghirshman (1938) utilized material from the North and South Mounds at Sialk to distinguish four main cultural periods: Sialk I and II (corresponding to the Late Neolithic) on the North Mound; and Sialk III (Chalcolithic) and Sialk IV on the South Mound. Ghirshman used site type terminology to construct this chronology, and divided each period into several subphases. Schmidt (1935; 1936) and Ghirshman (1938) both attempted to indicate the emergence of new cultural groups on the Central Plateau, corresponding to the different periods they had identified at Cheshmeh Ali and Tepe Sialk. Their work has strongly influenced later work, and subsequent archaeologists have employed their approach to study the prehistory of the region (e.g. McCown 1942a; 1942b; Majidzadeh 1981; Dyson 1991; Malek 1995).

Donald McCown (1942a; 1942b) divided the prehistoric sequence of Iran into two main cultural areas: western and southern Iran, which was characterized by the 'Buff Ware Culture'; and north-central and northeastern Iran, which contained three successive cultures named after the type sites: Sialk, Cheshmeh Ali and Hissar. McCown then compared the prehistoric cultural sequences of western and southern Iran, and north-central and northeastern Iran with each other (Table 3.0).

After the Second World War, research in Iran entered a new stage and many sites were excavated and surveyed (Fazeli 2001: 32). This, in conjunction with the introduction of the ^{14}C-dating method, led to the development of new chronologies for Iran, and the dismissal of McCown's chronology (Table 3.1) (e.g. Dyson 1968; Majidzadeh 1976; 1981). From the 1970s, Iranian archaeologists proposed their own chronologies for the Central Plateau, with 'types' and 'cultures' used to indicate temporal and spatial relations between different cultural groups (e.g. Negahban 1977; Majidazadeh 1976; 1981; Malek Shahmirzadi 1995). Yousef Majidzadeh (1981), based on Negahban's (1974; 1977; 1979) excavations at Zagheh on the Qazvin Plain (see Chapter Six) assumed Zagheh to be a key site in the study of the Neolithic culture of the Central Plateau; although more recent excavation has shown the site to have been entirely Transitional Chalcolithic (Fazeli et al. 2005). Majidzadeh thus divided the prehistory of the Central Plateau into four distinct periods: Archaic Plateau, Early Plateau, Middle Plateau and Late Plateau (Table 3.2). Majidzadeh (1981: 141) proposed that the Archaic Period was to be found only at the lower levels at Zagheh, and preceded the earliest levels at Sialk; the Early Plateau Period incorporated Sialk I and II, Cheshmeh Ali and Zagheh Levels VIII-I; the Middle Plateau Period was characterized by Sialk III_{1-5}; and the Late Plateau Period was represented by Sialk III_{6-7b}, Hissar IC and Ghabristan IV.

Malek Shahmirzadi (1995) also proposed a cultural sequence for the Central Plateau based on ceramic characteristic. His chronology comprised the: Formative Period; Zagheh Period, Cheshmeh Ali Period (Sialk I & II); and the 'Wheel-Made Pottery' Period (Fazeli 2001: 37-8). Based on ceramic characteristics, Malek Shahmirzadi proposed that the inhabitants of Mehranabad on the Tehran Plain, were the first human inhabitants of the Formative Period; the Zagheh Period began with the introduction of Zagheh Ware at Zagheh; and the Cheshmeh Ali Period was represented by Sialk Periods I and II which Malek conflated, and by the site of Cheshmeh Ali (see Chapter Six). Majidzadeh's (1981) and Malek Shahmirzadi's (1995) assignment of Zagheh to a period which preceded the foundation of Sialk

North, when subsequent excavations and ^{14}C dating have established that Zagheh was entirely Transitional Chalcolithic (Fazeli et al. 2005) and Sialk I was actually earlier, demonstrates the dangers of building chronologies for a region based purely on ceramic types.

Increasingly, scholars have utilized both the relative dating methods of stratigraphy, cross-dating and seriation, and absolute dating techniques to propose chronologies for the prehistoric period of Iran (e.g. Hole 1987; Voigt & Dyson 1992; Fazeli 2001; Coningham et al. 2004; 2006; Fazeli 2009). Hole (1987) defines the period from 8000-4000 BC in western Iran as the 'village period', which he subdivided into the Initial, Early, Middle and Late Village periods (Table 3.3). Hole adopted this terminology because he felt that to use the terms 'Neolithic' and 'Chalcolithic', as most authors do to refer to the earlier and later stages of the village period, "conflates chronology and cultural development" (1987: 30). Hole was also opposed to the use of regional sequences, which he believed were confusing to the non-specialist. Hole argued that the benefit of his system is that it is devoid of cultural implications, and "allows us to look at four slices of time for purposes of cross-regional comparisons, while retaining the ability to examine development and change within each region" (1987: 30).

Mary Voigt and Robert Dyson (1992), constructed a general chronology for Iran, which focused on regional sequences that they linked "through the traditional archaeological method of artefact comparisons" and ^{14}C dating (Voigt & Dyson 1992: 122). They placed a particular emphasis on ceramics in the construction of their relative chronology, because of the good representation of pottery in the archaeological record after 6500 BC: the fact that the ceramic industry generally changed more rapidly than any other artefact category; and because of their first-hand knowledge of Iranian ceramics (Voigt & Dyson 1992: 123). The resulting table (Table 3.4) shows the temporal position of Neolithic sites in Iran using their stylistic relationships. Voigt and Dyson deliberately constructed the table using no lines, since they

believed “that the available evidence does not permit such delimitations” (ibid.: 127).

Hassan Fazeli’s (2001) cultural sequence for the Central Iranian Plateau is “based on the relative dating methods of stratigraphy, cross dating and seriation methods” (Fazeli 2001: 39). Utilizing the results from the excavation of Cheshmeh Ali in 1997 and settlement survey on the Tehran Plain, Fazeli (2001: 40-1) defines the Late Neolithic and Chalcolithic sequence of the Tehran Plain as covering the following periods: Late Neolithic (ca. 6200-5500 BC); Transitional Chalcolithic (ca. 5500-4700 BC); Early Chalcolithic (ca. 4700-4000 BC); Middle Chalcolithic (ca. 4000-3500 BC); and Late Chalcolithic (ca. 3500-3000 BC). Fazeli (2001: 41) introduced the ‘Transitional Chalcolithic’ Period, to account for the clear distinction between its ceramics and those of the preceding Late Neolithic Period. The Transitional Chalcolithic Period is defined by the presence of ‘Cheshmeh Ali Ware’; a black-on-red ware, “typified by the use of elaborate designs and high technical quality (Fazeli et al. 2004: 17). In comparison, the characteristic ware of the Late Neolithic Period was a handmade, chaff-tempered software, usually coated with a thick slip, and fired in variable conditions (ibid.).

More recently, Fazeli (2009) has revised his chronology in light of evidence from excavations at Chahar Boneh, Ebrahim Abad (Fazeli et al. 2009), Zagheh and Ghabristan (Fazeli et al. 2005) on the Qazvin Plain; and at Cheshmeh Ali (Fazeli et al. 2004) and Tepe Pardis (Coningham et al. 2004; Fazeli et al. 2007) on the Tehran Plain. The ceramic variation at the two newly excavated sites of Chahar Boneh and Ebrahim Abad allowed Fazeli (2009: 7) to divide the Late Neolithic (ca. 6000-5200 BC) into two subphases: Late Neolithic I (ca. 6000-5600 BC) and Late Neolithic II (ca. 5600-5200 BC). Based on the evidence from excavations at Ebrahim Abad, Tepe Pardis and Cheshmeh Ali, and the new dates for Zagheh (which placed the lower levels much later than expected at 5200 BC; Fazeli et al. 2005), Fazeli was also able to divide the Transitional Chalcolithic into two phases: Transitional Chalcolithic I (5200-4600 BC) and Transitional Chalcolithic II (4600-4300 BC).

3.2b.The Neolithic and Chalcolithic periods – some definitions

As the above study demonstrates, the chronology of prehistoric Iran is regionally defined, and based upon local and site type names. It is also clear that date ranges and nomenclature of relative chronologies for the country differ substantially (Table 3.5)**.** Consequently, these conventions are not utilized in this study and instead Neolithic and Chalcolithic terminology is adopted, for ease of application and interregional comparison. In this thesis the terminology used will be as follows. The *Early Neolithic* (ca. 8000-6500 BC) period will be defined as that which immediately preceded the introduction of pottery. Elsewhere in the literature this period is referred to as both the 'Pre-Pottery' (e.g. Hole 2004) or 'Aceramic' Neolithic (e.g. Dupree 1980). The Early Neolithic period began in Iran ca. 8000 BC and ended ca. 6500 BC with the introduction of pottery (Hole 2004). The *Middle Neolithic* (ca. 6500-6200 BC) period will be characterized by the introduction of handmade, chaff-tempered pottery (Hole 2004). The *Late Neolithic* (ca. 6200-5500 BC) period will be defined as the final phase of the ceramic Neolithic, and is characterized by thick, low-fired, chaff tempered pottery, sometimes coated with a fine sand slip (Fazeli 2001: 41). It was a period of greater complexity and networks, anticipating the introduction of metallurgy. It should be noted that these are working definitions, which will be returned to later in the course of this thesis, and discussed in light of the cleaning and analysis of ^{14}C dates for Iranian Neolithic sites, and new findings from the Central Plateau.

The Late Neolithic period on the Central Plateau is generally equated with Sialk I Ware, and the Transitional Chalcolithic period by the appearance of Cheshmeh Ali Ware. It is therefore relevant to give a short description of these two types of ware, as their presence/absence will be noted at sites throughout this thesis. Sialk I Ware belongs to the Neolithic 'software' tradition, and is handmade, usually from poorly levigated clay, and chaff-tempered (Fig. 3.11 & 3.12). The surfaces are generally wet-smoothed by hand, but on certain examples the polishing is done with a damp cloth or piece of leather (Ghirshman 1938: 11). The surfaces are irregular with pot

marks and bumps from where the chaff has burnt out. Generally, the interior is better treated than the exterior. The colour of the vessels varies; the earliest vessels are dirty and dark, but this progressively improves, and later vessels are white. It is irregularly fired, and the middle sections crumble under the fingers (ibid.: 12). Deep bowls with concave bases, which are designed to be placed in the floor, pedestalled vases and pot stands are the main shapes (ibid.: 12-13). Vessels were decorated on interior and/or exterior surfaces with geometric motifs in brown or, more commonly, black paint. Typical decoration includes large horizontal bands of crosshatches, triangles, or straight lines with festoons, which may be derived from basketry (ibid.: 13). Black spots, circles, asymetrics and superimposed chevrons are also common.

Cheshmeh Ali Ware (Fig. 3.13 & 3.14) is a finely-made, painted, Transitional Chalcolithic Ware, which characterizes the upper part of Cheshmeh Ali IA, and is found distributed across the Central Plateau, from the Gorgan Plain to the east, to the Qazvin and Kashan Plains to the west (Dyson 1991; Wong et al. 2010). It is highly distinctive, and this, in conjunction with its widespread distribution across northern Iran, means that it is used as a marker of the Transitional Chalcolithic Period. The most readily identifiable examples have an orange-to-red surface colour, with a thin light-grey or pink core (Dyson 1991). The vessels are handmade and tempered with grit or very fine chaff. The thinnest, densest pieces, produce a ‘clink’ when struck (Voigt & Dyson 1992: 166). The surfaces are usually smoothed or lightly burnished, and often show signs of scraping (Malek Shahmirzadi 1977: 279, 281-4; Dyson 1991). Vessels range from egg-shell thin cups to storage vessels with sides two to three centimetres thick, and are characterized by a number of handless forms, the most common of which are small round-bottomed cups with flaring rims, large spherical bowls and pedestalled vases (Matney 1995). Cheshmeh Ali Ware, however, is best identified by its painted decoration. The paint itself is either dark brown, or more commonly black. The majority of the sherds are painted with geometric motifs including parallel bands, vertical strips, diagonals, wavy lines, chevrons, dots and dashes (Voigt & Dyson 1992: 166).

Another frequent motif is a floral or tree pattern, with curling branches emanating from a vertical stalk or trunk. Less common, are animal designs, including goats, ibexes, gazelles, snakes and stylized birds, which are arranged in horizontal bands across the vessels (Matney 1995). Vessel interiors are often painted in bands with cross-hatching which, like the decoration on Sialk I Ware, closely resembles basketry work.

3.3. The Iranian Neolithic

The second part of this chapter contains a review of the key Early Neolithic sites of Iran and the surrounding areas. The Neolithic of Iran has been poorly studied, particularly the earlier periods. In part this is due to the closure of Iran to western archaeologists for many years, following the 1979 Islamic Revolution, a period when Neolithic archaeology was becoming increasingly popular elsewhere in the world; and an emphasis among Iranian archaeologists on the Islamic period. As a result, most prehistoric sites were excavated prior to 1980, and these excavations, although well done for their day, cannot compare in terms of stratigraphic control and efficiency of recovery, to the standards established since then (Voigt & Dyson 1992: 122). The situation is slowly changing, and a number of Neolithic sites have been excavated by both Iranian and joint foreign and Iranian teams since 2000 (cf. Azamoush & Helwing 2006). However, it does mean that there has been an absence of archaeological science over the last 30 years, particularly in regard to radiocarbon dating,

Due to the size and diversity of Iran, it is useful to conceive of a number of core regions during the Neolithic (Hole 1987; 2004). Principally these are the northern, central and southern Zagros; the Khuzestan lowland; southern Iran; and the northeastern Kopet Dag region. Most of southern Iran, which is likely to have been important in the Neolithic, has not been sufficiently investigated, a situation which also pertains to much of northeastern Iran (Hole 2004). Outside of Iran proper, the Neolithic of Turkmenistan shares many similarities

with that of northeastern Iran, while Afghanistan – potentially important – has seen little research (cf. Dupree 1980). The Early Neolithic site of Mehrgarh is known from Baluchistan, but is poorly reported. To the west of Iran, many western Zagros sites in modern day Iraq and Turkey share similarities with the Iranian Neolithic sites in the Zagros Mountains (Hole 2004).

Only a handful of Early Neolithic sites have been excavated and published in sufficient detail to inform on the development of the Neolithic in Iran (Fig. 3.15). All are situated in areas where dry farming was possible (Hole 1998). From north to south these sites are: Hajji Firuz Tepe on the Solduz plain of Azerbaijan, Tepe Sarab on the Kermanshah plain, Tepe Guran in the Hulailan valley, Tepe Asiab, Ganj Dareh and Tepe Abdul Hosein in the mountains of Luristan, Ali Kosh on the Deh Luran plain, Chogha Bonut on the Susiana plain, Tall-e Mushki and Tall-e Jari A and B in the Kur River Basin, Tol-e Nirabad on the Mamasani Plain and Sang-e Chakmaq West in northeastern Iran. Final reports are available only for Hajji Firuz Tepe, Tepe Abdul Hosein, Ali Kosh, Chogha Sefid and Chogha Bonut, although important aspects of each of the others have been published. In terms of key sites excavated outside the borders of modern Iran, a final report is available for Jeitun, Turkmenistan, but none available for Mehrgarh, despite the site's potential.

3.3a. Northwestern Iran

Hajji Firuz Tepe

Hajji Firuz, the earliest well-excavated site in northwestern Iran, is located approximately 13 kilometres southwest of Lake Urmia, in the northeastern part of the Solduz Valley. Five other excavated sites have Hajji Firuz material at their bases, including Dalma Tepe (Young 1982), Yanik Tepe (Burney 1964), Hassanlu (Dyson et al 1969) and Tepe Seavan (Solecki 1969), but little of these have been reported (Meadow 1975: 282). Burney (1964: 55; see also Meadow 1975: 282) reports that more than four metres of alluvium have covered the plain surrounding Yanik Tepe since it was first occupied, and the

burial of early sites under alluvial deposits is a potential problem in the region (Brookes et al. 1989)

Sir Aurel Stein first investigated the site in 1936 (Stein 1940: 382-404). It was later excavated by members of the University of Pennsylvania Museum between 1958 and 1968 (Voigt 1983), who assigned the site a Late Neolithic date of ca. 6000-5700 BC. Hajji Firuz is an oval-shaped mound which, in its truncated state, approximately 140 metres by 200 metres in plan (Fig. 3.16) (ibid.: 7). It stands at just over 10 metres above the modern plain surface, and contains at least 12 metres of cultural deposits, of which the bottom 3-4 metres are Neolithic (ibid.: 18). The actual depth of the mound is not known, since the presence of a high water table prevented excavation to virgin soil. The site is situated within easy access to a variety of environments, and today, within a radius of five kilometres lies a perennial freshwater lake, marshes, a river, and cultivated fields (Meadow 1975: 282). Irrigation is not essential to farming in the area on the hillside slopes, although grain is usually irrigated on the plain (Hole 1987: 44).

The inhabitants of Hajji Firuz pursued an agro-pastoral economy supplemented by foraging and hunting (Voigt 1983: 295). Domesticated crops include emmer wheat, hexaploid bread wheat and lentil. Remains of rye and knotgrass – weeds that grow in cereal fields – were also present in the botanical remains. Hole (1987: 44) suggests that the agricultural fields were probably the muddy shores of seasonally filled fresh-water basins surrounding the site. Two types of wild pulses were found, which may have been gathered for food (Voigt 1983: 295). The inhabitants of Hajji Firuz kept domesticated dogs, goats, sheep and pigs, the latter three of which Meadow (1983: 401) reports were in the early stages of domestication. Goat bones outnumber those of sheep, but the sample is too small to say more than that they are equally represented (Meadow 1975: 282). Both small and large wild game were hunted, including red deer (*Cervus elaphus,* L.), aurochs (*Bos primigenius* boj.), wild boar (*Sus scrofa* L.), hare (*Lepus capensis* L.), badger (*Meles meles* L.) and red fox (*Vulpes vulpes* L.). No specimens of roe and

fellow deer or gazelle were identified, and they are assumed to have been absent from the area around Hajji Firuz as they are today (Voigt 1983: 270).

If bone weight is taken as a valid indicator of meat yield, then wild ungulates (including wild boar) contributed about 25 per cent of the total meat yield (Meadow 1975: 282). If, however, bone counts are taken as a base, and multiplied by factors expressing the relative weights of different species, then the yield from wild ungulates approaches, and even exceeds, 50 per cent. Thus, it is difficult to quantify the importance of wild species to the subsistence economy of the inhabitants of Hajji Firuz (ibid.: 282). Hole (1987: 44) has suggested that Hajji Firuz was inhabited by semi-transhumant pastoralists, who had permanent villages in the lowlands, but moved seasonally into the mountains to graze their animals. A similar practice has until recently been followed by modern Kurdish tribes living in the region (Hole 1987: 43).

The Neolithic period at Hajji Firuz is divided into 12 building phases labelled A (earliest) to L (latest), of which phase C is the best known. Buildings were generally similar in size and plan, consisting of free-standing, square or rectilinear houses, which ranged from five to eight metres in length (Meadow 1975: 226; Voigt 1983: 31-6). The buildings were separated by alleyways or large open spaces, and all were similarly aligned, with walls running in approximately cardinal directions (Voigt 1983: 306). Internally, the buildings were divided by short partition walls into two distinct areas which, on the basis of artefact typology and decoration Voigt (1983: 101) described as a ‘storage’ and ‘living’ room. Features include hearths and bins, and many of the houses had adjoining ‘courtyards’. Two non-domestic structures were identified, the smaller of which (Structure VII) had no defining features and was probably used for storage (ibid.: 207). The other, larger, building (structure VI) had a number of unusual interior features including a hearth, a low plaster platform with a central depression flanked by two blocks, a large number of food vessels and clay ‘tokens’ and some human burials. Voigt (1983: 315) suggests the building had a special function, perhaps serving as a meeting house, a women’s menstrual hut or a ritual structure.

Only the pottery from the later levels at Hajji Firuz was sampled, and the descriptions given cannot be taken as representative of the whole assemblage (Voigt 1983: 97). The pottery was handmade, poorly fired and chaff tempered, with vessels manufactured either by freehand forming, or a combination of freehand forming and basket moulding (ibid.: 149). The majority of the vessels were burnished on both external and internal surfaces, and larger vessels were wet smoothed. Most vessels were decorated with a red or brown slip. Vessel sizes range from miniatures, with rim diameters of less than 8 centimetres, to very large with rim diameters of over 50 centimetres, and some vessels were over 1-metre high. Common forms include carinated and straight-sided 'cups' or small bowls, open and closed bowls, trays, husking trays, collared jars and large *pithoi*. Decoration included, painted designs and, more rarely, incision (Voigt 1983: 99-102). Other baked-clay artefacts include arrow-shaft straighteners; miscellaneous geometrics or 'tokens', which were possibly 'memory aids' in an early recording system (cf. Schmandt-Besserat 1977); sealings; 'stamps', and a large number of spindle whorls (Meadow 1975: 282; Voigt 1983: 168). Unbaked and lightly-fired clay was used to produce animal and highly-schematic human figurines, including T-shaped figurines (Voigt 1983: 175-8).

The chipped-stone industry is described by Voigt as "quantitatively and qualitatively poor" (1983: 218), which is probably due to the lack of local, good quality stone. Most of the flint at the site would have to of been imported from outside the Ushnu-Solduz Valley, probably somewhere else in the Zagros. Obsidian was recorded from the site, which was sourced from at least two regions: one in the Lake Van region of eastern Turkey; and the other in the area of the Urmia Basin (Voigt 1983: 220). The industry is predominantly blade-based, and common tools include sickle blades, backed blades, retouched blades, reaming tools and geometrics in the form of trapezes (ibid.: 224).There is a general lack of cortical pieces, which suggests that the initial stages of core preparation occurred elsewhere, perhaps at or near the source of the raw material (ibid.: 227). In terms of artefact counts, obsidian pieces slightly outnumber those of flint, although obsidian only accounts for 31 per

cent of the assemblage by weight (Voigt 1983: 224). There is a scarcity of chipped-stone artefacts at Hajji Firuz compared to other contemporary sites (e.g. Ali Kosh, Tepe Sabz) which is probably explained by the lack of local flint sources (Hole et al.1969; Voigt 1983: 221).

Thirty-six ground stone artefacts were recovered, of which nearly 70 per cent were grinding tools (e.g. querns, mullers, mortars, pestles) (Voigt 1983: 245). No luxury items of ground stone, such as jewellery or stone bowls, were found, which is probably due to the lack of locally available suitable stone. A unique type of artefact were 'stamps' – large, rectangular blocks engraved with linear patterns – which may be related to the stamp seals that are found at contemporary sites in Mesopotamia and Anatolia (Voigt 1983: 259).

The majority of the bone artefacts were awls, which were presumably used for skin processing and the manufacture of textiles and baskets; although some may have been used as ornaments, applicators for cosmetics, or clasps or belt fasteners (Voigt 1983: 204). Only two types of shell artefacts were found: disc beads made from mother of pearl, which probably came from local freshwater clams; and a cowry shell bead or pendant, sourced from either the Persian Gulf or the Mediterranean.

Fifteen burials, containing the remains of at least fifty-three individuals, were recovered, all of which were confined to domestic houses (Voigt 1983: 60, 77). Bones were disposed of in a variety of ways, but most individuals were placed in ossuaries, usually in the form of bins or platforms, although in one case a large storage jar was used as a receptacle, and in other buildings bones were strewn on the floor. The skeletons that were articulated were laid in a flexed position, usually on their left side, with their torsos lying roughly north–south, and their heads to the north. Grave goods were relatively simple – typically small pottery vessels and clay spindle whorls, but occasionally tools – and were generally limited to large multiple burials (ibid.: 74).

3.3b. Central western Iran

Tepe Sarab

Tepe Sarab is located in the Mahidasht region of the central Zagros Mountains. The site is a very low mound, with two 'lobes' separated by a central north-south depression (Voigt & Dyson 1992: 157). It was originally excavated in the early 1960s under the direction of Robert Braidwood (Braidwood & Howe 1960; Braidwood et al. 1961), and was excavated again in 1978 by Louis Levine. Braidwood's earlier investigation identified only an Early Neolithic occupation, whilst Levine's revealed the presence of a distinct Early Neolithic and Middle-Late Neolithic occupation lying side by side. No botanical remains were recovered from the site, although it did yield many animal bones (Braidwood et al. 1961: 2009), particularly goats, which outnumbered sheep by about four to one (Legge 1996: 248). Legge (1996: 249), who analysed the faunal assemblage, suggests that the herd demography of the goats is consistent with that of a managed herd, and that the domesticated status of the sheep can be assumed as well. Gazelles were the principal wild species exploited (accounting for 12.3% of the animal remains), whilst cattle, pig and deer were uncommon (ibid). There was a great concentration on the exploitation of local land snails, which until recently were collected and eaten in great numbers by villagers in Kurdistan and Luristan (Braidwood et al. 1961: 2009).

Braidwood's original excavation recovered no architecture, with occupation represented by a series of ashy layers and a semi-pit structure, which led Braidwood (2001: 1961) to conclude that the site was only semi-permanently occupied. Frank Hole (1987: 47) has suggested, by ethnographic analogy with modern Kermanshah herders that the ash layers are the remains of seasonal campsites, occupied by transhumant pastoralists who constructed houses of reeds which they burnt on leaving.

Levine's later excavation identified both an Early Neolithic – as encountered by Braidwood (Braidwood et al. 1961) – and a Middle-Late Neolithic deposit.

The Middle-Late Neolithic deposits displayed some fragmentary evidence of mudbrick architecture, which suggests that the site may have been occupied for longer durations during this period. However, Hole (1987: 47) believes it unlikely that it was ever permanently occupied, as winters on the Kermanshah Plain are harsh, with temperatures reaching as low -20°C. The Middle Neolithic levels were characterized by a chaff-tempered 'Buff' and 'Sarab Standard Painted' Ware; and the Late Neolithic by 'Red Slipped' Ware, 'Sarab Linear Painted' Ware and 'Black-Slipped' Ware (Voigt & Dyson 1992: 157). Other small finds include animal and human clay figurines, including T-shaped (Alizadeh 2003: 6), chipped-stone tools in flint and obsidian, and finer works in ground stone, which Braidwood et al. (1961: 2008) believed shared strong similarities with elements from Jarmo, Iraq.

Tepe Guran

Tepe Guran lies in the Hulailan Valley of Luristan, western Iran, approximately 65 kilometres south of Kermanshah, at an elevation of 950 metres (Meldgaard et al. 1963: 104). It was excavated in 1963 by a Danish team under the direction of Mortensen (1964, 1974). It is a small mound, which measures 100 metres by 80 metres, and contains some 6-7 metres of cultural deposits, that span an occupation of at least 700 years. Twenty one architectural levels (A-V) are identified, of which levels D-V are Neolithic. The excavator dated the site to ca. 7300-6000 BC (Mortensen 1964: 30).

Botanical remains were only recovered from the later deposits, and evidence the cultivation of possibly domesticated two-row hulled barley, wild two-row barley, and the collection of pistachio (Mortensen 1974: 24). Domesticated goats were present from the earliest levels, where they represent 80-100 per cent of the ungulate remains, and wild animals, with the exception of gazelle, were rare (ibid): a few foxes and hares were recorded, but these may be intrusive (Bökönyi 1969: 4). In later levels, the importance of gazelle increased, and by the sixth millennium BC the ratio of goat to gazelle was roughly equal (Mortensen 1974: 25). The increase in the consumption of gazelle was accompanied by a corresponding increase in red deer, wild cattle,

wild pig, fox and wolf, and the profuse collection of the land snail *Helix salominiaca*. The change in subsistence – both in terms of a greater emphasis on hunting, and an increase in the species utilized – led Mortensen (1974: 24) to suggest that Tepe Guran transformed from a semi-permanent site, occupied by transhumant pastoralists, to a permanent site occupied by inhabitants who were more dedicated to cultivation, and had to venture further afield to gather wild resources; a conclusion supported by the fact that the first evidence of cereal cultivation roughly corresponds with the appearance of more substantial architecture, around 6200 BC.

The earliest settlement at Guran (levels Q-V) was made up of small rectangular and sub-rectangular wooden huts, with two or three rooms, which were spaced apart from each other, (Meldgaard et al. 1963: 110; Mortensen 1974: 21). The remains of straw-tempered mudbrick houses with stone foundations first appear in Level P alongside the wooden huts (Meldgaard et al. 1963: 110). For a short period both architectural traditions were in use together, but from Level M onwards all structures were of mudbrick (ibid.: 110-11). Generally rooms were small with rather thick interior walls, sometimes with recesses for low benches, tables, or openings to domed ovens. In later phases some of the internal walls were covered with a thin layer of white or red gypsum, and floors were paved in a kind of ‘terrazzo’ technique, with small pieces of white feldspar laid into red-coloured clay (ibid.: 111).

Clay was used from the earliest levels at Guran to produce human and animal figurines, although the first pottery is not evidenced until Level S, where it occurs in the form of an undecorated, lightly-fired, coarse ware (Meldgaard et al.1963: 113). Meldgaard (1963: 106, 119) believes the pottery production to be an indigenous development, which was technically related to that of the clay figurines. The ware was principally used for making thick-walled bowls with vertical or slightly-curved sides and flat or rounded rims, which were wet smoothed or burnished. In Level R a second type of ware, an undecorated buff ware, came into use. This ware was chaff tempered, surface slipped and occasionally burnished, with a colour varying from buff to orange buff. It was

primarily used to make oval or circular bowls, some of which were carinated. A third type of ware, a fine 'Red Burnished' ware, came into use from Level H, and common forms include open bowls and cups with flat or rounded bases (ibid.: 117-8). The earliest painted ware, 'Archaic Painted' Ware, is recorded from Level R, and was characterized by a chaff-tempered fabric, which was surface slipped and occasionally burnished (ibid.: 116). Typical forms include bowls and beakers with curved or vertical sides, decorated with motifs that resemble basketry or netting. It was later replaced by 'Standard Painted' Ware – a finely chaff-tempered, surface-slipped and occasionally burnished ware, which developed over time. The earlier vessels were typically bowls with curved sides and flat bases, whilst later vessels occurred in the form of slightly-carinated bowls (ibid.: 117). Motifs were applied obliquely in the form of blobbed lines which, over time, evolved into small, square, rectangular or polyhedric spots.

The chipped-stone industry was based on flakes and blades, including microliths (Meldgaard et al. 1963: 118). The most common tool types were sickle blades with surface gloss, end-of-blade scrapers and borers. The vast majority of the utilized pieces (~80%) were not retouched (ibid.: 119). In later levels large numbers of tools typically associated with agriculture, including querns, mullers and sickle blades with gloss, were found. Such tools are noticeably absent in the lowest levels, perhaps because cereal cultivation was not practiced by Guran's earliest inhabitants (ibid.: 120). Flint dominates in all levels amounting to an average of 90–95 per cent of the total, and only a small amount of obsidian was found. Ground-stone types include a single celt, sling shots, polishing and rubbing stones, palettes, mortars, pestles, mullers and querns. Marble was used to manufacture semi-globular bowls and inverted, conical vessel forms with flaring rims. Polished stone was also used to produce what the excavators identified as a 'phallus' sculpture (ibid.: 116). Worked-bone tools include awls, spatulas and pins. Ornaments in the form of buttons, beads, and pendants were made of shell, bone, stone, mother-of-pearl and slightly-baked clay. Necklaces and bracelets were made

of alabaster and marble. Clay 'nails' of uncertain use were also recovered. Most of the burials at Guran were primary interments beneath house floors. The exception is a one-metre deep pit at the base of the site which contained the probable secondary interment of at least four individuals (Meldgaard et al. 1963: 112). Grave goods were rare. Those that were found include perforated animal teeth, shell beads and geometric microliths.

Tepe Asiab

Tepe Asiab is an Early Neolithic open-air site, situated on the Qara Su River, in the western foothills of the Zagros Mountains, approximately five kilometres east of Kermanshah. The site has only been explored through a small sounding dug under the direction of Robert Braidwood (Braidwood & Howe 1960; Braidwood et al. 1961), the findings of which were inconclusive. The sounding revealed 2.5-3.0 metres of cultural deposits consisting of alternating layers of clay, stones, ash and a number of circular fire pits, some of which contained fire-cracked rocks. At the base of the sounding a large oval basin (ca. 10-metre wide), dug into virgin soil, was exposed. The basin contained two burials – one flexed; and one extended body covered with red ochre (Braidwood et al. 1961: 2008). Braidwood tentatively dated the site to ca. 10,000-9600 BC.

No botanical remains were recovered from Asiab, but indirect evidence in the form of blades with sickle sheen suggests the harvesting of wild cereals (Braidwood et al. 1961: 2008). A considerable diversity of animals were exploited including sheep, goat, cattle, pig, onager, red roe and fallow deer, and gazelle (Legge 1996: 248; Hole 1987: 33). Goat and to a lesser extent sheep, both probably in the early stages of domestication, account for 36 per cent of the identified bones (Bökönyi 1977: 20-2), and red deer constituted a further 38 per cent (Legge 1996: 248). Wild boar made up 18.6 per cent and wild cattle 6.5 per cent (Bökönyi 1977: 22). Various small mammals including badger, red fox and hare were also probably hunted, although it is possible that some of these animals may have burrowed into the site to die, and had nothing to do with the Neolithic inhabitants' subsistence (Bökönyi 1969: 4).

Various game birds were exploited, and great quantities of river clams were collected, but surprisingly, virtually no land snails, despite their importance at contemporary sites (e.g. Tepe Guran) (Braidwood et al. 1961: 2008). The diversity of the bone assemblage suggests that the inhabitants of Asiab ranged widely to obtain animals from different environments (Bökönyi (1977: 36-7). Bökönyi (1977: 37) suggests from the presence of corn crake (*Crex crex*), which winters in Iran, that Asiab was occupied during winter, however, Hole (1987: 33) cautions that the crake bones could also have been obtained in late autumn or spring.

Braidwood describes the chipped-stone industry at Tepe Asiab as "markedly homogenous" (Braidwood et al. 1961: 2008). Tools were predominantly of flint, and common forms include microlith blades, bipolar, discoids, amorphous blades, as well as cores with single platform and pyramidal shapes (Alizadeh 2003: 6). Lunates, semilunates and celts were notably absent. Other artefacts reported from Asiab include some "beads, pendants and bracelet fragments of marble, and numerous small clay objects, including a few enigmatic figurines" (Braidwood et al. 1961: 2008), some of which were 'T-shaped' (Alizadeh 2003: 6).

Ganj Dareh

Ganj Dareh (Fig. 3.17), which literally translates as 'treasure valley', is located in the Bisitun valley system of the Zagros Mountains at ca. 1350 metres above sea level, 37 kilometres from the provincial city of Kermanshah. It was excavated under the direction of Philip E.L. Smith (Smith 1967; 1968; 1972; 1974; 1975; 1978; 1990) during the 1960s and 1970s, who dated the site to ca. 8400-7000 BC (Early Neolithic). Unfortunately a full site report was never published.

Ganj Dareh is a tepe site, ca. 40 metres in diameter, which contains approximately 8 metres of cultural deposits that are almost totally Neolithic; there is a small amount of intrusive Islamic material in the uppermost levels (Smith 1974: 538). Smith (1972: 165) divides the Neolithic deposits into five

distinct occupational levels labelled A-E, of which the oldest (Level E) is aceramic (Smith 1972: 165). Level D is the best preserved due to its partial destruction by fire.

Smith (1968, 1972) reports that the botanical remains recovered from Ganj Dareh were inconclusive. There is some indirect evidence for the cultivation of cereals and legumes in the form of mortars, pestles, clay bins and containers found at the site (Smith 1968: 159). Frank Hole (1987: 49) reports that Ganj Dareh is situated at an elevation well above the zone of wild cereals today, and that it is probable cereals were brought to Ganj Dareh in an already domesticated form. The faunal remains include goat, sheep, wild cattle, deer, gazelle and boar (Smith 1974: 168). Goat was the principal meat animal, outnumbering sheep by about 15:1 (Zeder 1999: 15). M. Zeder (1999: 15; Zeder & Hesse 2000) reports that the demographic profile of the goats is consistent with that of a managed herd, and that the domestic status of the sheep can also be assumed; conclusions consistent with those of Richard Meadow (Meadow 1989a; 1989b; Bar-Yosef & Meadow 1995). The domestic status of the goats is further confirmed by evidence of several caprid hoof prints in the mudbricks of Level D, where goats had presumably walked over the bricks whilst they were drying. The high elevation of Ganj Dareh means that the inhabitants of Ganj Dareh would have had relatively easy access to wild goats, which inhabit the nearby flanks of the Zagros Mountains, thus they could potentially have been domesticated at or near Ganj Dareh (Zeder 1999: 15).

No architecture was recovered from Level E, but a number of round or oval shallow depressions containing fire-cracked rocks (fire pits?) were discovered dug into virgin soil (Smith 1974: 207). It is probable that for the duration of Level E Ganj Dareh was ephemerally occupied (Smith 1972: 167). Permanent architecture (presumably corresponding to permanent settlement) first appears in Level D in the form of solidly built, rectilinear, mudbrick houses (Smith 1968: 159). Many of the buildings contained very small rooms or cubicles, most of which were rectilinear, although some were round (Smith

1974: 207). Although no traces of material were preserved, clay containers resembling jars and small domed ‘bins’ set against the walls suggest that these areas were used for storage (Smith 1990: 332). The buildings were clustered together with no paths or lanes between them, and no clearly defined doors, although some rooms had round ‘port holes’ (ibid.). Some may have been two storeys with a living surface supported by wooden beams overlying the small rooms (Smith 1972: 166).

The lithic industry comprised both blade and flake tools, and was virtually undifferentiated throughout the levels (Smith 1968: 159). Common tool types include well-made parallel-sided blades, backed blades, side scrapers, end scrapers, cylindrical cone choppers, and a small number of geometric microliths in the form of trapezes and lunates. Alizadeh (2003: 5) regards the types of lithics at Ganj Dareh as comparable to assemblages from Tappeh Asiab, Chogha Bonut and Ali Kosh, however, in contrast to other Iranian Early Neolithic sites all of the tools at Ganj Dareh were made of flint, and no obsidian was recovered (Smith 1968: 159; 1974: 164). Ground stone tools include a large number of mortars, pestles, and rubbers (Smith 1968: 159).

Clay was used throughout the occupation of the site for the production of small human and animal figurines, a number of which were decorated with “peculiar fingernail impressions” (Smith 1968: 159). The majority of the animal figurines were fairly naturalistic and probably represent sheep or goat (Smith 1968: 159). Some human figurines were in stylized forms, including the so-called ‘T-shaped figurines, which have been reported from other contemporary sites (e.g. Asiab, Sarab) (Alizadeh 2003: 5). One sherd of pottery was found just above virgin soil, however, it was probably intrusive, and the manufacture of ceramic vessels did not begin properly until Level D (Smith 1972: 167-8; 1974: 539). The earliest pottery was a soft, lightly-fired, chaff-tempered ware. Some of the later sherds were decorated with peculiar crescent-shaped or ‘fingernail’ impressions (Smith 1968: 159; 1972: 167). Large bowls and jars were the primary forms. A well-made stone-lined kiln or oven filled with small fragments of clay was found in Level D, which may

represent an early attempt to create a controlled environment in which to fire pottery (Smith 1974: 207)

Most of the human skeletal material (comprising at least 41 individuals) was recovered from Level D, including several infant burials in small mud-walled cubicles under house floors (Smith 1972: 167). Adult burials occurred in both flexed and extended positions, and some burials may have been secondary. Only child and adolescent burials were associated with grave goods (Smith 1974: 207). There were two burials of particular note, one held the remains of an adult, an adolescent and a child interred in a 'sarcophagus' made of mudbrick and covered with a mud roof; the other contained an adolescent, wearing an elaborate necklace of 71 stone and shell beads (Smith 1972: 167). Included among these were five perforated shells tentatively identified as the marine gastropod *Oliva*, thus, part – or all – of the necklace represents an import, presumably from the Persian Gulf although the Mediterranean is a possibility (Smith 1974: 208). This is intriguing as there is no evidence of other imported materials at Ganj Dareh.

Tepe Abdul Hosein

Tepe Abdul Hosein lies some 75 kilometres east-southeast of Ganj Dareh, on the Khawa plain, ca. 1860 metres above sea level. It is a small mound, some 6 metres in height by 50 metres in diameter, which has been damaged by local villagers removing deposits for their fields (Fig. 3.18). The site was first visited by C. Goff and J. Pullar in 1970, and later excavated under the direction of Pullar for two months in the summer of 1978. There were two distinct prehistoric occupations of Abdul Hosein separated by a clear hiatus. Pullar (1990: 5) dates the earlier occupation, which is without pottery, to the early- to mid-seventh millennium BC (Early Neolithic); although it may be even earlier for virgin soil was never reached at the western edge of the site. The later occupation is dated by Pullar to the fifth millennium BC. It has been badly disturbed, and is not considered here.

Botanical remains were rare at the site, which may be because it was only occupied during winter (Hubbard 1990: 217). Agrostid grass was the most common seed encountered in terms of number, although in respect to bulk, roasted pistachio (which were commonly used in the past to preserve meat) and almond stones were the greatest. This, however, is probably a feature of preservation (ibid.). Three crop plants were identified: domesticated two-row hulled barley (*Hordeum distichon*); emmer wheat (*Triticum diccocum*) (possibly domesticated); and one seed of lentil (*Lens* sp.) of indeterminable status (Pullar 1990: 12). Several samples of oat were recovered, but Hubbard (1990: 120) argues that there is no reason to assume that it was cultivated. The majority of other plant remains, which include knotgrass (*Polygonum spp.*), milfoils (*Achillea cf. wilhelmsii*), sedge seeds and fenugreeks (*Trigonella sp.*), parallel the plant community existing in the immediate vicinity of the site today, and were probably used for animal fodder (Willcox 1990: 227). The restriction of the crop assemblage at Tepe Abdul Hosein to two or three crops, and the subordination of emmer to barley are unusual, as at most other contemporary sites emmer wheat dominated, and a greater variety of crops were cultivated (Hubbard 1990: 220). The faunal remains from the site have yet to be analysed, although a first impression suggests a change in emphasis from wild animals to domesticated caprines (Pullar 1990: 10). From the worked bones, sheep, goat, deer, boar and wolf/leopard have been identified.

No architecture was recovered from the earliest levels at Abdul Hosein, but this may be due to excavation bias as very little of the earliest levels was uncovered (Pullar 1990: 5). Occupation is instead represented by a number of pits dug into virgin soil. Traces of architecture appear gradually, and in later levels substantial mudbrick houses were constructed. It is possible that collectively these levels represent the transition from temporary to permanent settlement at the site (Pullar 1990: 6).

Although the earlier occupation of the site was aceramic, clay was used to manufacture tokens and animal figurines which, with the exception of two (a

boar & a pig), are similar to those found at other eighth to seventh millennium BC sites in western Iran (Alizadeh 2003: 5; Pullar 1990: 10). The chipped-stone industry was predominantly a blade industry, which Pullar (1979: 154, 1990: 12) reports shared many similarities with that of Tepe Asiab and Ganj Dareh. Common forms include: bladelets, blades and blade cores, sickle blades and end scrapers. Obsidian, though absent from the earliest levels, was recovered from the later levels associated with architecture. It was primarily sourced from the Nemrut Dagh Mountains of Anatolia, and represents to date the earliest evidence of obsidian in the Zagros Mountains (Pullar 1990: 6, 12). Thus, it has important implications for understandings of trade and cultural contact in the Zagros Mountains during this period. In terms of other small artefacts worked-bone tools and beads of shell, stone and polished tortoise shell were recovered from most levels. Several Neolithic burials – primarily from the upper aceramic levels – were exposed (Pullar 1990: 10). One burial consisted of a fully-extended young woman, associated with the bones of a baby or foetus buried beneath a house floor. In an earlier phase of the same building a crouched burial was found blocking a doorway, which had been plastered up with mud (ibid).

3.3c. Southwestern Iran

Deh Luran and Susiana Plains

Ali Kosh

Ali Kosh is located on the Deh Luran plain in the northwest corner of Khuzestan (Voigt & Dyson 1992: 123). The site, which was excavated under the direction of Frank Hole in 1963, is a roughly flat-topped circular mound with a diameter of some 135 metres (Fig. 3.19) (Hole et al. 1969: 29). It contains seven metres of deposits, of three of which lie below the present plain surface, and which collectively span period the Early-Late Neolithic. Three distinct occupational phases are distinguished at Ali Kosh: Bus Mordeh

(ca. 7500–6750 BC); Ali Kosh (ca. 6750–6000 BC); and Mohammad Jaffar (ca. 6000-5600 BC).

The botanical remains were analysed by Hans Helbaek (1969). Ninety per cent of the seeds identified from the Bus Mordeh phase were from annual legumes and wild grasses native to northern Khuzestan including: alfalfa, spiny milk grass, *Trigonella* (a small plant of the pea family), oats and caper (Hole et al. 1969: 343). Some of these seeds are no larger than a clover seed, and the amount of work involved in their harvest must have been considerable (Hole & Flannery 1967: 169; Helbaek 1969: 389). In addition emmer wheat and two-row hulled barley were cultivated. Although the number of seeds of these plants constituted less than 10 per cent of the carbonized seed remains, wheat and barley have significantly larger grains than most of the other plants mentioned and were probably two of the preferred foods (Hole & Flannery 1967: 171). Seeds of *Scirpus* (sea club-rush) mixed in with the grains suggest that the fields were near marshy grounds (Helbaek 1969: 389).

In the ensuing Ali Kosh phase, there was a drastic increase in the cultivation of cereals, with emmer wheat and two-rowed hulled barley grains accounting for around 40 per cent of the identified remains (Hole & Flannery 1967: 175). There was a corresponding increase in the presence of weedy taxa associated with cultivation, and a real tapering off in the collection of small-seeded wild legumes, with the latter accounting for only 20 per cent of the identified carbonized seeds (a decrease of some 70 per cent from the Bus Mordeh Phase) (ibid.: 175). The preference for cereals continued into and during the Mohammad Jaffar phase.

Goats formed a major component of the diet throughout the occupation of Ali Kosh, and their importance is further attested by the production of lightly-baked clay goat figurines (Hole et al. 1969: 344). During the Bus Mordeh phase the herd demography of the goats is consistent with that of a managed herd (Hole & Flannery 1967: 173), although the animals barely differed morphologically from their wild phenotype, suggesting they were in the initial

stages of domestication (Hole et al. 1969: 334). The Ali Kosh phase goats were “clearly domesticated” (Hole & Flannery 1967: 175), whilst those of the Mohammad Jaffar phase were “highly domesticated” (Hole et al. 1969: 4). Sheep were also herded, but were greatly outnumbered by goat in all phases (Hole & Flannery 1967: 177). Hunting was an important part of the economy in all phases, and gazelle, auroch, onager and wild boar were all important resources. During the Ali Kosh phase, there was an increase in the hunting of wild ungulates, which was accompanied by the development of a special set of butchering tools (Hole et al. 1969: 348). Aquatic resources, including carp, catfish, mussel and turtle, also formed an important part of the diet. Small mammals contributed only a minor part of the diet during the Bus Mordeh and Ali Kosh phases, although they were more widely utilized in the Mohammad Jaffar phase. This may have been because herd animals had out-competed the larger wild ungulates for grazing land (Hole et al. 1969: 334).

The earliest architecture at the site is in the form of single-roomed buildings, constructed from large untempered clay slab bricks, held together with mortar (Hole et al. 1969: 42). These structures were generally no more than two-by-two-metres wide, and were often built adjacent to each other so as to share a common wall (ibid.: 342). In contrast, the structures of the Ali Kosh and Mohammad Jaffar phases, were large multi-roomed buildings, with rooms exceeding three-by-three metres in diameter and external walls more than one-metre thick (Hole & Flannery 1967: 175). The buildings were still constructed of large, clay slab bricks, although the walls were often finished with fine mud plaster. Where walls came together they were simply butted against each other, with no attempt made to interlock them (Hole et al. 1969: 42). House floors were of stamped mud or clean clay, often covered by woven mats of reed or club rush. Many houses had associated ‘courtyards’, often containing domed, brick ovens and brick-lined roasting pits. No ovens occurred inside the buildings, which is unsurprising given the heat of Khuzestan summers (Hole et al. 1969: 347). Mohammad Jaffar phase houses were built on solid stone foundations and, in some cases, interior walls were painted with red ochre (ibid.: 350).

The lithic industry at Ali Kosh was predominately blade-based (Hole et al. 1969: 76-91). The blades were generally well made and frequently quite narrow, some measuring only a few millimetres in width, and most were used without any further modification (ibid.: 348). Common forms included backed blades with, and without, oblique truncations; blade end scrapers; and flake scrapers. Drills, reaming tools, burins, and large-core based scrapers were also manufactured and used. Most tools were made of locally-sourced flint, but a small number were manufactured from obsidian (1% in Bus Mordeh & 2% in Ali Kosh & Mohammad Jaffar phases), probably from the Lake Van region of southeastern Anatolia (ibid.: 74-5). Ground stone querns and mullers were used during the Bus Mordeh phase, but became more common during the ensuing Ali Kosh phase, from which mortar and pestle was also an innovation (ibid.: 188). Implements of worked bone include awls, spatulas and needles (ibid.: 214-9).

Figurines were manufactured from unbaked and lightly-fired clay. The earliest forms were rather generalized animal figurines, which Hole et al. (224-5) suggested, on the basis of body shape, were probably goats and/or sheep. In the Ali Kosh phase both animals and humans were represented, including 'T-shaped' figurines (ibid.: 224), while in the Mohammad Jaffar phase animal figurines were negligible (Hole 1977: 5). Pottery was not present during the Bus Mordeh and Ali Kosh phases, and during these phases soft stone vessels were used. Forms include low, open bowls with flat bases; bowls with out-turned or beaded rims; oval bowls with slightly incurved rims; and low shallow trays (Hole et al. 1969: 107). The first evidence of basketry occurs in the Ali Kosh phase (although it was probably practiced in earlier periods as well; ibid.: 224), and some baskets were waterproofed with asphalt. Pottery, in the form of soft, friable, chaff-tempered vessels, first appears in the Mohammad Jaffar phase, and is divided into three types: 'Jaffar Plain', 'Jaffar Painted' and 'Khazineh Red' wares (Hole et al. 1969: 352). 'Jaffar Plain' Ware was a chaff-tempered, buff ware that was burnished or wet smoothed. Vessel forms include small carinated bowls, bowls with convex walls, and slightly out-turned rims, rounded vases, and deep bowls with simple rims and flat, rounded, or

slightly carinated bases (ibid.: 115-7). 'Jaffar Painted' Ware was identical, except for the addition of geometric designs in fugitive red ochre paint (e.g. zigzags, chevrons, pendant triangles & lozenges) (Hole et al. 1969: 352), which reportedly share some similarities with the designs on contemporary pottery from Tepe Guran, Tepe Sarab and Hajji Firuz Tepe (Flannery & Hole 1967: 181; Hole 1977: 5). 'Khazineh Red' Ware first appeared ca. 6000 BC as a minor part of the assemblage, although it steadily increased in importance (Hole 1977: 5). It is a chaff-and-grit tempered ware, with a soft red slip and burnish, and common forms include hole-mouthed jars, hemispherical bowls with beaded or occasionally slightly curved rims, and carinated bowls.

In a tradition that lasted throughout the Neolithic, the inhabitants of Ali Kosh wore pendants of boar tusk, shell and polished flat pebbles, 'buttons' of tusk and pearl, and necklaces and bracelets of stone and shell beads (Hole et al. 1969). Later additions include the addition of turquoise and cold-hammered beads. Thus, it is evident that the inhabitants of Ali Kosh were participating in an ever-widening trade network (although the amount of material circulated was fairly small), with obsidian from Turkey, turquoise from northeastern Iran, specular hematite from Fars and seashells from the Persian Gulf (Hole 1977: 5).

No burials were recovered from the Bus Mordeh phase. During the succeeding Ali Kosh individuals were buried under house floors, in a flexed position, and were often accompanied by grave goods; while in the Mohammad Jaffar, individuals were inhumed outside, in a semi-flexed position, generally on their left side, facing west (Hole 1977: 5). The majority of burials were accompanied by grave goods, which included items of personal adornment, baskets (possibly with perishable food stuffs) and red ochre. It is evident from the burials that skull deformation was practiced (Hole et al. 1969: pl. 12).

Chogha Bonut

Chogha Bonut is a small mound, lying on the northeastern edge of the Susiana plain. In its truncated and artificially rounded state, the site measures some 50 metres in diameter by 5 metres in height (Fig. 3.20) (Alizadeh 2003: 1). It was originally excavated by Helen Kantor for two seasons in 1976/77 and 1977/78, however, further investigation was abruptly halted by the 1979 Islamic Revolution, during which most of the material excavated by Kantor was destroyed or disappeared (Alizadeh 2003: xxxi). Excavation was renewed in 1996 under the direction of Abbas Alizadeh, for one short season. Occupation at the site is divided into six chronological phases (Bonut A-F), the earliest of which, Bonut A, is pre pottery. Alizadeh (2009) dates the site to the late eighth millennium BC Early (Neolithic), making it, to date, the oldest lowland village site, known in southwestern Iran.

Chogha Bonut is located in the 250-mm precipitation isohyet, the borderline of successful rainfed agriculture in the Near East. Today, the area surrounding the site is treeless, however prior to human interference it would have supported steppe or savannah vegetation (Miller 2003: 127). The botanical remains are mainly comprised of cereals, principally domesticated two-row (& possibly six-row) barley (*Hordeum vulgare*), and domesticated emmer wheat (*Triticum dicoccum*) (Miller 2003: 125). A small amount of einkorn wheat (*T. monococcum*), as well as a few grains tentatively identified as hard wheat (*T. durum*), are also represented, but may have not been crops in their own right. Pulses and other legumes include a wild heterogeneous type, *Pisum/Vicia/Lathyrus* (pea/vetch/grasspea), and a few seeds of probable lentil (*Lens*) of indeterminable status (ibid.: 123, 125). *Prosopis*, a non-pulse legume was also found, as well as a few wild grasses, including goat-face grass (*Aeiglops*), wild oat (*Avena*), and rye grass (*Lolium*) (ibid.: 127).

The faunal remains were dominated by domesticated goat, with a small number of sheep; cattle (both wild & domesticated); and gazelle (*Gazelle subgutturoso*) (Redding 2003: 140). Other hunted animals include wild pig (*Sus scrofa*), birds and brown bear. From the extreme range in size of the

cattle remains Redding (2003: 140) proposes that a small number of domestic cattle were kept, probably as an insurance resource (although perhaps for milk) while wild cattle were hunted. Goitered-gazelle (*Gazelle subgutturoso*) was the principal hunted animal. Brown bear is not found on the Susiana plain, and its presence indicates that the inhabitants of Chogha Bonut travelled into the surrounding mountains. The remains of a number of giant Indian gerbil (*Tatera indica*) were also recovered, which do not appear to represent recent intrusions (Redding 2003: 141). The area does not support this type of gerbil today, and their presence suggests that during the occupation of Chogha Bonut, the area around it was much wetter. Indeed, Redding (2003: 141) suggests it may even have been irrigated.

No solid architecture was recorded from the earliest phase (Bonut A), but a few fragmentary pieces of mudbrick suggest that solid architecture might be present elsewhere on site (Alizadeh 2009). The buildings of the later phases were typically small, rectangular mudbrick houses, with two or three rooms, and an associated open courtyard (Alizadeh 2003: 32, 40). They were built of long, cigar-shaped, mudbricks, similar to those across the Susiana Plain to southern and central Mesopotamia (ibid.: 40). No special structures are reported, but parts of a much larger building were recovered from Bonut C.

Unfired and lightly-baked clay was used to manufacture human and animal figurines. Crudely-shaped animal figurines were recorded from the earliest levels, whilst anthropomorphic T-shaped figurines occur only from the upper layers of Bonut A onwards (Alizadeh 2003: 22). Pottery first appears in Bonut B in the form of a straw-tempered software. Basket impressions exhibited on a few pieces of the ware indicates that some, if not all, the vessels were basket moulded (ibid.: 47). Shapes were simple and include dimpled-based, open hemispherical bowls, straight-sided shallow trays and hole-mouth jars. The majority of the vessels were plain, though some were decorated with a simple band of red paint. A variety of this ware, 'Red-slipped Straw-tempered' Ware, had a denser paste, was surface smoothed, and had a red wash (ibid.: 47). Some vessels were also burnished. A slightly later development was

‘Smear-Painted’ ware. This ware was rather well-baked, tempered with fine straw, or more frequently chaff, and coated on both surfaces with brownish-buff or light-maroon slip or wash (ibid.: 47-8). The exterior surface was usually decorated with a red-brown paint apparently applied by fingers. Simple forms include hemispherical bowls with a beaded or blunt lip, and dimple-base and hole-mouthed jars (ibid.: 48).

The chipped-stone industry was “an advanced, basically blade industry” (Alizadeh 2003: 21), which remained largely undifferentiated throughout the Neolithic occupation of the site. The presence of some non-local, high-quality flint cores indicates some form of regional exchange, although in contrast to the neighbouring, roughly contemporary site of Ali Kosh, obsidian blades were rare (Hole et al. 1969: 105; Alizadeh 2003: 21, table 3.1). Few ground-stone tools were recovered, but this may be an accident of discovery (Alizadeh 2003: 22). Fragments of polished-stone vessels and bracelets were found, and bone tools were present, predominantly in the form of awls, although a needle and a ‘spatula’ were also recovered (ibid.: 82).

Marv Dasht and Mamasani Plains

Tell-e Mushki

Tell-e Mushki It is a small circular mound, located in the Marv Dasht Plain, some 12 kilometres southeast of Persepolis (Alizadeh 2006: 43). It measures some 70 metres by 70 metres in extent, stands 1 metre above the present plain surface, and contains some 1.7 metres of cultural deposits (Hole 1987: 54; Alizadeh 2006: 43).. The site was first excavated in the 1950s by Louis Vanden Berghe. It was later excavated by a Japanese team led by Shinji Fukai (Fukai et al. 1973) in 1965; and was most recently excavated in 2004 for a short season, by a joint expedition from ICHTO and Chicago’s Oriental Institute.

No faunal or botanical material was reported from the Japanese excavation, and not enough material was recovered from the 2004 excavation to draw any definitive conclusions, from which barley (probably domesticated) was the only cereal recorded (Miller & Kimiaie 2006: 109). This is in sharp contrast with sites in southwestern Iran (e.g. Ali Kosh & Chogha Bonut), where wheat is attested from the earliest levels (Alizadeh 2006: 13). Wild plant species, especially those species well-suited for fodder, are well represented, suggesting that pastoralism may have been the main source of subsistence, and cereal cultivation of minor importance (Miller & Kimiaie 2006: 110). However, this conclusion is not supported by the faunal remains, which show a conspicuous absence of domesticated sheep, and a very low presence of goat, with the majority of the assemblage belonging to wild species of bovines and equids (Mashkour 2006: 105), although this may be due to excavation bias (Alizadeh 2006: 13).

The Japanese team defined five architectural phases (I-V), of which level I is the earliest (Alizadeh 2006: 43). *Pisé* and straw-tempered mudbrick fragments were found, but no complete architectural plans could be identified. Similar architecture was recorded by the 2004 excavation, associated with domestic structures including ovens, fire pits and storage bins. Frank Hole (1987: 54) and Abbas Alizadeh (2006: 10) have both suggested that Mushki was a seasonal campsite used by pastoralists (Hole 1987: 54; Alizadeh 2006: 10).

Pottery was present throughout the sequence. The Japanese expedition reported both red-washed and buff-slipped varieties, although the latter was less prevalent (Fukai et al. 1973: 24). The 2004 expedition identified three types of handmade, straw-tempered software (‘Plain Coarse’, ‘Painted Burnished’ & ‘Painted Buff’ Ware), as well as several other minor types of decorated pottery (Alizadeh 2006: 8-9, 42).

The artefact assemblage was simple and comprised stone and bone tools, a few cold-hammered copper points, flint and obsidian blades, stone bracelets, beads and labrets, shell (dentalium & cowrie) ornaments and a few simple

animal figurines (Alizadeh 2008: 43). The presence of obsidian at Mushki points to the connection of the inhabitants with the northwest, the presence of seashells (possibly from the Persian Gulf) attests to contact with southern regions, whilst the copper objects and beads made of turquoise evidences connections to the east and northeast (ibid.: 9-10).

Tall-e Jari A

Tall-e Jari A is located on the Marv Dasht plain, some 200 metres southeast of Tall-e Mushki. It measures ca. 120 metres in length, and stands 2.5-2.8 metres above the present plain surface (Alizadeh 2006: 43). The site was originally excavated by a Japanese expedition, but their final results remain unpublished. More recently, it was excavated for a short season in 2004, under the direction of Abbas Alizadeh.

No botanical and faunal information is available from the Japanese excavation, while the botanical assemblage from the 2004 excavation is too small to make any firm conclusions. Some remains of domesticated barley were found, but, like Tall-e Mushki, the majority of the plant remains recovered were from wild species, particularly those that make good fodder (Miller & Kimiaie 2006: 110). The faunal record is dominated by domesticated sheep and goat, suggesting that the site was primarily a pastoral site. A few domesticated cattle, and a small amount of gazelle, were also evidenced (Mashkour 2006: 105).

Straw-tempered mudbricks and *pisé* were used from the earliest levels to construct small, rectangular, multi-roomed houses with open courtyards, hearths, and ovens (Alizadeh 2006: 10, 43). The Japanese team documented three architectural phases (Levels I-III), although the 2004 excavation report the architecture to be homogenous throughout (ibid.: 41).

The Japanese expedition reported plain and decorated varieties of a straw-tempered software (‘Jari Plain’ & ‘Jari Decorated’ ware) from the basal levels, and a ‘Black-on-Buff Painted’ Ware from the later levels. However, the 2004

excavation recorded only ‘Black-on-Buff Painted Ware, which Alizadeh describes as “typical Bakan B2/Gap ware” (2006: 43). Alizadeh (2006: 42) tentatively suggests that the discrepancy between the findings of the two excavations may be because different areas of the site were sampled.

Tall-e Jari B

Tall-e Jari B lies some 150 metres from Tall-e Jari A, and shares a similar history of excavation. It measures ca. 120 metres in length, and rises 2.5-2.8 metres above the present plain surface (Alizadeh 2006: 43).No information is available on the botanical or faunal remains. From the earliest levels, *pisé* and mudbrick was used to construct buildings with small, cubic rooms, ranging in size from 2.0 by 1.5 metres, to 3.5 by 2.5 metres (ibid.: 43). The walls were decorated with red paint, and some of the structures had stone foundations (ibid.: 43). Alizadeh (Alizadeh et al. 2005: 103; Alizadeh 2006: 42) reports that, as at Jari A, the architecture and material culture, including pottery, was homogenous throughout; although the Japanese team claimed differently.

The pottery consisted of typical Jari painted and plain wares, which can be divided into three types: two plain wares and one prominent painted buff ware (Alizadeh et al. 2005: 103). The plain wares were much the same as those recovered from Jari A and Bakun B1, and were chaff-tempered with occasional small grits. Where decoration was applied, the paint was fugitive. Wide shallow and bell-shaped bowls were common; as were tall, cylindrical beakers with concave sides (ibid.). Small finds include simple stone and bone tools, copper pins, shell and stone ornaments, flint and obsidian blades, clay animal figurines, spindle whorls and some grinding stone tools (ibid.: 43, 46). No intramural burials were found, with the exception of a doubtful child burial (ibid.: 43).

Tol-e Bāsi

Tol-e Bāsi (Fig. 3.21) lies in the eastern Rāmjerd Plain, Fars, and consists of two originally separate roughly circular mounds: A and B. Based on surface survey, Mound A measures 220 metres in diameter and has an elevation of

1631 metres above sea level; and Mound B measures 200 metres in diameter and stands 1629 meters above sea level (Fig. 3.22) (Bernbeck 2010a: 21). If both mounds were occupied simultaneously in the Late Neolithic, the settlement would have had a maximal extent of 6.9 hectares. However, it is unclear whether the occupation of the two mounds was continuous or sequential during this period. At present irrigation is encroaching the mound and farmers have pumped water up on to its lower southern end (Bernbeck 2010a: 21). Not long ago, Mound A was bulldozed along its northwestern edge in order to extend the irrigable agricultural land, and approximately one quarter of the mound was destroyed in the process. Damage to Mound B has also occurred, and its southeastern periphery is cut away, leading to the destruction of approximately one third of the mound (ibid.). Radiocarbon dating suggests that the Neolithic phase at Tol-e Băsi can be dated to ca. 6200-5530 cal. BC or, of the single oldest date is excluded, ca. 6020-5530cal BC (Pollock 2010: 263).

Based on the distribution of surface pottery it appears that the Late Neolithic occupation of the site was concentrated in the northwestern part of Mound A, and consequently this area was selected for excavation in 2003 (Bernbeck 2010a: 27). Five excavation units (A-E) were opened. Little architecture was encountered, and that which was exposed all seems to have consisted of rectangular, multi-roomed structures that were built of *chineh* (Pollock 2010: 64). The remainder of the excavated area comprised mainly of large open areas that seem to have been used for a variety of activities. Ashy deposits and other evidence of burning were common, as were fire installations of various kinds. Some exterior surfaces were covered with considerable quantities of artifacts. The occupants engaged in repeated preparation of surfaces, but appear to have made little effort to keep them clean of burnt debris and other debris. Together with the general paucity of artifacts, Pollock (2010: 64) suggests that the debris accumulation on the surface implies successive, short-term occupation, probably in the colder months of the year when fires would have been needed for warmth. Pollock argues that if the

occupations were relatively brief then the residents might not have seen the need to remove debris.

The faunal remains from Băsi are poorly preserved and highly fragmented rendering identification difficult (Pollock et al. 2010: 292). The majority of mammalian remains derive from domesticated goats and sheep. Domesticated cattle are the second most common animal resource. A few pig bones are present, suggesting that pig was only of limited economic importance. In terms of wild species, gazelle is the one species clearly attested, particularly in the earlier levels. Minor species include felids, rodents, birds, fish, amphibians, reptiles and terrestrial crabs, although none of these were necessarily used for human food (ibid.).

Densities of plant remains were low. In terms of domesticated species remains of two-row barley, einkorn (*Triticum monococcum*) and free-threshing wheat (*T. aestivum/durum*) are present. Wild taxa include Aegilops, Scripus maritimus (fresh-water weed), Setaria – which were probably used are fuel – and almond and pistachio. Pollock et al. (2010: 292) comment that the botanical assemblage from Băsi is more restricted than that of contemporary sites, where lentils, flax and six-row barley are typically present. They suggest that the absence of these taxa at Băsi may be due to small sample sizes or poor preservation.

Bernbeck describes the Neolithic pottery at Băsi as, “a highly fragmented assemblage that is to some extent similar to ceramics known from other Late Neolithic sites in the Kur River Basin” (2010b: 65). Bernbeck (2010b: 71, tab. 5.4) identifies 17 different types of ware, which can be broadly be divided into two distinct groups: “vegetal temper” and “vegetal-mineral temper” (ibid.: 69). The distribution of the wares is very uneven, with 11 of the wares amounting to less than 1 per cent of the total assemblage each, while the other 6 occur in significant proportions. “Vegetal Unpainted Ware” (49% of the total count) and ‘Vegetal-Mineral Unpainted Ware” (18%) are the most frequent. Bernbeck suggests that both of these are complement wares, i.e. the sherds were from

unpainted parts of otherwise painted vessels (Vegetal Black-on-Buff & Vegetal Mineral Black-on-Buff account for 14.2 % & 4.2 % of the total count respectively. The other two most prominent wares are “Vegetal Coarse Chaff” (7.2%) and “Vegetal Straw Tempered” (3%).

The repertoire of vessel shapes was very restricted. “Bag-shaped” vessels are the most common, accounting for 70 per cent of all the identified shapes, and unlike the other forms are usually painted (Bernbeck 2010b: 72, 77; Pollock et al. 2010: 289). Coarse, large basins are also well represented, while vats and hole-mouth vessels are less common. Bernbeck suggests that ceramic production at Băsi during the Late Neolithic, “focused on the fabrication of a few basic shapes, each of which was used for a multiplicity of different tasks” (2010b: 72), rather than specificity.

The overall decorative structure of the Baši vessels is very similar to that of Jari B vessels in that all of the vessels have horizontal registers and vertical registers are not used; and almost all of the painted vessels are decorated with three superimposed registers (Bernbeck 2010b: 80). In such cases the upper register (at the rim) and the lower one contain identical motifs, while the main motif is always different to these peripheral motifs i.e. A-B-A structure. Eighty-seven per cent of the main motifs are comprised of three designs: a “Baši” motif, consisting of a stepped pattern with lines extending obliquely from the sides and ending in points; a “ladder” motif, consisting of pairs of lines with points or short slashes in between, giving the motif the appearance of multiple ladders; and a “Hook” motif, consisting of small unconnected design elements in the shape of hooks (Bernbeck 2010b: 80). The “Hook” motif is known from a wide geographical area, stretching from the Mamasani region to the Marv Dasht (Weeks et al 2006b).

The overall density of chipped stone at Baši is relatively low, as is also the case at a number of other Late Neolithic sites in the Zagros and neighbouring lowlands (Pollock et al. 2010: 290). Early stage reduction appears to have occurred off site, possibly near the raw material sources. The assemblage is

essentially blade-based. Most tools are plain retouched pieces, but there are also a number of sickle blades, notched pieces, geometric microliths, perforators and truncated blades. Pollock et al. (2010: 290) believe the tool repertoire to show similarities to that of Tal-e Muški and Tal-e Jari. Grinding and pounding implements include hammer stones, grinding slabs and pecking stones made from locally available limestone and sandstone (Pollock et al. 2010: 291).

More than 180 “miniature cylindrical objects” or labrets were recovered (Pollock et al. 2010: 290). Most of the objects are ceramic, but a small number are made of a soft whitish stone and one of bone (ibid.). Some show traces of paint. Similar objects are known from more or less contemporary sites over a wide geographical region extending from southern Turkmenistan to southwestern Iran, which are otherwise characterized by distinctive ceramic assemblages. The use of labrets remains controversial. Based on use wear analysis it seems unlikely that they were used as tools (Pollock et al. 2010: 291), presenting two possible alternatives: either they were used as some sort of mnemonic device; or they were worn as personal ornamentation. Bernbeck et al. (2010: 291) suggest based on ethnographic parallel that the latter seems the more likely.

Other small finds were mainly made of clay or fired ceramic and include sling balls, spindle whorls, and bits of clay containing dark red paint, seemingly from walls or floors (Javeri et al. 2010: 192-3). A single animal figurine with horizontal black stripes and two horns was recovered, which the excavators suggest represents domesticated cattle or wild equid (Javeri et al. 2010: 197). Seven bone awls and reamers were recovered, pointing to the working of hides or fabric (ibid.: 193; Bernbeck et al. 2010: 291). In terms of personal ornamentation two possible pendants were recovered: one made from turquoise and pear shaped; the other a small pierced conical shell most likely of Chalcolithic date (Javeri et al. 2010: 194). Beads were made of stone and dentalium.

Fragments of limestone and sandstone vessels were present, which probably originally formed part of square- or rectangular-shaped vessels (Javeri et al. 2010: 195). Several other pieces of worked stone were recovered, including a hammerstone, two stone balls, and a shaft straightener (Bernbeck et al. 2010: 291). A few small pieces of copper, including some fragments of pins, could not be clearly dated (Javeri et al. 2010: 198).

In general, the inhabitants of Baši relied on resources available at or quite near to the settlement, including limestone, sandstone and cherts (Pollock 2010: 294). However, long-distance connections are attested by the presence of shell from the Persian Gulf and turquoise, the presence of which underscores the importance of Băsi in the Bakun period (Javeri et al. 2010: 194). At the neighbouring site of Tal-e Bakun A long-distance connections is evidenced by the presence of obsidian, Persian Gulf shells, bitumen, lapis lazuli and turquoise (Alizadeh 1988), leading Javeri et al. (2010: 194) to suggest that either a small portion of these items reached Baši via Bakun, or the site itself was directly part of such a network of interregional interaction.

A survey of rock shelters near Tol-e Baši.

During survey near Tol-e Băsi four rockshelters (Dareh Gaći I-IV) and a chert quarry were discovered (Heydai 2010: 265). The rockshelters were small, tower-shaped structures, formed by large erratic boulders, and are situated at the base of Kuh-e Ayub, ca. four kilometres south of Tol-e Băsi. They are not large or particularly well-suited for protection from the wind and the rain, but their existence between the plain and the mountains means that they are convenient for people to use while in transit or for short stops. Ethnographic and contextual evidence shows that the shelters are used today for bird hunting, and Heydai (2010: 265) suggests a possibly functional analogy is their use as refuges for hunting expeditions in the past. Some lithic artefacts were found, although the distribution between the sites is highly uneven, possibly because of depositional processes. The chert quarry was located in a ravine near to the main rocky bluff of the Kuh-e Ayub. The position of the rockshelters between the quarry and Tol-e Băsi leads to an alternative

explanation for their use. They may have been way stations for villagers on the way to the quarries, and given the lack of cortex at Baši and its presence at the rockshelters, were perhaps where the primary stages of lithic production took place (Heydai 2010: 267).

Tol-e Nurabad

Tol-e Nurabad lies on the Dasht-e Nurabad, on the outskirts of the modern town of Nurabad-e Mamasani, western Fars (Potts et al. 2005: 89). It is situated next to a perennial stream, the Korr-e Sangan, which was probably influential to the location of the site (Weeks et al. 2006: 31). It was excavated for two seasons in 2003 and 2004, by a joint research team from the ICHTO and the University of Sydney (Potts et al. 2005; Potts & Roustaei 2006). The site lies at an elevation of 965 metres above sea level, measures 90,000 square metres, and stands 24 metres above the current plain surface (Potts et al. 2005: 87). Today, the entire area around and on the mound, is under cultivation, and ploughing along the east and north sides have exposed a section approximately 16-18 metres high, into which two small soundings were dug (ibid.: 90).

No information is currently available on the botanical remains from the site (Weeks et al. 2006: 67). The faunal assemblage was analysed by Marjan Mashkour. Caprines are by far the predominant taxa in all periods at the site. They represent 65-95 per cent of the number of identifiable specimens of taxa used for food, followed by cattle which never exceed 15 per cent (Mashkour 2006: 136). However, Mashkour cautions that if the same data were analysed in terms of meat weight, the impression would be very different, since cattle provide on average 10 times more meat than caprines. Rather surprisingly, there is an almost total absence of evidence of hunting (ibid.: 137). This is in contrast to other contemporary sites elsewhere in Fars (e.g. Tall-i Mushki, Tal-i Jari A & B, Tal-i Bakun A & B), where gazelle and equid hunting were still important.

The Neolithic occupation of the site was substantial, and eight Neolithic architectural phases are recognised (A27-19). The earliest phase, A27, is represented by only a small, ephemeral, ashy fireplace and overlying fill. However, given the limited area excavated, it is probable that more substantial occupation existed elsewhere on the site (Weeks et al. 2006: 71). The architecture from the other Neolithic phases is comprised of superimposed, substantial mudbrick and *pisé* rectilinear structures, which exhibited a general continuity in alignment.

The pottery was a handmade, chaff-tempered software, which was present from the earliest levels. It was well-fired, handmade and generally slipped or burnished on both interior and exterior surfaces, and the majority were decorated on the exterior surface with mono- or biochrome painted motifs (e.g. grouped horizontal lines, diagonal lines, 'basketry' & crosshatching) (Weeks et al. 2006: 41-3). Bowls were the most common form, and closed-jar forms and carinated vessels were also represented (ibid.: 43).

The chipped stone tool assemblage was very small. Only one obsidian artefact was found, and the great majority of the tools were chert or flint, which was probably sourced locally (Weeks et al. 2006: 63). It was essentially a blade-based industry, with a high proportion of debitage. Small finds include clay 'labrets', balls and tokens, two possible clay figurines, and small bone beads (Weeks et al. 2006: 64-5).

Tang-e Bolaghi: TB130 and TB75

Tang-e Bolaghi or the Bolaghi Valley (Fig. 3.23) was subject to two seasons of survey and excavation in 2005 and 2006 by a joint Iranian-Japanese team, as part of a salvage project for the Sivand Dam area (cf. Tsneki & Zeidi 2008) Tang-e Bolaghi covers an area of ca. 25 kilometres squared. Located between Pasargadae and Persepolis it must have been an extremely important traffic route from at least as early as the Epipalaeolithic (Tsneki & Zeidi 2008: 5, 7); a conclusion supported by archaeological survey (Yamauchi & Nishiyama 2008: 216).

According to earlier work (cf. Tsneki & Zeidi 2008 & references therein), there are more than 100 archaeological sites in Tang-e Bolaghi, including modern nomadic camps and graveyards. The prehistoric material is found in a few caves and shelters at the foot of the mountains surrounding the valley. Two of these caves have been excavated (TB130 & TB75; Fig. 3.24) and date to the Epipalaeolithic/Early Neolithic (Tsneki & Zeidi 2008: 7). TB75 or *Hajji Bahrami* (Fig. 3.25) is a relatively large cave, strategically located so that from the entrance the central part of the Bolaghi Valley, with a partial view to the south through to the Kamin Plain, is visible (ibid.: 43). The cave is situated 1875 metres above sea level, and the opening measures 9 metres wide by 2.8 meters high, with a depth of 19 metres (Fig. 3.26). Four small trenches were opened: A-D. Trench B was sunk in the middle of the terrace slope and contained approximately one metre of cultural deposits, all of which were assigned to the Proto-Neolithic. Trenches C and D were sunk in the frontal part of the cave. Both reached virgin soil at ca. two metres depth, and produced the same cultural phases: Islamic, Achaemenid, Proto-Neolithic and Epipalaeolithic (ibid.: 45).

TB130 is located ca. 1.2 kilometres east of TB75. It is not as deep, and is described as “more of a shelter than a cave” (Tsneki & Zeidi 2008: 71) (Fig. 3.27). Its outlook is not as open as that of TB75, with only a limited view of the Bolaghi Valley. The cave opening stands at 1848 metres above sea level, and measures 9-metres high by 8-metres wide; the interior covers an area of ca. 50-metres squared (Fig. 3.28) (ibid.: 71). Five trenches (A-E) were opened, all of which – with the exception of A – contained Proto-Neolithic layers (ibid.: 74).

There is no fertile land for agriculture near to either of the caves (Tsneki & Zeidi 2008: 71). Botanical information is only available from TB75. Just a small number of charred seeds were recovered. The initial plant list for the site is: Astragalus/Trigonella type legumes, *Gramineae*, lentil, barley, an intact wheat grain (bread wheat?), which given the early date of the context is

probably intrusive, *Prunus* or *Amygdalus* and *Papaveraceae* (Tanno 2008: 151-3).

Information on the faunal remains is available only from TB75 (Hongo & Mashkour 2008). Gazelle (*Gazella* sp.) are the most commonly encountered taxa both in the Epipalaeolithic and Proto-Neolithic layers. Sheep (*Ovis* sp.) and goats (*Capra* sp.) are also present in both levels, and dramatically increasing in number (particularly goats) in the Proto-Neolithic, i.e. the total number of identified sheep and goat in the Epipalaeolithic layers is 17 per cent, increasing to 46 per cent in the Proto Neolithic (ibid.: 136). Cattle (*Bos* sp.) are not encountered in the Epipalaeolithic, and a single molar was identified in Proto-Neolithic layers (ibid.: 137-8). Pigs are similarly not present in the Epipalaeolithic, but a few specimens occur in the Proto-Neolithic. In terms of miscellaneous small mammals and other animals, a few fox (*Vulpes vulpes* sp.) and hare (*Lepus capeusis*) are found in Proto-Neolithic layers, and birds, reptiles, rodent and amphibian bones are occasionally found (ibid.: 139). Among the reptiles, land turtle is relatively common. The results of the faunal analysis suggest a wide range of fauna were exploited at TB75. Medium-sized bovids were the most important game, of which gazelle were the most significant (ibid.: 143). An increase in proportion of sheep and goat, especially goat, from the Epipalaeolithic to the Proto Neolithic is evident, possibly related to domestication. However, “this cannot be determined with the evidence at hand” (ibid.: 144).

In total 10,703 stone artefacts were collectively recovered from TB75 and TB130, manufactured from a chert-like flint, varying in colour from dark-brown to green (Ohnuma 2008: 87). The assemblage is composed of tool types such as: end-scrapers, thumbnail scrapers, denticulated pieces, notched pieces, non-geometric and geometric microliths (ibid.: 96). Katsuhiko Ohnuma, who analysed the assemblage, believes that the lithic assemblage as a whole, might be easily dated to the Epipalaeolithic of the Zagros Mountains, but taking the overall technological-typology into consideration, “can be more

readily placed within the chronological framework from the Zarzian to the Proto-Neolithic of the Zagros Mountains" (Ohnuma 2008: 97).

3.4. The Neolithic of surrounding areas

3.4a. Turkmenistan

Jeitun

Jeitun is the Neolithic type site of southwestern Turkmenistan. The site, which lies 25 kilometres northwest of the city of Ashkabad (Fig. 3.29), measures some 7000-square metres, stands 5.5 metres above the present plain surface, and contains approximately 3 metres of cultural deposits (Fig. 3.30) (Harris & Gosden 1996: 376). It was discovered and first excavated in the 1950s by V.M. Mason; a subsequent phase of excavations was carried out by the Jeitun Archaeological Project, a British-Soviet collaboration, between 1989 and 1992 (Harris et al. 1993); and a British team, under the direction of David Harris returned to the site from 1993-1994. Most recently, Harris has undertaken a larger regional investigation in the region, searching for the precedent(s) of Jeitun (cf. Harris 2010b).

Jeitun lies in a liminal location, between the fault-mountain front and piedmont, which mark the northern edge of the Iranian plateau; and the southern edge of the Karakum desert. As such, its inhabitants would have had access to a range of different ecotones, which included the foothills of the mountains; the whole width of the piedmont; and the sand ridges and clay flats of the southern Kara Kum desert (Harris et al. 1993: 327). Today, the area around Jeitun receives around 200 mm of rainfall annually (Harris 2010a: 27). This is the very limit for rainfed agriculture (Oates & Oates 1976: 111), suggesting that the inhabitants of Jeitun may have utilized locally high water-tables to water their crops (Harris et al. 1993: 327).

The botanical remains evidence the cultivation of hulled and naked varieties of (probably six-row) cultivated barley (*Hordeum vulgare* L.), domesticated

einkorn (*Tritticum monococcum* L., both one- & two-grained forms), another, emmer-like, type of wheat of uncertain origin; and, tentatively identified, free-threshing wheat (of *T. aestivum/durum* type) (Charles & Bogaard 2010: 151-3; Harris 2010a: 73-74, 147). Of the cereals wheat, predominantly einkorn, was the most abundant type (Charles & Bogaard 2010: 151; Harris et al. 1993: 332; 1996: 436-9). This is unusual, as at most early agricultural sites in southwest Asia, einkorn wheat usually constitutes part of a more diverse crop assemblage (Harris et al. 1993: 31-2), and it may be that the emphasis on it at Jeitun was for ecological reasons (Harris 2010a: 147). Wild plant remains include a relative abundance of caper seeds (*Capparis* sp.), which suggests that the fruits may have been collected for human food (Charles & Boggard 2010: 153); and the grasses *Bromus* spp. and *Eremopyrum* sp., *Alyssum* sp., and club rush (*Scirpus maritimus*), which were probably brought onto the site as animal dung (ibid.: 154, 165; Larkum 2010: 148).

Phytolithic analysis of the botanical remains evidences numerous large silica skeletons, which may imply that cereal cultivation at Jeitun involved irrigation (cf. Rosen & Wiener 1994: 126-30), and was not dependent only on ground water and the low annual rainfall (Larkum 2010: 149). Supporting this interpretation are the archaeological findings from the most recent investigations at the site, where a human-made ditch-like feature was encountered close to the site, with ^{14}C dates that suggest that it was contemporary with Jeitun (Harris 2010b). The practice of irrigation agriculture at Jeitun is also suggested by the wild plant remains, which include moisture-loving species such as club rush, which grow in areas of high water table, such as deliberately irrigated plots (Harris et al. 1993: 327-8).

Morrell and Clegg (2007: 3289) interpret the presence of domesticated barley at Jeitun, as evidence of a possible secondary domestication of barley. However, there is presently insufficient archaeobotanical evidence to resolve whether barley was domesticated, or introduced into the region as an already domesticated crop from northern Iran (Harris & Gosden 1996: 381; Willcox 2005: 535-8; Harris 2010a: 75-6, 226). In terms of wheat, Harris reports that

there is no evidence it was domesticated locally in Turkmenistan and its presence at Jeitun, “is almost certainly the result of its introduction as a domesticated cereal from somewhere west of the Caspian” (Harris 2010a: 76). This hypothesis is supported by the evidence from Mehrgarh, western Baluchistan (see below), where domesticated einkorn is reported from the earliest levels; Constantini (1984: 31), but is unlikely to have been domesticated locally, as the region lies outside of the known range of wild einkorn (Harris 2010a: 78).

The faunal remains evidence the presence of domesticated sheep, goat and dog, attesting to the practice of caprine pastoralism (Harris et al. 1993: 334). The herd demography suggests that the caprines were exploited mainly for meat, although their function as multi-purpose animals – also supplying meat, hair, wool and skins – cannot be ruled out (ibid.: 335; Harris 2010a: 175). Both the zoogeographic and genetic evidence presently available, suggest that the animals were not domesticated locally (Harris 2010a: 226-7). In terms of hunted wild animals, goitred gazelle (*Gazella subgutturosa*) were the most heavily exploited; other wild animals include red fox (*Vulpes vulpes*), wild boar (*Sus scrofa*), hare (*Lepos tolai*), steppe cat (*Felis libyca*) and tortoise (*Testudo* sp.), as well as possible wild bezoar goat (*Capra aegagrus*) and urial sheep (*Ovis vignei*). Whilst the gazelle were locally available, the wild sheep and goats (if they have been correctly identified) would have had to have been hunted some distance (up to 40 kilometres?) away from the site (Harris et al. 1993: 334).

The earliest occupation of the site is represented by a series of cultural levels with no architecture, which are suggestive of possible earlier seasonal encampments at the site before the more permanent occupation (Kehl 1984: 49). The architecture of the later levels is characterized by small, one-roomed, mudbrick buildings, with associated courtyards and outhouses (Masson 1961: 204). The buildings vary in size from ca. 3.5 by 3.5 metres to ca. 6.25 by 6.25 metres, with the exception of three small structures, which may have been used for storage (Harris 2010a: 191). Common features include internal

hearths, storage bins, painted projections and niches, and floors of painted lime plaster (Masson 1961: 204). It is unclear whether Jeitun was occupied continuously year round, and from year to year, by the whole population, or whether some, or all, of the Jeitun inhabitants moved seasonally (Harris 2010a: 194). An alternative possibility is that Jeitun was occupied for short periods of several years, interspersed with periods of temporary abandonment followed by reoccupation.

The lithic industry is essentially blade based, and dominated by fine and regular blades extracted from single platform cores (Harris 2010a: 180). Sickle blades were particularly abundant, and account for 37 per cent of the assemblage (Harris et al.1993: 324). Thus, “in the most general terms the Jeitun assemblage is not atypical of what one would expect for an early Neolithic settlement” (Conolly in Harris 2010a: 180).

Pottery, in the form of a handmade, chaff-tempered software, is present from the earliest levels (Masson 1961: 204; Harris 2010a: 188). Jennifer Coolidge (in Harris 2010a: 188), who analysed the pottery from both Mason’s original excavation and the 1994 excavation, identified four types of ware: a ‘Buff’ Ware and ‘Red’ Ware, which predominate; and small amounts of a ‘White’ Ware and ‘Grey’ Ware. Decoration, where present, was simple, consisting mainly of wavy or ‘bracket-line’ lines or a ‘cellular pattern’ (Masson 1961: 204). There is no definite evidence of kiln structures, nor is there any evidence of the systematic exchange of pottery with other groups, and it is probable that pottery production at Jeitun was a household activity (Harris 2010a: 188-9).

Other small artefacts include bone borers, needles and spatulas (Masson 1961: 204); a number of lightly-baked clay animal figurines, some of which were distinctly dog like (Harris & Gosden 1996: 380); and three unworked cowry (Harris et al. 1993: 336). The latter represent the only evidence of long distance trade at Jeitun, from which most of the evidence points to localized

activity at the household level. Only one burial was recovered, in the form of a child buried in the yard of one of the buildings (Harris 2010a: 195).

No pre-Jeitun sites are known from southwestern Turkmenistan, and it is difficult to ascertain where the site's first inhabitants came from. Harris (2010a: 233) suggests that Jeitun, and similar sites, may have been founded as sedentary settlements by migrant agropastoralists, seeking new land to occupy with their crops and livestock, who possibly interacted with pre-existing, more mobile groups.

3.4b. Caspian Sea Plains

Two Early Neolithic sites are known from the Caspian Sea plains, the neighbouring sites of Hotu and Belt Caves (Fig. 3.31), which lie in the cliffs of the southeastern Caspian shore near Sari. Both were excavated under the direction of C.S. Coon from 1949–51 (Coon 1952; 1951; 1957), who reported them to have long sequences of occupation, which included Neolithic deposits.

Belt Cave

The Neolithic deposits at Belt Cave are divided into a pre pottery (Level 2b) and a pottery (Level 2a) phase. No botanical remains were recovered, but Coon (1952: 231) reported the presence of domesticated sheep and goat throughout the deposits, although there presence has not been verified. A variety of wild animals were exploited, including wild sheep and goats, seals, gazelles, voles and birds. The pottery from Level 2a was characterized by a handmade, chaff-tempered software, the surface of which was often burnished, and in some cases rubbed with red ochre (Coon 1952: 242; Voigt & Dyson 1992: 171). Other small finds included bone tools, hand stones, querns, microliths, blades and flakes (Coon 1952: 242).

Hotu Cave

At Hotu Cave, which appears to be later than Belt Cave, pottery is present from the earliest levels, and Coon (1952: 242) believes the site to have been founded by the people who left Belt Cave. It contained 2. 5 metres of Neolithic deposits, from which Coon (1952: 243) reported the presence of domesticated sheep and goat. The earliest pottery was a similar software to that found at Belt Cave, but a few pieces had the addition of a brown slip or a fugitive red paint (Voigt & Dyson 1992: 171); and from the later levels, a thin-walled 'Black-on-Red' Ware, typical of the Transitional Chalcolithic, is reported (Coon 1952: 242; Voigt & Dyson 1992: 172). The chipped stone tool industry was predominantly comprised of flake and pebble tools, as well as some blades and microblades (Dupree 1952: 250-3, 257). Other small finds include piercing tools of bone and polished stone; and six skeletons, sprinkled with red ochre, from towards the back of the cave (Coon 1952: 242).

3.4c. Afghanistan

No recent archaeological work has been done in this region. C.S. Coon identified a 'Mesolithic' at Kara Kamar, which yielded 58 tools, primarily cores and blades, but no geometrics; and the remains of wild sheep, gazelle and mole vole (Coon 1957). Two reputedly Early Neolithic sites are reported at Aq Kupruk (Dupree 1952; 1980; Dupree et al. 1972) in northern Afghanistan; and two further prehistoric sites have been reported from Harzar Su and Gurziwa, but these need further confirmation (Srivastava 2008: 10).

Aq Kupruk I & II

Aq Kupruk I (*Ghar-i Mar* or 'Snake Cave') and Aq Kupruk II (*Ghar-i Asp* or 'Horse Cave') are neighbouring cave sites located on the terraces of the River Balkh, near the modern town of Aq Kupruk, northern Afghanistan. Both were excavated by the Louis Dupree from 1962 to 1964, who identified a pre-pottery Neolithic period at the site, which he subdivided into subphases A and B; and a pottery Neolithic period (Dupree et al. 1972). No botanical evidence

is available, but the presence of sickle blades implies that some sort of harvesting may have occurred (Dupree et al. 1972: 80). The faunal remains evidence what were originally interpreted as domesticated sheep, goat and cattle (Dupree et al. 1972: 73); although their domestic status has since been questioned (Harris 2010a: 51). Wild animals included red deer (*Cervus elaphus*); gazelle (*Gazella subgutturosa*); horse (*Equus caballus*) and onager; possibly wild goat (*Capra hircus* spp.); and freshwater mollusks (Dupree et al. 1972: 57, 73). No architectural remains were encountered at either site, and it is possible that they were inhabited by nomadic groups (Dupree et al. 1972: 33; Srivastava 2008: 100). Chipped-stone tools were manufactured from a local flint, and types included blades, perforators, end and side scrapers, points, burins, sickle blades and microblades (Dupree et al. 1972: 14, 28); groundstone tools were present in later levels, and included limestone hoes, querns, celts and pounders (ibid.: 75). Bone tools were rare, although this may be a feature of preservation, and types included awls, points and needles (ibid.: 28, 30). Other small finds included steatite bowl fragments and fragments of incised turtle shell (Dupree et al. 1972: 75; Dupree 1980: 264).

Dupree reported that, “a change in the stratigraphy at Aq Kupruk I and II heralded the introduction of pottery into the area” (1980: 263). Two types of ceramic wares were identified: a more common, crude, undecorated software, tempered with sherds or chaff (Dupree et al. 1972: 33, 75; Srivastava 2008: 101); and a better-fired ware, with zigzag incisions characteristic of the Neolithic pottery of the ‘Jeitun Culture’ of Turkmenistan (Dupree 1980: 263). Dupree (1980: 263) suggested that this pottery also offered close parallels to that from Hotu and Belt Caves.

3.4d. Baluchistan

Mehrgarh

Mehrgarh remains, to date, the earliest known Neolithic settlement in South Asia. It has been subjected to two major excavation campaigns between 1974

to 1985 and 1997 to 2000, under the direction of Jean-Francois Jarrige, on behalf of the French Archaeological Mission in Pakistan. Mehrgarh is located at the foot of the Bolan Pass, ca. 150 metres above sea level, in a rich alluvial landscape, which would have offered a range of different ecological niches (Jarrige et al. 1995: 63). It spreads over some 200 ha, but this area was never totally settled at any one time, and the Neolithic occupation was limited to areas MR3 and 4 (Fig. 3.32) (Jarrige & Lechevailler 1980: 253). Some seven metres of Neolithic deposits have been recorded, which are divided into Period I (pre pottery), Period IIA (first appearance of pottery); and Period IIB, (distinguished by the development of a more advanced pottery industry) (Jarrige et al. 2005: 130). There is a problem with the ^{14}C determinations for Mehrgarh (see Chapter Five), and consequently most of the ^{14}C measurements show little coherence with the archaeological stratigraphy and context (Jarrige 2000: 282). The excavators estimate that Period I spanned the eighth millennium BC to ca. 6000 BC, while Periods IIA and B cover the sixth millennium BC (Jarrige 2005: 27).

The botanical remains were preliminarily analyzed by Constantini, and are still awaiting further analysis. Constantini reported that they were dominated by domesticated six-row barley, and that wild and domesticated species of two-rowed barley, spheroccoid barley, einkorn wheat and free-threshing wheat were also present in much smaller amounts (Constantini 1984: 24; Constantini & Lentini 2000: 136). The barley from the earliest levels is believed to exhibit poorly domesticated characteristics (Constantini 1984: 29-30; Jarrige 2005: 27), and given this, and the presence of both wild and domesticated species of two-row barley at the site, it is probable that barley was domesticated at Mehrgarh (Jarrige et al. 1995: 64). Indeed, Baluchistan has long been considered by botanists to have been one of the probable centres of the origins of barley (Jarrige & Lechevallier 1980: 254). The local domestication of wheat at Mehrgarh cannot be ruled out (Possehl 2002: 27-8), however, no morphological wild wheat is known from South Asia, and it is probable that it was domesticated elsewhere (Meadow 1996: 395). Constantini (1984: 29) also identified the presence of cotton (*Gossypinu* sp.),

which represents the earliest example of the use, and possible domestication, of cotton in the Old World. Its use at the site is further attested, by the finding of several remains of cotton threads on a copper bead from a Neolithic burial (Moulherat et al. 2002: 1395).

Richard Meadow (e.g. 1981; 1984; 1996), who analyzed the faunal remains, reported a major shift in Period I from the hunting of wild animals, to the herding of domesticated sheep, goat and cattle (Meadow 1984: 35). While in the earliest levels of Period I wild animals accounted for over 50 per cent of the faunal assemblage, in later levels over 90 per cent of the remains were from domesticated sheep, goat and cattle; although a low representation of gazelle, wild sheep, onager, and other occasional forms continued (Meadow 1981: 152). It is suggested that sheep and cattle were domesticated at Mehrgarh, while the goats were already domesticated, or at least 'proto-domesticated' before the occupation of the site (Meadow 1984: 37-40; Meadow & Patel 2002: 396). Domesticated cattle increased in importance throughout the Neolithic, and came to dominate the assemblage. This contrasts sharply with the situation at southwest Asian sites, where caprines dominated throughout the Neolithic. It also has important implications for the social organization at Mehrgarh, for whereas a sheep or goat can feed a family, the slaughter of a cow provides more than ten times as much meat, and far more than one family could consume, meaning that the meat would either have to be preserved and stored, or distributed amongst a larger group (Meadow 1984: 37). Cattle also involve a greater investment in time and resources than smaller ungulates, and thus constitute a greater risk (ibid.: 37).

Nine Neolithic architectural phases are recognized. Each was initiated with the edification of mudbrick houses, which at some point, maybe after two to three generations (Jarrige et al. 2005: 132), were abandoned (Fig. 3.33). Settlement then appears to have moved elsewhere on the site, and the abandoned buildings filled with rubbish and human burials. After an unknown duration of time, burial in the area ceased, the area was leveled and buildings were once more erected.

The buildings were quadrangular structures, typically divided into 4, 6 or 10 small rooms or compartments, which were internally or externally connected by small openings (Jarrige et al. 2005; Lechevallier & Quivron 1981: 75-7). There is a great deal of homogeneity between the buildings, which suggests they were constructed to a rather stereotypical plan. With the exception of numerous charred seeds, no artefacts were found within the buildings, and Jarrige et al. (1995: 248, 372) have suggested that they were used for grain storage. Numerous post holes and fire pits occur around the edges of the built-up areas of the site, which may be the remains of temporary domestic structures (Jarrige et al. 1995: 366). It is possible, then, that Mehrgarh was primarily used for storage, and only semi-permanently occupied.

There was an intensive use of stone tools. Generally local flint from the bed of the River Bolan was used, although occasionally other hard stones, including limestone, sandstone, diorite and chlorite, were used (Lechevallier 1995: 280). The industry was “predominantly a blade and bladelet industry which showed great homogeneity” (Lechevallier 1984: 50). Common types include microliths, sickle elements, borers and pointed tools; and heavy duty tools for tasks such as wood cutting and tilling. The predominant ground stone tools were grinding stones and small hand grinders (Lechevallier 1995: 281). Tools from the earliest levels were usually rougher than those of later ones, and it was only in the later levels that stone axes were polished. Stone vessels were generally absent in Period I, except for a few shallow bowls found in the upper levels and in graves in Cemetery 9 (Jarrige et al. 2005: 139). The principal form of container at Mehrgarh before the advent of pottery appears to have been bitumen-coated baskets. Bone tools occurred throughout the deposits and include points, needles, picks, chisels, choppers and scrapers, which were used for a variety of functions including the working of animal products, digging, piercing, sewing leather and cloth, basketry, weaving and pottery decoration (Russell 1995: 585).

A few fragments of fire-hardened clay are reported from Period I levels, but these were probably intrusive, and fully-fledged pottery production does not

appear until Period IIA (Jarrige 2000: 268, 281). The earliest ware was a handmade, chaff-tempered software, which was occasionally burnished and red slip, and is believed to have been an indigenous development (Vandiver 1995: 658). A later, albeit rare, development was a finer 'Red' Ware, which was occasionally decorated with simple geometric designs in black paint (Jarrige 2000: 281). The vessels varied in size and shape, from small bowls to basins with flat bases (Jarrige 1995: 422).

Clay figurines were a major element of the material culture, and were present from the earliest levels (Jarrige 2005: 27). To begin with the majority of the figurines were anthropomorphic, although in later levels animal figurines did become more prevalent (ibid.: 28). The anthropomorphic figurines are divided into two main kinds: standing and flexed or sitting types. Standing figurines were almost exclusive to Period I, and often bore traces of red ochre; while sitting or flexed figurines, which were first evidenced from Period II, were largely schematic, and generally biconical. A number of the human figurines show clear marks of having been pierced through the body by small twigs, perhaps in some form of ritual activity, although it is difficult to ascertain, as few figurines occurred in primary contexts, and most were found broken in trash deposits or in the secondary fill of abandoned rooms (ibid.: 31-34).

Ornaments occurred primarily in burial contexts, and types include beads – used to make headbands, necklaces, belts, bracelets, anklets and pubic coverings –pendants, rings and armlets (Jarrige et al. 1995). They were made from an extensive array of materials including both local (e.g. stone, leather, bone & copper) and more 'exotic' materials (notably marine shells, lapis lazuli, serpentine and turquoise. The latter evidence the practice of long-distance trade, as the nearest source of marine shell is over 500 kilometres away on the Makron Coast (Kenoyer 1995: 566), the lapis lazuli is probably from Khorassan; and the turquoise from Badakhshan (Lechevallier & Quivron 1981: 89). No evidence for the processing of any of these 'exotic' materials was found at suggesting it was the finished artifacts that were traded (Jarrige et al. 2005).

Over 200 Neolithic burials were excavated, most of which were single interments of fully-articulated skeletons with grave goods (Jarrige et al. 2005: 137); where disarticulation did occur, it was predominantly of young individuals whose graves nearly all lacked grave goods (Sellier 1995: 465). The standard orientation of the burials was east to west (81.3%), with heads to the east, facing south (Lechevallier 1995: 367). The skeletons were mainly flexed, and lay predominantly on their left sides, with the arms and legs drawn together, and the hands in front of the face in a 'praying' position. Almost all of the burials were in funerary chambers, which had been dug into one side of the bottom of a pit, and were sealed with a mudbrick wall (Cucina & Petrone 2005: 81). A large amount of ochre was used in the burials. Indeed, sometimes whole cakes of ochre were placed next to the corpse, which may have been in some way connected with mummification (ibid.). Grave goods included a rich variety of both utilitarian and ornamental offerings (Jarrige et al. 2005: 138). Particularly striking examples of the latter include elaborate shell headbands which were on the skulls of several females. Other interesting deposits include unretouched blades, microliths, and flint cores all positioned along the body of an adult male; a display of stone and bone tools placed in the hand of another; and an interesting cluster of bone tools and ornaments found next to an adult female (Jarrige et al. 2005: 138). Several burials occurred in which offerings of one or more young goats were placed in a semicircle at the feet of the deceased, which was often a young female (Cucina & Petrone 2005: 81; Jarrige 2005: 137). Such burial offering are unique in the Neolithic of South Asia (Lechevallier et al. 1982: 105; Petrone 2000: 295), and are indicative of the important social and economic changes that were occurring at Neolithic Mehrgarh (Petrone 2000: 296). Eleven drilled teeth were identified from among the Neolithic burials. These teeth, some of which were drilled more than once, represent the earliest proto-dentistry known in the world (Coppa et al. 2006: 756).

3.5. Discussion

This chapter has provided an overview of our current knowledge of the Neolithic of Iran and neighbouring regions. As even the most cursory glance reveals, there exists wide variation in the amount of archaeological research that has occurred in different regions. While southwestern Iran and the Central Zagros have been relatively well investigated, there exist large lacunas in our knowledge of the Neolithic of other regions, particularly that of the Central Plateau, northeastern and southern Iran. The situation is further hindered by the lack of absolute chronologies for most regions, meaning that it is often difficult to compare the Neolithic of different regions. In this thesis, the pre pottery or Early Neolithic, is considered to be from ca. 8000-6500 BC, and the Middle Neolithic and Late Neolithic, both of which had pottery, from ca. 6500-6200 BC and ca. 6200-5500 BC respectively.

The Neolithic of each region was unique; however, there were a number of core reoccurring factors (Table 3.6). All known Early Neolithic sites (ca. 8000-6500 BC) in Iran were situated in regions where dry farming was possible, either by rainfall and/or locally high water tables. The settlements were few, and often widely spaced, usually in areas with a good source of water, arable land and easy access to wild species of plants and animals (Hole 1987; 2005). People lived in structures of unbaked mudbrick and *pisé*, or in tents and bush shelters, and there was a general trend throughout the Neolithic towards the more permanent occupation of settlements. For example, the archaeological evidence points to the presence of ephemeral occupations during the Early Neolithic at Tepe Guran, Tepe Sarab, Tepe Abdul Hosein, and possibly Chogha Bonut, before the appearance of substantial mudbrick architecture in later periods, presumably evidencing the permanent occupation of the sites, at least by some members of the group.

Nearly all of the sites had a subsistence economy based on agropastoralism, supplemented by hunting and foraging. The one exception is Tell-e Mushki, from where no domesticated sheep and few goats remains were recovered

(Mashkour 2006: 105), although this may be a feature of excavation bias (Alizadeh 2006: 13). The continuation of both hunting and foraging alongside agropastoralism, emphasises how the Iranian Neolithic was very much a period of transition. At all the sites for which quantitative data is available (e.g. Tepe Sarab, Tepe Guran, Ganj Dareh Tepe, Ali Kosh), goats greatly outnumbered sheep, which is surprising, given that in later periods sheep were to become the preferred domesticate in Iran (Hole & Flannery 1967: 177). It is possible that this had something to do with the differential speed of the spread of sheep and goats across the western Zagros after their initial domestication, as the spread of sheep was much slower than that of goats (cf. Mashkour et al. 2006; Zeder 2011).

The importance of cereal cultivation varied between sites, and different phases within sites. For example, in the earliest period at Ali Kosh, the Bus Mordeh Phase, 90 per cent of the botanical remains were from wild annuals, with only 10 per cent coming from cultivated emmer wheat and two-row barley, but in the succeeding Ali Kosh Phase, the gathering of wild annual decreased in importance, and more than 40 per cent of the assemblage was comprised of cultivated cereals (Helbaek 1969: 389). Emmer wheat was the dominant cultivated cereal at Hajji Firuz Tepe, Ali Kosh, Jarmo and Jeitun, while two-row barley was the dominant species at Tepe Guran, Tepe Abdul Hosein, Chogha Bonut, and Mehrgarh. The subordination of emmer wheat to barley at the latter sites is unusual for the Neolithic sites, where emmer usually dominates (Hubbard 1990: 220), and may have something to do with local environmental conditions. The cereal species cultivated at all of the Iranian sites, was largely limited to two-row barley and emmer wheat. The restriction to these cereals is unusual compared to contemporary sites in the Near East, where generally a greater variety of crops were cultivated (Hubbard 1990: 220; Harris et al. 1993: 31-2; Harris 2010a: 147). There is greater diversity at some of the sites from neighbouring regions, for example, domesticated einkorn, emmer and barley are known from Jarmo (Watson 1983: 501), and domesticated six-row and two-row barley, einkorn and free-threshing wheat are all attested at Mehrgarh (Constantini 1984: 29).

During the Early Neolithic (ca. 8000-6500 BC) tools were made exclusively of stone, bone or wood, and other perishable fibrous materials (Hole 2005). At some sites (e.g. Ali Kosh, Mehrgarh) there is evidence that baskets coated in bitumen to waterproof them, were used as vessels. The chipped stone industry was essentially a blade industry, and was remarkable homogenous throughout the Neolithic. Both local flint, and at many of the sites, obsidian, were used to manufacture tools. The exceptions are Tepe Asiab, Ganj Dareh and the earlier levels at Tepe Abdul Hosein, from which obsidian was not recovered, possibly because of the early date of these sites.
Clay was used from the Early Neolithic (ca. 8000-6500 BC) to manufacture unbaked or lightly baked clay animal and human figurines, which were common at most sites, perhaps, indicating some sort of shared cultural practise or belief. A thesis further supported by the widespread distribution of enigmatic T-shaped figurines, which are reported from Hajji Firuz Tepe, Ganj Dareh, Sarab, Asiab, Ali Kosh, Chogha Bonut and Jarmo. Pottery is evidenced from the beginning of the Middle Neolithic period (ca. 6500 BC), in the form of a widely-distributed, handmade, chaff-tempered software. At a number of sites the appearance of pottery has been explained as an indigenous development (e.g. Hajji Firuz Tepe, Ali Kosh, Mehrgarh), although its presence can alternatively be perceived as part of a much larger phenomenon, in which the means and methods for manufacturing pottery spread between groups.

What we would understand today as personal ornamentation was popular, and people wore bracelets, pendants, rings and labrets (Hole 2005). Many of these items were made from non-local resources, including marine shells from the Persian Gulf (found at Ali Kosh, Hajji Firuz Tepe, Ganj Dareh Tepe Abdul Hosein, Tall-e Jari, Jarmo, Jeitun & Mehrgarh), lapis lazuli (Mehrgarh), turquoise (Ali Kosh, Mehrgarh), serpentine (Mehrgarh) and specular hematite (Ali Kosh), the presence of which attests to the existence of long-distance trade and communication networks. These became increasingly developed throughout the course of the Neolithic, and by the Late Neolithic period (ca. 6200-5500 BC) cold-hammered copper is known from Ali Kosh, Tall-e Mushki,

Tall-e Jari B and Mehrgarh, anticipating the introduction of widespread metallurgy (cf. Thornton 2009).

Burials primarily involved the interment of individuals in a flexed position, under house floors, and the spreading of red ochre (possibly something to do with the process of mummification; Cucina & Petrone 2005: 81) was common. There is though, variation between the sites as to whether or not grave goods were offered. For example, the inclusion of grave goods in all burials was the norm at Ali Kosh and Mehrgarh and in child burials at Ganj Dareh; while no grave goods were reported from burial contexts at Hajji Firuz Tepe, Tepe Guran and Hotu Cave. Burials were also reported from Tepe Asiab, Tepe Abdul Hosein, Tall-e Jari B and Jeitun, but not in any great number, and there is not enough information to reach any firm conclusion as to whether it was customary to include grave goods.

As well as the similarities outlined above, there were also marked variations between the cultural practises at different sites. For example, Ali Kosh is the only site to date, from which there is evidence of deliberate skull deformation (Hole et al. 1969: 349), while at Ganj Dareh Tepe both the clay figurines and pottery were ‘decorated’ with distinct fingernail impressions. While the majority of sites from the Middle Neolithic period onwards (ca. 6500 BC) appear to have been permanently occupied, at least by some members of the group, it is possible that Mehrgarh was never permanently occupied, and that the site was used for storage; a conclusion further supported by the small size of the rooms in the compartmented buildings, the lack of any domestic material from within them, and the evidence of numerous postholes and fire pits from the perimeters of the site, which are interpreted as the remains of semi-permanent domestic structures (Jarrige et al. 1995: 366). The burials at Mehrgarh were also distinct to any evidenced elsewhere in the Near East, Central or South Asia. The burials were highly standardized, with individuals interred in a funerary chamber, in a flexed position, orientated east-west, with the heads to the east, facing south (Lechevailler 1995: 367). Grave goods accompanied nearly all of the burials, and included a rich variety of both

ornamental and utilitarian offerings. The choice of grave goods often seems to have been very personal with, for example, in one grave an adult male (possibly a flint knapper?) buried with unretouched blades, microlithics and flint cores positioned down one side of the body; and several burials occurred with offerings of one or more goats placed in a semicircle at the feet of the decreased, who was usually a young female (Jarrige 2005: 137).

3.6. Conclusion

Both similarities and differences, then, exist between the Neolithic sites of Iran and neighbouring regions. Though a number of traits were shared, including the location of sites in areas where dry farming was possible; an economy based on agropastoralism and supplemented by foraging and hunting; the use of mudbrick and/or *pisé* architecture, the trading and use of obsidian, and from the beginning of the Middle Neolithic (ca. 6500) the widespread manufacture of handmade, chaff-tempered software, there were also important differences. These include the emphasis that was placed on different domesticated species at individual sites, be it sheep, goat, cattle, barley or einkorn; disconformity in the internal layout of domestic buildings; the presence of a special building at Hajji Firuz Tepe, possible used for meetings or ritual purposes (Voigt 1983: 315); and distinct variations in the amount and different types of non-local materials found at each site. Indeed, some sites appear to have been far more actively involved in trade networks than others. For example, while at Ali Kosh turquoise from northeastern Iran, shells from the Persian Gulf, copper from the Central Plateau, specular hematite from Fars and obsidian from Turkey, are all found (Hole et al. 1969); at Jeitun the only evidence of long-distance trade is the presence of three cowrie shells (Harris et al. 1993).

The evidence, therefore, points to the existence of increasingly complex networks of trade and communication, along which ideas and technology were shared, but also the importance of regional cultural identities, and the local interpretation and adaption of this technology. Further understanding of

the important interplay of the adoption of shared cultural adaption and the maintenance of regional and local identities, will be gained through the study of the emergence and development of Neolithic societies on the Central Plateau, a previously underexplored, but potentially very important region. In the next chapter the methodology of this research is outlined.

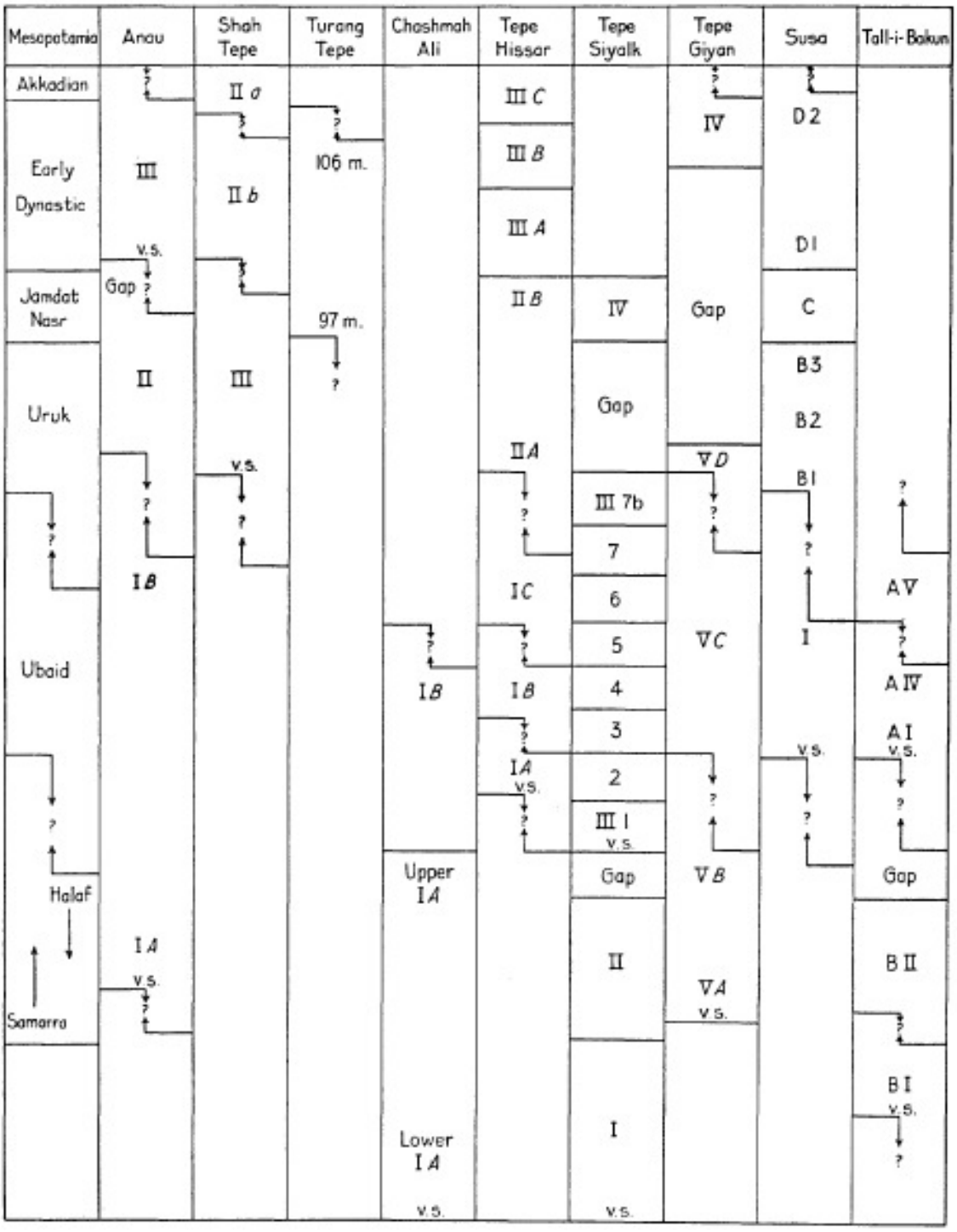
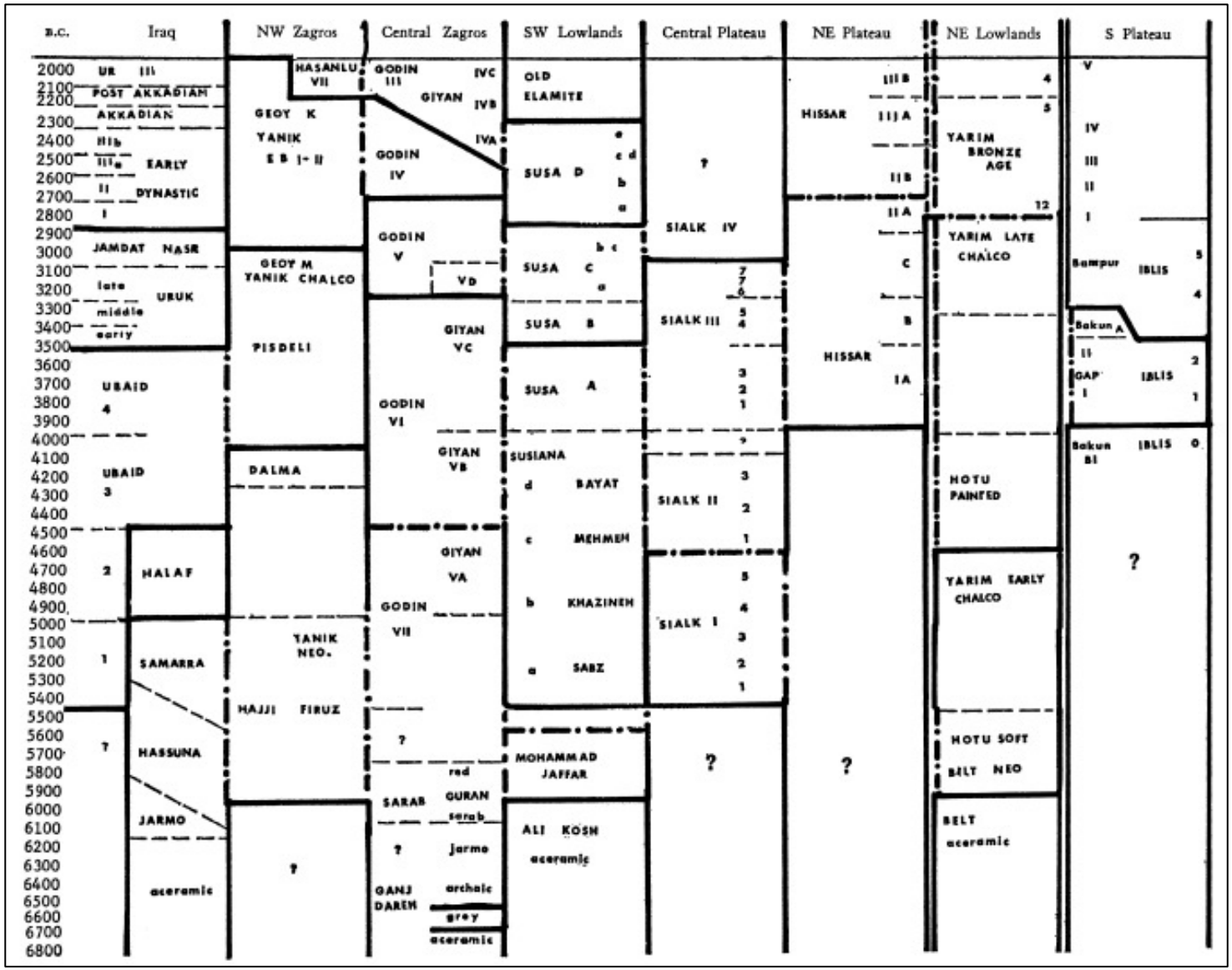


Table 3.0: *McCown's comparative stratigraphy for Iran. The vertical height of a column covered by a period does not indicate length of time. The relative upper and lower limits of the levels and Mesopotamian periods are indicated by the horizontal half lines which are joined vertically by arrow headed lines separated by question marks (e.g. in the column headed 'Tepe Hissar', Hissar IC may be as late as Sialk III7b, or Hissar IIA may start almost at the beginning of Sialk III7). Virgin soil is abbreviated 'v.s.' (After McCown 1942a: table 2.)*

Table 3.1: *R.H. Dyson's relative chronology of Iran. (After Dyson 1968: 310)*



Periods		Tepe Hissar	Tepe Sialk	Morteza Gerd (Cheshmeh Ali)	Ghabristan and Zagheh	Qara Tepe	Tepe Mahmoudieh	Ismailabad	Qumm Region (Qara Tepe)
Late Plateau	B	IC	GAP		Gh.IV 3–1				
	A		III 6–7b		Gh.IV 6–4				
Gray-Ware		Gap	Gap		Gh.III 8–7				
Middle Plateau	C	IB	III 4–5	X	Gh.II 10–9				X?
	B	IA	III 2–3	Ch.Ali IB X	Gh.I 13–11 Plum-				
	A		III 1	Plum-Ware B	16–14 Ware				
			Plum-Ware A	Plum-Ware A	19–17	Plum-Ware	Plum-Ware		Plum-Ware
Early Plateau	B		II	Ch. Ali Upper IA	Late Ch.Ali	X	X	X	X
	A		I	Ch.Ali Lower IA	Early Ch.Ali				
Archaic Plateau					Zagheh Ware				
					Neolithic belt				

Table 3.2: *Majidzadeh's relative chronology for the early prehistoric period of the Central Iranian Plateau. (After Majidzadeh 1981: 142.)*

Period	Deh Luran	Susiana	Azerbaijan	Kangavar	Karkheh Drainage	Fars
Late Village Period (ca. 4500-4000)	Saragarab Susa A	Terminal Susa A Susa A (4200-4000)			Middle Chalcolithic	Lapui (3900-3400)
Middle Village Period (ca. 4500-5000)	Farukh (4400-4200) Bayat (4600-4400) Mehmeh (4800-4600)	Susiana d (Choga Mish Phase) Susiana C	Pisdeli (4700-3900)	Godin VIII Godin IX (4400-3800)		Bakun (4800-3900)
Early Village Period (ca. 6000-5000)	Khazineh (5000-4800) Sabz (5200-5000) CMT (5400-5200)	Susiana b (Jaffarabad Phase) Susiana a Archaic III	Dalma (5200-4700)	Godin IX Shahnabad (5200-5000)	Early Chalcolithic J-Ware	Shamsabad (5500-4800)
Initial Village Period (ca. 8000-6000)	Surkh (5700-5400) Sefid (6000-5700) Mohammad Jaffar (6300-6000)	Archaic II Archaic I	Hajji Firuz (6100-5400)		Late Neolithic (5500) Early Neolithic (6000)	Jari (6000-5500) Mushki (6000)
Pre-ceramic (pre-8000)	Ali Kosh (6700-6300) Bus Mordeh (7500-6700)	Preceramic				

Table 3.3: *Relative chronology of regions during the village period. All the dates are approximate according to their best calibration at the time of publication in 1987. (After Hole 1987: table 1 & 2.)*

Date (BC)	Southwest Lowlands (Khuzestan)		Southwest Zagros	Southeast Iran		Central west Iran		Central north & northeast Iran		Northwest Iran	
	Deh Luran	Susiana	Marv Dasht	Kerman	Soghun	Mahidasht	Kangavar	Central Plateau	Damghan/ Khorsan	S. Urmia	NE Urmia
4500										Hassanlu IX (Dalma)	
	Bayat	M. Susuana 3				E. Siahbid	Godin X				
5000	Mehmeh Khazineh Sabz	M. Susiana 2/1 E. Susiana	Transitional Jaffarabad	Iblis I	Yahya VI	J Ware	Shanabad				
	Chogha Mami	Archaic Susiana 3		Iblis 0	Yahya VII	L. Sarab		Cheshmeh Ali	Cheshmeh Ali		
5500	Transition.		Jari		Murabad		Sarab	Sialk I	Jeitun		
	Surkh	Archaic Susiana 2	Mushki								
	Sefid	Archaic Susiana 1							Sang-i Chakhmaq	Hassanlu X (Hajji Firuz)	Yanik L. Neolithic
??	Mohammad Jaffar	Formative Susiana				E. Sarab		Zagheh			
	Ali Kosh	Aceramic Susiana				Ganj Dareh					
	Bus Mordeh						Abdul Hosein				

Table 3.4: *Chronological chart showing a summary of the relationships between regional sequences. (After Voigt & Dyson 1992: fig. 2.)*

<table>
<tr><th>Schmidt (1936)</th><th>Ghirshman (1938)</th><th colspan="2">McCown (1942)</th><th>Dyson (1968)</th><th>Majidzadeh (1981)</th><th>Dyson (1968)</th><th>Voigt & Dyson (1992)</th><th>Malek Shahmirzadi (1995)</th><th>Fazeli (2001)</th></tr>
<tr><td rowspan="3">Cheshmeh Ali Upper IA</td><td rowspan="3">Sialk II,₁₋₃</td><td rowspan="4">Cheshmeh Ali Upper IA</td><td rowspan="2">Gap</td><td>Gap</td><td rowspan="2">Plum Ware A</td><td>Gap</td><td rowspan="6">Cheshmeh Ali (5500 BC)</td><td rowspan="5">Cheshmeh Ali Period (Sialk I & II)</td><td rowspan="3">Early Chalcolithic Period (ca. 4000-4700 BC)</td></tr>
<tr><td rowspan="3">Sialk II (4100-4600 BC)</td><td rowspan="3">Sialk II (4100-4600 BC)</td></tr>
<tr><td rowspan="3">Sialk II</td><td rowspan="3">Early Plateau A</td></tr>
<tr><td rowspan="3">Cheshmeh Ali Lower IA</td><td rowspan="3">Sialk I, _{I-5}</td><td rowspan="3">Sialk I (4600-5400 BC)</td><td rowspan="3">Sialk I (4600-5400 BC)</td><td rowspan="3">Transitional Chalcolithic Period (ca. 4700-5500 BC)</td></tr>
<tr><td rowspan="3">Sialk I</td><td rowspan="2">Early Plateau B</td></tr>
<tr><td>?</td><td rowspan="3">?</td><td rowspan="2">Zagheh Period</td><td rowspan="3">Late Neolithic Period (ca. 5500-6200 BC)</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td>Archaic Plateau</td><td>Sialk I (??)</td></tr>
<tr><td colspan="2"></td><td colspan="2">Cheshmeh Ali Lower IA</td><td colspan="2"></td><td>Zagheh (??)</td><td>Formative Period</td></tr>
</table>

Table 3.5. '*Table of Tables': proposed chronologies for the Central Plateau.*

Site	Region	Economy	Cereals	Animals	Architecture	Typical burials	Chipped stone industry	Ceramic industry	Figurines	Non-local materials
Hajji Firuz Tepe	NW Iran	Agro-pastoral suppl. by foraging & hunting	Dom. emmer	Dom. sheep, goat, pig & dog	Mudbrick buildings divided into 2	Subfloor burials in ossuaries	Blade based	Chaff-tempered software	Animal & human, (including T-shaped)	Obsidian; cowry shell beads
Tepe Sarab	NW Iran	Pastoral? suppl. by foraging & hunting	*n.d.*	Dom. goat (& sheep	Later levels mudbrick buildings	None recovered	*n.d.*	Chaff-tempered software	Animal & human (including T-shaped)	Obsidian
Tepe Guran	NW Iran	Agro-pastoral suppl. by foraging & hunting	Later levels dom. 2-row barley	Dom. goat & sheep; increase in importance of hunting	Wooden huts followed by mudbrick buildings	Individual, subfloor burials	Blade based	Chaff-tempered software in later levels	*n.d.*	Obsidian
Tepe Asiab	NW Iran	Pastoral? suppl. by foraging & hunting	*n.d.*	Dom.(?) sheep & goat; but mainly red deer & wild boar	None	2 burials: one flexed; one semi-flexed.	Blade based	Pre pottery	Stylistic figurines including-shaped	Obsidian, but may be intrusive; marble beads, pendants & bracelet fragments
Ganj Dareh	NW Iran	Pastoral? suppl. by foraging & hunting	*n.d.*	Dom. goat & sheep; wild cattle, deer, gazelle, boar	Later levels mudbrick buildings	Individual subfloor burials; only children grave goods	Blade based	Pre pottery	Animal & human (including T-shaped)	Marine shell beads; notably no obsidian
Tepe Abdul Hosein	NW Iran	Agro-pastoral suppl. by foraging & hunting	Dom. 2-row barley; dom. emmer	Not reported	Mudbrick buildings appear gradually	1 subfloor burial	Blade based	Chaff-tempered software in later levels	Animal	Obsidian in later levels); marine shell & stone beads; & fragments of tortoise shell
Ali Kosh	SW Iran	Agro-	Dom.	Dom. goat	Mudbrick	Transition	Blade	Chaff-	Animal &	Obsidian;

		pastoral suppl. by foraging & hunting	emmer; dom. 2-row barley; dom.(?) lentil	(dominant) & sheep; hunting of wild animals important	buildings with courtyards	from subfloor to outdoor burials, both with grave goods	based	tempered software in later levels	human (including T-shaped)	turquoise, marine shell; specular hematite & copper beads
Chogha Bonut	SW Iran	Agro-pastoral suppl. by foraging & hunting	Dom. 2-row barley; dom. emmer	Dom. sheep, goat & cattle(?); gazelle principal wild animal	Later levels mudbrick buildings	None recovered	Blade based	Chaff-tempered software in later levels	Animal & human (including T-shaped)	Obsidian (but rare); polished stone vessels & bracelets
Tell-e Mushki	SW Iran	Agro-pastoral suppl. by foraging & hunting	Some dom(?) barley but mainly wild species	No sheep & few goats; mainly wild equids	Remains of mudbrick and *pisé*, but no architectural structures	None recovered	Blade based	Chaff-tempered software	Animal	Obsidian; copper points; turquoise beads; marine shell ornaments
Tell-e Jari	SW Iran	Agro-pastoral suppl. by foraging & hunting	Some dom(?) barley but mainly wild species	Dom. sheep & goat, some dom. cattle; gazelle	Mudbrick & *pisé* buildings	Doubtful child burial	*n.d.*	Chaff-tempered software	Animal	Obsidian; copper pins; shell & stone ornaments
Tol-e Băsi	SW Iran	Agro-pastoral suppl. by hunting.	Some dom. Barley, einkorn & bread wheat	Dom. sheep & goat; some dom. cattle; gazelle	Little archit.; mainly open platforms with fire installations.	None recovered	Blade based	Chaff and mineral-chaff tempered software	1 animal figurine	Shell ornaments, turquoise; clay & soft stone labrets
Tol-e Nurabad	SW Iran	Pastoral	*n.d.*	Dom. caprines (dominate) & cattle; almost no hunting	Mudbrick & *pisé* buildings	None recovered	Blade based	Chaff-tempered software	Animal?	Obsidian (1 piece); clay labrets
Tang-e Bolaghi: TB75 & TB130	SW Iran	Foragin & hunting; possibly pastoral		Gazelle; sheep & goat (status unclear),	None	None recovered	Geometrics	None recovered	None recovered	None recvoered

				some cattle & pig						
Jarmo	NE Iraq	Agro-pastoral suppl. by foraging & hunting	Dom. Einkorn, emmer & dom(?) & wild 2-row barley; legumes & wild grasses	Dom. goats, sheep & cattle; gazelle	Mudbrick buildings	None recovered	Blade based	Later levels chaff-tempered software	Animal & human (including 'mother goddess'	Obsidian; marine shell beads
Jeitun	SW Turkmenistan	Agropastoral	Dom. einkorn & barley; wild grasses	Dom. sheep & goat; gazelle	Mudbrick buildings with courtyards	1 child burial	Blade based	Chaff-tempered software	Animal (dog?)	Marine shell beads
Hotu Cave	Caspian Sea Plains	Pastoral? suppl. by foraging & hunting	*n.d.*	Dom(?) sheep & goat; wild sheep & goat, seals, gazelle, birds	None	6 skeletons buried towards back of cave	Pebble & flake tool based; some blades	Later levels handmade chaff-tempered software	None reported	None reported
Belt Cave	Caspian Sea Plains	Pastoral suppl. by foraging & hunting	*n.d.*	Dom. sheep & goat & dom(?) pig; gazelle	None	None recovered	Blade based	Chaff-tempered software; later levels 'Red-on-Black' ware	None reported	None reported
Aq Kupruk	NE Afghanistan	Pastoral suppl. by foraging & hunting	*n.d.*	Dom(?) sheep & goat; gazelle, red deer, equids, wild goat	None	None recovered	Blade based	Chaff-tempered ware	None reported	Steatite bowl fragment & incised turtle shell
Mehrgarh	Baluchistan	Agro-pastoral suppl. by	Dom. 6-row & 2-row barley,	Dom. goat, sheep & cattle	Mudbrick compartmented buildings;	Individuals in flexed position in burial	Blade based	Chaff-tempered software	Mainly human, but animal	Marine shell, turquoise, lapis lazuli &

		foraging & hunting	einkorn & free-threshing wheat; wild barley		firepits & postholes on peripheries	chambers with grave goods		from later levels	increase in later levels	serpentine jewellery

Table 3.6: Summary of the economy and cultural attributes of the Neolithic sites mentioned in the text.

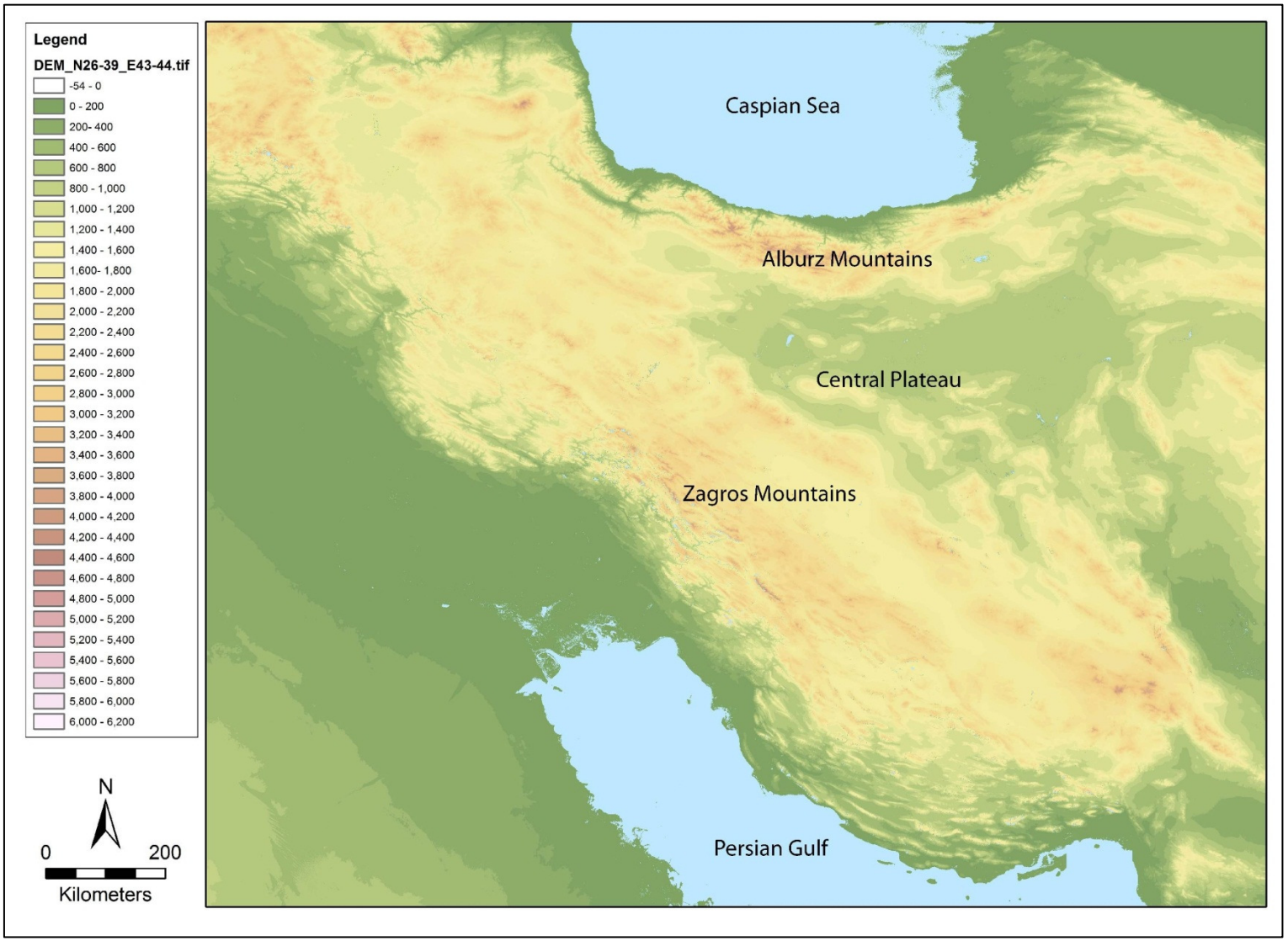


Figure 3.0: *Topographical map of Iran showing main geographical features.*

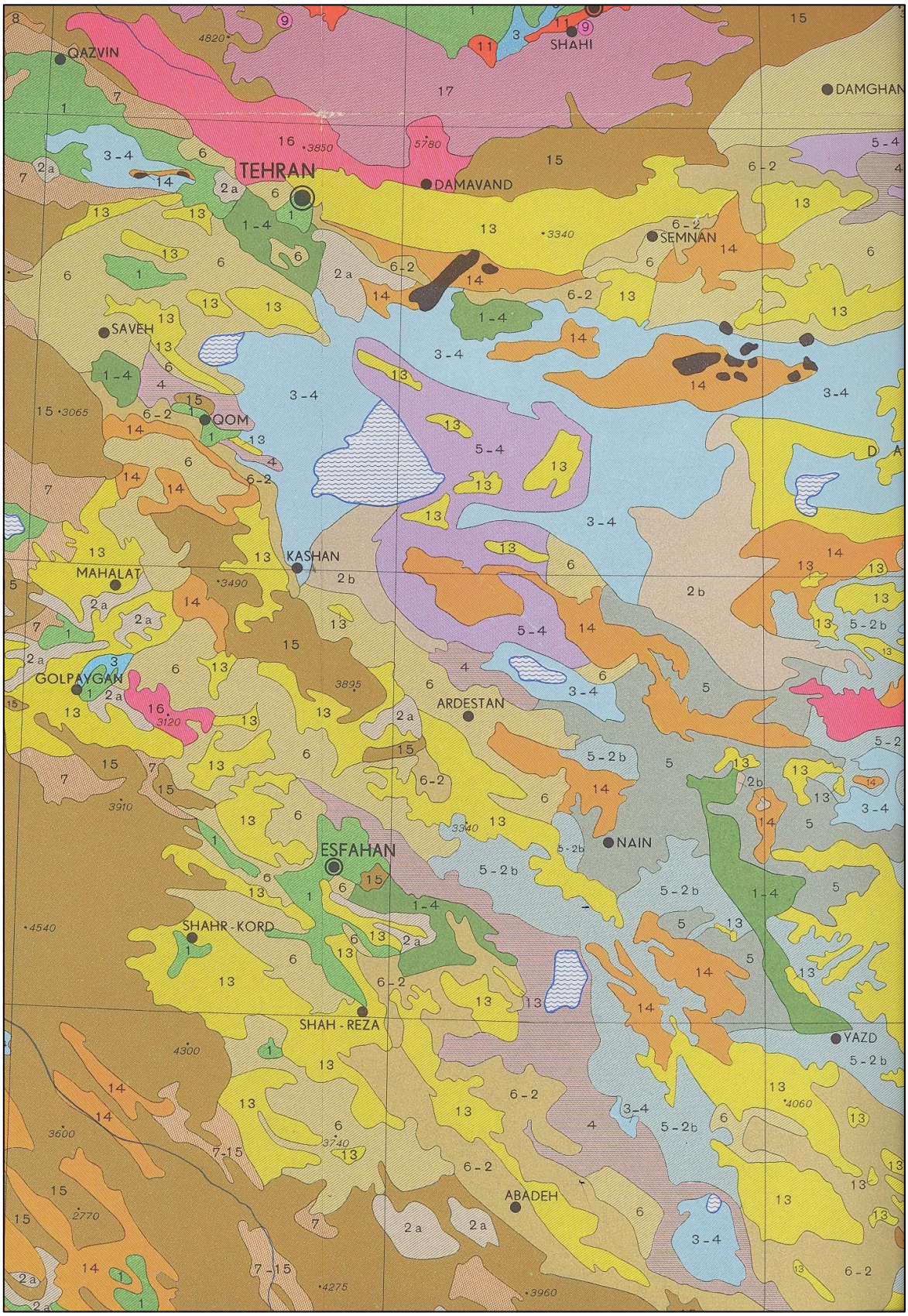
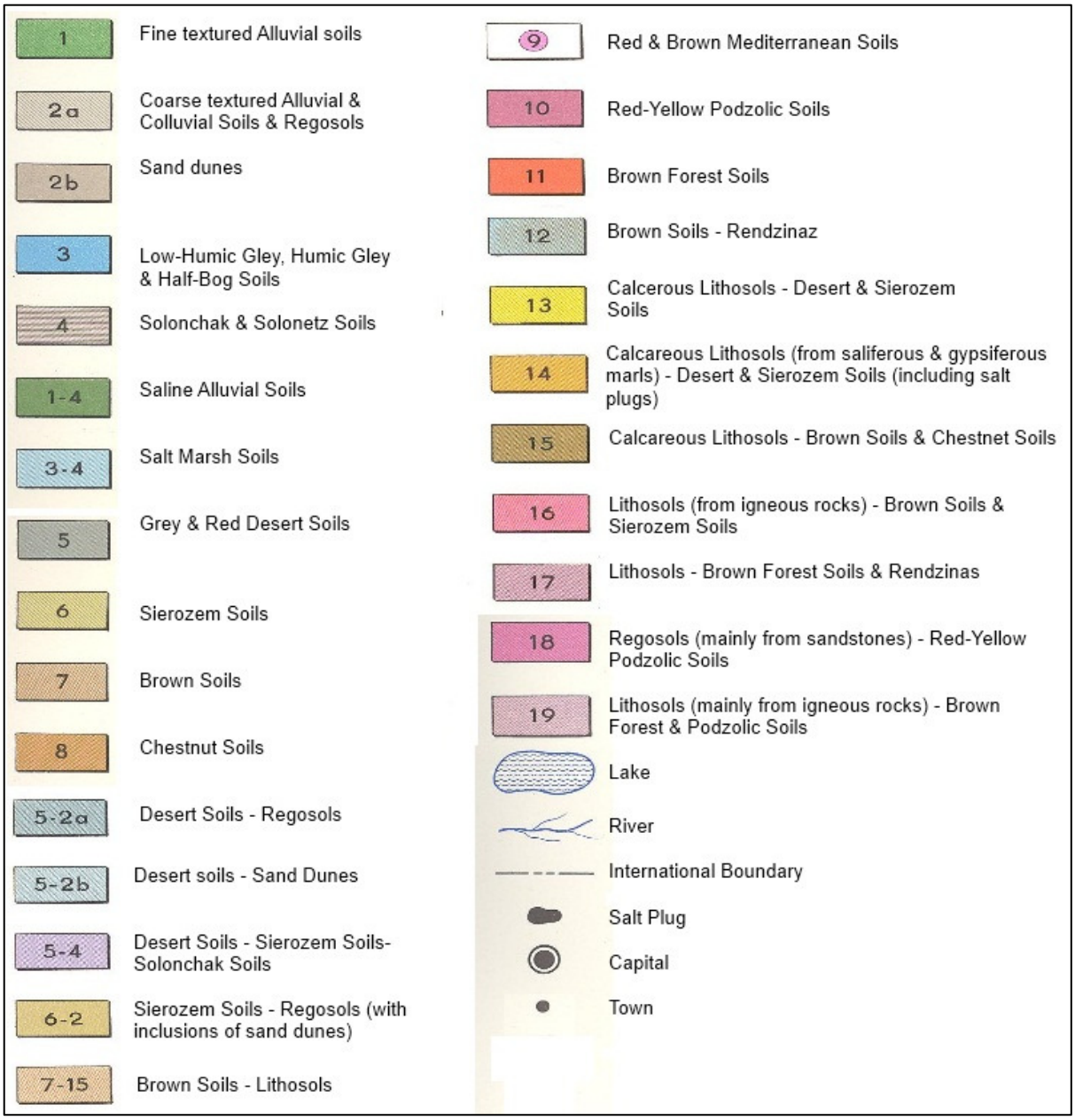


Figure 3.1: *Soil map of Central Plateau. Scale 1: 2,500,000. (After Dewan & Famouri 1964.)*



Key to Figure 3.1.

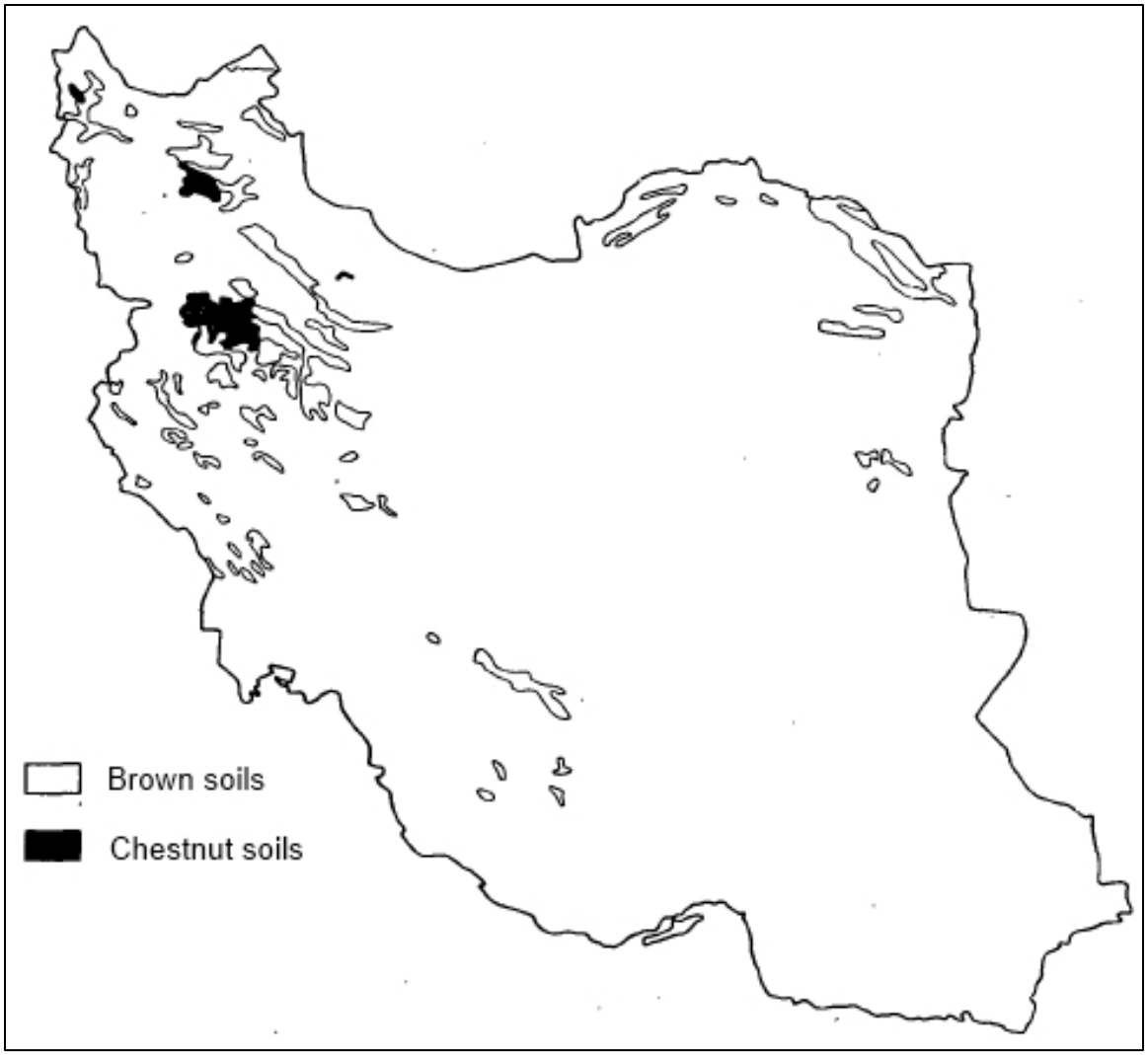


Figure 3.2: *Distribution of Brown Soils & Chestnut Soils. (After Dewan & Famouri 1964: map D7.)*

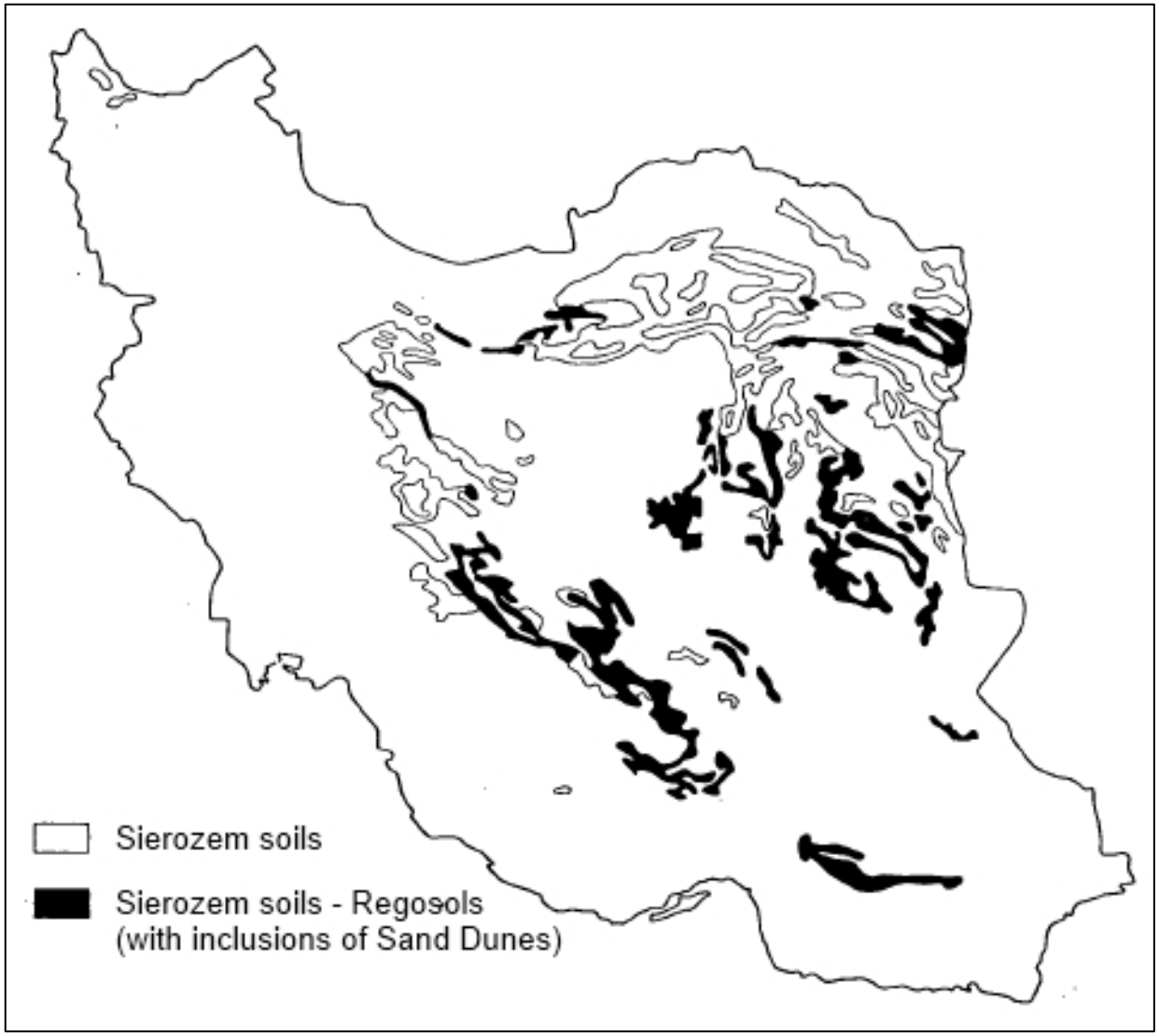


Figure 3.3: *Distribution of Sierozem Soils. (After Dewan & Famouri 1964: map D6.)*

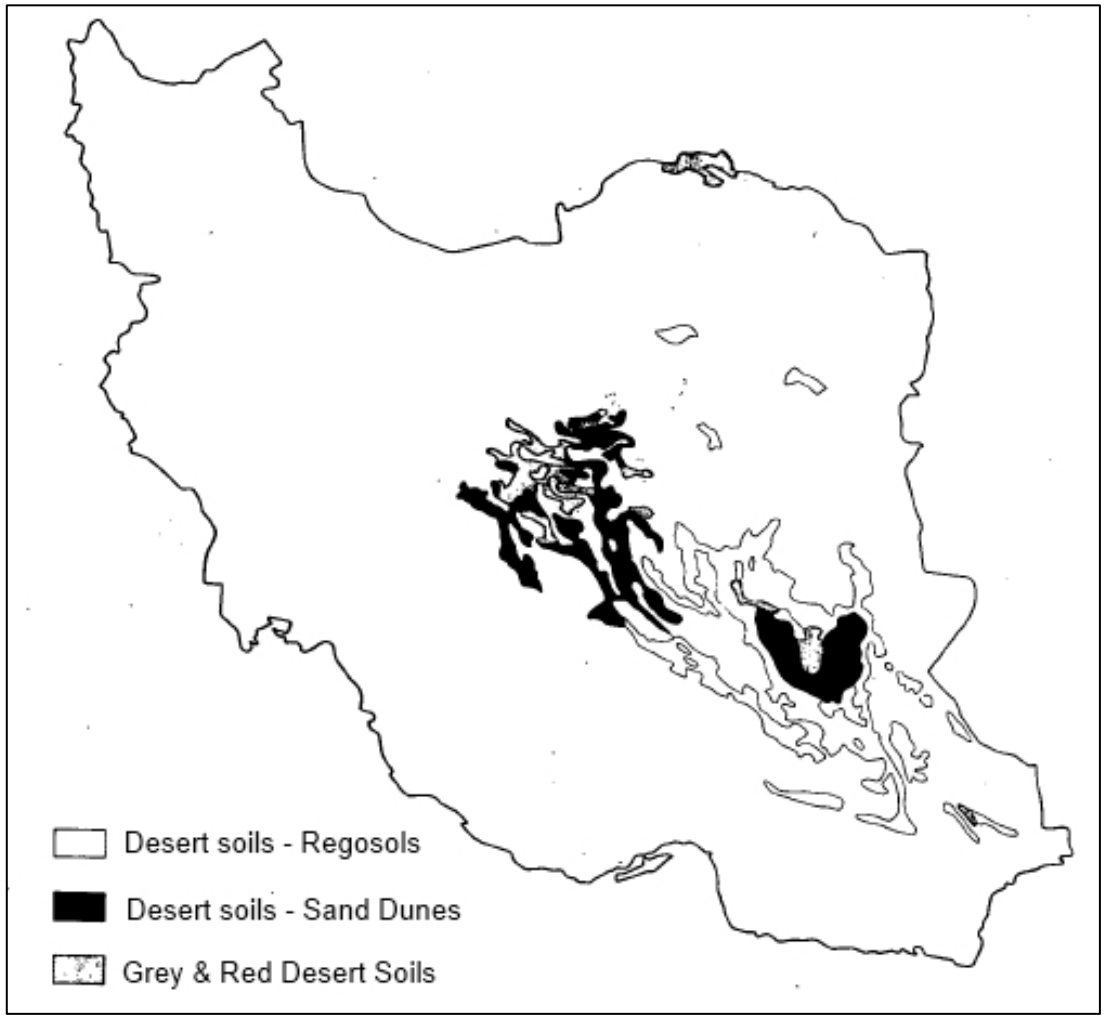


Figure 3.4: *Distribution of Desert Soils. (After Dewan & Famouri 1964: map D5.)*

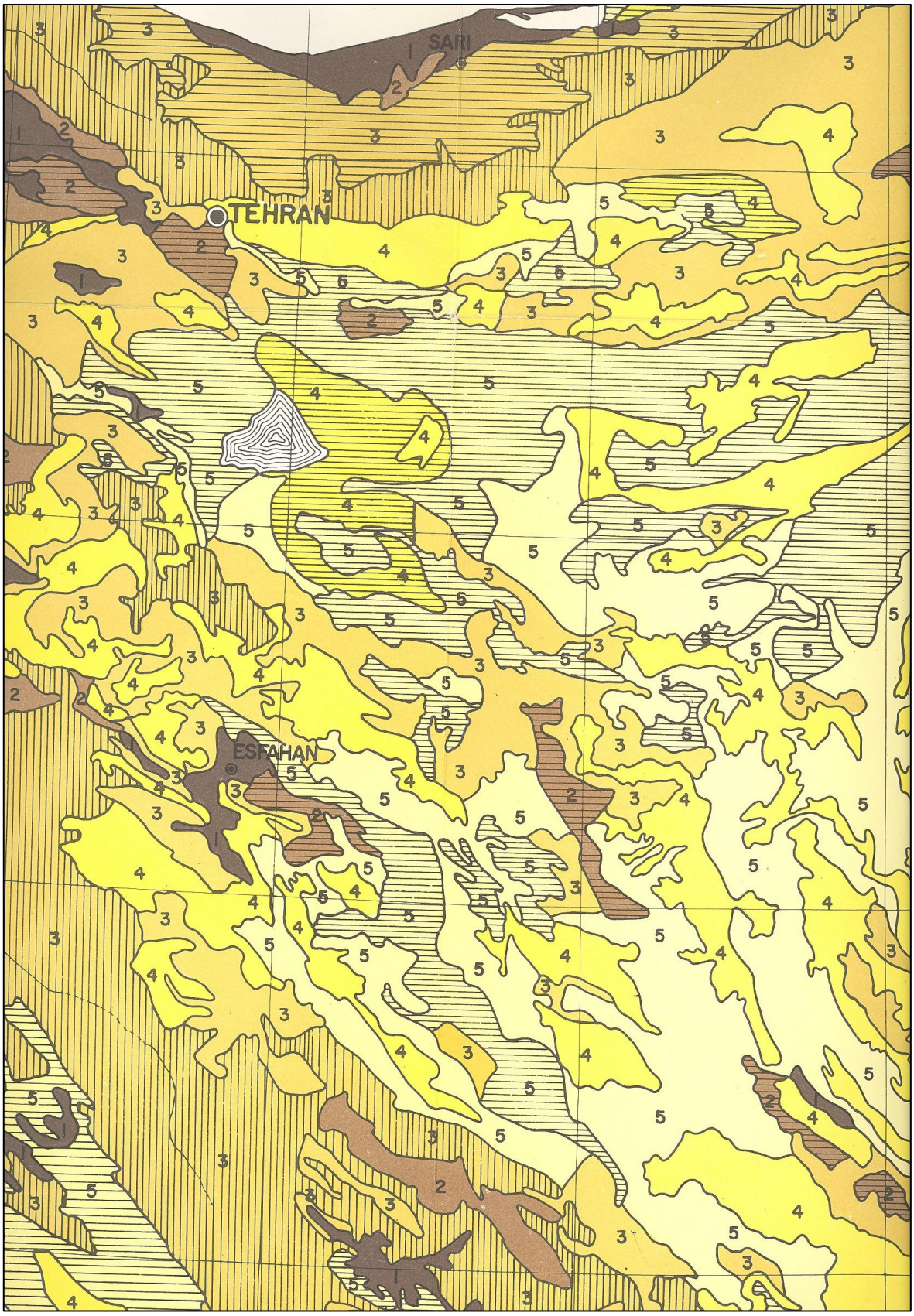
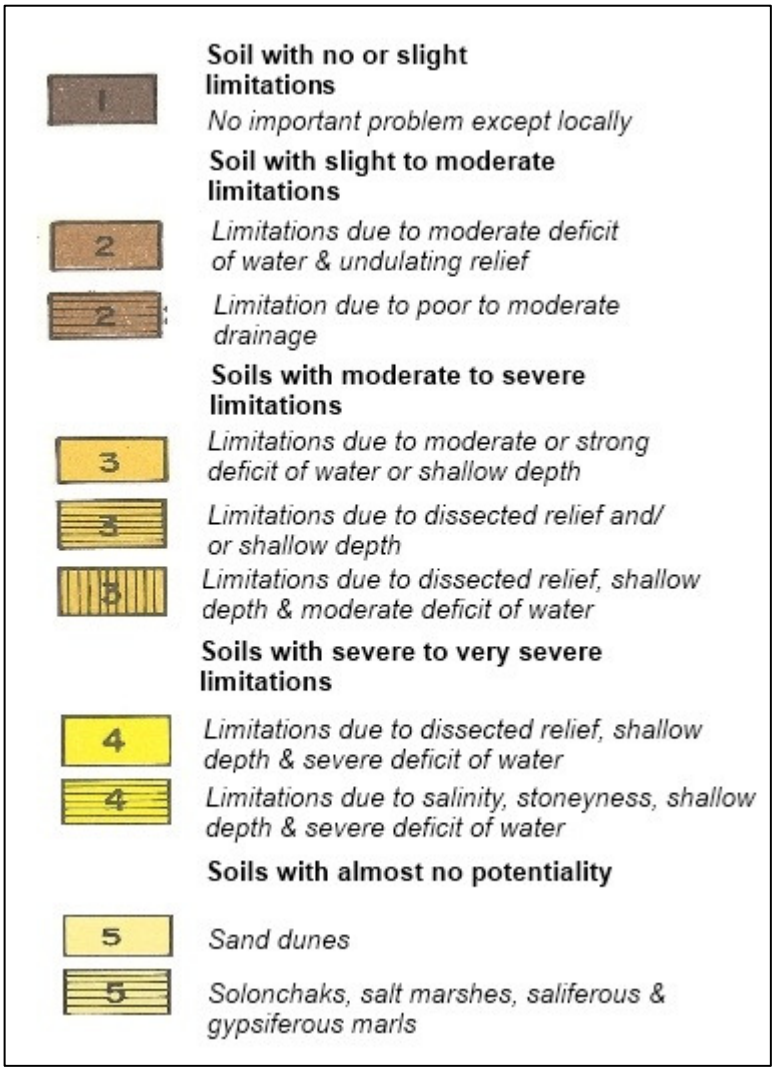


Figure 3.5: *Soil potentiality map for the Central Iranian Plateau. Expressed in terms of soil limitations for agricultural production October 1963. Scale 1: 2,500,000. (After Dewan & Famouri 1964.)*


1
Soil with no or slight limitations
No important problem except locally
Soil with slight to moderate limitations
2
Limitations due to moderate deficit of water & undulating relief
2
Limitation due to poor to moderate drainage
Soils with moderate to severe limitations
3
Limitations due to moderate or strong deficit of water or shallow depth
3
Limitations due to dissected relief and/ or shallow depth
3
Limitations due to dissected relief, shallow depth & moderate deficit of water
Soils with severe to very severe limitations
4
Limitations due to dissected relief, shallow depth & severe deficit of water
4
Limitations due to salinity, stoneyness, shallow depth & severe deficit of water
Soils with almost no potentiality
5
Sand dunes
5
Solonchaks, salt marshes, saliferous & gypsiferous marls

Key to Fig. 3.5

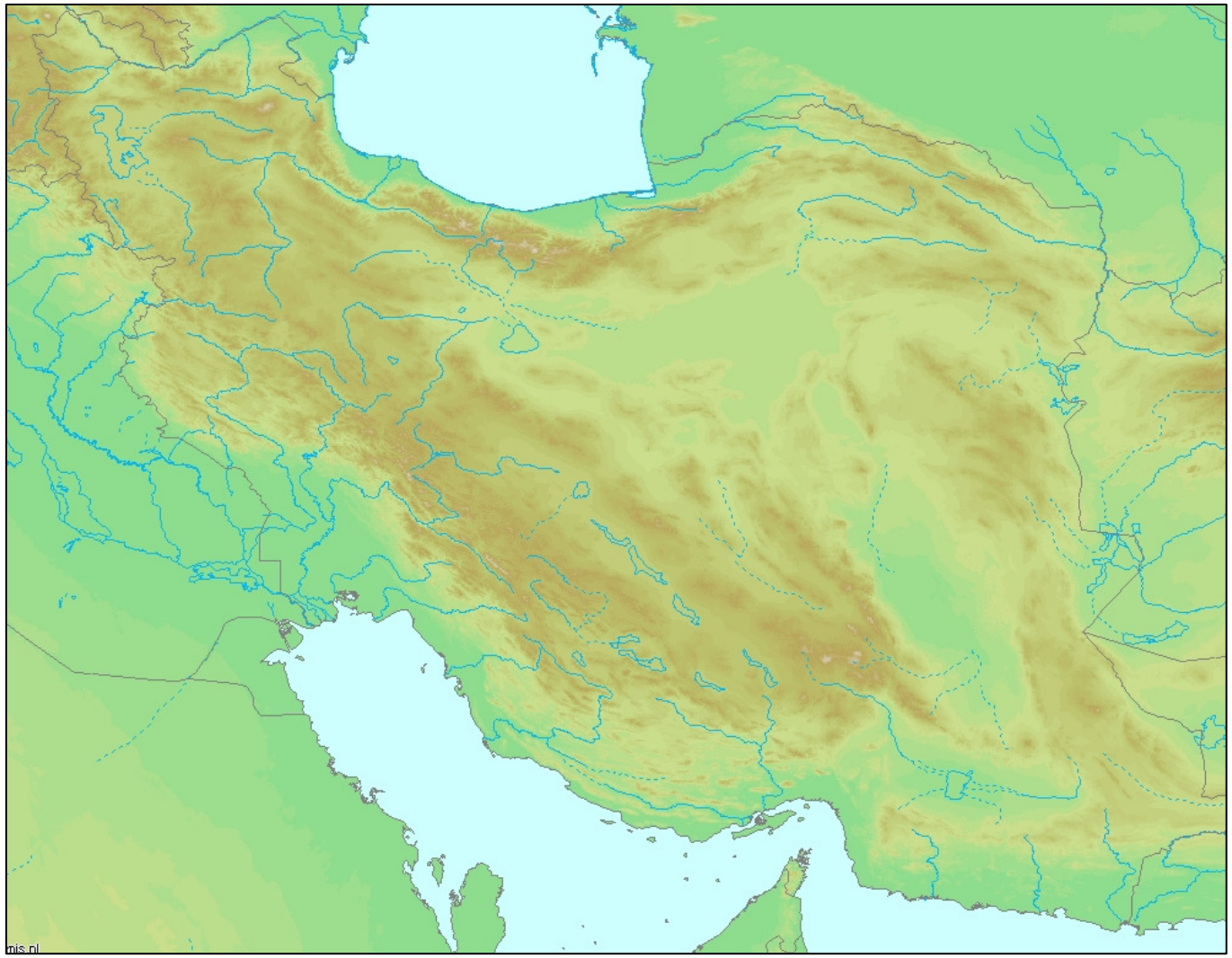


Figure 3.6: *Map showing the rivers of Iran. (After ECO Geoscience Database)*

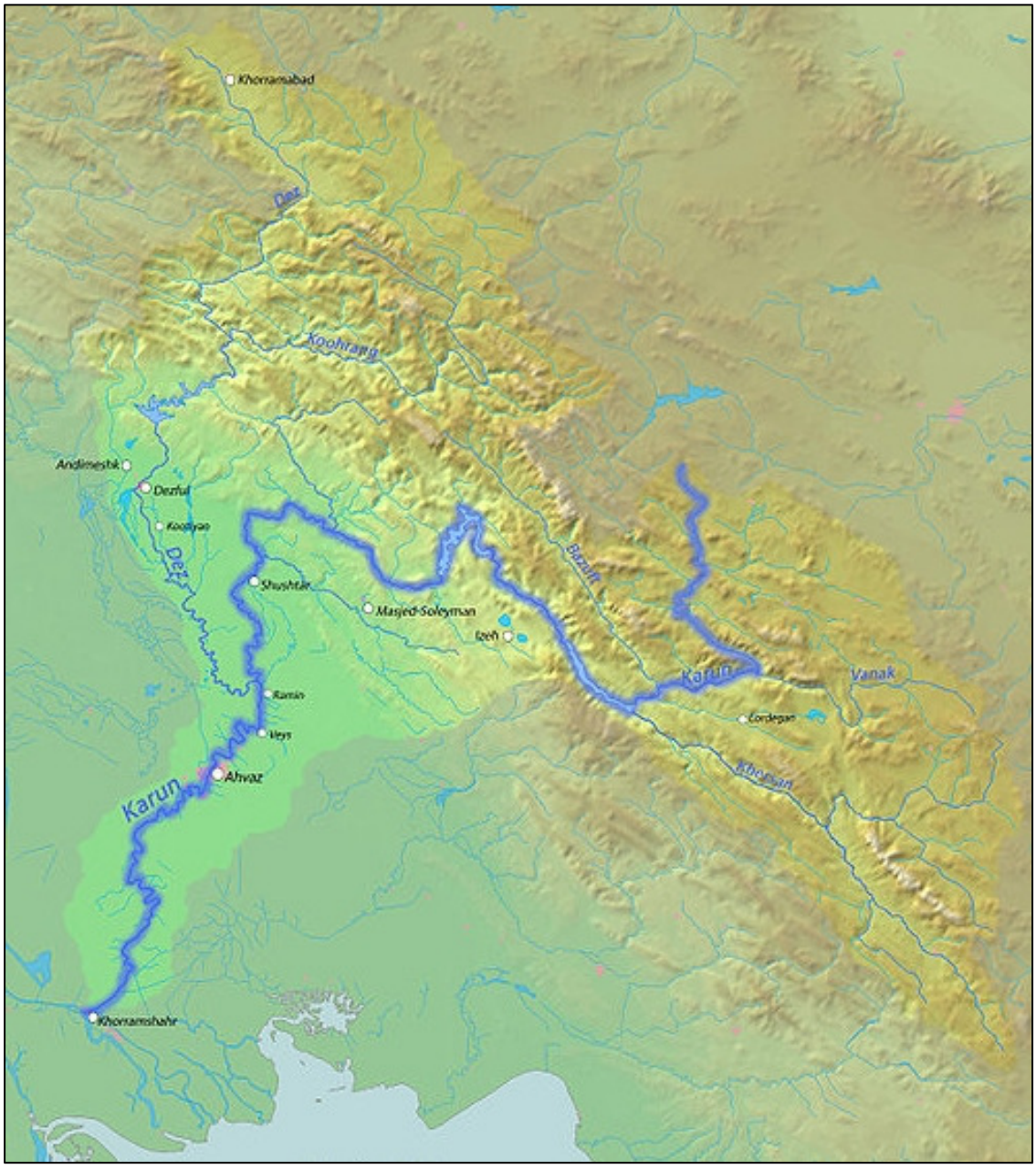


Figure 3.7: *Map of the River Karan, the only navigable river in Iran. (After ECO Geoscience Database)*

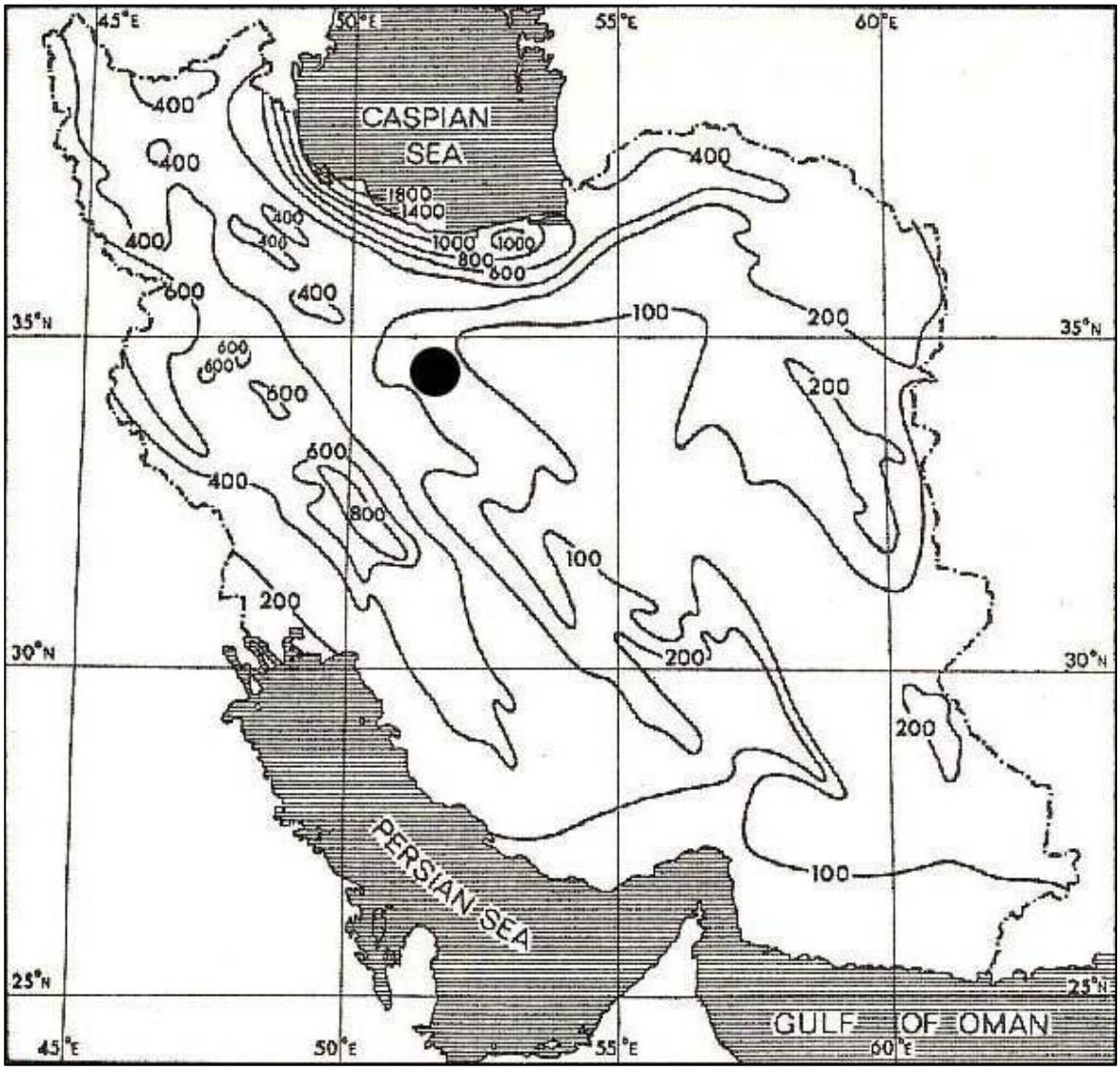


Figure 3.8: *Mean annual amount of precipitation (mm), 1951-60. Dot marks study area. (After Ganji 1968: 79.)*

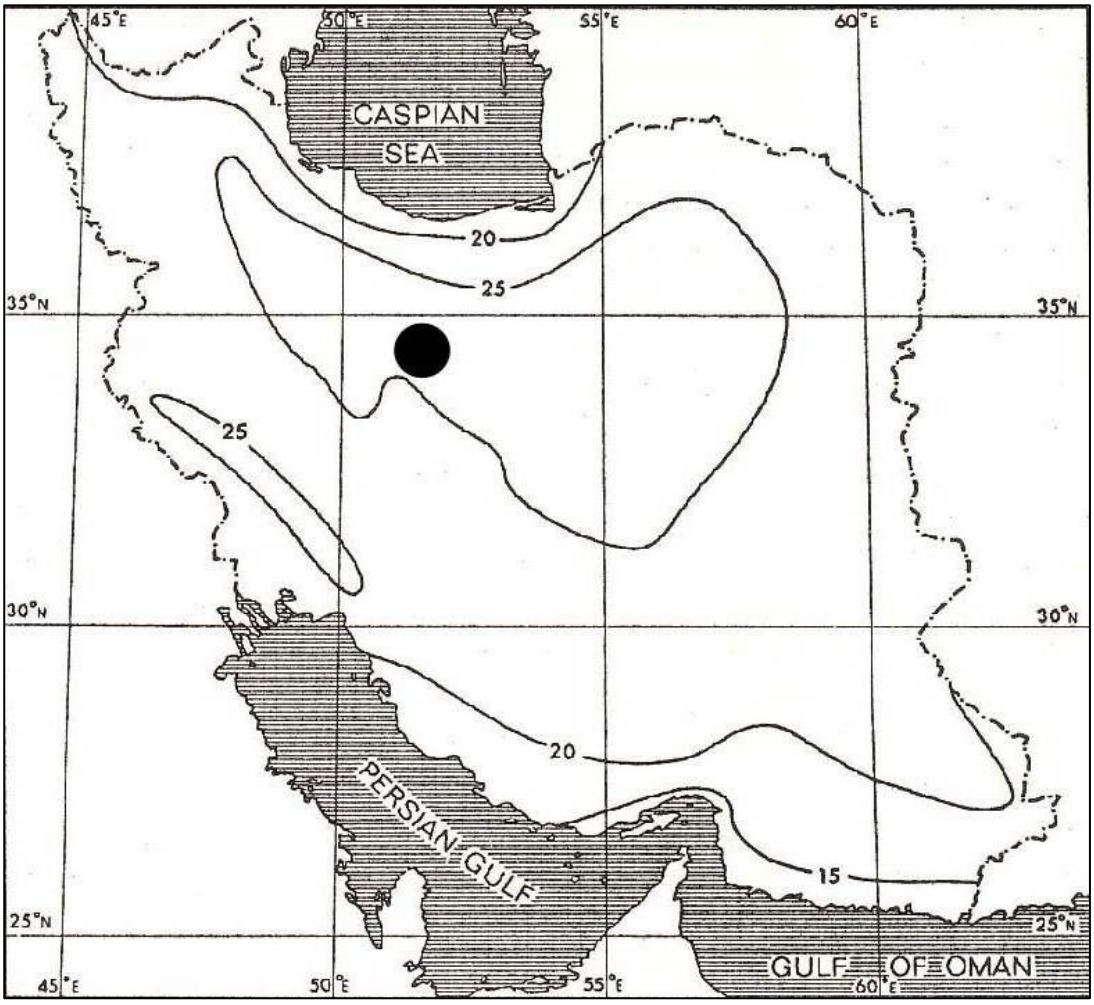


Figure 3.9: *Mean annual range of temperature (°C). Dot marks study area. (After Ganki 1968: fig. 78.)*

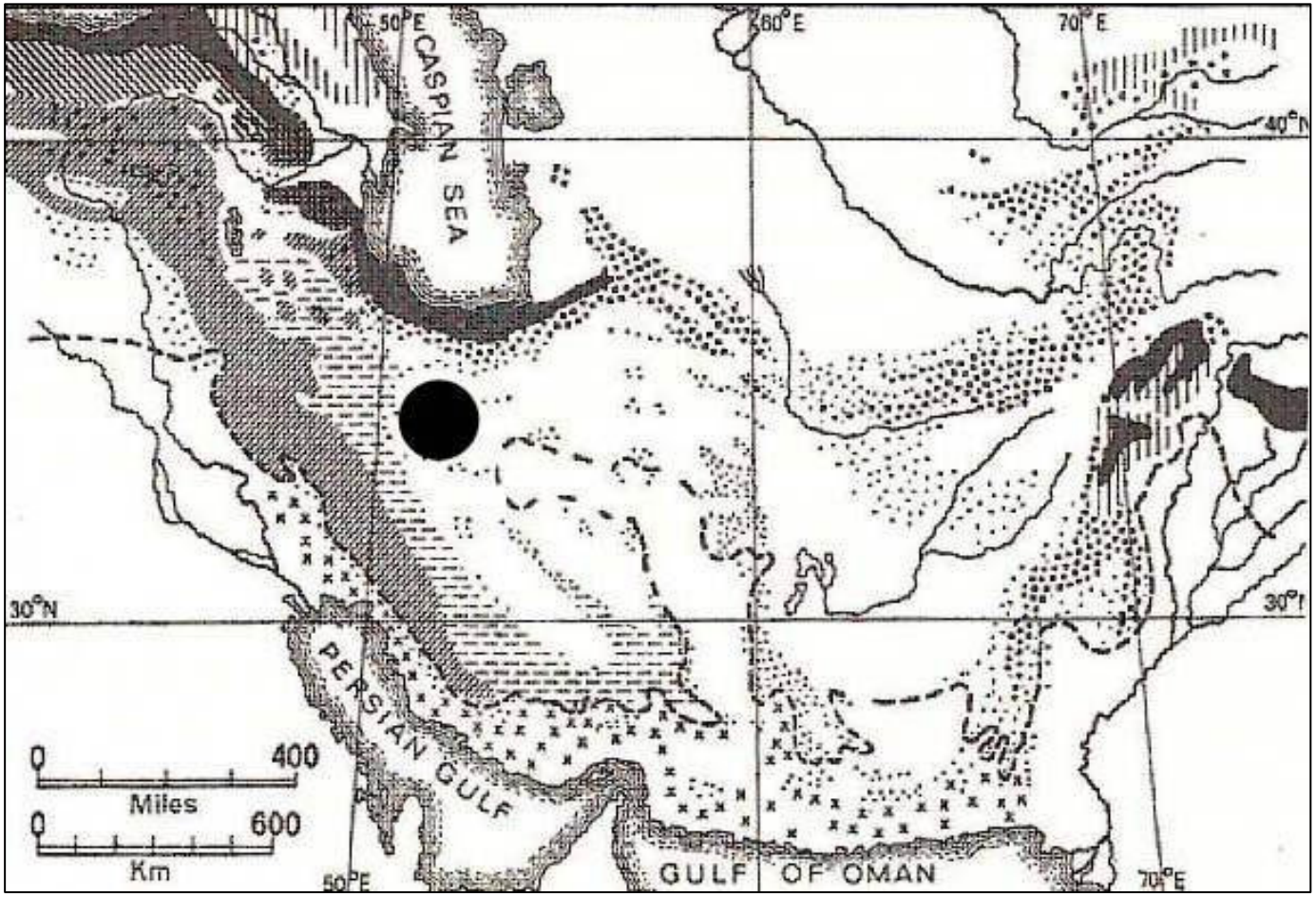


Figure 3.10: *Types of vegetation. Dot marks study area. (After Bobek 1968: fig. 88.)*

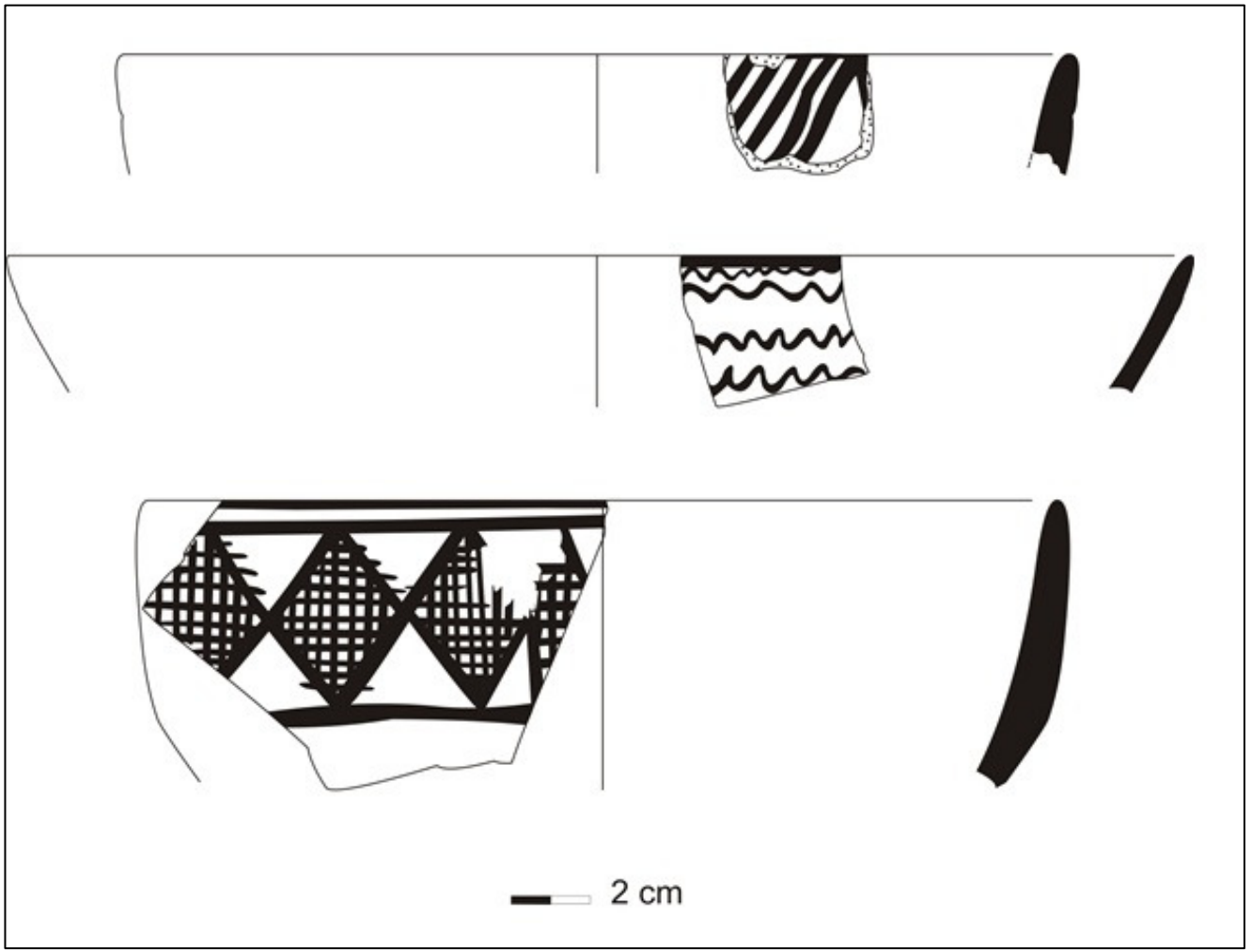


Figure 3.11: *Design motifs from Sialk I Ware.*

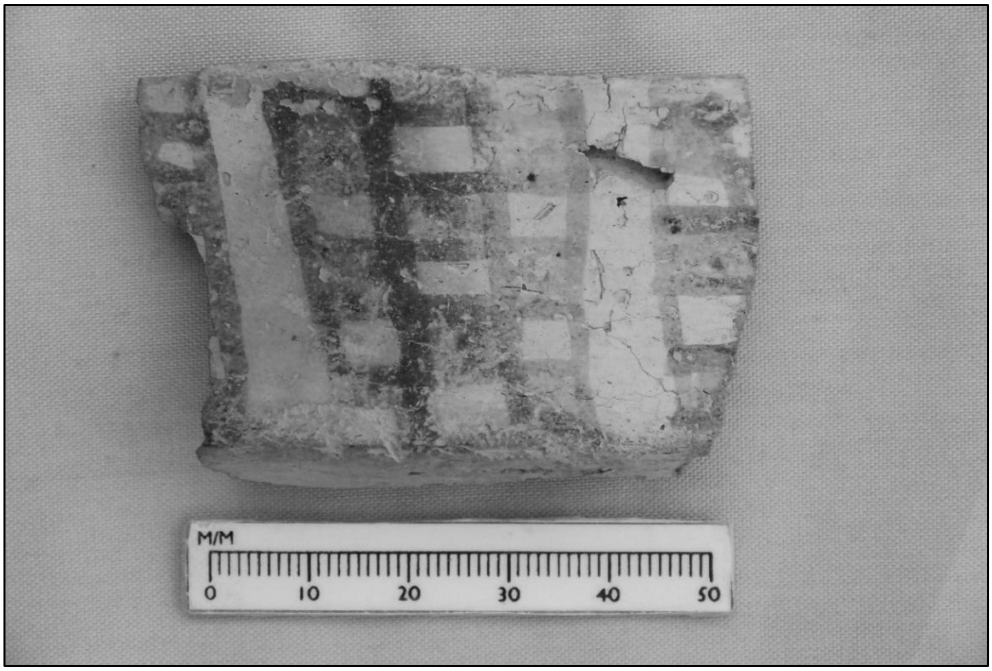


Figure 3.12: *Typical Sialk I 'Buff' Ware*

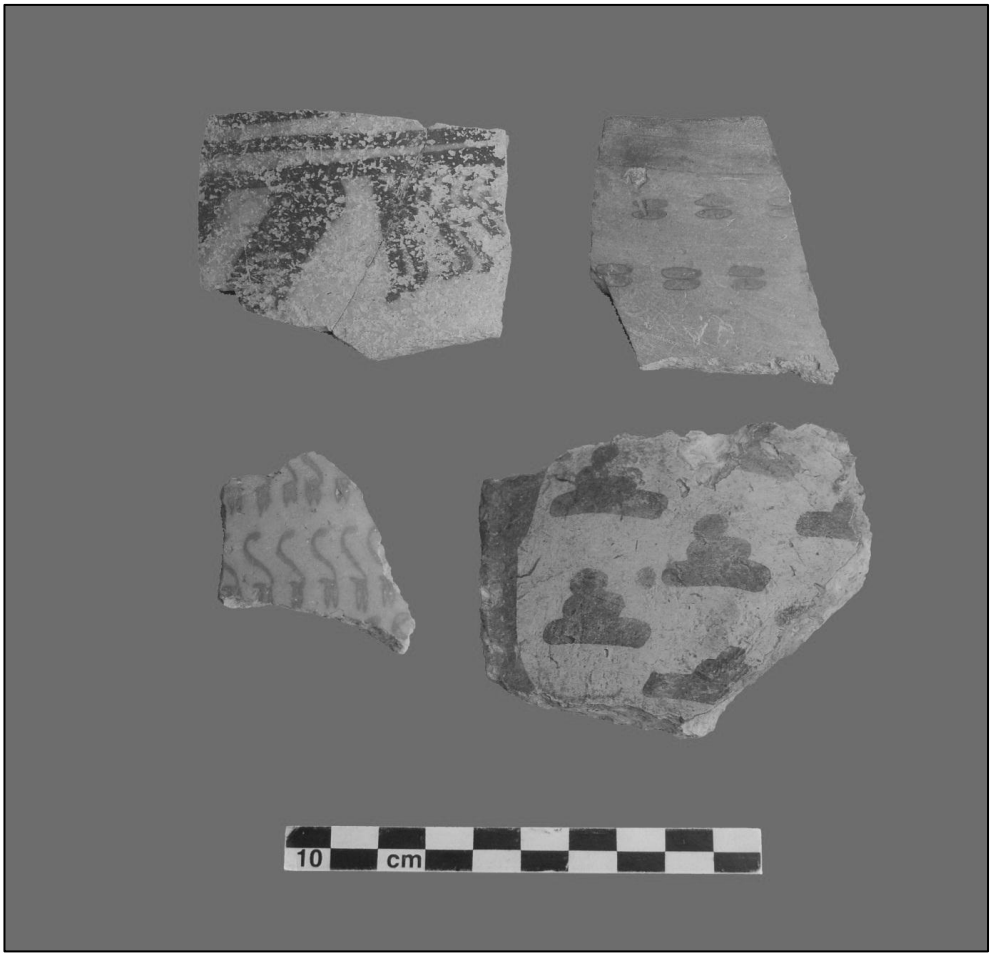


Figure 3.13: *Typical 'Chesmeh Ali' Ware of the Chalcolithic Period.*

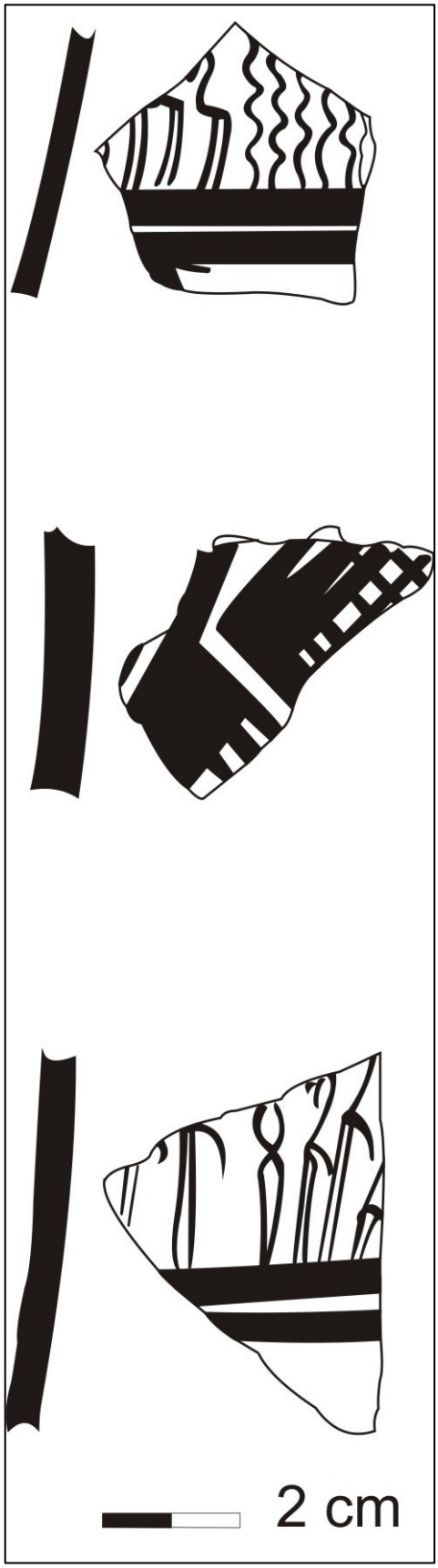


Figure 3.14: *Design motifs from Cheshmeh Ali Ware.*

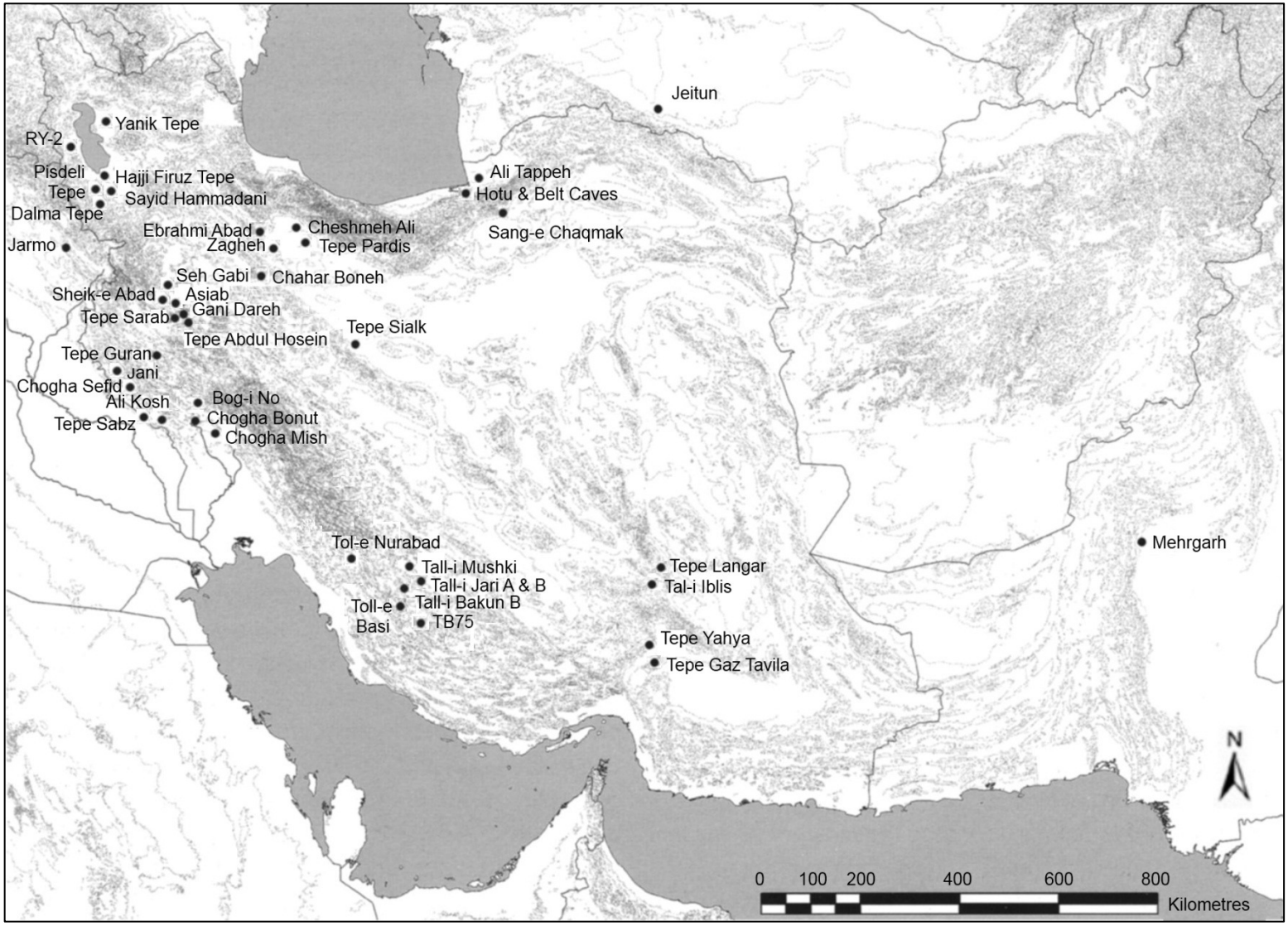


Figure 3.15: *Map of Iran showing key Neolithic sites in Iran and surrounding areas.*

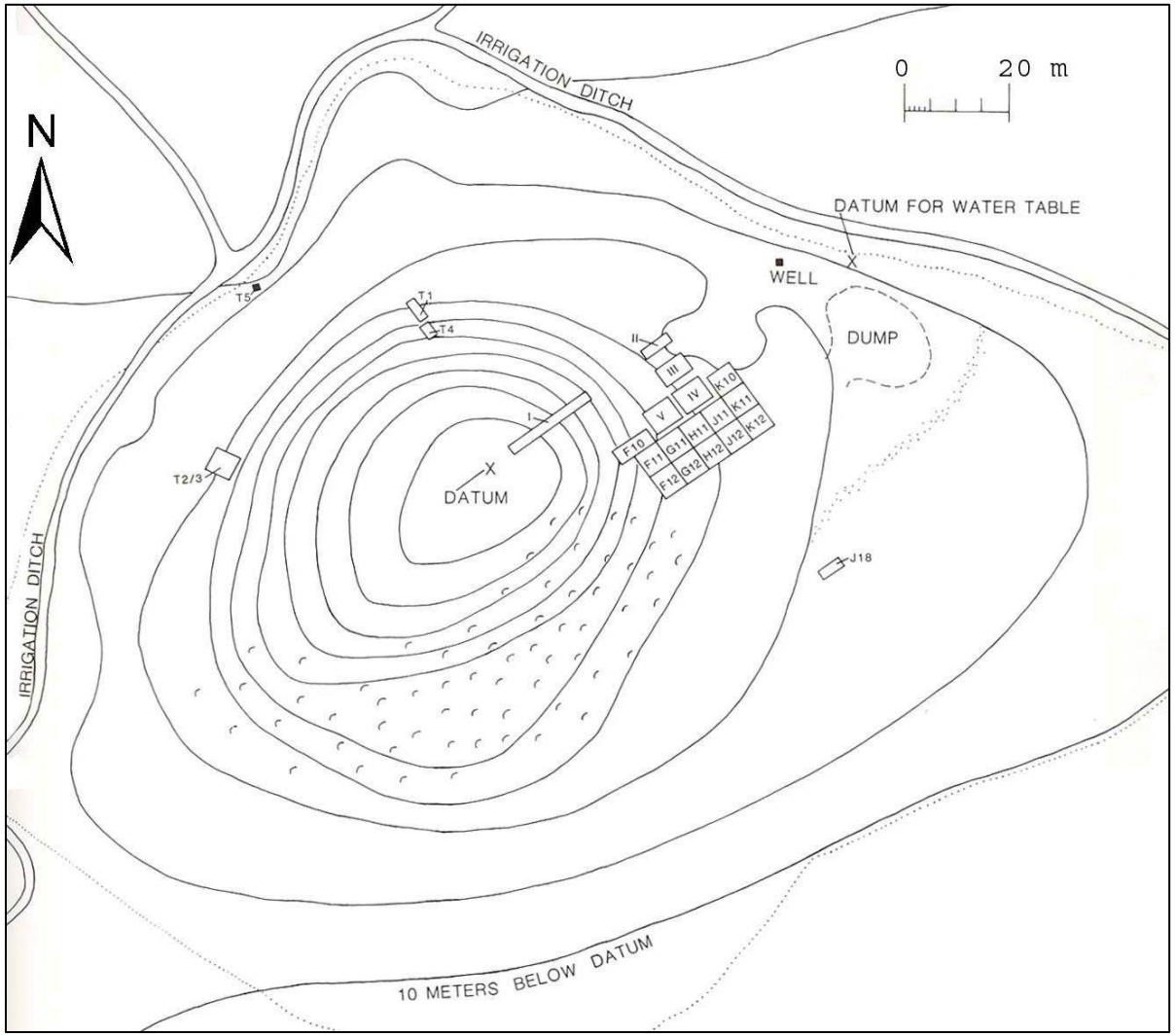


Figure 3.16: *Contour plan of Hajji Firuz Tepe. Contour interval: 1 m. (After Voigt 1983: fig.5.)*

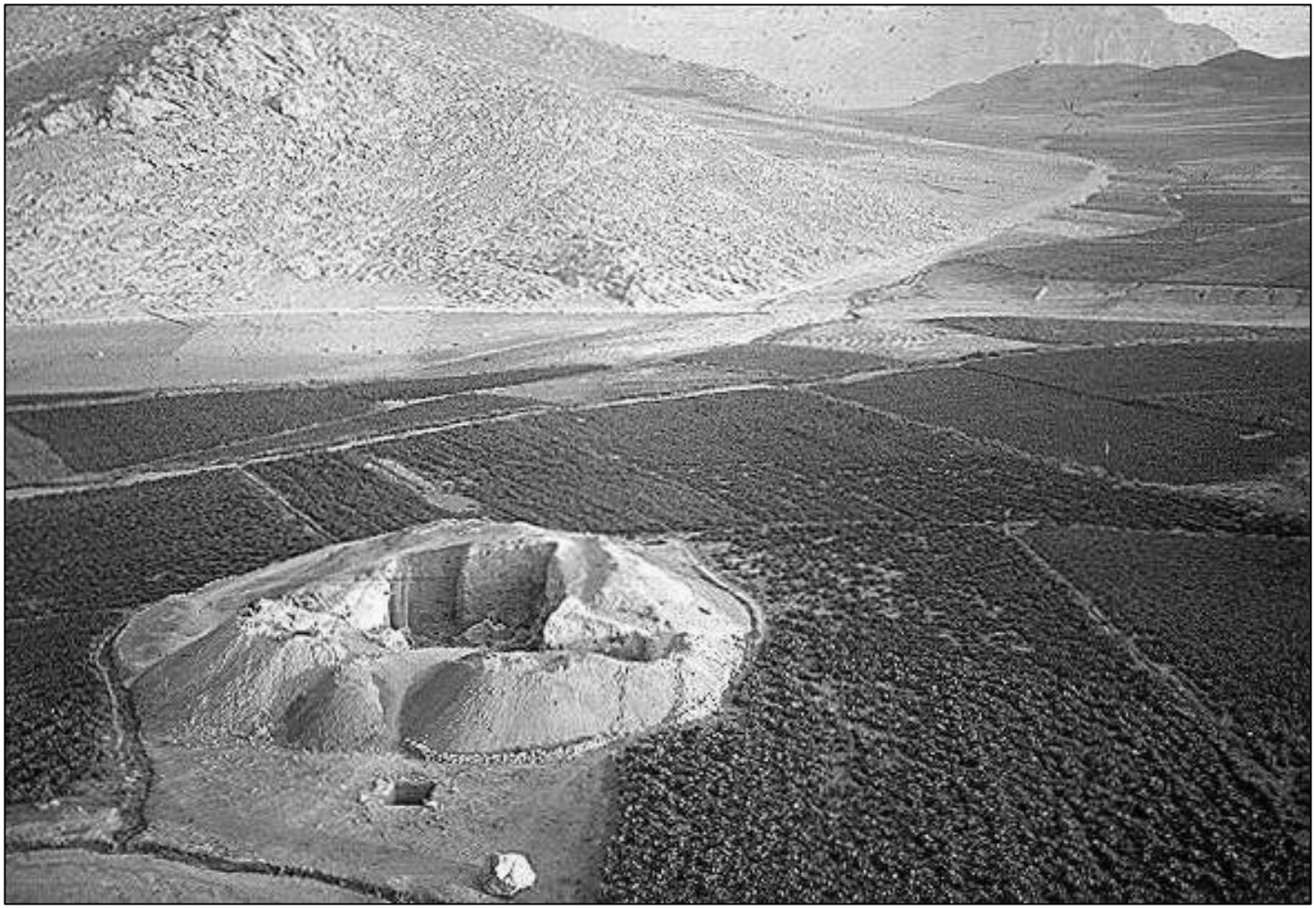


Figure 3.17: *Aerial view of Ganj Dareh under excavation in the 1970s. (After Brian Hesse, University of Alabama at Birmingham.)*

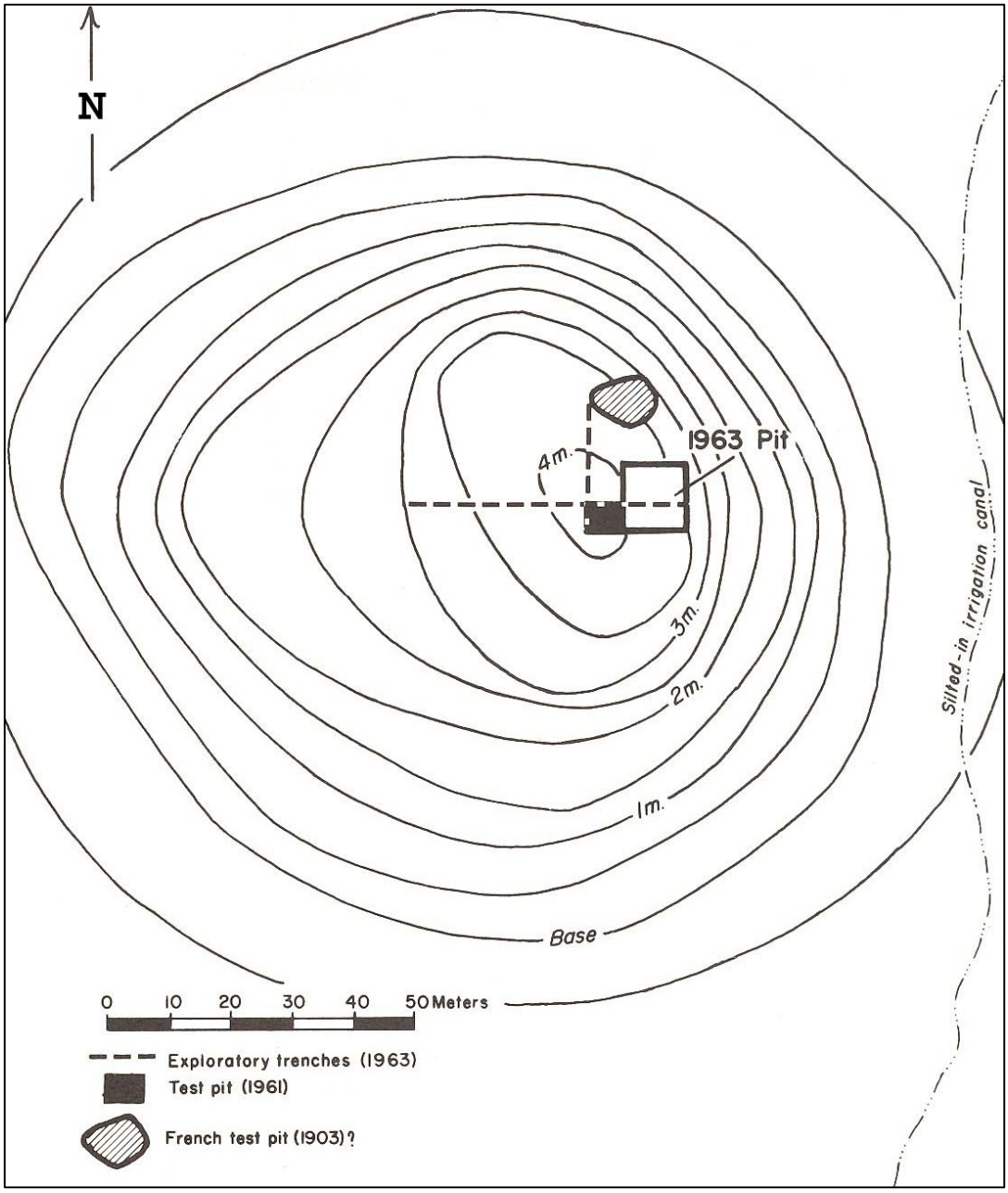


Figure 3.18: *Plan of Tepe Abdul Hosein showing location of squares opened in 1978. (After Pullar 1990: fig. 2.)*

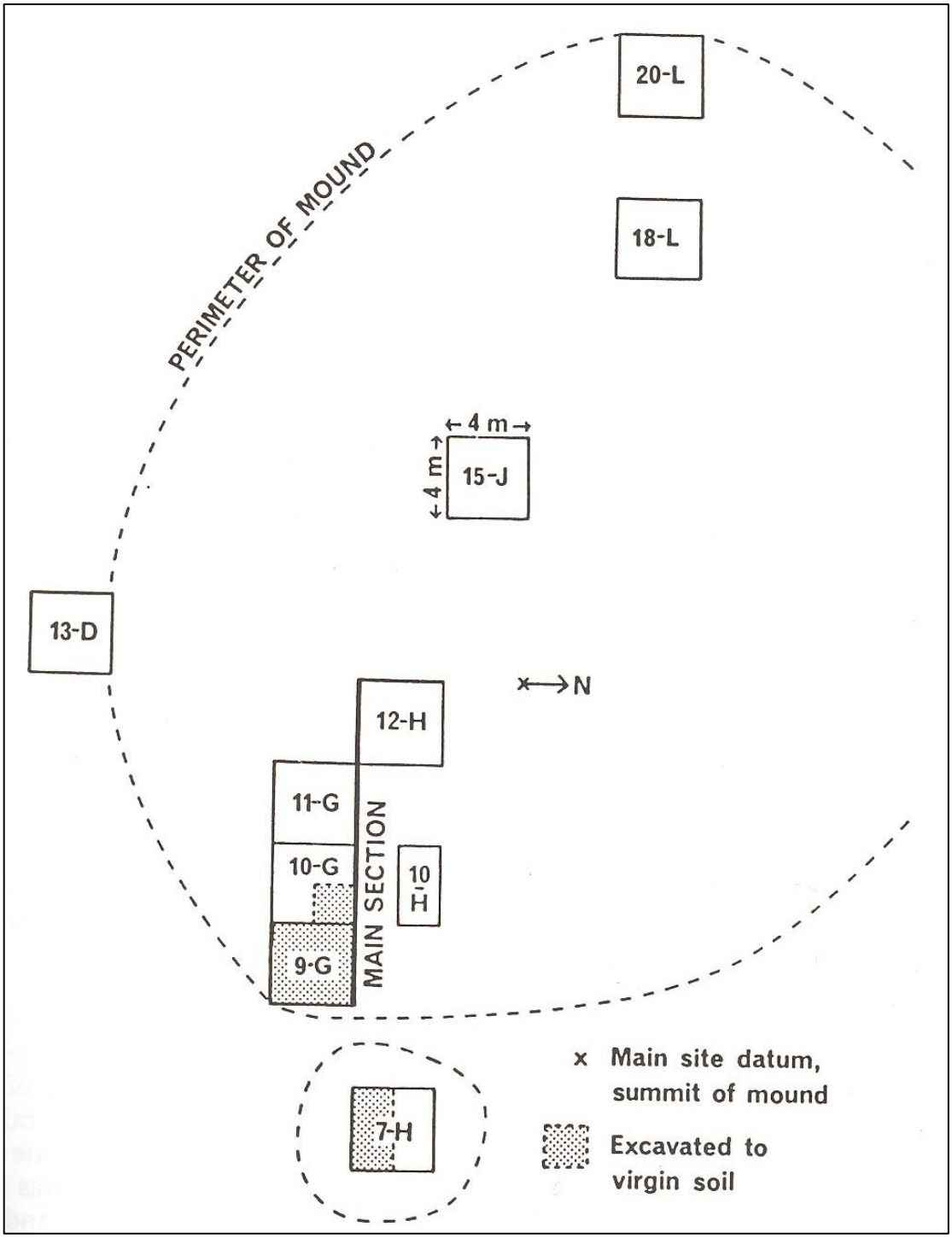


Figure 3.19: *Site plan of Ali Kosh. (After Hole et al 1969: fig. 4.)*

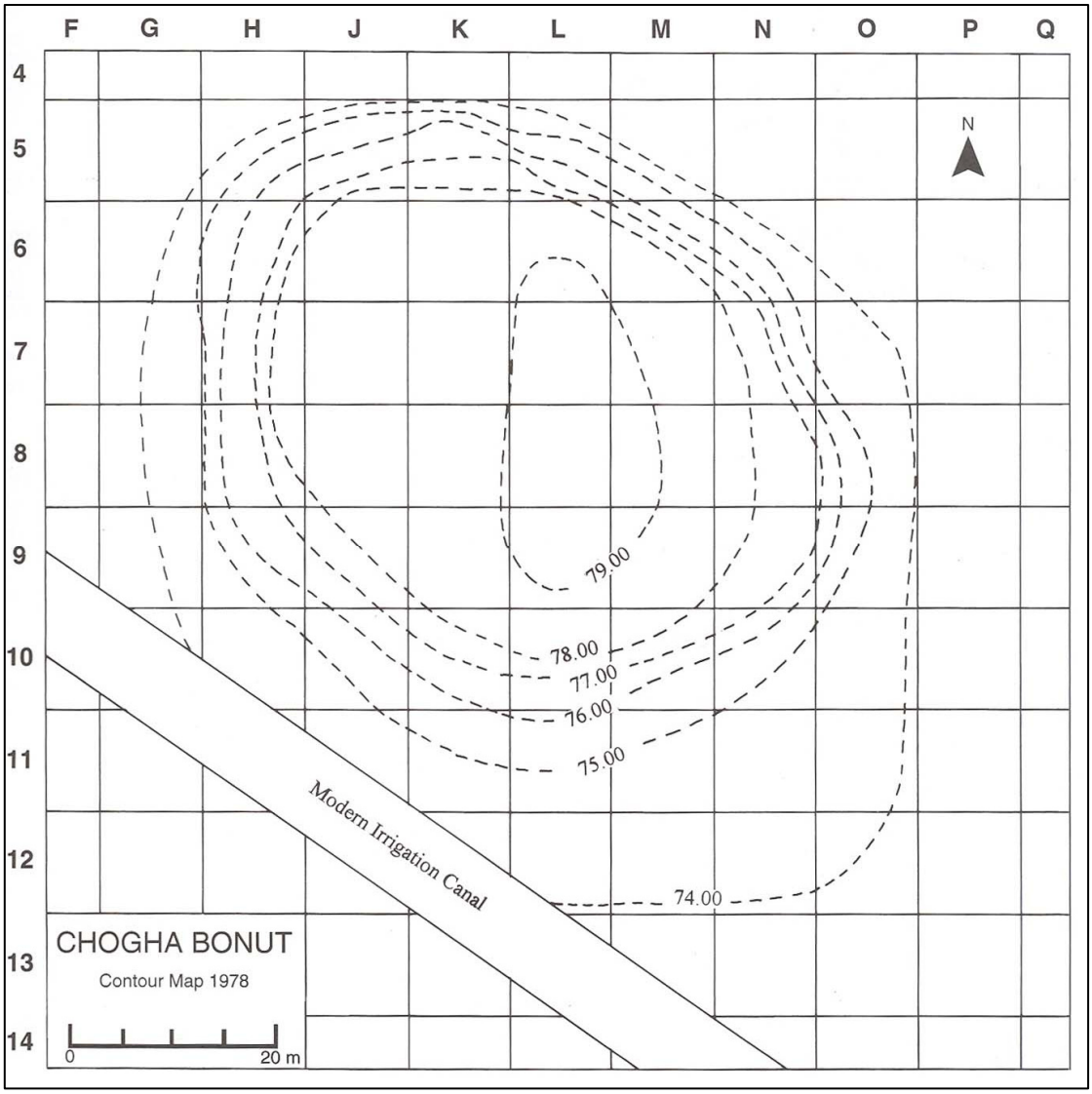


Figure 3.20: *1978 contour map of Chogha Bonut. (After Alizadeh 2003: fig. 4.)*

Figure 3.21. *View of Tol-e Baši with excavation in progress. (After Pollock et al. 2010: fig. 1.2.)*

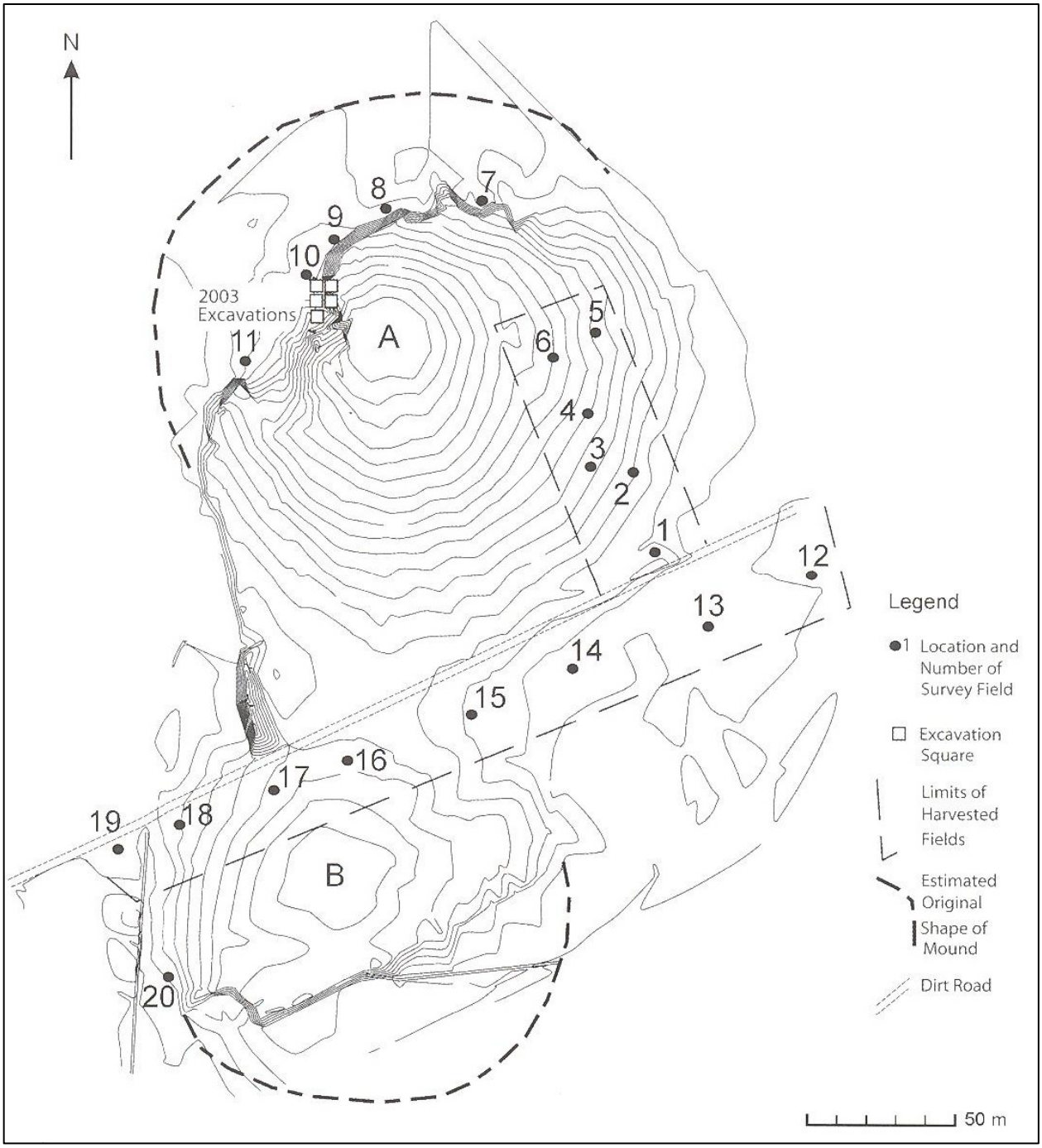


Figure 3.22: *Plan of Tol-e Baši & location of collection fields of 2006 survey. (After Pollock et al. 2010: fig. 3.1.)*

Figure 3.23: *General view of Tang-e Bolaghi. (After Tsuneki & Zeidi 2008: pl. 1.21.)*

Figure 3.24: *Satellite image of the area of TB75 & TB130. (After Tsuneki & Zeidi 2008: pl. 4.1.)*

Figure 3.25: *TB75 cave. (After Tsuneki & Zeidi 2008: pl. 1.25.)*

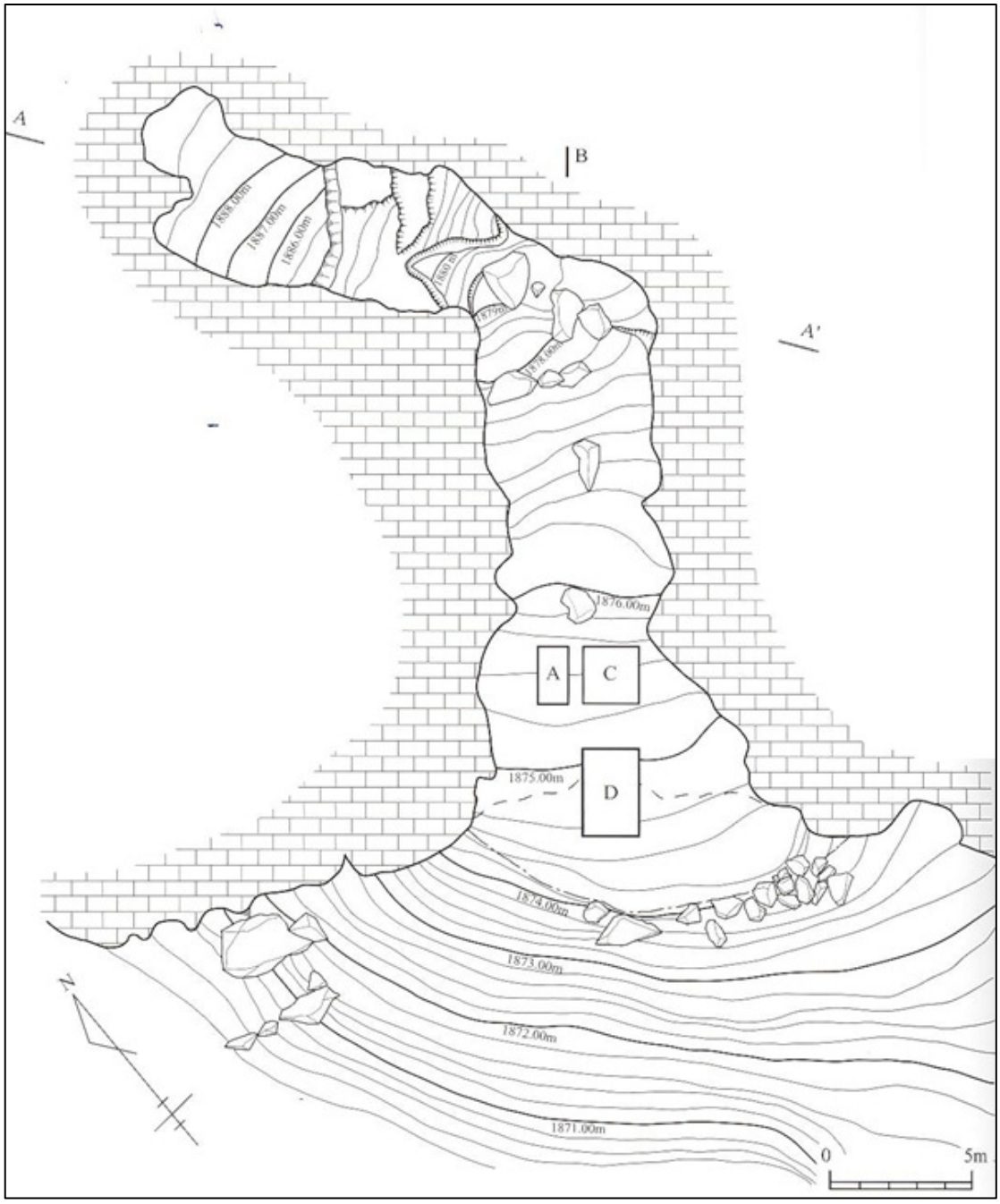


Figure 3.26: *Plan of TB75. (After Tsuneki & Zeidi 2008: fig. 4.3.)*

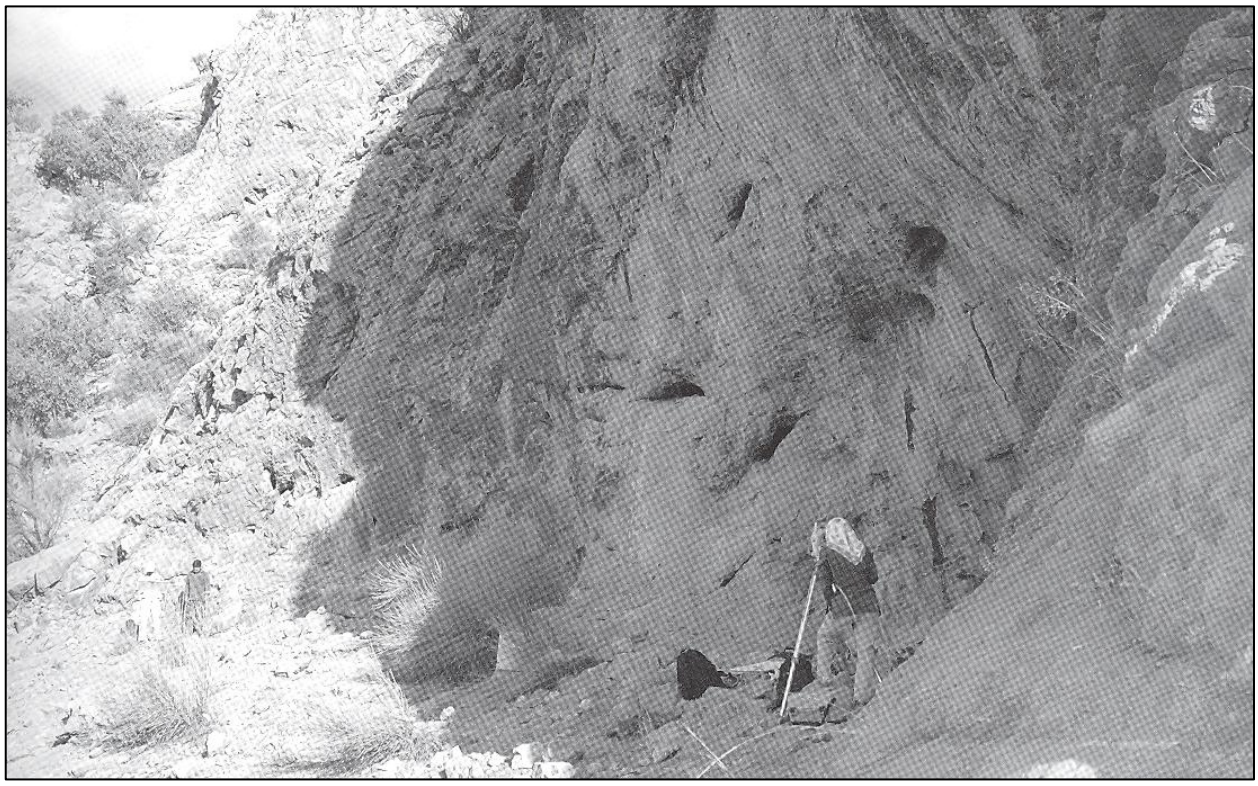


Figure 3.27: *Shelter of TB130. (After Tsuneki & Zeidi 2008: fig. 5.3.)*

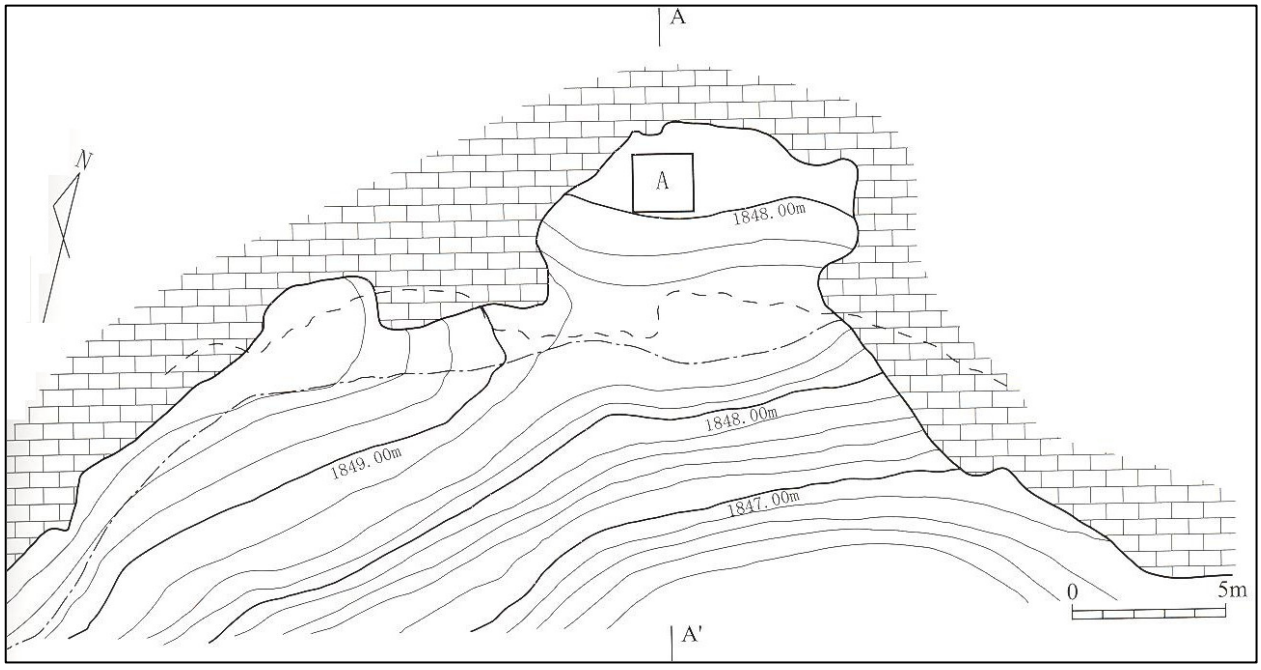


Figure 3.28 *Shelter of TB130. (After Tsuneki & Zeidi 2008: fig. 5.3.)*

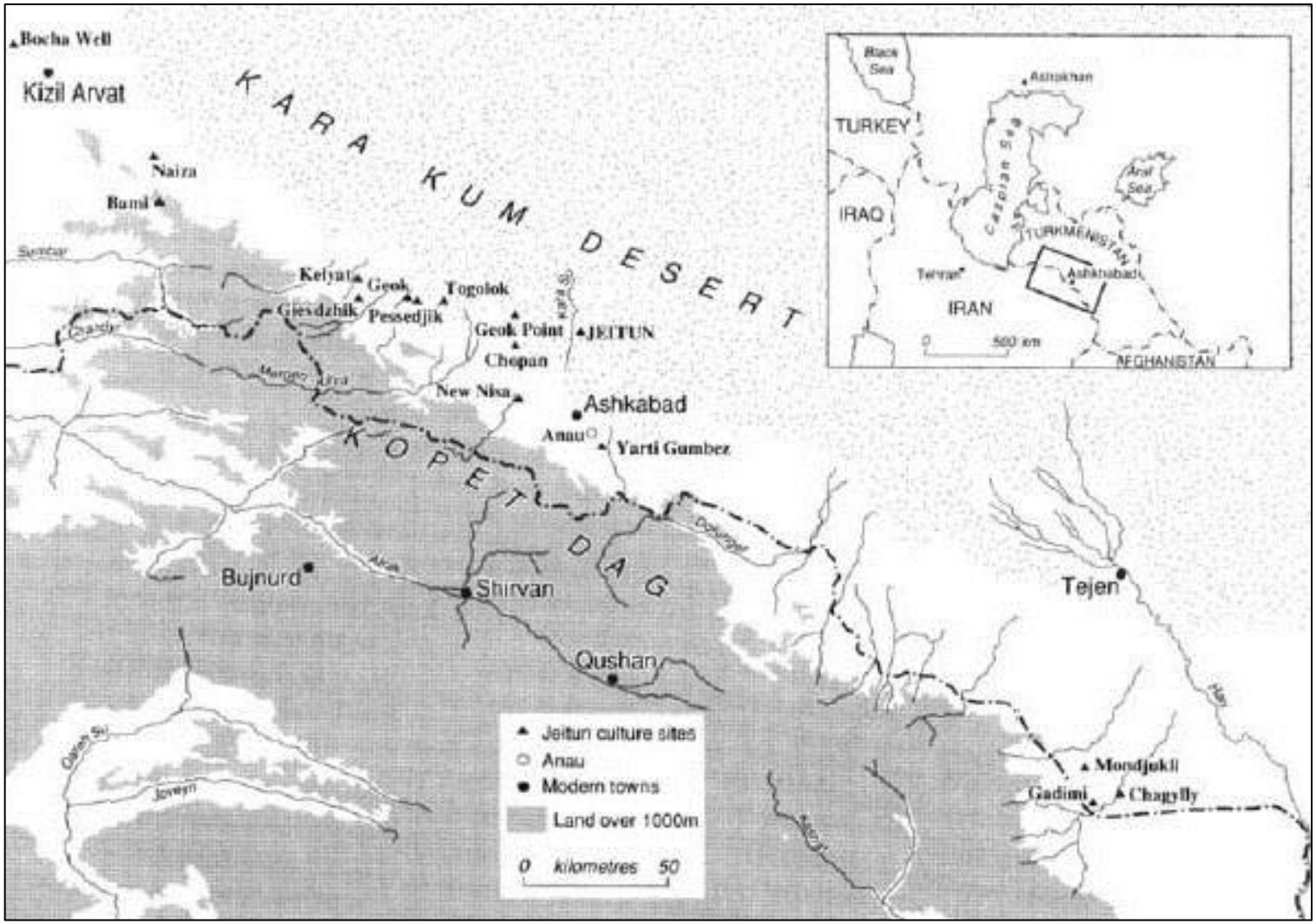


Figure 3.29: *Southern Turkmenistan showing the location of Jeitun & other sites of the Jeitun culture. (After Harris et al 1993: fig. 1.)*

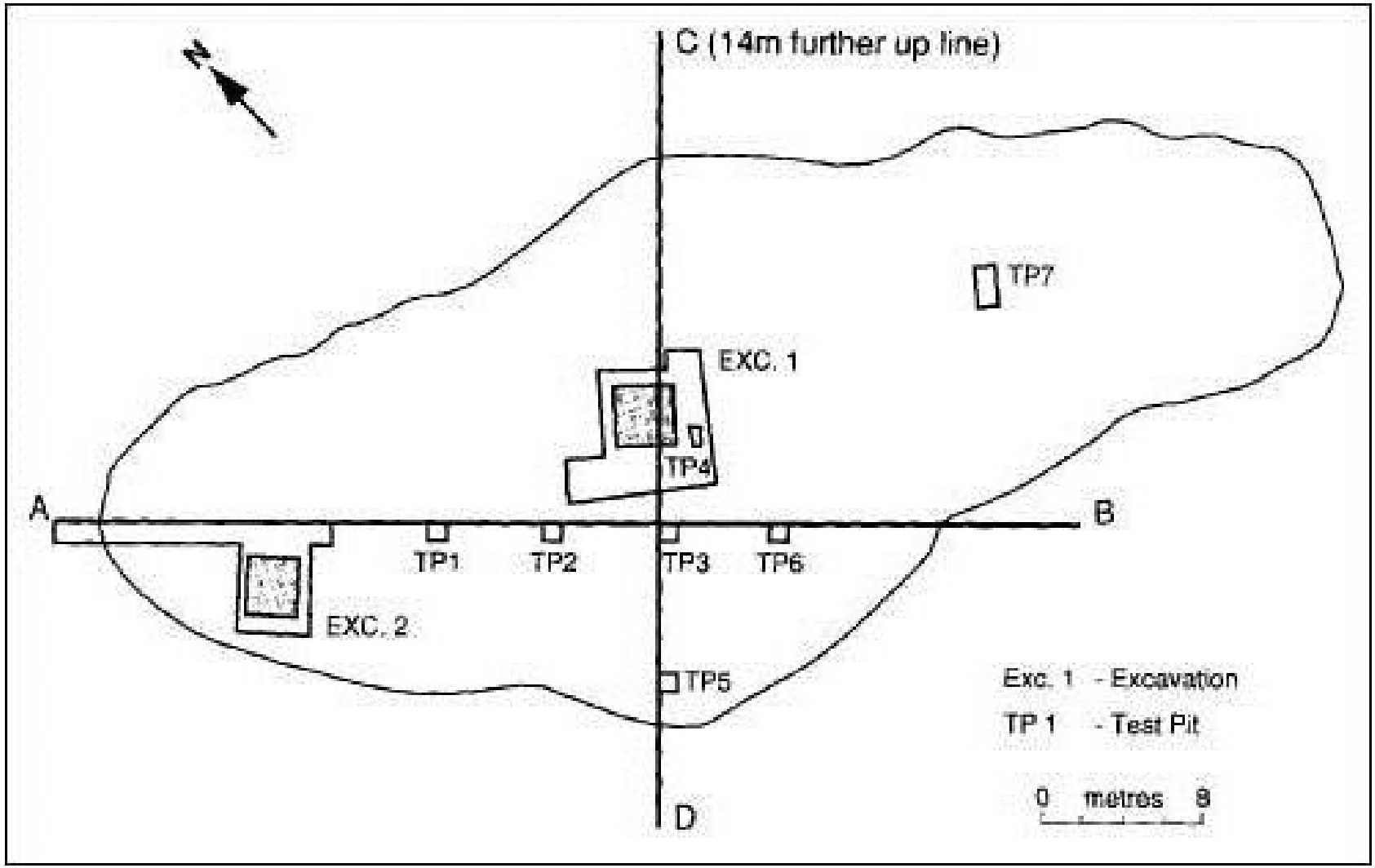


Figure 3.30: *Sketch plan of Jeitun. (After Harris et al 1993: fig. 2.)*

Figure 3.31: *Hotu & Belt caves as seen from the road. (After Coon 1952: fig. 1.)*

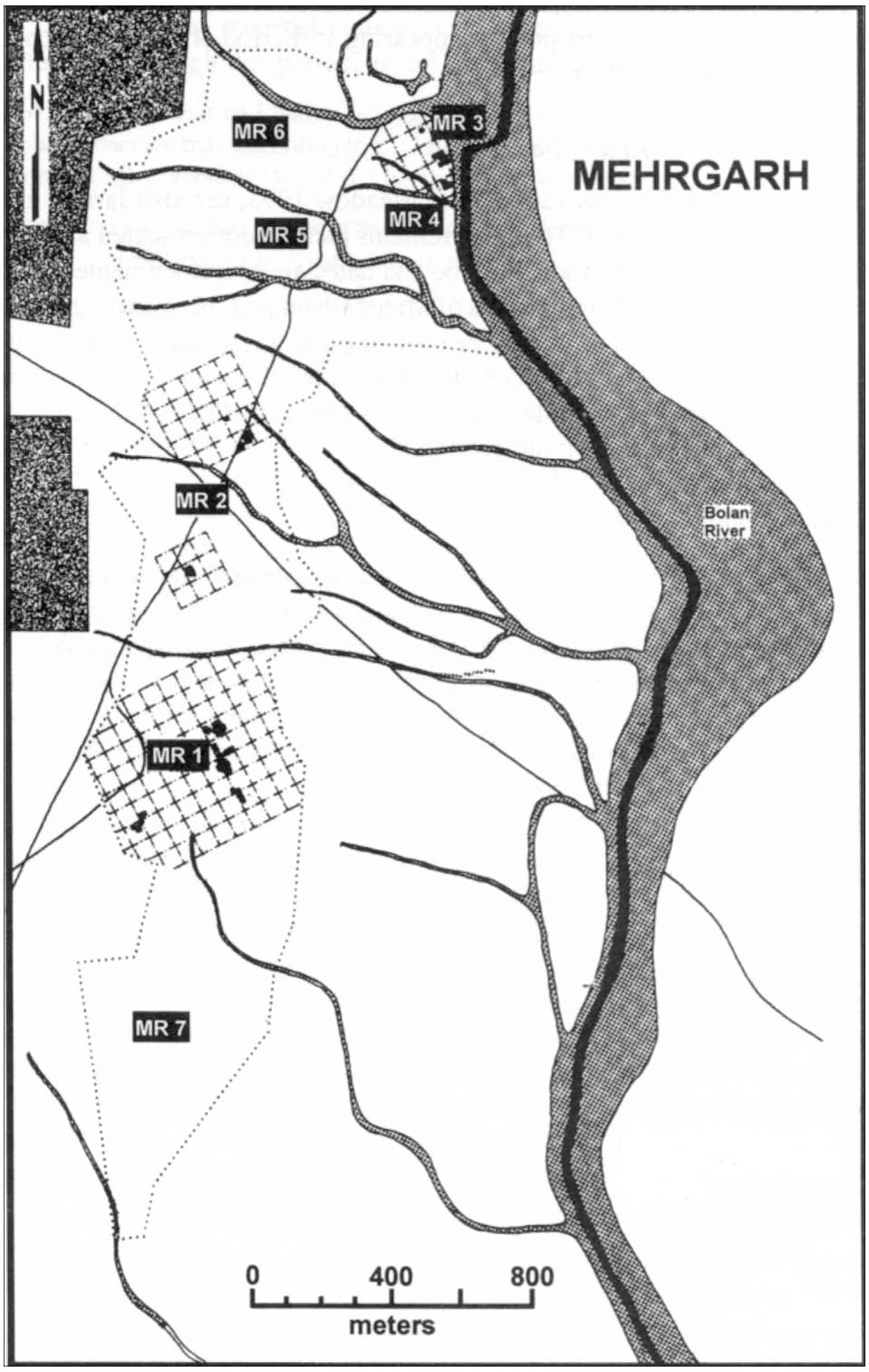


Figure 3.32: *Site plan of Mehrgarh. Neolithic deposits are found areas MR3 and MR4. (After Jarrige et al.1995: 98.)*

Chapter Four

Methodology

"New problems arise as more is learned of the first attempts at food production and settled village life" (Braidwood et al. 1961: 2008)

4.0. Introduction

The preceding two chapters have considered the origins and spread of agriculture in the Near East and Central Asia, and the regional characteristics of the Neolithic of Iran and neighbouring regions. It will have become apparent, that although no consensus exists as to exactly where and when agriculture originated, it is generally accepted that it first appeared in the Fertile Crescent, especially the upper reaches of the Tigris and Euphrates Rivers ca. 8000 BC, from where it spread into and across Europe, probably by a mixture of migration and indigenous development, although the significance attributed to either varies enormously between scholars (e.g. Ammerman & Cavalli-Sfroza 1984; Zvelebil & Rowley-Conwy 1984, 1987; Renfrew 1987; Dennell 1992; Whittle 1996; Thomas 1998, 2001; Diamond 1997, 2002; Price et al. 2001; Bellwood 2002; Hather & Mason 2002). In comparison, the spread of agriculture in Central Asia has received surprisingly little attention, and it has been assumed, rather than tested, that agricultural spread eastwards by a 'wave of advance' similar to that which operated in Europe (Renfrew 1987; 1989). It is a primary aim of this research to address the current lacuna in our understanding of the origins and spread of agriculture in Central and southern Asia, and to assess whether, as hypothesised by Renfrew (1989: 149) a wave of advance operated to the east as well as the west. All known Early Neolithic sites in Iran are located in western Iran, in the Central Zagros (e.g. Asiab, Sarab, Ganj Dareh, Hajji Firuz Tepe) and southwestern lowlands (e.g. Ali Kosh, Choga Bonut) and, to date, none are known on the Central Iranian Plateau. In order to ascertain whether the dearth of sites is a result of lack of

archaeological research, or represents a real absence, this research will involve a review of the existing material from the Central Plateau, and the results of new archaeological research on the Tehran, Qazvin and Kashan Plains, in which I participated. The purpose of this chapter is to explicitly state the aims and objectives of this research, and to establish the methodology through which they will be achieved.

4.1. Aims and objectives

As noted in Chapter One, the aim of this research is to test for the presence of Early Neolithic occupation on the Central Iranian Plateau, with particular focus on the Qazvin, Tehran and Kashan Plains. The objectives of this research are to:

i. Review models of the sequential Neolithic occupation of Iran;
ii. Analyse the published material on Early Neolithic sites in Iran and neighbouring regions;
iii. Recalibrate and evaluate the "chronometric hygiene" (Spriggs 1989) of the available ^{14}C determinations for Neolithic sites in Iran and neighbouring regions;
iv. Spatially plot the evaluated ^{14}C dates on to a geographic map of Iran; and
v. Review the data from recent survey and excavation projects on the Tehran, Qazvin, and Kashan Plains, including my own research on the latter, to evaluate the evidence of early Neolithic occupation.

4.2. Modeling

Explaining the transition to agriculture is a long-standing and central problem in prehistoric archaeology, which traces its history back to the large-scale synthetic works of Vere Gordon Childe (Childe 1925; 1942; 1953). Childe believed that agriculture originated in the uplands of Southwest Asia, where

wild grasses and animals fit for domestication could be found. The control of food production allowed for population expansion, “beyond the narrow limits imposed by the naturally available supply of wild fruits and game” (Childe 1925: 15), facilitating the spread of farming into Europe, by “the migration or colonization of farmers and shepherds from the Near East” (Childe 1968: 368). To demonstrate the pattern of the spread, Childe produced two maps plotting the distribution of Early Neolithic sites (Fig. 4.0 & 4.1), which he believed to “exhibit quite clearly the gradual spread of Neolithic farmers, or at least farming from the south-east” (Childe 1925: 321). The maps did not have any temporal scale, but this aside, were remarkably accurate considering the time at which Childe was writing. Roman Ghirshman was one of the first scholars to specifically focus on the development of agriculture in Iran. He perceived agriculture to have emerged as the outcome of a long, slow indigenous process, which was facilitated by a postulated switch to a ‘dry’ climatic regime ca. 13,000 BC, and human intuition and general familiarity with the landscape (Ghirshman 1951: 28). Ghirshman specifically accredited the development of food production to women, arguing: that, “whereas man made but little progress, woman with her primitive agriculture introduced many innovations during the Neolithic period” (1954: 28).

The advent of ^{14}C dating in the 1950s (cf. Libby 1955), and its subsequent refinement throughout the second half of the twentieth and early twenty-first century, has provided a new, sensitive instrument for testing models of the spread of agriculture (Dolukhanov et al. 2005: 1441). Grahame Clark (1965a; 1965b) mapped the earliest uncalibrated ^{14}C determinations from a sample of Neolithic sites onto a map of Europe, by dividing the sites into a three-fold grading system dependent on age: over 5200 BC; 5200-4000 BC; and 4000-2800 BC (Clark 1965b: 45) (Fig. 4.2). From the resulting “clear and coherent” pattern of site distribution, Clark (1965b: 48) was able to discern a clinal pattern of spread into Europe along the Danube front, similar to that described by Childe (1925). The determinations Clark used were uncalibrated, and he made no attempt in his analysis to convey the standard deviation of individual samples, sharing Waterbolk’s view that “one carbon-14 date from a site or culture is no date; only series of dates that mutually make sense, can be used

for chronological purposes" (Waterbolk 1960: 18). His map was also sketchy in places, particular for much of Eastern Europe, for where there was a lack of ^{14}C determinations. However, Clark saw his work very much as a preliminary guide to future research, believing that, "even a crude message is better than none" (1965a: 66).

Clark's pioneering work was followed by more extensive and inclusive studies by Albert J. Ammerman and Louis L. Cavalli-Sforza (1971; 1973; 1979; 1984) who used ^{14}C measurements from a total of 53 Neolithic sites to map the spread of farming. Sites were selected for having: (a) dated deposits belonging to one of the 'Neolithic cultures' in the region; (b) no suspected contamination of the dating sample; and (c) ^{14}C determinations with a standard error of 200 years or less (ibid. 1984: 55). Where more than one layer or level was dated at a site, only the date from the earliest level was used; and in situations where this level had more than one date, a weighted average of the available data was used. Excluded from the analysis were sites from the Alps, as "retardation of the spread was expected owing to unfavourable ecological and geographical factors" (ibid.: 55-6). As was the convention of the time, all of the ^{14}C ages used were uncalibrated.

Following Clark (1965a; 1965b), Ammerman and Cavalli-Sforza applied their set of ^{14}C determinations to a geographic map of Europe (Fig. 4.3), and found that the distribution of the ^{14}C determinations showed a clear cline from southeast to northwest, mirroring the pattern depicted in Clark's maps. Ammerman and Cavalli-Sforza also produced a second map, which used a series of 500-year interval isochrones or lines to represent the ^{14}C determinations (Fig. 2.5). This map too exhibited the same clinal pattern, with the oldest sites closest to the origin in the Near East, and the sites becoming increasingly younger with movement in a northwest direction from this origin. Ammerman and Cavalli-Sforza acknowledged that the coverage on some parts of the maps was "thin", but argued that "the map as a whole should only be viewed as a current approximation" (1984: 59). They advocated that the map could be progressively improved as more ^{14}C determinations become available, and knowledge of local Neolithic sequences increased. Such work

has been done more recently by Gkiasta et al. (2003), Pinhasi et al. (2005) and Bocquet-Appel et al. (2009).

Gkiasta et al. (2003) re-evaluated the ^{14}C record, in order to establish the extent to which the inclusion of ^{14}C dates produced in the 20 years since Ammerman and Cavalli-Sforza's (1984) original analysis, supported or modified their work. Using a data set of ^{14}C determinations from 508 Neolithic sites, Gkiasta et al. (2003: 48) performed a major axis regression analysis, similar to that originally employed by Ammerman and Cavalli-Sforza (1984) (Fig. 4.4 & 4.5). They then expanded on Ammerman and Cavalli-Sforza's work: undertaking other map visualizations and statistical analysis, experimenting with geographically-weighted regression, which allows for the detection of local variation in trends in large-scale spatial datasets; and using ranges of calibrated dates rather than point values (Gkiasta et al. 2003: 49). Despite the use of a larger dataset, the results of Gkiasta's spatial analyses closely resembled Ammerman and Cavalli-Sforza's: sites were older close to the origin in the Near East and become increasingly younger in a north-westwards direction from this origin (ibid.: 51). Gkiasta et al.'s work also provided a similar overall rate of spread (~1.3 kilometres/year), although the dispersion around the mean rate was somewhat greater, which suggests that may be due to greater variance in the rate of spread of early farmers across Europe than Ammerman and Cavalli-Sforza originally assumed (Gkiasta et al. 2003: 54-5).

Susan Colledge et al. (2004) were the first to test the 'Wave of Advance' using both ^{14}C determinations and the archaeobotanical record. Colledge et al. used existing data on the distribution of Neolithic founder crops, including einkorn, barley, wheat, flax, lentil, pea, bitter vetch and chickpea, and ^{14}C determinations for 40 Early Neolithic sites in southwest Asian and southeastern Europe, to elucidate the nature and probable routes of the spread of agriculture (Colledge et al. 2004: 26) (Fig. 4.6a & b). Colledge et al.'s (2004: 37) findings indicate that cereal domestication first emerged in the Levantine corridor during the early tenth millennium BC (where it was restricted to just a few sites for the next 400–500 years), before spreading

further westwards across Europe, ca. 8700 BC, and support the 'Wave of Advance'.

John Robb (1991; 1993) offers a different perspective on the spread of agriculture. Robb identifies a paradox applicable to all archaeological study, in that "random, directionless processes can add up to 'directed' results" (1991: 287), the results of which are sometimes so strikingly large and unidirectional, that they resemble central problems in archaeology. Robb employs a simulation of the spread of Indo-European languages across Eurasia to demonstrate this paradox, which is equally applicable to the spread of agriculture. The parameters of the stimulation are based on several generalizations about tribal social life which include: that groups generally live at low population densities in networks of villages of 100–1000 people; that social life is typically very fluid e.g. groups grow, dwindle, merge, go extinct; and that this 'normal' social flux may change the language and the language family spoken in a given region. Finally, groups that share language familiarity need not share anything else e.g. technology, economy, religion and, thus, "language affiliation is a neutral trait…and language change is random" (Robb 1991: 288).

To run the simulation, hypothetical 'territories' on a map of Eurasia were filled by a symbol signifying the linguistic family there (Fig. 4.7), with the resulting map depicting the hypothetical language distribution at time 0. The number chosen to represent the probability that a given territory will undergo language change during one turn was set arbitrarily at 0.35 (Robb 1991: 288). During each turn for every territory a random number was generated. If this number fell below the pre-set probability, the territory was considered to have undergone linguistic change and been re-colonized by a neighbouring territory, also selected randomly (ibid.). The simulation was run for 2000 turns (Figs. 4.8-4.10), the results of which showed how individual language families can be rapidly replaced by just a few groups by a totally random process: after 120 turns only 20 of 64 language families remained; after 340 only 9 remained; and during the last 400 turns only 2 language families remained. The pattern shown by the simulation is general to any situation, in which

traceable lineages may go extinct every generation or time interval, including inherited surnames, the inheritance of mitochondrial DNA, and – as is particularly apposite to this research - the replacement of forager economies by farming economies (Robb 1996: 288-9).

4.3. The Neolithic of Iran

The history of archaeological investigation in Iran has been sporadic. Nearly 50 years on, Ghirshman's statement that "whole areas of Iran remain untouched by archaeological research" (1954: 29), unfortunately, still holds true. Hassan Fazeli (2001: 27) divides twentieth century archaeology in Iran into two stages: pre- and post-World War II. To these might be added a third stage: after the Islamic Revolution of 1979. From 1928 to the beginning of World War II a number of excavations took place by foreign archaeologists, including Ernest Hertzfeld and Eric Schmidt's excavation of Persepolis in Fars (Schmidt 1953; 1957; 1970) and Schmidt's (1935a, 1935b, 1936) excavations at Cheshmeh Ali; Alexander Langsdroff and Donald McCown's excavation of Tall-i Bakun; Georges Contena and Roland Ghirshman's excavation of Giyan, near Nihavand (Ghirshman 1954); Ghirshman's excavation of Tepe Sialk on the Central Plateau (Ghirshman 1938); and the excavation of Tureng Tepe by Frederick Wulsio.

After World War Two, the focus of archaeological research changed, partly as the result of Gordon Childe's (1942; 1953) hypothesis that the origins of the Neolithic were to be found in the Near East (see p. 10). This attracted many archaeologists to work in the Zagros Mountains. Perhaps the two most prolific archaeological projects of this period were those of Robert Braidwood (Braidwood 1960; 1961; Braidwood & Howe 1960; Braidwood et al. 1983), who began excavations at the Neolithic sites of Ganj Darah, Sarab and Siahbid in the Kermanshah region; and Frank Hole and colleagues' survey and excavation work on the Deh Luran Plain (Hole & Flannery 1967; 1968; 1977; 1987; Wright 1969; 1981; Hole et al. 1969). Indeed, archaeology in Iran during this time has been described as, "at the cutting edge of record and

data processing" (Winter quoted in Lawler 2003: 971). One area that was largely ignored during this period was the Central Iranian Plateau, despite Schmidt's and Ghirshman's earlier excavations in the region (Fazeli 2001: 29). Some work was done by Iranian archaeologists such as Ezzat O. Negahban's (1979) excavation of the prehistoric sites of Zagheh, Ghabristan and Sagzabad on the Qazvin Plain, but this all came to an abrupt halt with the Islamic Revolution of 1979.

In the aftermath of the revolution all foreign digs were stopped, universities were closed, and Iranian archaeologists were forced to either flee or wait for an intellectual thaw (Lawler 2003: 971). Sites were looted and/or destroyed by urban expansion, and previously excavated archaeological material was lost (Alizadeh 2003: xxxi; Lawler 2003: 971). It is only within the last decade that western archaeologists have been readmitted back into Iran, to work in equal collaboration with Iranian archaeologists (Lawler 2003: 970). However, this situation is liable to change with the current political situation in the country.

As part of this research, published material on the Early Neolithic of Iran and neighbouring regions is considered, with particular weight given to: the subsistence economies, architecture, material culture and burial practice, which are all believed to be important components of the 'Neolithic' (Hodder 1990). It is recognized that the recovery and analysis of both botanical and faunal remains will always be biased by preservation processes, cultural practice and excavation methodology (Zvelebil 1993: 150). The presence of architecture at a site indicates it was semi-, if not permanently, occupied. It also provides a useful indicator of the economic and social structure of a site (Hodder 1990; Watkins 1990). Material culture, including stone tools, pottery, jewellery and figurines, is an important medium for the portrayal of group and individual identity (cf. Díaz-Andreu et al. 2005), as well as providing a useful proxy for marking prehistoric trade and communication networks. It would be expected, although cannot be presumed, that if agriculture spread by migration it would have followed earlier trade routes (Sherratt 2007: 20). Burial practice provides an important insight into a group's beliefs and customs. Similar burial practices between sites can be indicative of a shared

cultural and belief system, which may be due to the spread of a common ancestral population, and/or the maintenance of community ties.

In light of the disrupted history of archaeological research in Iran, the majority of prehistoric sites were excavated in the 1960s and 1970s, before many of the archaeological procedures (e.g. fine sieving, floatation, ^{14}C dating) that are treated as routine today had come into practice. There is, then, a lack of scientific methods in much Iranian archaeology. This has not been helped by the isolation of Iranian archaeologists working in the 1980s and 1990s from the rest of the world. Due to limited research there also exist extensive lacunas in our knowledge of certain regions, particularly southern and northeastern Iran (Hole 1998).

For those sites that have been excavated, a wide discrepancy exists between the levels of information available. Whereas the findings of some excavations have been fully published e.g. Ali Kosh, Choga Bonut, Tepe Abdul Hosein, others such as Tepe Sabz, Asiab and Ganj Dareh, remain lost in an evanescence of seasonal reports and short notes in journals. The type and range of data recovered and recorded from different sites also varies considerable depending on the aims and objectives of the excavator(s), and time and financial constraints. Although this research does the best to overcome these handicaps, a full report on the Neolithic of Iran – as is available for the Neolithic of Mesopotamia – is not possible given the current level of information.

4.4. Radiocarbon determinations

A fundamental part of this research involves the creation and analysis of a dataset of all the ^{14}C determinations for Neolithic sites in Iran and neighbouring regions that are currently available. Sites are classified as Neolithic, ca. 8000–5500 BC, on the basis of conventional assignment. ^{14}C determinations will be obtained from a variety of sources including site excavation reports, *Radiocarbon* and other journals, laboratory databases,

and relevant datasets from universities and archaeological bodies. In conjunction with the ^{14}C determinations, additional information that will be collected includes: the laboratory number of each ^{14}C determination; the nature of the material dated; the contexts of the ^{14}C samples; any economic and/or cultural associations; and relevant excavator or laboratory comments.

4.4a.The radiocarbon method

This section outlines the radiocarbon (^{14}C) method, for it is requisite to understand the processes by which ^{14}C determinations are attained in order to be able to assess their chronometric hygiene and level of confidence. A number of the references cited in this section are relatively old. This is because the vast majority of ^{14}C dates available for Iranian sites were measured before 1980 and, therefore, the published material relative to the problems associated with ^{14}C dating during this period, is most appropriate.

The dominant natural mechanism for the production of ^{14}C is a secondary effect of cosmic-ray bombardment in the upper atmosphere (Taylor 1997: 66). Following production, ^{14}C is rapidly oxidized to form carbon dioxide (CO_2). Most ^{14}C – around 85 per cent – is absorbed in the oceans, while about 1 per cent enters the terrestrial biosphere, primarily by means of the photosynthesis pathway (ibid.: 66). Consequently, all living organisms are constantly exchanging ^{14}C with their environment. Once an organism dies, carbon exchange stops, and the amount of ^{14}C gradually decreases through radioactive beta decay. The best estimate of the half life of ^{14}C is 5730 years, however, for historical reasons the Libby half life of 5568 years is conventionally used in the calculation of a ^{14}C result (Bowman 1990: 11).

^{14}C dating is a radiometric-dating method, which uses the naturally occurring radioisotope ^{14}C to estimate the age of carbonaceous material up to around 58,000–62,000 years ago (Plastino et al. 2001: 161). Measurements are conventionally made by counting the radioactive decay of individual carbon atoms by Gas Proportional Counting (GPS) or Liquid Scintillation Counting

(LSC), and for samples of a sufficient size (several grams of carbon) this technique is still used. However, most methods are relatively insensitive, and due to the long decay rate of ^{14}C subject to large statistical uncertainties: when there is little ^{14}C to begin with, the relatively long half life of ^{14}C means that very few of the ^{14}C atoms will decay during the time allotted for their detection (ibid.; Bowman 1990: 33). Accelerator Mass Spectrometry (AMS) which directly measures the number, or proportion of the number, of ^{14}C atoms in a sample, greatly increases the sensitivity of conventional dating methods (Bowman 1990: 34). AMS requires much smaller sample sizes – typically towards a factor of 1000 smaller (www.radiocarbon.eu) – which means that small carbon samples such as seeds, which would be totally destroyed by conventional-dating methods, can be measured. Although the techniques of conventional and AMS dating are fundamentally different, both produce ^{14}C results that can be interpreted in the same way (Bowman 1990: 31). The AMS method is not without its issues, and in particular the dating of plant macrofossils can be problematic (Lowe & Walker 2000: 56; for case studies see Walker et al. 1999; Turney et al. 2000). Consequently, similarly to conventional determinations, AMS dates should not be taken at face value, and individual determinations need to be evaluated for their reliability.

Two major issues associated with both conventional and AMS dating are: the stratigraphical integrity of the sample; and the level of contamination. Matthew Spriggs and Atholl Anderson have developed a methodology for evaluating the 'chronometric hygiene' of ^{14}C dates (Spriggs 1989; Spriggs & Anderson 1993). In brief, this method consists of setting out a protocol of acceptability for ^{14}C ages, whereby dates are accepted or rejected according to sample material, pretreatment conditions, stratigraphic context, cultural association and other criteria (Spriggs & Anderson 1993: 207-8; see also Millard 2008: 849).

A fundamental assumption of ^{14}C dating is that no process other than radioactive decay has altered the level of ^{14}C in a sample since its removal from the atmosphere (Bowman 1990: 27). Thus, any addition of carbon-containing material is contamination, and must be removed. This is done by

the pretreatment of samples in laboratories. The risk of contamination increases with decrease in sample size – very small samples pose a greater risk (Barker 1970: 39). Two of the main contaminants are calcium carbonates (e.g. limestone), which dissolve in groundwater and can then be deposited in a sample; and humic acids from buried soils (Bowman 1990: 27). In most samples carbonates can be removed by an acid wash, whilst humic acids can be eradicated using dilute alkali and acid washes in sequence (ibid.). A particular problem in earlier measured samples that were hand sorted, was contamination by rootlet penetration (Barker 1970: 39).

Some sample materials are easier to pretreat than others. One of the easiest to treat materials is wood charcoal, which due to its burning is chemically inert (Bowman 1990: 27). More difficult materials include wood, shell and bone. A specific problem with bone is that whilst the protein fraction is the easiest to date, it is not always well preserved, can begin to degrade in warm conditions, and is susceptible to attack by fungi or bacteria (ibid.: 29). Some samples are too chemically fragile to be pretreated, and for these samples contamination cannot be ruled out (Barker 1970: 39).

The apparent age of a sample can also be influenced by affects beyond laboratory control. Of these probably the most commonly encountered is 'pre-sample growth' or the 'Old Wood' effect. Wood, particularly timbers, can be recycled and reused in later buildings or structures, resulting in the wood having a much earlier ^{14}C age than the building it is supposed to 'date'. Trees can also be very long lived, and this represents another problem, with the age difference between the heartwood and sapwood of some trees being hundreds of years, for example, bristlecone pines can live for some 4000 years (Bowman 1990: 51). It is consequently advisable, whenever possible, to date samples of twiggy material or short-lived species (ibid.).

The apparent age of carbon samples can also be affected by the 'marine' or 'reservoir' effect (Aitken 1990; Lowe & Walker 2000; Lowe et al. 2001). The mixing rate of carbon in deep oceans is slow, and really deep waters of the present day can show a ^{14}C age of several millennia (Bowman 1990: 24;

Lowe et al. 2001: 1176). Upwelling of ^{14}C depleted deep water means that surface water – and the marine animals and carbonates that feed on it – can have an apparent ^{14}C age relevant to the atmosphere (Lille et al. 2008; Zaitseva et al. 2009); an effect that cannot be accurately quantified (Dolukhanov et al. 2009: 784). Freshwater shells, although escaping the marine effect, can be affected by hard water, in which the presence of dissolved calcium ions, or other sources of carbon, results in depleted ^{14}C concentrations (Bowman 1990: 25-6). The hard-water effect can also influence the apparent ^{14}C age of marine organisms where a substantial carbon-rich freshwater influx is encountered, such as at river mouths and estuaries (ibid.).

Isotopic fractionation can also effect the ^{14}C concentration of a sample. Three isotopes of carbon (^{12}C, ^{13}C & ^{14}C) exist. In any biological pathway there is a tendency for the lightest isotope (in this case ^{12}C) to be preferentially taken up, followed by the next lightest (Bowman 1990: 20). Thus, growing plants and animals have lower ^{14}C levels than the atmosphere, and if this difference is significant, will appear older when dated. Fortunately fractionation can be corrected for after laboratory analysis (ibid.: 21).

Another issue with ^{14}C dating is the issue of bulk sampling. Conventional dating requires large samples, and in the earlier days of the process bulk carbon samples were often used, the resulting ^{14}C determination of which was an average of several carbon sources and thus meaningless. Small samples can be equally problematic, as there is a greater risk of stratigraphic mobility, and although sample selection should control for this possibility, this is not always the case (Pettitt et al. 2003: 1690). It is also important that an association can be established between a carbon sample and the archaeological event it is supposed to date, for unless it is possible to infer a definite relationship between the two, “a large and indeterminable error is introduced” (Barker 1970: 39).

All dates published by a laboratory are given an associated error term, which corresponds to the laboratory’s estimate of the precision of the measurement;

it does *not* take into account all of the factors that can influence ^{14}C measurements. As ^{14}C measurements can often not be repeated (due to time, resources, the depletion of the sample material etc.) error terms are usually estimated (Bowman 1990: 38). The distribution of results for ^{14}C measurements that can be repeated is Normal or Gaussian. Assuming this holds for ^{14}C ages when the error is estimated at a 1 sigma error term ($\pm 1\sigma$), means there exists: a 68.3 per cent chance that the true result will lie within $\pm 1\sigma$; a 95.4 per cent chance within $\pm 2\sigma$; and a 99.7 per cent chance within $\pm 3\sigma$ (ibid.: 38). Alternatively, there is nearly a 1 in 3 chance that the result does not lie within $\pm 1\sigma$ of the experimental one. ^{14}C ages are conventionally published with a $\pm 2\sigma$ error term (Bowman 1990: 39). To evaluate the true error in a ^{14}C result three sets of counting statistics need to be incorporated for the sample, background and modern standard.

Unfortunately, there is no convention for defining how a laboratory should perform error estimates, and error terms need to be addressed with caution (Pettitt et al. 2003: 1989). Traditionally, error terms often included only the statistical counting uncertainty (usually of ±60 years or less) giving a false sense of accuracy (Barker 1970: 40). Today, laboratories are encouraged to try to quote the overall uncertainty, which is determined from a control sample of a known age and verified by international inter-comparison exercises (Scott 2003).

All ^{14}C determinations that have been accepted by the laboratory are issued with a laboratory reference number. Such reference numbers consist of a laboratory identifier (e.g. BM for British Museum) followed by a hyphen and then a number (e.g. BM-1224) (Bowman 1990: 42). Table 4.0 lists the lab codes of all the ^{14}C measurements used in this research.

Systematic errors can arise in a laboratory resulting in erroneous ^{14}C ages. Laboratories can test whether they have systematic errors by taking part in both official Inter-Laboratory Comparability tests and unofficial comparisons. Systematic errors can occur in many different ways depending on the method

used to measure the ^{14}C content. In Liquid Scintillation Counting for example, care has to be taken to avoid evaporation of benzene. An unexpected loss of 1 per cent in the modern reference can give sample ages too young by around 80 years, and continued evaporation will give even larger biases (Bowman et al. 1990: 59). This was experienced by the British Museum in the early 1980s (Tite et al. 1987), and would have gone undetected if not for interlaboratory comparison, which showed that the British Museum's dates were on average some 200 years younger than the consensus data (Bowman et al. 1990: 59). Cases such as these emphasise the importance for ^{14}C laboratories to participate in regular interlaboratory comparisons, to ensure accurate and consistent ^{14}C measurements (cf. Scott 2003; Scott et al. 1989).

^{14}C ages are usually reported in ^{14}C years before present (BP), where 'present' is defined as 1950. This is based on a nominal, and assumed constant, level of ^{14}C in the atmosphere equal to the 1950 level. A raw BP date cannot be used directly as a calendar date, because the level of atmospheric production of ^{14}C has not been strictly constant (Niklaus et al. 1994: 194). The level is affected by variations in cosmic ray activity, which is in turn effected by changes in the earth's magnetic field (Kudela & Bobik 2004). In addition, there are substantial reservoirs of carbon in organic matter, the ocean, ocean sediments and sedimentary rock, and changes in the earth's climate can affect the carbon flow between these reservoirs and the atmosphere, leading to changes in the atmosphere's ^{14}C fraction (Bowman 1990: 18). Aside from these natural processes, the level can also be affected by human activity. Starting with the beginning of the Industrial Revolution in the 1700s and continuing to the 1950s, the fraction level of ^{14}C in the atmosphere has decreased, because of the admixture of large quantities of CO_2 into the atmosphere from the combustion of fossil fuels (the Suess effect) (Bowman 1990: 19). However, during the 1950s and 1960s atmospheric ^{14}C almost doubled, due to atmospheric bomb tests (Reimer et al. 2004: 1299).

To correct for variations in atmospheric ^{14}C, ^{14}C ages (BP) need to be calibrated into calendar dates (BC/AD). Standard calibration curves are available, based on comparison of ^{14}C dates of samples that can be dated

independently by other methods (e.g. dendrochronology & deep ocean sediments). Originally, calibration curves only extended back to around 5000-years ago and calibration was problematic (Waterbolk 1971: 15). However, recent calibration curves (e.g. IntCal 09) extend back over 50,000 years (Reimer et al. 2009).

The calibration curve is not a monotonic function, thus, as true age increases the ^{14}C age does not necessarily increase, and in fact it may decrease as a consequence of wiggles (Bowman 1990: 46). If the Gaussian or normal distribution of a ^{14}C result and associated error term is transformed by such a curve on the calendar axis, the distribution of the calendar dates is no longer Gaussian, nor is it is mathematically definable, and its form will depend on the part of the calibration curve under consideration (ibid.). Calibrated dates are therefore not central dates with an error term, but a range of ranges.

There are significant plateaus in the calibration curves, for example, the plateau at 11,000–10,000 ^{14}C BP that is believed to be associated with changing ocean circulation during the Younger Dryas. Over the period of 0–10,000 years BP, the average width of the uncertainty of calendar dates is ~335 years, although in well-behaved regions of the calibration curve the width decreases to ~113 years, while in ill-behaved regions it increases to a maximum of 801 years. Significantly, in the ill-behaved regions of the calibration curve, increased precision of measurement does not have a significant effect on increasing the accuracy of the dates (Niklaus et al. 1994: 196).

Many ^{14}C measurements from Iranian Neolithic sites – some of which were produced as early as the 1950s – are not calibrated, and those which are have not been calibrated with the most recent, internationally accepted, calibration curve, IntCal09 (Reimer et al. 2009). To improve the validity of the measurements in this thesis, all ^{14}C ages are calibrated using the calibration software OxCal 4.1 which utilises IntCal09 (Brook Ramsey 2009).

4.4b. Chronometric hygiene

As emphasised in the above section there are a range of questions that must be asked of any ^{14}C measurement before it can be accepted. However, to date there is no systematic procedure for quatlity control for ^{14}C dating in archaeology (Pettitt 2003: 1685). In this research the 'chronometric hygiene' (Spriggs 1989: 601), or 'robustness' (Lowe et al. 2001: 1176) of individual ^{14}C determinations will be evaluated in accordance to how well they fulfil the criteria described below. Those that fail to meet the criteria will be assigned a chronometric hygiene score of 'no confidence', whilst those that fully meet the criteria will be scored as 'reliable enough to accept without further questioning'. ^{14}C determinations that fall inbetween the two will be assigned scores of 'questionable' or 'acceptable' confidence, depending on how well they fulfil the following criteria:

i. *The sample material.* A wide range of materials are employed in ^{14}C dating, each of which has been affected to a greater or lesser extent by physical processes, including reburial or redisposition, and/or chemical alteration (Lowe et al. 2001). Thus, in all cases it is essential to know the material of the carbon sample that is being measured.

ii. *The proficiency of the laboratory in which the determination was recorded*. To achieve consistency between the ^{14}C determinations made by different laboratories most, although not all, laboratories participate in laboratory inter-comparison. In this research if a ^{14}C determination is from a laboratory which does not participate in regular laboratory inter-comparison, or the laboratory is not well known, the determination will be treated with 'no confidence'.

iii. *The pretreatment conditions.* All ^{14}C determinations should be published with the appropriate contextual information concerning the nature of the samples selected for dating, the treatment of the sample prior to and during measurement, and any correction factors employed (Lowe et al. 2001: 1177). Thus, it is important that the ^{14}C determinations used in this research come from well-recorded

contexts and are stratigraphically secure, for if the sample material is suspect “any further manipulation of the date…can only lead to spurious results” (ibid.: 1176). In this research, the following information on the pretreatment of a sample is required as a minimum: (a) the dating laboratory’s sample codes; (b) the type of measurement (i.e. AMS or radiometric) conducted by the laboratory; (c) a note of any non-routine pretreatment if appropriate; and (d) a statement of any correction factors applied in the age calculation, e.g. marine reservoir correction.

iv. *The number of dates available for the site*. It must be ensured that ^{14}C determinations are stratigraphically secure. If only one ^{14}C determination is available for a site, then its confidence must be questioned, for in such a case it is difficult – Pettitt argues “impossible” (Pettitt et al. 2003: 1690) – to assess the date’s accuracy (Buck et al. 1994: 245; Lowe et al. 2001: 1176). Interpretation is similarly difficult if the only dates that are available for a particular horizon are widely spaced (Pettitt et al. 2003: 1690).

v. *The level of association between what is being dated and the anthropomorphic activity that it is supposed to date.* In all cases it needs to be established that the ^{14}C determination dates the earliest occupation of the site (Millard 2008: 851). Where contexts are dubious the determinations will be treated with little to no confidence.

vi. *The error term*. It is generally advised that samples with error terms of ±100 or more ^{14}C years should be rejected, because the laboratory treatment is unreliable (Pettitt, pers. comm.). However, given that most ^{14}C dates used in this research were measured on the early days of ^{14}C dating, when error terms were generally much higher than they are today, such an approach would risk throwing the baby out with the bath water. Consequently, in this research error terms of up to ±150 ^{14}C years will be accepted as reliable enough to be used without further questioning for conventional measurements. In the case of AMS dates, due to their higher

precision and the more recent adoption of the procedure, dates with error terms of ±100 ^{14}C years or more will be treated as unreliable.

In accordance with the above criteria, an example of ^{14}C determinations which can be treated with 'confidence' (i.e. 'good' dates) are the ^{14}C determinations for the Neolithic site of Tal-e Bakun A, southwestern Iran:

Lab. no.	Context	Sample material	^{14}C date (BP)	Date (cal. BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-207562	Sq. BB 27, Level 3: trash heap	Charred seeds	5560±40	4447-4357	4462-4338	Reliable	Known material & context
Beta-210983	Sq. BB27, Level 4 (basal)	Charred seeds	5570±40	4448-4362	4488-4342	Reliable	Known material & context

(After Alizadeh 2006: table 9.)

Both of the carbon samples were recently collected, from well-secured contexts, by the 2004 Joint ICHTO-Oriental Institute excavation. The ^{14}C dates were measured by AMS by a well-known laboratory, Beta-Analytic, which participates in interlaboratory comparisons (Scott 2003). Both dates are assigned laboratory codes, and are in stratigraphic agreement. Consequently, the dataset provides a relatively secure basis for calibration exercises (Lowe et al. 2001: 1176).

On the other hand, an example of a date set with 'no confidence', i.e. a 'bad' date, is the single ^{14}C measurement available for the site of Sayid Hammandini, in the Solduz Valley, Azerbaijan.

Lab. no.	Context	Sample material	^{14}C date (BP)	Date (cal. BC)		Hygiene	Reason
				68.2%	95.4%		
Shell Development Co.	Vertical face cut in mound by villagers	Charcoal & ash	7800± 210	7027-6462	7296-6241	Unreliable	Only date for site

(After Hole et al. 1969: table. 78.)

The sample was collected from an unsecure context, and submitted to the Shell Development Company laboratories, now defunct, for conventional measurement. The ^{14}C determination it is not assigned a laboratory number; is from a bulk sample; has an error of ±210 ^{14}C years; comes from an unsecure context; and as the only date for the site is stratigraphically unsupported. In cases such as these, it is difficult to assess the accuracy of the date, to isolate adverse dates, and to obtain realistic calculations of the age estimate (Lowe et al. 2001: 1176). The ^{14}C determination, then, cannot be treated with any confidence.

It is generally advisable to be suspicious of all dates produced before the 1990s, as it has been discovered that in previous years, more contamination occurred than was originally assumed (Pettit pers. comm.). Indeed, M.G.L. Baille (1990) reports that for determinations made in the 1970s and early 1980s, some 30 per cent of results had true dates outside the predicted 95 per cent ranges based on the laboratories deviations. However, as the majority of the ^{14}C determinations of for prehistoric sites in Iran were made before 1980, in this research all determinations that meet the chronometric hygiene criteria, whether made prior to 1980 or not, are used. Furthermore, no distinction is made in this research between ^{14}C dates obtained by conventional or Accelerator Mass Spectrometry (AMS) techniques, because given the date at which many of the ^{14}C determinations cited in this research were measured, the main source of their uncertainty is not the accuracy of radioactivity measurements in the laboratory, but effects of contamination in the field by older or younger carbon (Dolukhanov et al. 2005: 1442). Similarly, no division is made between dates from short-lived, e.g. carbonized seeds and long-lived, e.g. charcoal materials, as in nearly all cases the plausible life time of the later is still comparable – or less than – the typical total error of ^{14}C dates (ibid.). In terms of the dates used in this research, no claim to avoid errors of both exclusion and exclusion is made, but since the interest is identifying large-scale processes on the basis of a large number of observations, it is not believed that this will affect the conclusion.

4.4c. Calibration

The level of ^{14}C in the atmosphere is not constant, and ^{14}C determinations need to be calibrated into calendar dates, before they can provide reliable estimates of the dates of events of interest (Blackwell & Buck 2003: 223). Calibration has greatly improved in recent years, but no attempt has been made since Voigt and Dyson's (1992) study of the chronology of Iran, to recalibrate the Iranian Neolithic series of determinations. An important component of this research, then, is the calibration of the existing 'raw' ^{14}C dates using the software program Ox Cal 4.1 (Bronk Ramsey 2009), which employs the calibration curve IntCal 09 (Reimer et al. 2009). The spatial-temporal distribution of the calibrated ^{14}C determinations will then be explored, by plotting the determinations onto a geographic map of Iran. A similar methodology will be used to that of Clark (1965b: 48) with the ^{14}C determinations grouped into temporal categories, in this case of 1000 years. Where a number of carbon samples from a site have been measured over an extended period e.g. in cases where sites have been re-excavated, the most recently measured samples will be used. Where two samples have been tested from the same laboratory at the same time that with the earlier laboratory number will be the one quoted. No major claim is made that the list is in any sense complete. To achieve this would require a major collaboration between Iran and all the countries that have, and are continuing, to excavate it, which would take many years.

It may seem, given all the problems associated with ^{14}C dating outlined above, and the issues with statistical reliability and calibration, that ^{14}C dating is not always worth the effort. However, the advantage of ^{14}C dating is that for all these problems, it provides a chronological framework whose precision can be refined within scientific and operational parameters (Lowe et al. 2001; Blackwell & Buck 2003; Gamble et al. 2005).

4.5. Excavation and settlement survey in the Central Iranian Plateau

To date, no Early Neolithic sites are known from the Central Iranian Plateau. There are two possible explanations for this: either there was no Early Neolithic occupation of the Central Plateau and settlement was confined to larger sites from the Mid-Neolithic onwards; or depositional processes have buried all but the largest of Neolithic sites (cf. Brookes et al. 1982).

Alluvial aggradation is a major inhibiting factor in the identification and recording of prehistoric sites on the Central Plateau. Within the last 1000 years there has been a dramatic shift in environmental regime, and "while it is not known at present what effect the shift had on human populations, this event and subsequent environmental recovery have greatly affected the available surface record of the majority of occupations" (Brookes 1989: 35). Ian Brookes (Brookes 1989; Brookes et al. 1982) instigated some of the earliest work on investigating the impact of alluvial processes on the visibility of archaeological sites. Using the evidence from archaeological and geographical survey in the Qara Su Basin, central west Iran, Brookes demonstrated that more than 10 metres of alluvium had accumulated in some areas of the basin since the abandonment of pre-Bronze Age sites (Brookes 1989: 36). Brookes employed two types of evidence to support his case: stratigraphic evidence from Jameh Shuran, and the geographic distribution of visible pre- and post-Bronze Age sites. Jameh Shuran is a five-metre high tell site in the Qara Su Basin. Whilst the top one metre of cultural deposits at the site date to ca. 200-400 BC, the material from one metre below the surface was estimated to be from ca. 1000 BC (Brookes 1989: 36). Thus, at least one metre of alluviation has accumulated since the earlier occupation of the site. Further evidence of site burial is apparent in the distribution of sites mapped by size and age in the Qara Su Basin, which indicates that small – and even some large – prehistoric sites now lie beneath the alluvial surface (Fig. 4.11).

Brookes' work on alluvial processes in the Qara Su Basin is supported by Gavin Gillmore and colleagues (Gillmore et al. 2007; 2009; 2011) more recent

work on the Central Plateau. Gillmore et al. (2007: 44) used geomorphological survey to show that Late Neolithic deposits on the Tehran Plain can be covered by up to five metres of alluvial sediment from adjacent alluvial fans, and suggest that earlier sites may be buried even deeper. Gillmore's findings for the Tehran Plain are paralleled by those of Armin Schmidt and Hassan Fazeli on the Qazvin Plain, from where they report the base of the Chalcolithic tell of Ghabristan to be buried beneath more than six metres of alluvium (Schmidt & Fazeli 2006: 39). Collectively, these studies indicate that on the Central Plateau extensive alluvial deposits have been responsible for the partial, or in some cases complete (Gillmore et al. 2007: 51), burial of archaeological sites, and that this is something that needs to be factored into any study of the region.

A method for combating the effects of alluviation is *qanat* survey, a technique that was effectively employed on the Tehran Plain by Robin Coningham and colleagues (Coningham et al. 2004; 2006; Fazeli et al. 2007). In most of Iran the average annual precipitation is less than 250 mm, which is the minimum required for successful rainfall cultivation (Oates & Oates 1976: 111). Therefore, for successful crop production water has to be imported. Until recently, this has achieved through the widespread use of underground water conduits or *qanats*, the number of which in Iran is quite outstanding: there have been estimates of over 40,000, although an estimate of around 40,000 seems more probable (Cressey 1958: 39; Beaumont 1974: 421).

Qanats are created by digging a vertical shaft (the *madar chah* or 'mother well') down to the groundwater horizon on alluvial fans and plains, usually to a depth of between 10–50 metres (Beaumont 1974: 421; 1989: 128). From the mother well the *qanat* is continued by driving vertical shafts and excavating a tunnel down slope from the mother well. The shafts are usually spaced between 8–50 metres apart, depending on the overburden and the depth of the tunnel, and it is through these shafts that all the excavated material is removed. The excavated material accumulates in ring-like mounds (*kavar*) around the shaft, which from the air resemble small craters or huge 'doughnuts'. *Kavars*, then, effectively provide an inverted stratigraphy of the

plain (Gillmore et al. 2007: 430). Coningham (Coningham et al. 2004; 2006; see also Gillmore et al. 2007: 430) has demonstrated that by fieldwalking along *qanat* lines, and examining the pottery and stone artefacts from the *kavars,* it is possible to ascertain whether prehistoric sites are buried beneath the surface, providing much needed information on site visibility and size. For example, in the 2004 season of settlement survey on the Tehran Plain, Coningham (2006: 57–8) identified 6 prehistoric sites from 30 kilometres of *qanat* line, whilst only 8 prehistoric sites were recorded from 105 kilometres of transect walking.

Due to the success of Coningham's *qanat* survey on the Tehran Plain, *qanat* settlement survey was undertaken as part of this research, in order to collect data regarding the frequency, distribution and density of prehistoric sites on the Kashan Plain. It was anticipated that due to alluvial deposition on the plain, prehistoric sites – particularly those of the earlier periods – may have become buried. The methodology of the *qanat* survey is as follows. *Qanat* systems were selected at random, and their length was walked by a survey team of three or more people. Following Coningham et al. (2004: 3), sites were defined by the presence of a feature, a single lithic find spot, a scatter of ceramics, or fire-cracked rocks. When found, sites were located using handheld GPS units, photographed, measured and sketched. Major chronological indicators were noted, and samples of ceramic sherds and lithics collected, bagged, and returned to the field laboratory for further analysis. Information on each site was catalogued using a recording sheet, which included a record of the site's name (where available), coordinates, elevation, general description, condition and finds. A major issue with the *qanat* survey was that many *qanat* lines on the Central Plateau are being – or have been – replaced by electric water pumps and irrigation systems. As a result *qanat* lines are rapidly disappearing or falling into disrepair and, thus, it is of the utmost importance that *qanat* surveys – which provide a valuable tool for identifying buried sites (Coningham 2006: 58) – are conducted as soon as possible.

4.6. Conclusion

The methodology is implicit in all research, and structures, some might say determines, its outcome. It is thus vital in any archaeological research to clearly state the aims and objectives, and the nature by which they will be achieved. This chapter has identified and discussed the methodologies that will be used in this thesis, including a review of the existing information available on the Iranian Neolithic; the chronometric evaluation and calibration of the currently available ^{14}C determinations for Neolithic sites in Iran; the study of the spatial and temporal distribution of the latter; and a review of recent archaeological survey and excavation work on the Tehran, Qazvin and Kashan Plains, including my own work on the Kashan Plain.

The strength of the approach outlined in this chapter is that it combines a range of complementary archaeological tools and techniques to produce a synthetic report on the Neolithic of Iran. Such a synthesis has not been attempted before and will provide a useful reference, not only for the Iranian Neolithic, but for the spread and development of agriculture in Central Asia as a whole. The approach is limited to some extent by a shortage of reliable ^{14}C dates for Iran, and the country's sporadic history of archaeological investigation, but it is hoped that new data from the Central Iranian Plateau will more than compensate for these short comings. In conclusion, this thesis will utilize both existing and new material in order to bring a fresh perspective to the study of the development and spread of agriculture in Iran and Central Asia.

In the following chapter the available ^{14}C dates from Neolithic sites in Iran (as of 2010), will be collated, assessed in terms of their chronometric hygiene, and re-calibrated using the calibration software program OxCal (Brook-Ramsey 2009).

Laboratory code	Laboratory
AA	NSF, USA
Beta	Beta Analytic, USA
BM*	British Museum, England
C*	Chicago
GAK	Gakushuin University, Japan
Gif	Gif sur Yvette, France
GrN	Groningen, The Netherlands
Gx	Geochron Laboratories, USA
I*	Teledyne Isotopes, USA
K	National Museum, Denmark
0*	Humble Oil & Refining, USA
OxA	Oxford Radiocarbon Accelerator Unit, England
P*	University of Pennsylvania, USA
PRL	Physical Research Laboratory, India
Qu*	Centre de Recherches Minerales, Quebec, Canada
Sh*	Shell Development Co., USA
SI*	Smithsonian Laboratories, USA
TUNC*	Tehran University Nuclear Centre, Iran
UCLA*	University of California, Los Angeles, USA
UGa	University of Georgia, USA
WSU*	Washington State University, USA

Table 4.0: *A list of Radiocarbon laboratories and their laboratory codes. Not all of the laboratories that are listed are still in operation, and those that have ceased to operate, or have changed their code designations, are marked with a *. (After www.radiocarbon.org/Info/labcodes.html.)*

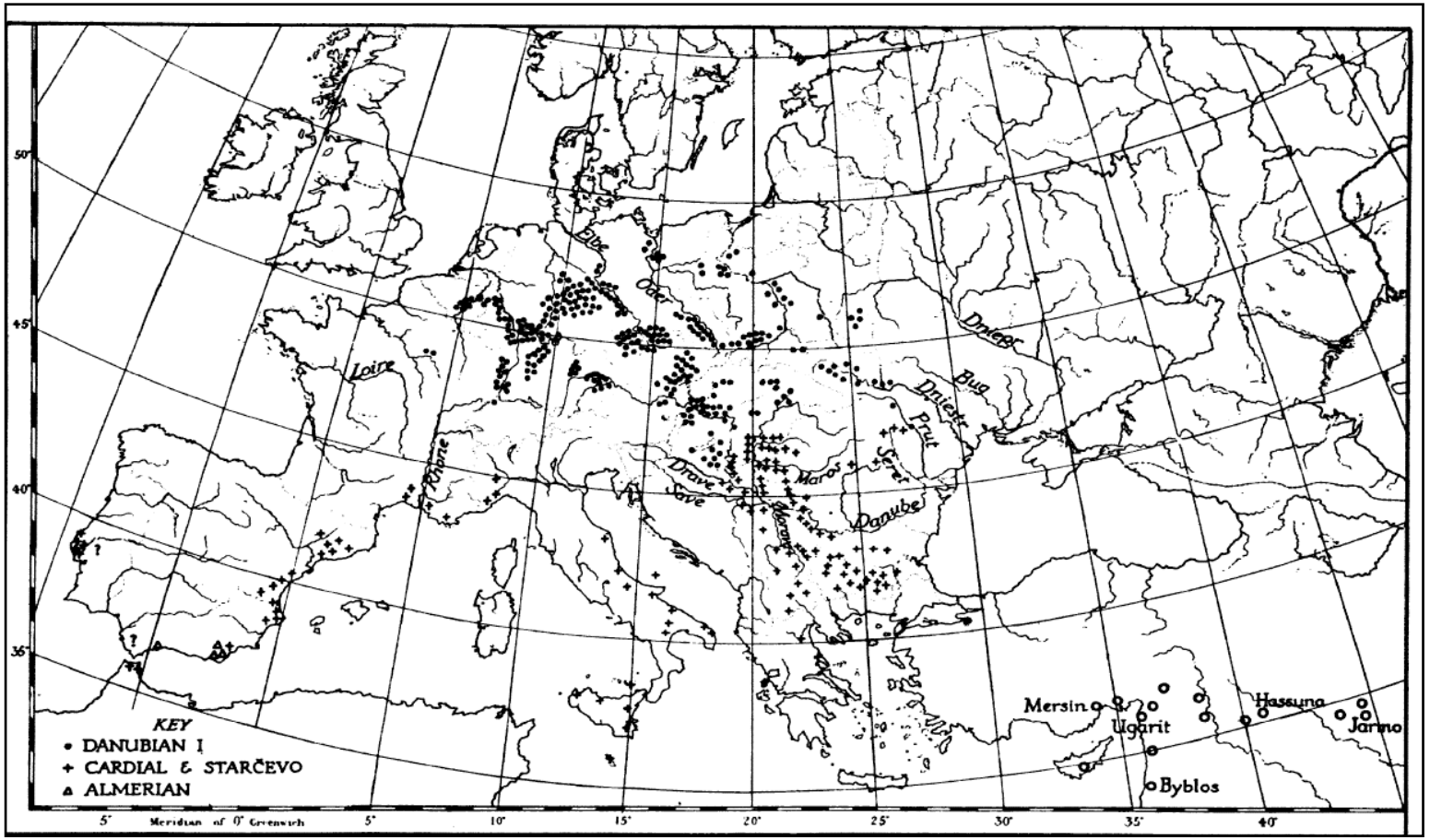


Figure 4.0: *Childe's map of the spread of the spread of farming in Europe during Period I. (After Childe 1925: map I.)*

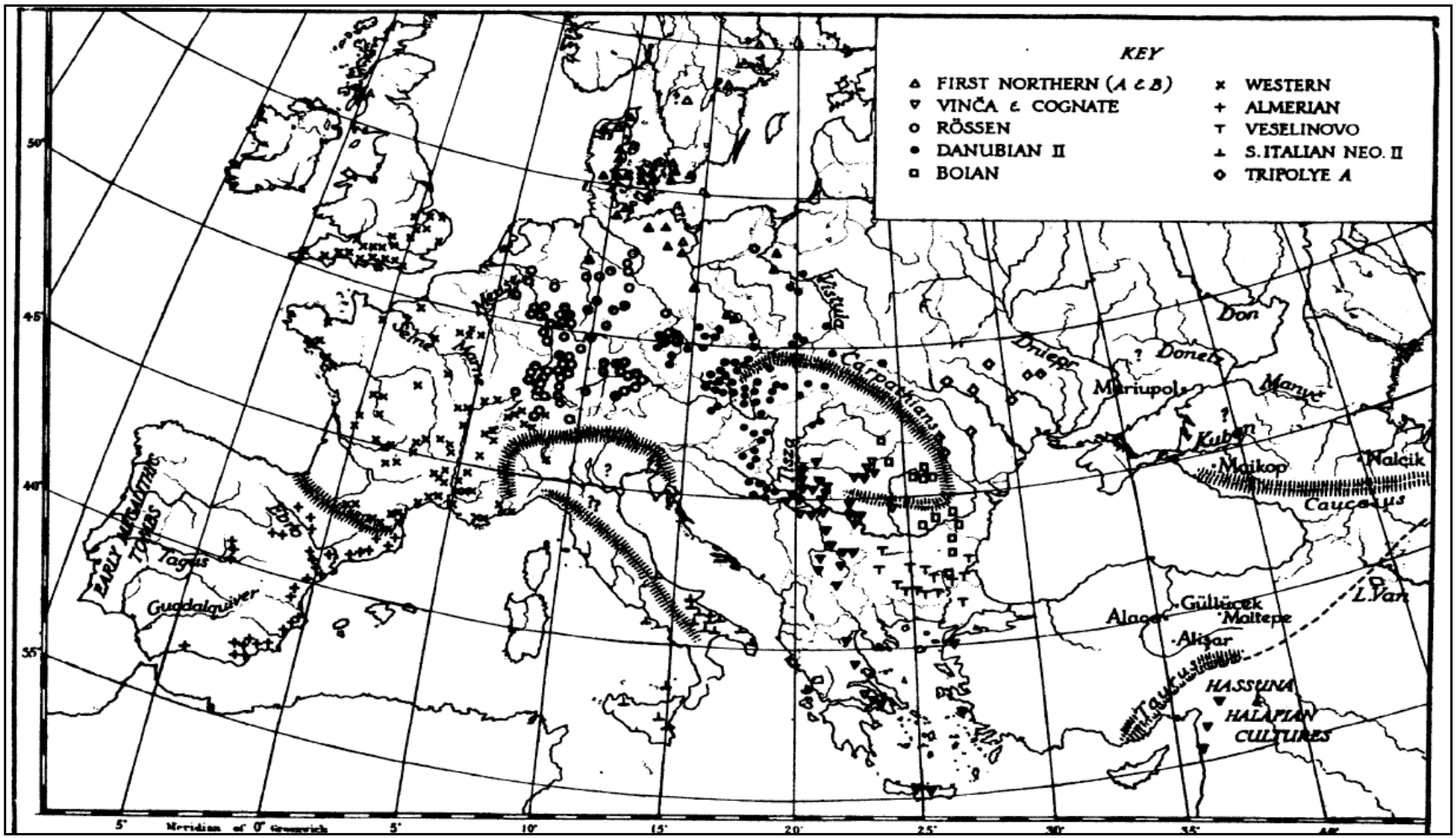


Figure 4.1: *Childe's Maps of the spread of farming in Europe during Period II. (After Childe 1925: map II.)*

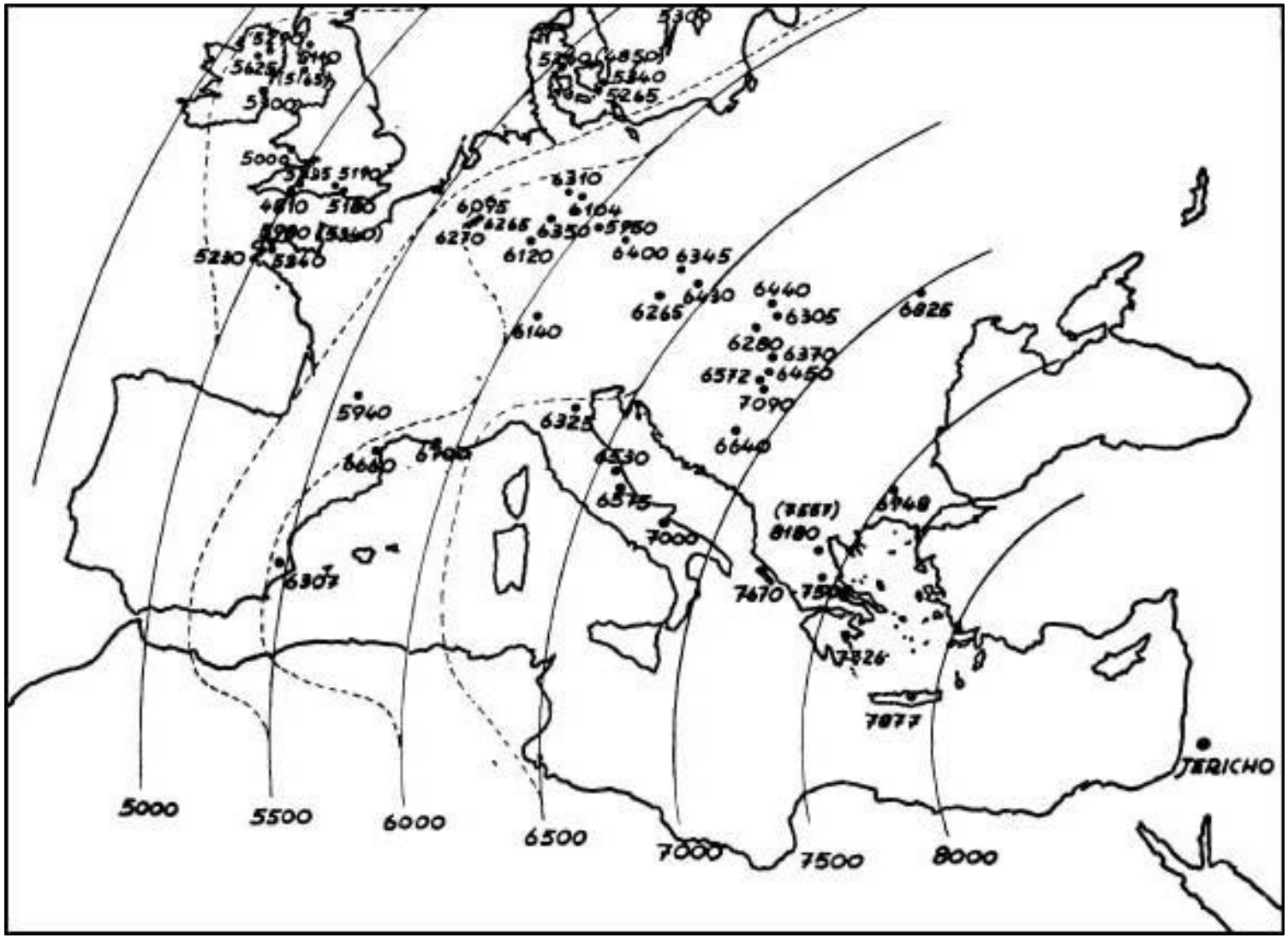


Figure 4.2: *Map showing the spread of farming into Europe. Dates are in years B.P. Arcs indicate the expected position of the spread at 500-year intervals. The broken curved lines represent an attempt to take into account some regional variation in the rate of spread. (After Ammerman & Cavalli-Sforza 1973: fig. 6.).*

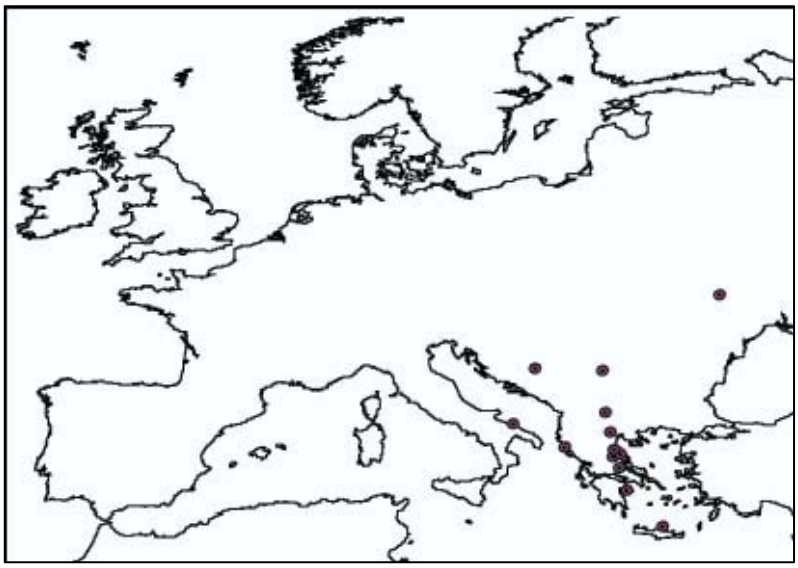
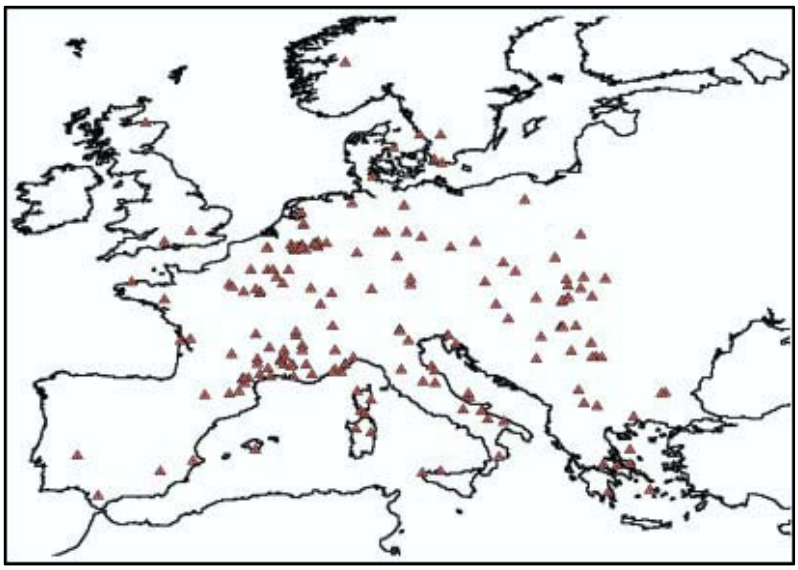
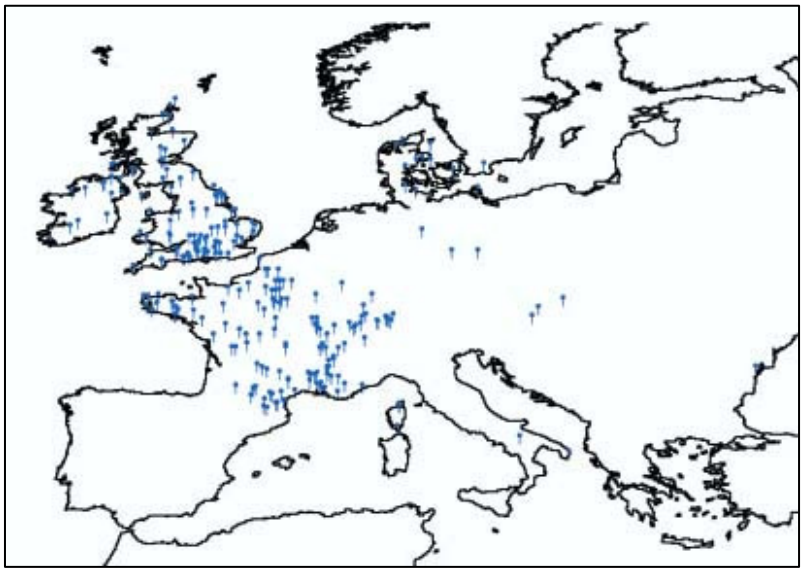


Figure 4.3: *Maps to show the spatial distribution of Neolithic sites. (After Gkiasta et al. 2002: fig. 4.)*

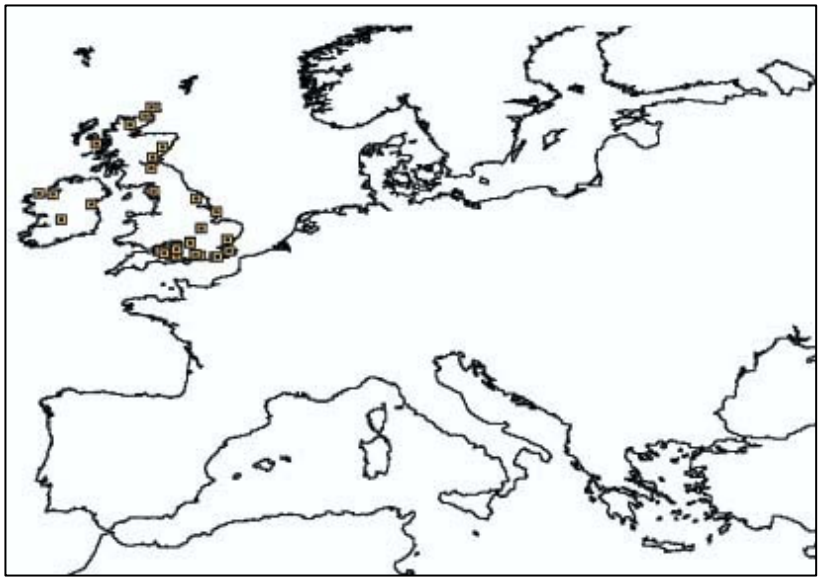
4.3a. *Neolithic site ^{14}C ages greater than 5200 BC.*



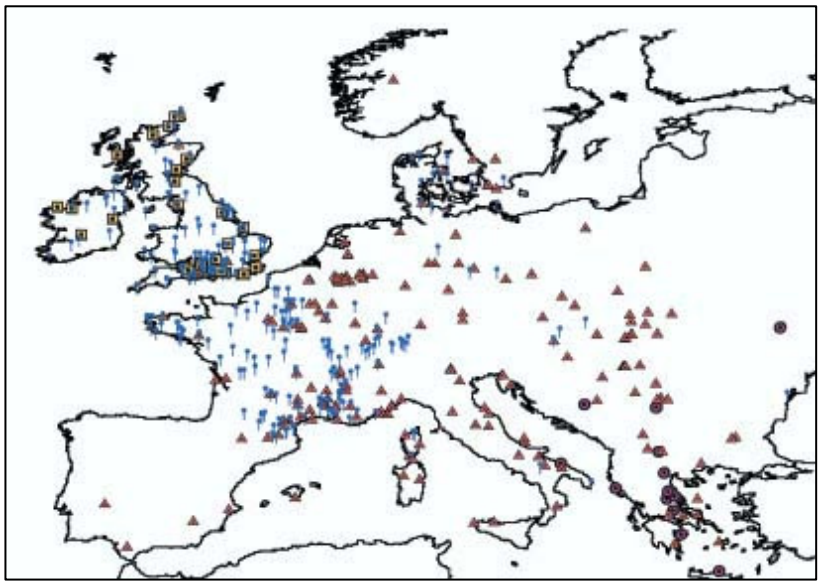
4.3b. *Neolithic sites, ^{14}C ages from 5200-4000 BC.*



4.3c. *Neolithic sites, ^{14}C ages from 4000-2800 BC.*



4.3d. *Neolithic sites, ^{14}C ages from 2800 BC.*



4.3e. *All the Neolithic sites grouped within the 1200-year time intervals.*

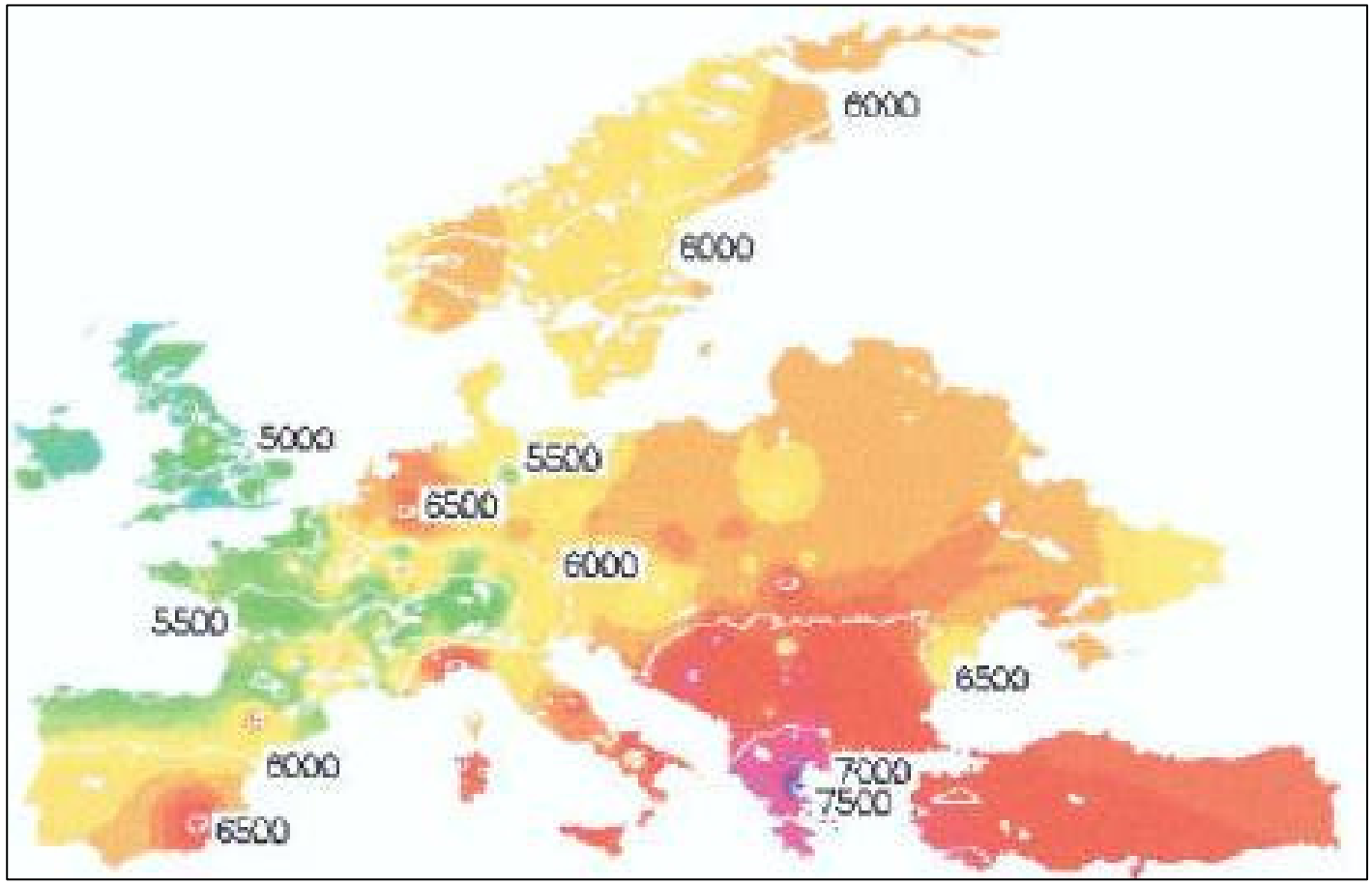


Figure 4.4: *Isochron map for the distribution of Early Neolithic sites using 508 radiocarbon dates. Isochrons are created at 500-radiocarbon-year intervals. Dates are uncalibrated years BP. (After Gkiasta et al. 2002: fig. 7.)*

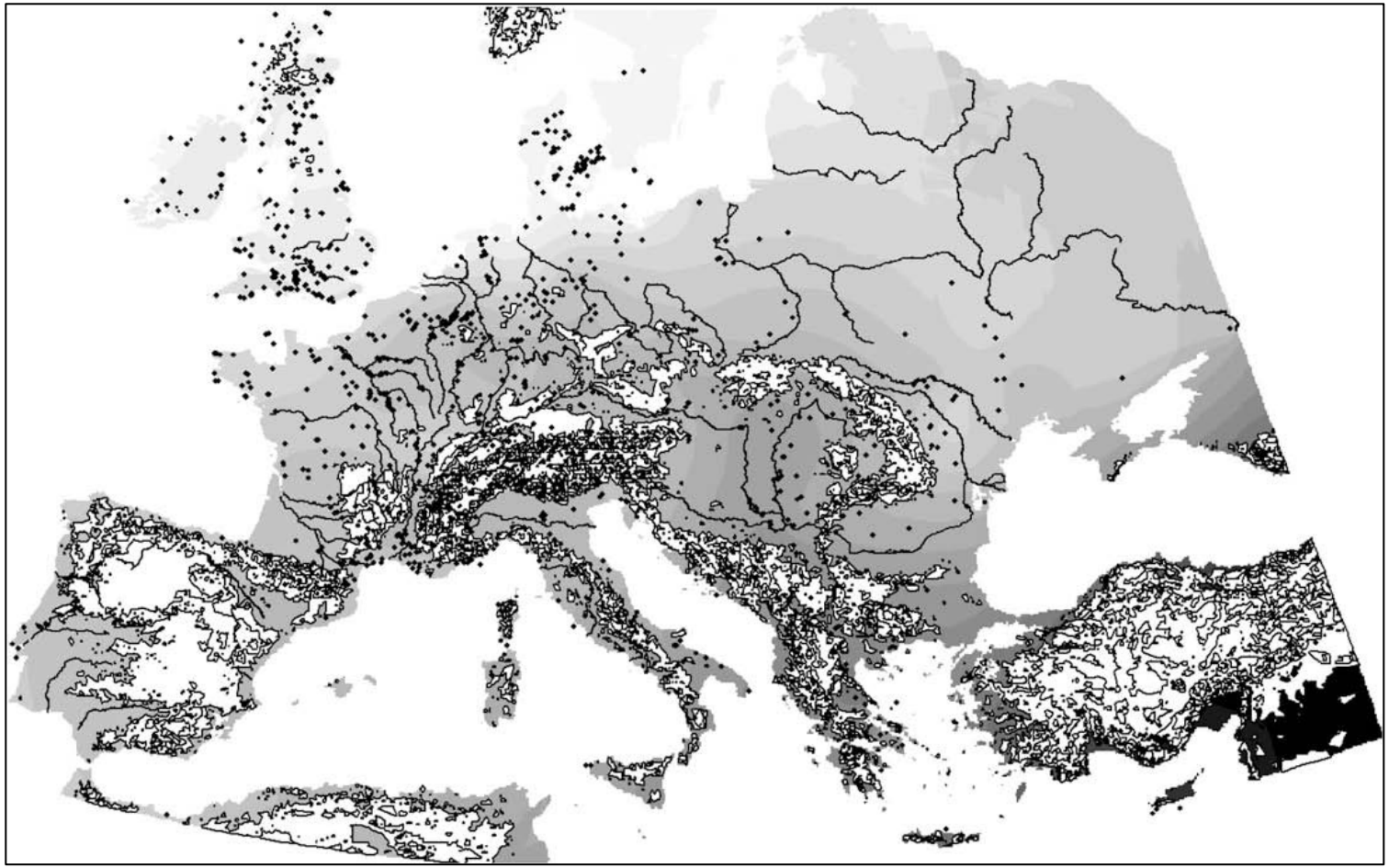
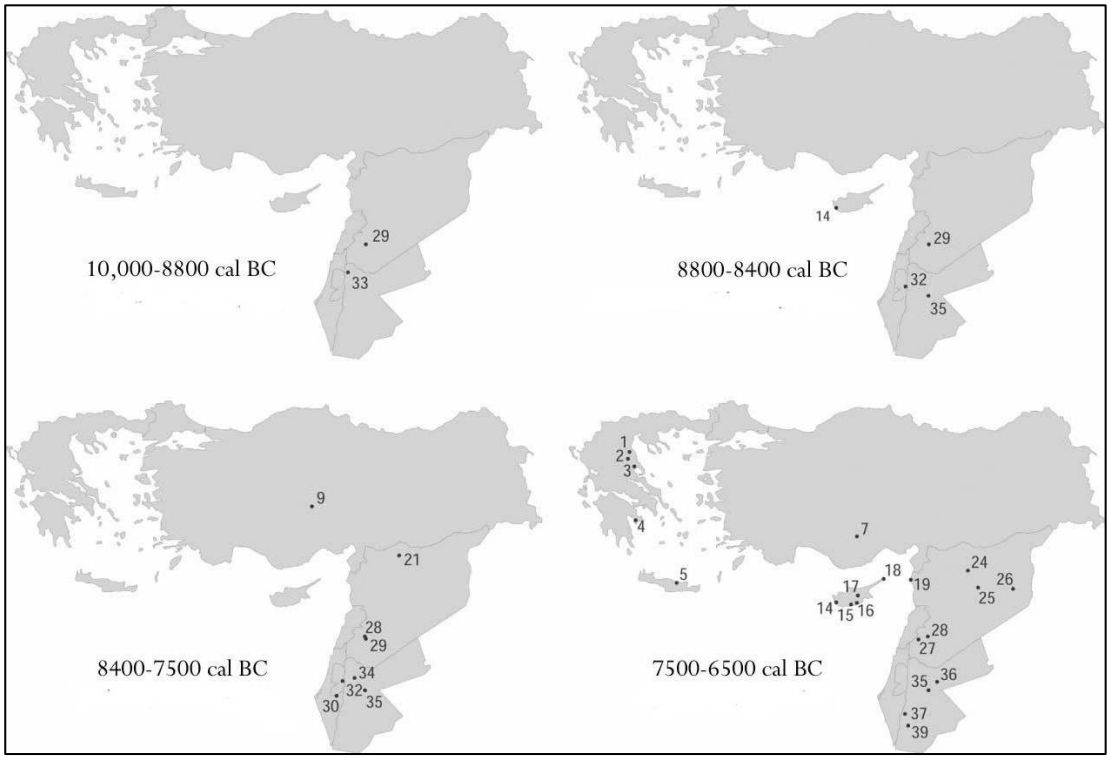
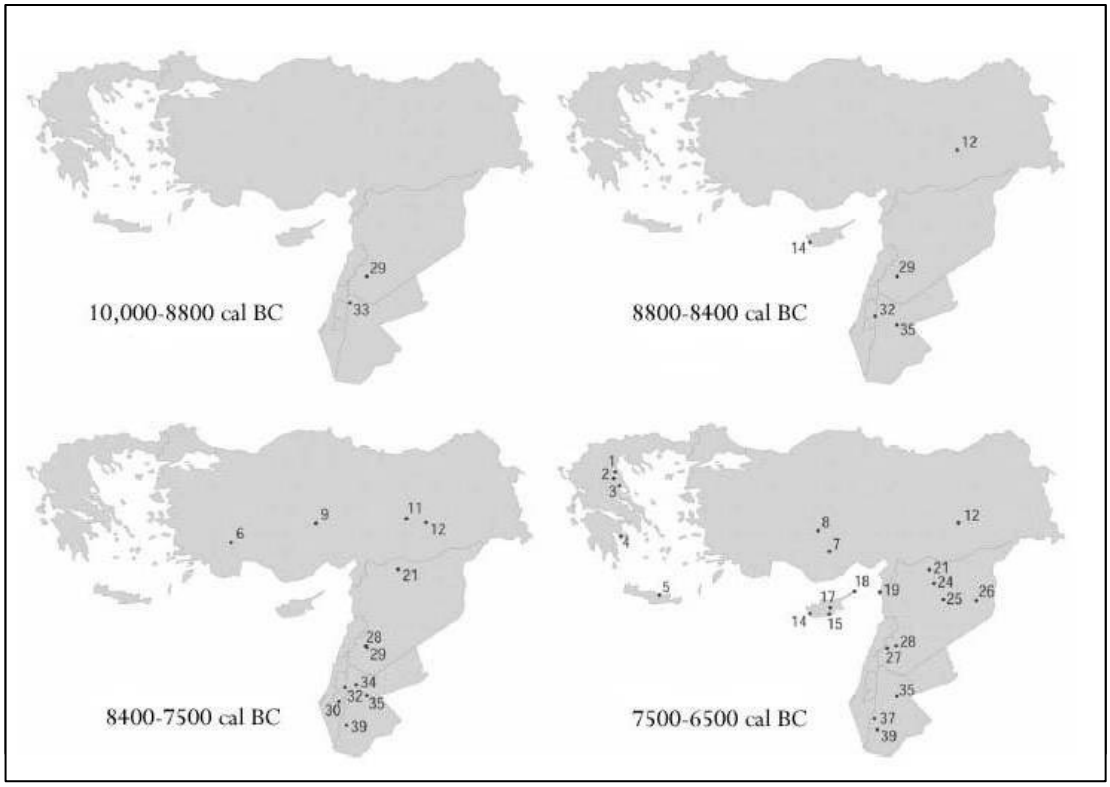


Figure 4.5: *Distribution of 940 archaeological sites of the Early Neolithic, bounded by 250-year isochrones. Five hundred-year isochrones can be obtained by skipping one isochrone. (After Bocquet et al. 2009: fig. 5.)*



1 Gediki	14 Mylouthkia	27 Ramad
2 Argissa	15 Shilourokambos	28 Ghoraife
3 Seskio	16 Khirokitia	29 Aswad
4 Franchthi Cave	17 Dhali-Agridhi	30 Nahal Hemar
5 Knossos	18 Cape Andreas Kastros	31 Netiv Hagdud
6 Hacilar	19 Ras Shamra	32Jericho
7 Can Hassan III	20 Dja'de	33 Iraq ed-Dubb
8 Catalhoyuk	21 Halula	34 'Ain Ghazal
9 Asiklihoyuk	22 Jerf al Ahmar	35 Wadi Jilat 7/13
10 Nevali Cori	23 Mureybit	36 Azraq
11 Cafer Hoyuk	24 Abu Hureya	37 Wadi Fidan A/C
12 Cayonu	25 El Kowm I/II	38 Beidha
13 Hallon Cemi	26 Bouqras	39 Basta

Figure 4.6a: *Sites with references to domestic hulled barley 10,000-6500 cal BC. (After Colledge et al. 2004: fig. 3.)*



1 Gediki	14 Mylouthkia	27 Ramad
2 Argissa	15 Shilourokambos	28 Ghoraife
3 Seskio	16 Khirokitia	29 Aswad
4 Franchthi Cave	17 Dhali-Agridhi	30 Nahal Hemar
5 Knossos	18 Cape Andreas Kastros	31 Netiv Hagdud
6 Hacilar	19 Ras Shamra	32Jericho
7 Can Hassan III	20 Dja'de	33 Iraq ed-Dubb
8 Catalhoyuk	21 Halula	34 'Ain Ghazal
9 Asiklihoyuk	22 Jerf al Ahmar	35 Wadi Jilat 7/13
10 Nevali Cori	23 Mureybit	36 Azraq
11 Cafer Hoyuk	24 Abu Hureya	37 Wadi Fidan A/C
12 Cayonu	25 El Kowm I/II	38 Beidha
13 Hallon Cemi	26 Bouqras	39 Basta

Figure 4.6b: *Sites with reference to domestic emmer/einkorn, 10,000-6500 cal BC. See key to Fig. 4.5. (After Colledge et al. 2004: fig 4.)*

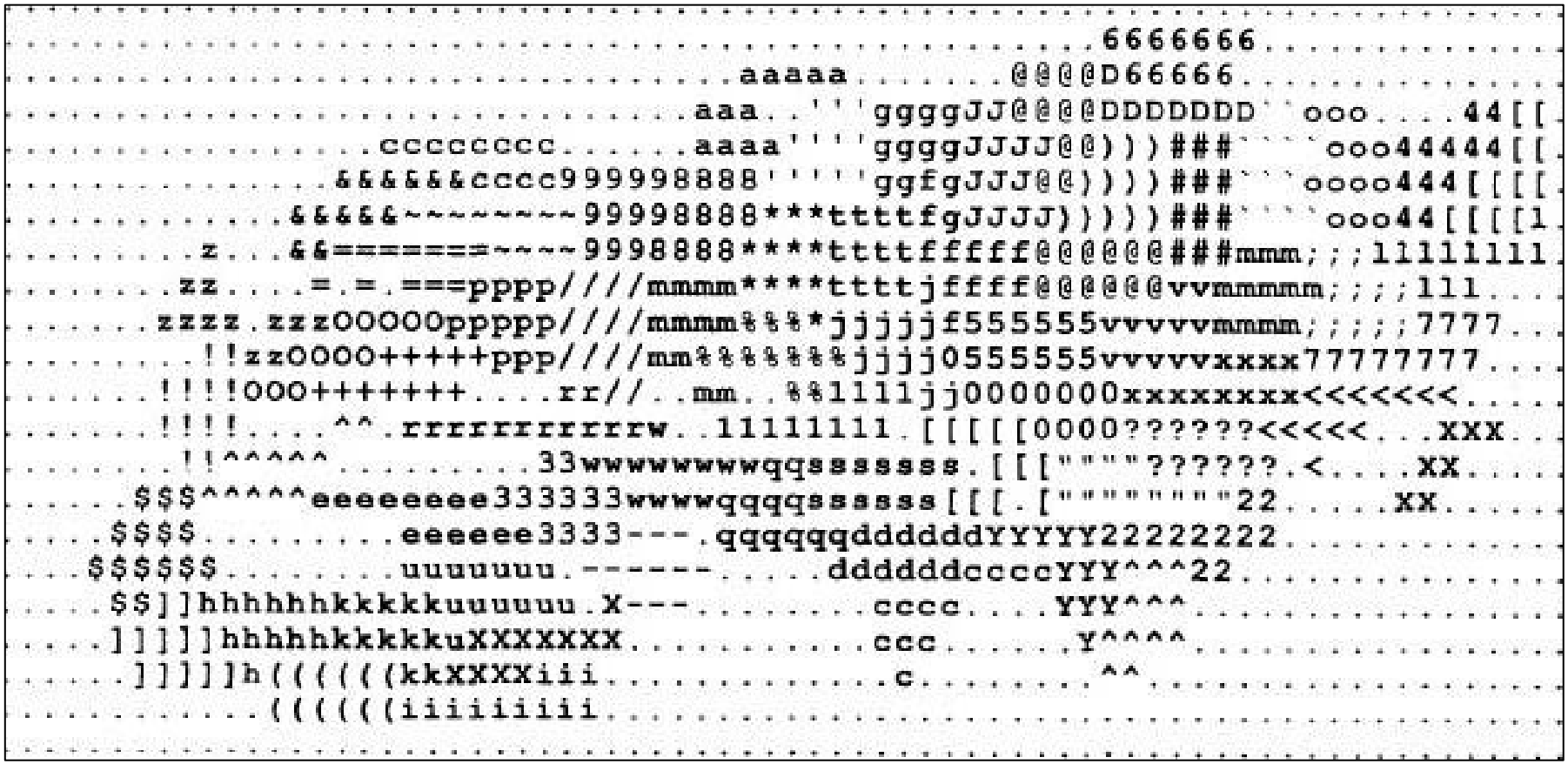


Figure 4.7: *General map of Eurasia showing simulated language distribution at time 0. Dots represent oceans, the Sahara, and the Himalayas. (After Robb 1991: 288.)*

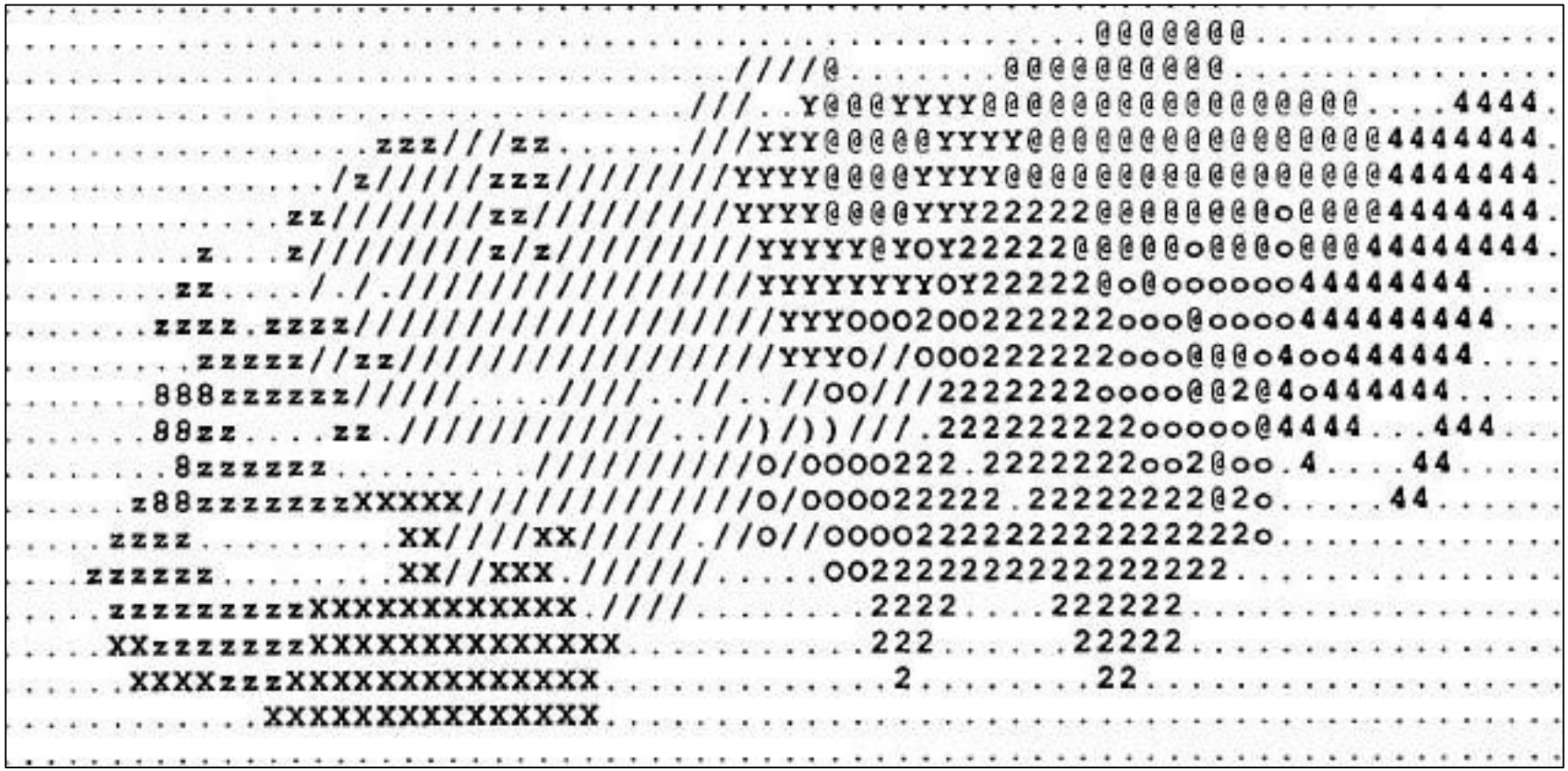


Figure 4.8: *Stimulated language distribution after 60 turns. (After Robb 1991: 289).*

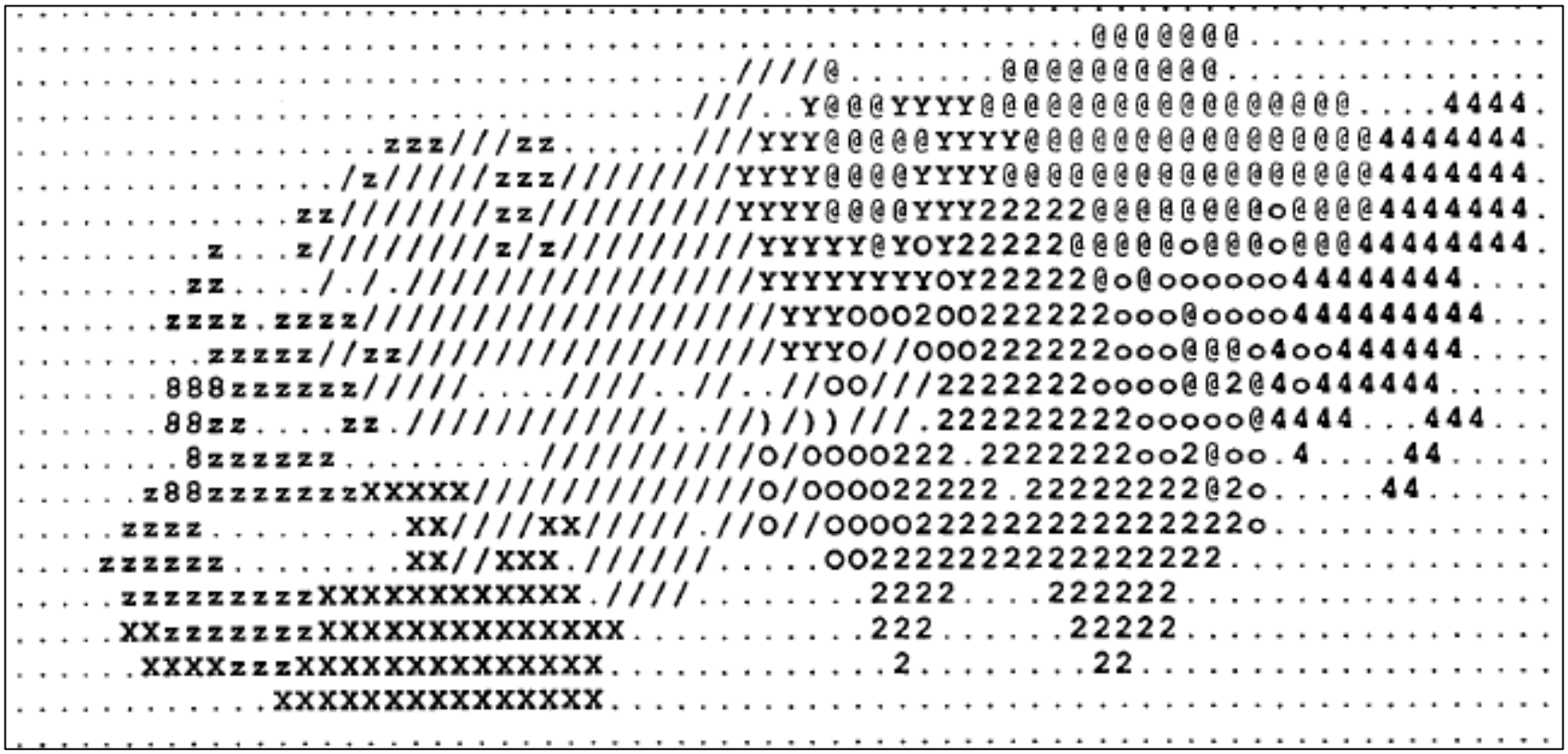


Figure 4.9: *Stimulated language distribution after 340 turns. (After Robb 1991: 290.)*

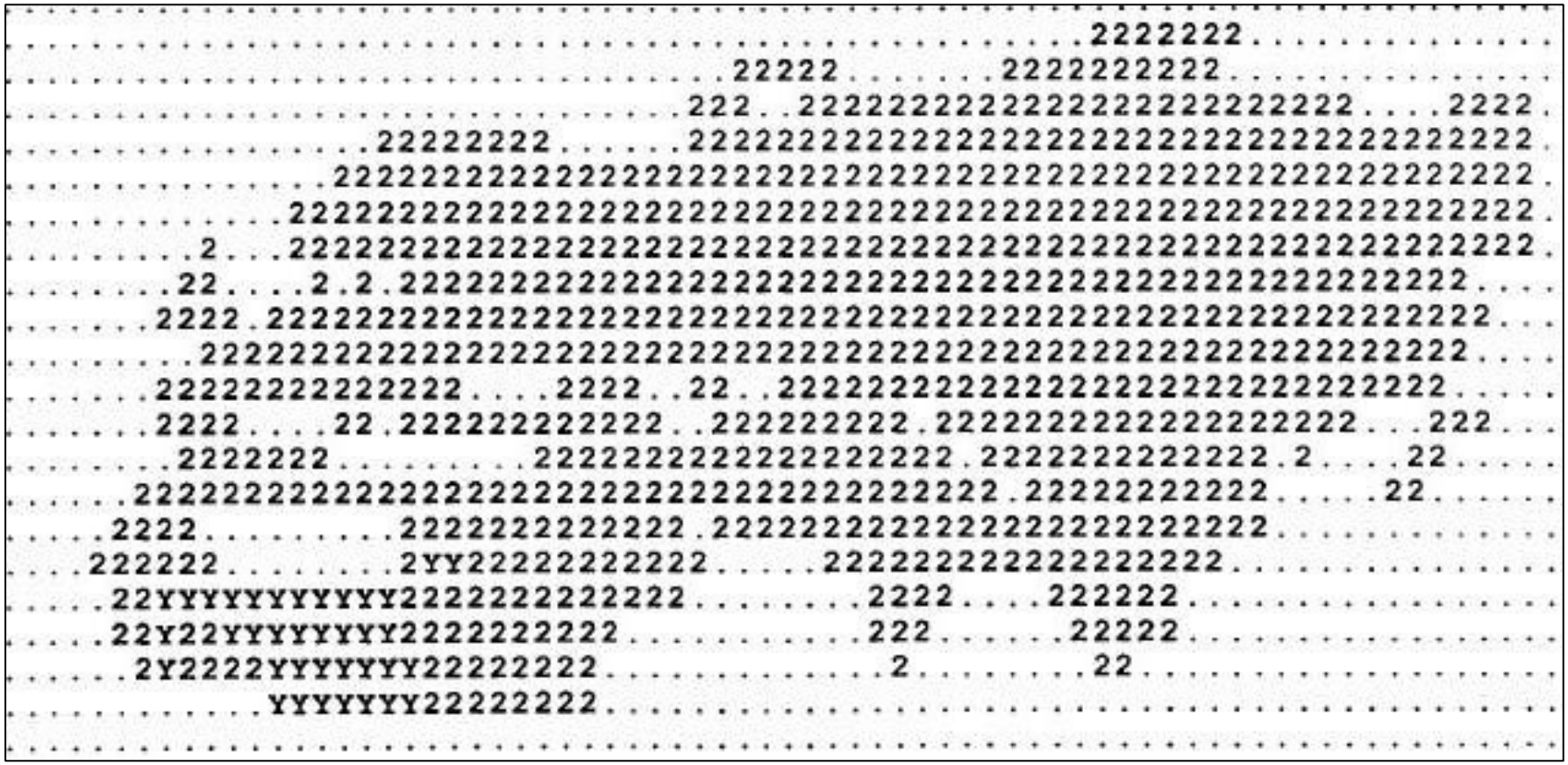


Figure 4.10: Simulated *language distribution after 2000 turns. (After Robb 1991: 291.)*

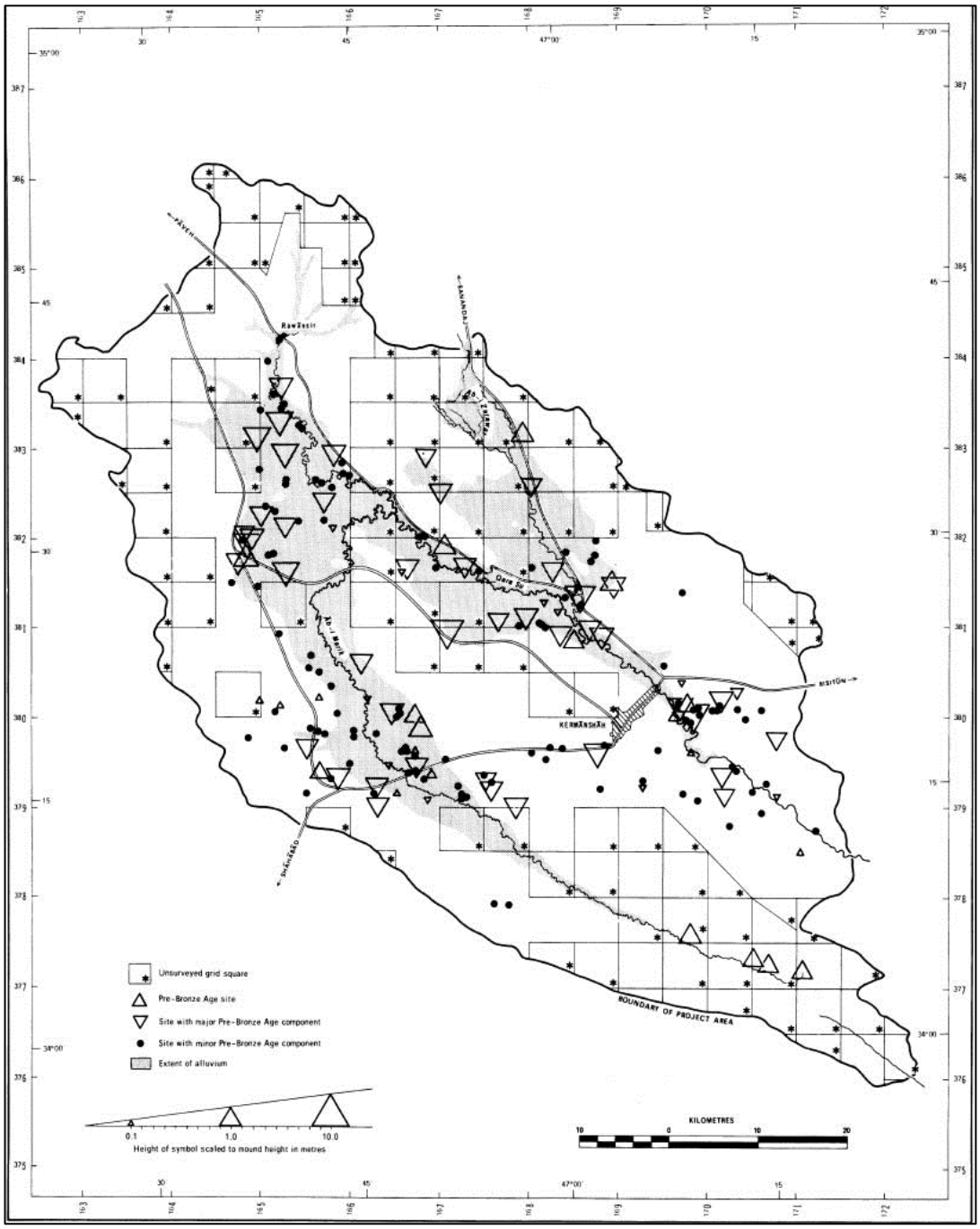


Figure 4.11: *Distribution and present height of archaeological sites in the Mahidasht project areas containing pre-Bronze Age material. In the figure sites abandoned before the Bronze Age (i.e. Neolithic & Chalcolithic sites containing no later material) are almost all restricted to the area outside of the alluvium or lie close to its border with fans where it would be expected to be the thinnest (ibid..: 36). (Although 2 sites occur well within the alluvial border, these are only 0.5 m and 0.2 m high and so could represent only the unburied summits of larger mounds.) Sites with only some pre-Bronze Age components show no such geographic restriction, because as they were occupied longer they were likely higher than the older mounds, and therefore less susceptible to burial by alluvium. (After Brookes et al. 1982: fig. 10.)*

Chapter Five

Radiocarbon Dating

"Dates in the early Near East are troublesome; we just guess."
(Braidwood 1950: 89)

5.0. Introduction

A key objective of this research is to collate, assess the chronometric hygiene of, and calibrate existing ^{14}C determinations from Neolithic sites in Iran and neighbouring regions. Such a comprehensive study has not been undertaken before, but is essential in order to gain an informed understanding of the absolute chronology of the development and spread of agriculture in Iran. Using the methodology described in Chapter Four, in the first section of this chapter a dataset of all ^{14}C determinations for Neolithic sites in Iran and surrounding regions currently available to the author is collated. The ^{14}C determinations were obtained from a range of sources that include: fully-published site reports, seasonal excavation reports, *Radiocarbon* and on-line resources. All of the ^{14}C determinations were calibrated using the calibration software OxCal 4.1 (Brook-Ramsey 2009), which employs the calibration curve IntCal 09 (Reimer et al. 2009); and their chronometric hygiene evaluated using criteria similar to that originally employed by Spriggs and Anderson (1993: 207-8; Anderson 1991: 782-3), and expanded on by Paul Pettitt et al. (2007) and Andrew Millard (2008). In the second section of the chapter, the spatial and temporal distribution of the calibrated, 'cleaned' ^{14}C determinations is plotted, in order to gain a clear understanding of the distribution pattern of early farming sites in Iran and neighbouring regions.

5.1. The ^{14}C determinations

This section contains a list of all the ^{14}C determinations from the earliest phases/levels of Neolithic sites in Iran and neighbouring regions that were available at the time to the author. It is important to note that the list does not exclude determinations rejected by the excavator, since new data can sometimes result in the rehabilitation of dates rejected at an earlier stage of study (Voigt & Dyson 1992: 123). All of the ^{14}C determinations cited in this research, unless otherwise noted, are calculated and published in terms of the original Libby half-life value of 5568±30 (Libby 1949) to ensure uniformity. The ^{14}C determinations are all listed with the error terms with which they were originally published, although the author is aware that some published error terms – in particular those from the earlier days of ^{14}C dating – do not take into account all the factors that can be measured in a laboratory. Unfortunately, it has not been possible to subject any of the ^{14}C measurements to Bayesian analysis, because for the majority of the measurements the stratigraphic associations between the dates could not be assured. The ^{14}C determinations are listed according to geographical region, with dates for Iran considered first, followed by those from key Neolithic sites in neighbouring regions.

5.2. Neolithic sites in Iran

5.2a. Northwestern Iran

Southern Urmia Basin

South of Lake Urmia lies the Ushnu-Solduz Valley; a rich, well-watered plain, which forms a crossroads with routes leading: west through the Keleshin Pass into northern Mesopotamia; east onto the plateau; and north into the Caucasus (Voigt & Dyson 1992: 174). Information on the Neolithic of the region comes primarily from excavations at Hajji Firuz Tepe (Voigt 1983), Dalma Tepe and Pisdeli Tepe. ^{14}C dates are available for all three sites.

Hajji Firuz Tepe, *36º59'30 N, 45º27'28 E, Solduz Valley*

Hajji Firuz Tepe (see pp. 108-12) is located in the northeastern portion of the Solduz Valley, and was excavated for three seasons in 1958, 1961 and 1968 by the University of Pennsylvania (Voigt 1983). The site, which currently measures 140 metres by 200 metres in plan (although it is probable that it originally extended further west), stands 10.3 metres above the present plain level (ibid.: 10). The Neolithic period is divided into phases A (earliest) to L (latest), of which Phase C is the best known. Three ^{14}C dates are available for the site measured by the University of Pennsylvania (laboratory code prefix P). P-455 is from a bulk sample and should be ignored; small rootlets were noted throughout the stratum from which P-502 was taken, and although all visible rootlets were removed by hand (the standard procedure of the day), the sample was probably contaminated. P-1843 is from a known material and context, but given that the measurement was made in the 1960s in the formative years of the ^{14}C method, the date should be treated as of questionable confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-455	D-15, basal stratum	Charcoal, clay & ash	7926 ±86	7027-6686	7059-6611	Unreliable	Bulk sample
P-502	Op. V: upper part of 3-m deep cut	Fine ash & clay sample	6895 ±83	5881-5714	5978-5641	Unreliable	Possible contamination
P-1843	Lvl 6, Ph. D, struct. VI, 2	Charcoal	6870 ±100	5873-5663	5983-5621	Quest.	Measured before 1980

(1963, *R.* Vol. 5: 90; 1974, *R.* Vol. *16: 219-37.)*

Dalma Tepe, *37º00' N, 45º29' E, Solduz Valley*

Dalma Tepe was excavated for brief periods under the direction of C. Burney from 1958–9; and by T.C. Cuyler Young in 1961 (Hamlin 1975). It is located at the southwestern end of Lake Urmia, and is a small, nearly circular mound, some 50 metres at its base and 4 metres in height. Due to the high water table, excavations were only conducted to 3.5 metres depth, and virgin soil

was never reached. Only one ^{14}C date is available for this site (P-503), and as it is stratigraphically unsupported, it cannot be treated with any confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-503	Op. 4	Ashy soil	5986±87	4996-4779	5207-4687	Unreliable	Only 1 date

(1963, *R.* Vol. 5: 90)

Pisdeli Tepe, *37º00' N, 45º29'E, Solduz Valley*

Pisdeli is a small mound that was excavated by the University Museum of the University of Pennsylvania between 1958 and 1961. Three ^{14}C determinations are available for the site:

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-504	Op II, Strat. 5	Ashy soil	5518 ±81	4455-4269	4544-4084	Question.	Measured before 1980
P-505	Op. II, Strat. 10	Ashy soil	5638 ±85	4545-4265	4685-4341	Question.	Measured before 1980
P-157	S. I: 240 cm depth	Ash	5460 ±160	4457-4064	4681-3966	Unreliable	High error

(1958, R. Vol. 1: 50; 1963, R. Vol. 5: 89)

P-157 has a large error term and should be ignored; P-505 and -504 are in stratigraphic support, from a well-recorded context, and have error terms of less than 100 ^{14}C years, however, they should be treated with caution due to their measurement in the 1950s.

Sayid Hammadani, Solduz Valley

No excavation has been conducted at Sayid Hammadani. A single carbon sample was collected from the site by Frank Hole and K. Flannery in 1961, and submitted to the Shell Development Co. (laboratory code prefix Sh-) for dating (Hole et al. 1969: 339).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Sh-	Vertical face cut by villagers	Charcoal & ash	7800 ±210	7027-6462	7296-6241	Unreliable	Single date, no lab. code, etc.

(Hole et al. 1969: 339.)

The date is published without a laboratory code; is from a bulk sample which is stratigraphically insecure; and has an error of over 100 ^{14}C years. It should be treated with no confidence.

RY-2, *37º42'N 45º48'E*, *Urmia, Azerbaijan*

RY-2 is an unexcavated site near the modern town of Urmia. Two ^{14}C determinations are available for the site, the carbon samples for which were collected from a vertical face cut into the mound by villagers. Consequently, both dates are stratigraphically insecure and unreliable.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Sh-	*n.d.*	Charcoal & ash	5730±190	4688-4489	4781-4369	Unreliable	No context
P-866	*n.d.*	Charcoal	5445±72	4365-4177	4450-4057	Unreliable	No context

(Hole et al.1969: 339)

Northeastern Urmia Basin

Most of the archaeological information for the prehistoric period of this area comes from the Late Neolithic levels at Yanik Tepe (Burney 1961; 1962; 1964; Burney & Lang 1972), for which, unfortunately, only four ^{14}C determinations are available.

Yanik Tepe, *37º56' N, 45º54' E, Khosrowshah Valley*

Yanik Tepe lies east of Lake Urmia, approximately ca. 40 miles southwest of Tabriz, and was excavated for three seasons in 1960–2 under the direction of C.A. Burney (Burney 1961; 1962; 1964). It is a large mound, covering an area

of 20 acres, with a maximum height of 16.50 metres, and contains levels spanning from the Late Neolithic to the Early Bronze Age (Burney 1961: 138). The Neolithic occupation at the site is restricted to Trench P, which was dug in a low mound a few 100 metres from the main mound.

Lab. no	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-1244	Level P7	Charcoal	7035± 69	5991-5846	6026-5752	Quest.	Before 1980
P-1243	Level P5	Charcoal	6926± 80	5889-5730	5983-5671	Ques.	Before 1980
P-1246	Level MC17	Charcoal	5267± 73	4229-3991	4318-3961	Quest.	Before 1980
P-1245	Level MC8	Charcoal	5090± 56	3961-3801	3989-3714	Quest.	Before 1980

(1969, R. Vol. 11: 150)

The ^{14}C determinations for Yanik Tepe were measured from known sample materials from secure contexts. However, given that the measurements were made in the 1960s, the ^{14}C dates should be treated with questionable confidence.

5.2b. Central Western Iran

Western Luristan

Western Luristan is characterized by folded mountain chains and associated valley systems (Voigt & Dyson 1992: 153). ^{14}C dates are available for two prehistoric sites in the region: Tepe Guran (Meldgaard et al. 1963) and Bog-i-No (Hole et al. 1969), although only the former has been excavated.

Tepe Guran, 32º30' N, 47º15' E, Hulailan Valley

Tepe Guran (see pp. 114-17) lies at an elevation of ca. 1000 metres in the foothills of western Lorestan. It is a modest site of less than two hectares, which was excavated by a Danish team in 1963. Twenty-one architectural strata (A-V) are distinguished at the site, of which Level V is the earliest (Meldgaard et al. 1963: fig. 9). The lowest 1.5 metres of the mound (levels V-

T) are aceramic, but until the final report is published a more detailed description of these strata is not possible (Voigt & Dyson 1992: 154). Two ^{14}C date sets are available for the Neolithic occupation of the site: a set from samples submitted by the original excavation team to The National Museum, Denmark (laboratory prefix K); and a set from bone samples submitted by Melinda Zeder for AMS dating to Beta Analytic (prefix Beta); in the early 2000s.

Lab. no.	Context	Sample type	^{14}C age (BP)	Date (BC)		Hygiene	Reason
				68.2%	95.4%		
K-1006	S. GII: 12-15 cm above virgin soil	Charcoal (*Pistacia* sp. & indeterminate species)	8410 ±200	7607-7091	8170-6831	Unreliable	Unadjusted for fractionation
K-879	S. GI, Level H	Charcoal from herbaceous stalks	7760 ±150	6811-6445	7060-6366	Unreliable	Unadjusted for fractionation
K-856	Grave no. 11, Level C	Charcoal (*Quercus* sp.)	3170 ±120	1608-1307	1741-1123	Unreliable	Unadjusted for fractionation
Beta-147111	Level D	Bone (collagen)	7630 ±60	6563-6430	6599-6396	Reliable	Known material & context
Beta-147112	Level F	Bone (collagen)	7260 ±40	6208-6069	6223-6050	Quest.	Rather late
Beta-147113	Level H	Bone (collagen)	7950 ±40	7027-6713	7035-6696	Reliable	Known material & context
Beta-147131	Level H	Bone (collagen)	7810 ±40	6679-6598	6751-6508	Reliable	Known material & context
Beta-147114	Level K	Bone (collagen)	7080 ±60	6015-5900	6066-5838	Quest.	Rather late
Beta-147115	Level L	Bone (collagen)	7940 ±40	7023-6700	7032-6690	Reliable	Known material & context
Beta-177116	Level L	Bone (collagen)	8130 ±40	7171-7062	7298-7047	Reliable	Known material & context
Beta-147116	Level N	Bone (collagen)	3690 ±40	2140-2026	2199-1960	Unreliable	Too late
Beta-147117	Level P	Bone (collagen)	7890 ±40	6811-6654	7027-6642	Reliable	Known material & context
Beta-147118	Level Q	Bone (collagen)	8070 ±40	7132-6860	7174-6829	Reliable	Known material & context

Beta-147119	Level R	Bone (collagen)	8000 ±50	7048-6828	7062-6706	Reliable	Known material & context
Beta-147122	Level T	Bone (collagen)	8170 ±40	7248-7075	7308-7065	Reliable	Known material & context
Beta-147120	Level U	Bone (collagen)	8060 ±40	7081-6842	7141-6825	Reliable	Known material & context
Beta-117121	Level V	Bone (collagen)	7820 ±50	6735-6592	6916-6506	Quest.	Rather late
Beta-177177	Level V	Bone (collagen)	8280 ±40	7453-7196	7469-7184	Reliable	Known material & context

(Zeder 2008a: 258)

None of the samples submitted to the National Museum were adjusted for fractionation, and the measurements should therefore be treated as unreliable. In terms of the Beta-Analytic dates, Beta-147116 is completely out of stratigraphic agreement and should be ignored; and Beta-146112, -147114 and -11712 are rather late compared to the other dates. The remainder of the dates are AMS measurements from known sample materials and contexts, are in loose stratigraphic agreement, and are reliable enough to be used without further questioning.

Bog-i-No, 33º28' N, 48º21' E, near Khorramabad

Bog-i-No is an unexcavated site that lies near to the modern city of Khorramabad (Young 1966). A single ^{14}C date is available for the site, which was obtained from a sample collected by Frank Hole and Kenneth Flannery from a vertical face cut into the mound by local brick makers (Hole et al. 1969: 339).

Lab. code	Context	Sample type	^{14}C age (BP)	Date (BC)		Hygiene	Reason
				68.2%	95.4%		
I-1492	*n.d.*	Charcoal & ash	6200± 140	5317-4987	5470-4836	Unreliable	Only one date for site

(Hole et al. 1969: 339)

The date is stratigraphically insecure, from a bulk sample and unsupported; it should not be treated with any confidence.

Eastern Luristan: Kermanshah and Kangavar

Eastern Luristan consists of a series of valley systems running roughly east to west, which formed part of the great trade route or High Road that crossed from Iraq through the Zagros to the Central Plateau (Voigt & Dyson 1992: 156). It covers a large region, which incorporates Kermanshah to the west; and Kangavar to the east. Most archaeological studies in the Kermanshah region have focused on the Marv Dasht, Kermanshah, and Bistiun plains, and smaller immediately adjacent valleys (Voigt & Dyson 1992: 156). The Early Neolithic of the region is defined by Philip E. Smith's excavations at Ganj Dareh from 1967-74 (Smith 1967; 1968; 1982; 1974; 1975; 1978), while the Middle to Late Neolithic is represented by Tepe Sarab (Braidwood et al.1961). The Kangavar Valley lies 90 kilometres east of the city of Kermanshah.
The Early Neolithic of the region is traditionally defined by Tepe Abdul Hosein in the Khawa Valley (Pullar 1979; 1992). ^{14}C determinations are available for five sites in eastern Luristan: Tepe Asiab, Tepe Sarab, Ganj Dareh, Tepe Abdul Hosein and Seh Gabi.

Tepe Asiab, co-ordinates of Kermanshah: 34º18' N, 47º04' E
Tepe Asiab (see pp. 117-18) lies five kilometres east of the modern city of Kermanshah, and is an open-air, midden campsite on the banks of the River Kara Su, ca. 1330 metres above sea level. The size of the site is ambiguous, but surface survey suggests that it originally extended over 20,000 square metres (Howe 1983: 115). It was excavated in 1959–60 by Robert Braidwood, of the Oriental Institute of Chicago, who uncovered some three metres of aceramic deposits with no architecture. Several different laboratories have ^{14}C-dated samples from Asiab, including The University of California (laboratory prefix UCLA), Beta Analytic, and Grongingen, Netherlands (prefix GrN).

Lab. code	Context	Sample type	^{14}C date (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
UCLA-1714C	120-140 cm depth	Caprid bone (collagen)	8700 ±100	7937-7595	8200-7575	Questionable	Before 1980
UCLA-1714B	140 cm depth	Caprid bone (collagen)	8900 ±100	8247-7979	8287-7731	Questionable	Before 1980
UCLA-1714F	150-60 cm depth	Caprid bone (collagen)	9050 ±300	8847-7659	9123-7475	Unreliable	Error of >150
GrN-6413	165-70 cm depth	Charcoal	9775 ±85	9329-8961	9449-8839	Acceptable	Known material & context
Beta-159555	30-45 cm depth	Bone: collagen	9480 ±80	9118-8638	9152-8575	Questionable	Stratigraphy inconsistent
Beta-159554	45-60 cm depth	Bone: collagen	9380 ±60	8741-8572	8808-8473	Questionable	Stratigraphy inconsistent
Beta-159552	75-90 cm depth	Bone: collagen	7790 ±60	6684-6529	6801-6471	Unreliable	Too late

(Berger & Protsch 1973: tables 1 & 2; Howe 1983: 116; Zeder 2008a: 257.)

UCLA-1714F has an error term of ±300 years and is unacceptable. UCLA-1714B and -1714C are acceptable with a degree of caution as the measurements were made before 1980. The determinations are also somewhat controversial. Berger and Protsch (1973) extracted carbon samples from bone fragments provided by Braidwood from his excavations at Asiab. However, whereas the excavators had been unable to identify the bone fragments, or to report on the domesticated status of the animals, Berger and Protsch claimed that the bones were from domesticated sheep and goats (cf. Bökönyi et al. 1973; Howe 1983: 116). GrN-6413 is of known context and material. Although the only ^{14}C sample measured by Groningen Laboratories, it is stratigraphically supported by the UCLA measurements and can be accepted with a degree of caution. The Beta-Analytic measurements were made more recently, from samples submitted by Melinda Zeder in 2005. Beta-159552 is younger than would be expected, and should be ignored; Beta-159555 and -159554 are stratigraphically inconsistent and can be accepted with a degree of caution.

Tepe Sarab, 34º39' N, 47º15' E, Kermanshah

Tepe Sarab (see pp. 113-14) lies seven kilometres northeast of the city of Kermanshah. Three sets of ^{14}C dates are available for the site, two are conventional measurements made by the University of Pennsylvania (laboratory prefix P) and the University of California (laboratory prefix UCLA) in the 1960s; and the other are AMS measurements made by Beta Analytic in the early 2000s.

Lab. no.	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-466	Op. 1, Level 5	Charcoal	7956 ±98	7033-6708	7127-6599	Questionable	Possible contamination
P-465	Op. 1 , Level 4	Charcoal	7605 ±96	6589-6392	6640-6252	Questionable	Possible contamination
P-467	Op. 1, Level 1	Charcoal	7644 ±89	6591-6433	6656-6266	Questionable	Possible contamination
UCLA-1714A	*n.d.*	Bone	7850 ±0	-	-	Unreliable	No error term
Beta-159547	Level 1A	Bone (collagen)	7470 ±70	6414-6255	6458-6221	Reliable	Known material & context
Beta-159548	Level 3	Bone (collagen)	7950 ±60	7028-6710	7048-6682	Reliable	Known material & context
Beta-159550	Level 4	Bone (collagen)	8070 ±60	7142-6835	7292-6772	Reliable	Known material & context
Beta-159549	Level 5	Bone (collagen)	7800 ±60	6692-6530	6817-6477	Reliable	Known material & context

(1963, R. Vol. 15: 82, 91; Mellaart 1975; Zeder 2008a: 259)

UCLA-1714A is from an unknown context and is not published with an error term; it cannot be treated with any confidence. P-465, -466 and -467 were associated with snail shell and bone (*1963, R. Vol. 15: 82*), and may have been contaminated. They were also measured before 1960 and their level of confidence is questionable. The Beta Analytic measurements are from known materials and contexts and, although there are some internal inconstancies (Beta-159548 and -159550 although stratigraphically later are earlier in date than B-159549, perhaps suggesting that the accumulation of cultural deposits at Sarab was rapid), are reliable enough to be used without further questioning.

Ganj Dareh Tepe, 34º26' N, 48º07' E

Ganj Dareh (see pp. 118-21) is situated ca. 1350 metres above sea level in the Bisitun Valley, some 37 miles from the city Kermanshah. It is an oval site, measuring approximately 40 metres in diameter, and containing some 8 metres of Neolithic deposits, divided into Levels E to A. It was excavated by P.E.L. Smith for a number of field seasons during the late 1960s and 1970s (cf. Smith 1967; 1968; 1972; 1974; 1975; 1978; 1990), but a full report has yet to be published. Efforts to date the sites have been problematic. The earliest attempts produced a series of ^{14}C dates which suggested that the initial occupation of Ganj Dareh (Level E) was established ca. 9000 BC, after which there was a hiatus, until the occupation of the four subsequent levels ca. 7500 BC. However, more recent AMS dates for the site suggest that occupation was continuous (Zeder & Hesse 2000: 256).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
SI-4732	Level A	*n.d.*	8590± 70	7648-7547	7790-7517	Unreliable	Material unknown
SI-4733	Level B	*n.d.*	8525± 70	7597-7525	7716-7462	Unreliable	Material unknown
SI-4734	Level B	*n.d.*	8110± 70	7293-7033	7330-6826	Unreliable	Material unknown
SI-4735	Level B	*n.d.*	8460± 70	7582-7488	7597-7355	Unreliable	Material unknown
P-1486	Level B, 210-40 cm depth	Charcoal	8888± 98	8236-7873	8282-7725	Quest.	Before 1980
P-1485	Level C, 450 cm depth	Charcoal	9329± 190	8726-8462	8800-8305	Unreliable	Undersized
SI-4736	Level C	*n.d.*	8540± 70	7604-7524	7727-7482	Unreliable	Material unknown
SI-4737	Level C	*n.d.*	8650± 70	7731-7591	7939-7572	Unreliable	Material unknown
SI-4738	Level D	*n.d.*	8485± 70	7589-7508	7608-7356	Unreliable	Material unknown
SI-4739	Level D	*n.d.*	8140± 70	7292-7053	7748-6836	Unreliable	Material unknown
SI-4740	Level D	*n.d.*	8535± 70	7601-7523	7723-7479	Unreliable	Material unknown

SI-4741	Level D	*n.d.*	8950± 70	8258-7982	8291-7844	Unreliable	Material unknown
P-1484	Level D, 620 cm depth	Charcoal	8970± 100	8284-7970	8418-7753	Quest.	Before 1980s
Gak-994	Level D, 1 m higher than Gak-807	Charcoal mixed with ash & earth	8910± 100	8251-7941	8290-7737	Unreliable	Bulk sample
Gak-807	Level E, basal	Charcoal mixed with ash & earth	10,400 ±150	10,581-10,109	10,676 -9771	Unreliable	Bulk sample

(1967, R. Vol. 9: 61;1970, R. Vol. 12: 579)

The dates measured by Gakushuin Laboratory (laboratory prefix Gak) are from bulk samples and should be ignored. The Smithsonian Institute (prefix SI) measurements are published without the sample material, and should also be ignored. Their reliability can be further questioned, due to assignment of a single error term of ±70 ^{14}C year to all the measurements, implying that the error term only accounts for the statistical counting uncertainty, rather than the laboratory uncertainty. In terms of the University of Pennsylvania (prefix P) dates, P-1485 was undersized before NaOH pretreatment and should be ignored. P-1486 and -1484 were measured from known materials and secure contexts, and stratigraphically support each other, with the narrow time span separating them suggesting a rapid accumulation of deposits. However, given that the dates were measured in the 1970s, they should be treated with questionable confidence, due to the problems associated with ^{14}C dating during this period.

The Smithsonian Institute measured another series of carbon samples from Ganj Dareh in the early 1970s. Two of these determinations (SI-922 & -923) have large error terms and are unreliable. The other two dates (SI-924 & SI-925) are from known materials, well-recorded contexts, and have error terms of less than 100 ^{14}C years. However, the measurements were made before 1980, and need to be treated as of questionable confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	96%		
SI-922	Level E, 670-80 cm depth	Charcoal	8570 ±210	7975-7360	8242-7144	Unreliable	Error of >150
SI-923	Level E, 750-60 cm depth	Charcoal	8625 ±195	8165-7491	8270-7202	Unreliable	Error of >150
SI-924	Level E, 760-80 cm depth	Charcoal	8340 ±90	7525-7206	7576-7143	Acceptable	Before 1980
SI-925	Level E, below 780 cm depth	Charcoal	8385 ±75	7536-7356	7584-7193	Acceptable	Before 1980

(1973, R. Vol. 15: 398-9)

A series of AMS date sets are also available for Ganj Dareh. The first set to be made were measured in the early 1990s at the Oxford Accelerator Unit (laboratory prefix OxA), while a second set was more recently measured from bone samples submitted to Beta Analytic by Melinda Zeder (Zeder & Hesse 2000).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-108238	Level A, 180-200 cm depth	Bone (collagen)	8780 ±50	7952-7748	8179-7612	Reliable	Known material & context
OxA-2099	Level B (F1.70)	Charred barley (Hordeum sp.) seed	8840 ±110	8204-7793	8249-7614	Unreliable	Error of >100
Beta-108239	Level B, 165-80 cm depth	Bone (collagen)	8930 ±50	8239-7948	9267-7956	Reliable	Known material & context
Beta-108240	Level B, 220-40 cm depth	Bone (collagen)	8780 ±50	7952-7748	8179-7612	Reliable	Known material & context
Beta-108241	Level B, 240-60 cm depth	Bone (collagen)	8720 ±50	7789-7611	7939-7601	Reliable	Known material & context
Beta-108242	Level B, 280-300 cm depth	Bone (collagen)	8940 ±50	8246-7987	8270-7962	Reliable	Known material & context
OxA-2100	Level C (F1.110)	Charred barley seed	9010 ±110	8309-7969	8533-7794	Unreliable	AMS with error of >100
Beta-108243	Level C, 460-80 cm depth	Bone (collagen)	8920 ±50	8231-7982	8271-7941	Reliable	Known material & context
OxA-2102	Level E (F1.136)	Charred barley seed	8690 ±110	7937-7591	8201-7548	Unreliable	AMS with error of >100

OxA-2101	Level D (F1.129)	Charred barley seed	8850 ±100	8205-7826	8251-7658	Unreliable	AMS with error of 100
Beta-108244	Level D, 430-60 cm depth	Bone (collagen)	8840 ±50	8181-7825	8210-7756	Reliable	Known material & context
Beta-108245	Level D, 580-600 cm depth	Bone (collagen)	8940 ±50	8246-7987	8270-7962	Reliable	Known material & context
Beta-108246	Level E, 580-5 cm depth	Bone (collagen)	8870 ±50	8205-7956	8231-7817	Reliable	Known material & context
Beta-108247	Level E, 665-75 cm depth	Bone (collagen)	8830 ±50	8171-7795	8208-7749	Reliable	Known material & context

(Hedges et al. 1990: 231)

Despite the usually high precision of AMS dating, the Oxford Accelerator Unit dates all have high error terms and should be treated as unreliable. The Beta-Analytic dates are from known sample materials, collected from secure contexts, and have error terms of less than ±100 ^{14}C years. Although there are some internal inconsistencies in the date set, for example, Level E contains some of the oldest and earliest dates, this is probably due to the rapidity with which the deposits accumulated (Zeder & Hesse 2000: 2256). The dates, then, can be accepted as reliable enough to be used without further questioning:

Tepe Siahbid, 34°30' N, 47°15' E, Kermanshah

Tepe Siahbid is located 10 kilometres to the northeast of Kermanshah. It was excavated under the direction of Braidwood, who described the site as a "small painted pottery site" (Braidwood et al. 1961: 208). Braidwood divided the deposits at the site into two chronological units on the basis of stratigraphy and changes in the ceramic industry (ibid.). Two ^{14}C dates are available for the site measured by the University of Pennsylvania (laboratory prefix P) and The Centre de Recherches Minérales, Québec (prefix QU). P-442 was measured from a bulk sample and should be ignored. The sample material for QU-1035 is unknown, and it too should be ignored.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-442	Op. 1, Level 1, 105 cm depth	Charcoal & large amounts of clay	5828 ±80	4786-4590	4896-4493	Unreliable	Bulk sample
QU-1035	Op. 1, Level 1, Lot 130	*n.d.*	5870 ±120	4896-4561	5038-4458	Unreliable	Material unknown

(1963, R Vol. 5: 91; Voigt & Dyson 1992: 134.)

Sheikh-e Abad, *34º36'42 N, 47º16'11 E, Kermanshah*

Sheikh-e Abad lies in the highland Zagros at an altitude of 1425 metres above sea level. It, and the nearby contemporary site of Jani (see below), were identified during survey by Y. Mohammadifar, A. Mortarjem and K. Abdi, and both are currently being investigated by the Central Zagros Archaeological Project (CZAP), a joint Irano-British project. Sheikh-e Abad contains an occupation sequence of some 10 metres, which is almost entirely aceramic Neolithic. There are currently three ^{14}C dates available for the site, but unfortunately they have been fully published. The sample material for Beta-258646 and – 258648 is unknown, and the ^{14}C dates must be treated as unreliable. Although the sample material for Beta- 258647 is published, it lacks stratigraphic support, and is of questionable confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-258647	Tr. 1, above virgin soil	Ash	9810 ±60	9312-9238	9436-9176	Quest.	Stratigraphically unsupported
Beta-258646	Tr. 2, -350 cm depth	*n.d.*	7690 ±60	6590-6472	6637-6446	Unreliable	Sample mat unknown
Beta-258648	Tr. 3	*n.d.*	7590 ±40	6468-6426	6504-6390	Unreliable	Sample mat unknown

(Matthews et al. 2010)

Jani, *33º56'52 N, 46º47'00 E, Kermanshah*

Jani lies 90 kilometres southwest of Sheikh-e Abad, and is situated in the lower, warmer mountain valleys at 1280 metres above sea level. It is subject to on-going excavation by the CZAP project (Matthews et al. 2010). Currently, only one ^{14}C determination is available for the site, the material and

pretreatment of which is unknown. Thus, the determination as it stands cannot be treated with any confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-258649	Main section: mid-sequence	*n.d.*	8140± 60	7282-7057	7344-6867	Unreliable	Single date

(Matthews et al. 2010)

Kangavar Region and Eastern Luristan

Tepe Abdul Hosein, *34º11' N, 48º10' E, Kangavar*

Tepe Abdul Hosein (see pp. 121-23) is located in the Khawa Valley, Lurestan. It is a small mound some 6 metres high, with a diameter of ca. 50 metres. There is evidence of a distinct aceramic and ceramic Neolithic occupation of the site with a clear break in between. ^{14}C samples were collected from the lower and middle sections during the 1978 excavation season and submitted to Geochron Laboratories (laboratory prefix GX) for measurement (Pullar 1981: 179). Unfortunately, the sample material for all the determinations is unreported, and the measurements cannot be treated with any confidence.

Lab. Code.	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
GX-6353	Unit 12032, 22 cm depth	*n.d.*	8100 ±255	7351-6699	7589-6472	Unreliable	Material unknown
GX-6355	Unit 12053, 32 cm depth	*n.d.*	8665 ±100	7819-7580	8171-7523	Unreliable	Material unknown
GX-6357	Unit 11021, 150 cm above natural	*n.d.*	8935 ±245	8326-7682	8728-7539	Unreliable	Material unknown
GX-6356	Unit 11045, 100 cm above natural	*n.d.*	8945 ±275	8426-7676	9112-7485	Unreliable	Material unknown
GX-6358	Unit 11051, 75 cm above natural	*n.d.*	7485 ±280	6636-6056	7058-5811	Unreliable	Material unknown
GX-6359	Unit 11061, basal deposit	*n.d.*	8655 ±240	8197-7519	8322-7142	Unreliable	Material unknown

(Pullar 1981, 1990: 4)

Seh Gabi, 34º35' N, 48º00' E, Mahidasht Province

Seh Gabi is situated at a strategic location on the natural road leading from the Mesopotamian Plain to the Central Iranian Plateau, across the Zagros Mountains (Levine & Hamlin 1974). The site is formed of seven small mounds (A-G), of which only Mound C contains Neolithic material. Although three ^{14}C dates are available for Mound C, the sample material is unreported and the dates cannot be treated with any confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
SI-2668	AA20 313#301	*n.d.*	6220±80	5298-5066	5362-4964	Unreliable	Material unknown
SI-2669	AA21 319#301	*n.d.*	6195±105	5297-5028	5372-4848	Unreliable	Material unknown
SI-2670	BB21 315#301	*n.d.*	6055±80	5190-4841	5212-4787	Unreliable	Material unknown

(Voigt & Dyson 1992: 135.)

5.2c. Southwestern Iran

Deh Luran

The Deh Luran Plain lies in the northwestern corner of Khuzestan, on a traditional trade route between Mesopotamia and the Susiana Plain. ^{14}C dates are available for the sites of Ali Kosh, Tepe Sabz and Chogha Sefid (Hole et al. 1969; Hole 1977). The earliest settlement in the area – known locally as the Bus Mordeh phase – is defined at Tepe Ali Kosh (Hole et al. 1969: 34-40).

Ali Kosh, 32º33' N, 47º19' E

Ali Kosh (see pp. 123-27) lies at an altitude of ca. 200 metres. It is a roughly flat-topped, circular mound, with a diameter of 135 metres, which was excavated by Frank Hole and Kent Flannery in 1961 (Hole et al. 1969: 29). The mound is comprised of seven metres of cultural deposits, which are divided into three distinct Neolithic occupational phases: the aceramic Bus Mordeh (BM) and Ali Kosh (AK) phases and the ceramic Mohammad Jaffar (MJ) phase.

The ^{14}C determinations for Ali Kosh are problematic. The first set of ^{14}C measurements were made by a number of different laboratories during the 1960s. Due to the lack of standardization between ^{14}C laboratories during this period, the dates are from a range of sample materials, upon which different extraction techniques were practiced, and the result is several non-conforming data sets (Zeder & Hesse 2000), which cannot be treated with any confidence.

Lab. no	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
I-1496	BM, Zone C1, Sq. 91, 525 cm depth	Charred seeds & ash	7380± 180	6410-6078	6596-5902	Unreliable	Bulk sample
I-1489	BM, Zone C2, Sq. 94, 690 cm depth	Carbonized seeds & ash	7670± 170	6744-6266	7037-6277	Unreliable	Bulk sample
UCLA-750D	BM, Zone C2, Sq. 76, 680 cm depth	Bits of charcoal	9900± 200	9862-9187	10,141-8790	Unreliable	Bulk sample
I-1491	AK, Zone B1, Sq. 69, 260 cm depth	Charcoal & ash	8100± 170	7326-6816	7501-6644	Unreliable	Bulk sample
I-1490	AK, Zone B1	Bits of Charcoal	9950± 190	9862-9254	10,257-8837	Unreliable	Bulk sample
SI-207	AK: Zone B1, 260 cm depth	Charcoal	7740± 600	7448-6060	8268-5562	Unreliable	Error of >150
O-1845	AK, Zone B2	Organic	8250± 170	7476-7081	7591-6775	Unreliable	Error of >150
O-1848	AK, Zone B2	Organic	7700± 330	7031-6251	7460-5992	Unreliable	Error of >150
O-1833	Same as O-1848	Charcoal	8425± 180	7602-7186	8165-7039	Unreliable	Error of >150
O-1816	Same as O-1848	Charcoal	8425± 180	7602-7186	8165-7039	Unreliable	Error of >150
Sh-1246	AK, Zone B2	Charcoal	8410± 200	7607-7091	8170-6831	Unreliable	Error of >150
Sh-1174	AK, Zone B2	Charcoal	8850± 210	8245-7722	8538-7537	Unreliable	Error of >150
I-1494	MJ, Zone A2, Sq. 59, 150 cm depth	Charcoal & ash	7820± 190	7025-6478	7293-6263	Unreliable	Bulk sample
I-1495	MJ, Zone A2	Charcoal/ charcoal & ash	7220± 160	6826-5915	6419-5792	Unreliable	Bulk sample

SI-160	MJ: Zone A2	Ash & carbonized *Prosopis* seeds	8920± 100	8253-7954	8293-7745	Unreliable	Bulk sample
SI-160R	MJ: Zone A2	Same sample as SI-160	8890± 200	8268-7754	8542-7581	Unreliable	Error of >150

(1965, R. Vol. 7: 354-5; 1968, R. Vol. 10: 290; Hole et al. 1969: 336-8)

All of the dates in the above table were processed in the 1960s, and no pretreatment data is available. It is probable that the majority of the measurements were made from bulk samples, even if this is not explicitly stated. Given this, and the fact that all of the ^{14}C dates have errors of over 150 ^{14}C years (with the exception of SI-160 which has an error term of 100 ^{14}C years), they should be treated as of no confidence. Other issues with the dates include that the nature of the sample material for O-1845 and -1848 is not specified, and that UCLA-750D SI-160 and SI-160R are much older than expected by the excavator (Hole et al. 1969: 338). Voigt and Dyson (1992: 135) have suggested that the reason some of the dates for Ali Kosh appear too old, may be due to the common use of bitumen by the early inhabitants; and the contamination of charcoal samples by this material. This would also account for the inconsistencies in the determinations.

More recently a set of AMS measurements have been made from bone samples from Ali Kosh, submitted to Beta-Analytic and Oxford Accelerator Unit (laboratory prefix OxA).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-118719	MJ, 70-80 cm depth	Bone (carbon)	8130 ±70	7292-7048	7350-6830	Acceptable	Known material & context
Beta-118720	MJ, 130-40 cm depth	Bone (carbon)	8140 ±70	7292-7053	7748-6836	Acceptable	Known material & context
Beta-118722	AK, 210-30 cm depth	Bone (carbon)	8110 ±80	7301-6863	7347-6776	Acceptable	Known material & context
Beta-118723	AK, 280-300 cm depth	Bone (carbon)	8490 ±90	7600-7471	7716-7336	Questionable	High error for AMS date
Beta-	AK, 380-	Bone	8340	7525-	7576-	Questionable	High error for

118724	400 cm depth	(carbon)	±90	7206	7143		AMS date
OxA-1773	BM, 100 cm above OxA-1774	Burnt bone (goat)	7830 ±90	6824-6513	7029-6480	Questionable	High error for AMS date
OxA-1774	BM, 100 cm below OxA-1773	Burnt bone (goat)	7950 ±110	7031-6700	7173-6591	Unreliable	AMS date with error of >100
OxA-1775	*n.d.*	Burnt bone (goat)	7480 ±90	6428-6253	6484-6100	Unreliable	Unknown context
Beta-108256	BM, 546 cm depth	Bone (collagen)	8000 ±50	7048-6828	7062-6706	Acceptable	Known material & context
Beta-122721	BM, 635 cm depth	Bone (carbon)	8540 ±90	7651-7491	7793-7356	Questionable	High error for AMS date

(1994, R. Vol. 36: 55-73; Zeder & Hesse 2000: 2256)

The Beta Analytic dates were all measured from bone fractions from secure contexts. However, they need to be accepted with a degree of caution, as they are inexplicable later than any of the Oxford measurements. Frank Hole believes “that the differences between the two laboratories are difficult to explain except as laboratory effects” (2000: 13), and suggests that either the Oxford measurements are around 500 years too young, or the Beta Analytic measurements around 500 years too old. The Beta Analytic measurements also suffer from some internal consistencies. For example, more than 500 years separates the two Bus Mordeh phase samples (Beta-122721 & Beta-108256). Zeder and Hesse (2000: 2256) suggest that this may be due to the use of both bone carbon and bone collagen samples. A number of the Beta and Oxford determinations (B-118724, OxA-1773, -1774, 1775) have high error terms given the usual precision of AMS measurements, and should be treated with questionable confidence. It is possible the high error terms are because after pre-treatment the sample quantity of bone carbon was very small (Zeder & Hesse 2000: 2256). However, as no pretreatment information on the samples is provided it is impossible to say. The provenance label for OxA-1775 was partly defaced, and it was sorted, perhaps incorrectly, into a Bus Mordeh context (Hole 2000: 13). The date should be ignored.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-137020	MJ, 50-60 cm depth	Bone (carbon)	7100 ±70	6048-5903	6096-5801	Acceptable	Known mat. & context
Beta-177122	MJ, 90-100 cm depth	Bone (carbon)	7550 ±40	6451-6399	6473-6270	Acceptable	Known mat. & context
Beta-118721	AK, 180-200 cm depth	Bone (carbon)	8720 ±100	7938-7601	8201-7548	Unreliable	Error of ±100
Beta-177124	AK, 230 cm depth	Bone (carbon)	8050 ±40	7075-6840	7131-6823	Acceptable	Known mat. & context
Beta-137021	AK, 250-270 cm depth	Bone (carbon)	8450 ±70	7581-7481	7594-7354	Acceptable	Known mat. & context.
Beta-177126	BM, 680 cm depth	Bone (carbon)	8530 ±40	7589-7548	7597-7529	Acceptable	Known mat. & context
Beta-137024	BM, 680-710 cm depth	Bone (carbon)	8410 ±50	7545-7382	7577-7355	Acceptable	Known mat. & context

(Zeder 2008a: 258)

The most recent set of ^{14}C measurements for Ali Kosh listed above represent, the most consistent set of ^{14}C determinations to date. The only date of concern is Beta-118721, which has an error term of 100 ^{14}C years and appears too old. It should be ignored. The other dates are all from known sample materials and contexts, and should be treated as of acceptable confidence.

Chogha Sefid, 32º37' E 47º15' N, Khuzestan

Chogha Sefid was excavated under the direction of Frank Hole in 1968-9. The site is located near to Ali Kosh on a well-drained alluvial fan, and is roughly oval in shape. It measures some 16 metres by 120 metres, and contains 20 metres of deposits, of which 3.5–5 metres are buried beneath the present plain surface (Hole 1977: 90). A number of phases are recognized at Chogha Sefid, of which the earliest are the Ali Kosh (AK), Mohammad Jaffar (MJ), Sefid (SF) and Surkh (SK) phases. A series of 10 ^{14}C determinations are available for the site, which were measured by the University of Georgia (laboratory prefix UGa).

Lab. no	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
UGa-305	AK, Zone A1	*n.d.*	10,245±40	10,130-9887	10,179-9866	Unreliable	Material unknown
UGa-294	AK, Zone A1	*n.d.*	8760±150	8169-7604	8251-7577	Unreliable	Material unknown
UGa-302	MJ, Zone SB/A	*n.d.*	8085±145	7301-6817	7455-6651	Unreliable	Material unknown
UGa-296	MJ, Zone SB/A	*n.d.*	8760±150	8169-7604	8251-7577	Unreliable	Material unknown
UGa-293	SE, Zone C1	*n.d.*	8000±720	7823-6101	9131-5617	Unreliable	Material unknown
UGa-297	SE, Zone C1	*n.d.*	8040±90	7122-6778	7294-6679	Unreliable	Material unknown
UGa-310	SE, Zone B2	*n.d.*	9530±145	9152-8718	9277-8487	Unreliable	Material unknown
UGa-300	SE, Zone B2	*n.d.*	11,270±90	11,325-11,146	11,391-10,964	Unreliable	Material unknown
UGa-295	SF, Zone A4	*n.d.*	9690±100	9274-8852	9306-8785	Unreliable	Material unknown
UGa-291	SK, Zone F	*n.d.*	7730±110	6678-6455-	7025-6394	Unreliable	Material unknown

(Hole 1977: 25)

Unfortunately, the sample material for the measurements is unpublished, and given this, the generally high errors of the dates, and the fact that they were measured in a laboratory before 1980, all the measurements should be ignored.

Tepe Sabz, 32º36' N, 47º16' E, Khuzestan

Tepe Sabz lies approximately 16 kilometres west-northwest of Ali Kosh. It is a large, squat mound, measuring 120 by 140 metres, which was originally almost square in shape; although nearly a third has now been eroded. It was excavated in 1963 under the direction of Frank Hole and Kenneth Flannery (Hole et al. 1969), and comprises 10.5 metres of cultural deposits, 7 metres of which stand above the current plain surface. Four phases of occupation are identified: the Sabz (SZ), Khazineh (KH), Mehmeh (MM) and Bayat (BY). A total of 16 ^{14}C samples from the site were collected by Frank Hole, and submitted to 3 different laboratories for analysis: Isotopes (laboratory prefix I), the University of California (prefix UCLA) and the Smithsonian Institute (prefix SI).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
I-1499	BY, Zone A1	Bits of charcoal from midden	6050 ±140	5207-4739	5314-4618	Unreliable	Bulk sample
I-1503	BY, Zone A2, TS 9-167	Carbonized wood	5860 ±230	4996-4462	5315-4266	Unreliable	Bulk sample
UCLA-750A	BY, Sq. 14, 270-80 cm depth	Carbonized wood & sheep/goat dung	6070 ±100	5205-4842	5286-4727	Unreliable.	Bulk sample
SI-203	BY, Zone A2, Sq. 1, 125 cm depth	Chunks of charcoal	6170 ±200	5322-4849	5520-4619	Unreliable	Bulk sample
SI-204	BY, Zone A2, Sq. 1, 135 cm depth	Charcoal fragments from midden area	6060 ±200	5218-4729	5467-4538	Unreliable	Bulk sample
SI-156	BY, Zone A3, 300 cm depth	Charcoal, seeds & sheep/goat dung	5770 ±120	4768-4489	4901-4359	Unreliable	Bulk sample
I-1502	BY, Zone A2, Sq. 15, 310 cm depth	Charred wood, seeds & dung	6060 ±140	5207-4801	5320-4619	Unreliable	Bulk sample
SI-205	Zone A2, Sq. 34, 620-30 cm depth	Carbonized wood (*Tamarix*?)	5700 ±250	4881-4269	5208-4042	Unreliable	Error of >150
I-1500	MH, Zone B1, Sq. 7, 380 cm depth & Sq. 9, 400 cm depth	Wood/carbonized wood	5410 ±160	4442-4044	4604-3815	Unreliable	Bulk sample
I-1493	MH, Zone B3, Sq. 25, 500 cm depth	Charcoal	6470 ±160	5614-5302	5710-5062	Unreliable	Error of >150
SI-206	KZ, Zone C1, Sq. 34, 620-30 cm depth	Carbonized wood (undersized)	7200 ±100	6211-5992	6343-5849	Unreliable	Possibly contaminated
UCLA-750B	KZ, Zone C3, Sq. 11, 270-80 cm depth	Carbonized grains of barley	6925 ±200	5992-5645	6212-5491	Unreliable	Bulk sample
I-1501	KZ, Zone C1, Sq. 21, 680 cm depth	Charcoal	7460 ±160	6465-6106	6631-6018	Unreliable	Error of >150
UCLA-750C	SZ, Zone D, Sq. 76, 680 cm depth	Chunks of carbonized wood	9050 ±160	8527-7969	8699-7732	Unreliable	Bulk sample
SI-255	SZ, Zone D1, Sq. 20, 940-60 cm depth	Charcoal fragments from midden (undersized)	1460 ±400	133-976	376-1276	Unreliable	Too late & poss. contaminated
I-1497	SZ, Zone D, Sq. 25, 960 cm depth	Carbonized wood	6740 ±190	5835-5485	6006-5340	Unreliable	Error of >150

(1965, R. Vol. 7: 355; 1966, R. Vol. 8: 413-22; 1967, R. Vol. 9: 379; 1968, R. Vol. 10(2): 290; Hole et al. 1969: 335-6)

According to the excavator, SI-255 was “apparently contaminated” (Hole et al. 1969: 336), and should be ignored. SI-206 was very small, and should also be treated as unreliable. Of the remaining dates, the majority were measured from bulk samples and/or have error terms of over 150 ^{14}C years, and should be treated as unreliable. Of particular note is SI-255 which is far too late. Other determinations which also stand out as being too late in respect to their stratigraphic positions are: SI-156, SI-150, SI-205 and I-1497, while UCLA-750C appears to be too early.

The Susiana Plain

From Deh Luran a route leads along the foothills to the southeast. The earliest farmers in Susiana seem to have settled within this zone, moving east of the River Dez before colonizing the rolling gravel plains to the south (Voigt & Dyson 1992: 129). ^{14}C dates for the region are available from Chogha Bonut and Chogha Mish.

Chogha Bonut, *32º13’20 N, 48º13’18 E, Khuzestan*
Chogha Bonut (see pp. 128-30) is located on the Susiana Plain at an elevation of 100 metres, roughly 20-kilometres southeast of the modern city of Dezful (Alizadeh 2009). It is a small mound which has been badly damaged by bulldozing, and in its truncated state it measures some 50 metres in diameter by 5 metres in height (Alizadeh 1997). Helene Kantor (1978; 1979; 1980) conducted a salvage excavation at the site in 1976, and it was more recently excavated by Abbas Alizadeh in 1996. AMS measurements have been made for the site by Beta Analytic from samples submitted by both Abbas Alizadeh and Melinda Zeder.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-104552	L39 (D.T.)	Organic sediment	8270± 100	7457-7180	7521-7072	Unreliable	Error of >100
Beta-106164	L39 (D.T.)	Charred material	8170± 60	7292-7072	7346-7050	Reliable	Known mat. & context
Beta-104553	Layer 13	Organic	10,980 ±100	11,097-10,756	11,151-10,702	Unreliable	Error of >100
Beta-104554	S.T. (76.10)	Organic	41,930 ±1000	*Out of range*		Unreliable	Huge error term
Beta-104555	Feat. 28	Charred material	8070± 50	7139-6841	7181-6817	Reliable	Known mat. & context
Beta-106165	F26/L32	Charred material	8020± 50	7059-6830	7076-6708	Reliable	Known mat. & context
Beta-106166	Feat. 14	Charred material	7950± 50	7028-6711	7041-6692	Reliable	Known mat. & context
Beta-177134	*n.d.*	Bone (collagen)	8040± 40	7068-6836	7081-6815	Unreliable	Unknown context
Beta-177132	*n.d.*	Bone (collagen)	8070± 40	7132-6860	7174-6829	Unreliable	Unknown context
Beta-177133	*n.d.*	Bone (collagen)	8120± 40	7142-7058	7296-7043	Unreliable	Unknown context

(*Alizadeh 2003: 149; Zeder 2008a: 258)*

Unfortunately, no information is available on the context of Beta-177134, -177132 and -177133, and they cannot be treated with any confidence because they are stratigraphically unsupported. The remainder of the dates were measured from samples submitted by Abbas Alizadeh (2003). Beta-104554 is obviously contaminated and unreliable. Beta-104552 and -104553 have high errors for AMS measurements and should not be treated with any confidence. Beta-106164, -104555, -106165 and -106166 are from known materials and contexts, and are reliable enough to be used without further questioning.

Chogha Mish, 32º13'26 N, 48º33'22 E, Khuzestan

Chogha Mish lies in the area below the Zagros foothills between Dezful and Susa, six kilometres to the east of Chogha Bonut. It was excavated under the direction of Pinhas Delougaz and Helene Kantor (Delougaz 1976; Kantor

1978; 1979; 1980; Delougaz & Kantor 1973; 1975; Delougaz, Alizadeh & Kantor 1996), on behalf of the Oriental Institute of The University of Chicago, for 11 seasons between 1961 and 78. They suggest that the site was occupied continuously, except for one or two presumably short breaks, from approximately the late sixth to early forth millennium BC. Three AMS dates are available for Chogha Mish, which were measured from samples collected by Abbas Alizadeh subsequent to the site's excavation (2003).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-106168	Sq. S18: 902	Charred material	6610 ±50	5615-5511	5623-5483	Reliable	Known material & context
Beta-106169	Sq. P22: 629	Charred material	6600 ±50	5611-5490	5621-5481	Reliable	Known material & context
Beta-106167	Sq. S22: 823	Charred material	8300 ±60	7478-7201	7519-7176	Unreliable	Too early

(*Alizadeh 2003: 149)*

Beta-106167 stands out as much older than the other two dates, and in light of the dates for Chogha Bonut – which is believed to have been abandoned contemporaneously with the establishment of Chogha Mish (Alizadeh 2003: 149) – should be ignored. Beta-106188 and Beta-106169 stratigraphically support each other, suggesting a mid-sixth millennium BC date.

Marv Dasht/Kur River Basin

The areas within the Kur drainage investigated most intensively by archaeologists are the Baiza and the Marv Dasht or Persepolis Plains (Voigt & Dyson 1992: 135). The key sites of this region for which ^{14}C dates are available are: Tal-i Mushki, Tal-i Jari A and B, Tal-i Bakun A and B and Tal-i Gap. More recently, Fars has been subject to archaeological research by a joint team from ICHTO and the University of Sydney, who have conducted survey and excavation work on the Mamasani Plain (Potts et al. 2005; Potts & Roustaei 2006), and obtained ^{14}C dates from eight Neolithic-Chalcolithic sites in the region.

Tal-i Mushki, 26º46' N, 52º53' E, Marv Dasht Plain

Tal-i Mushki (see pp. 130-2) was first tested by Vanden Berghe (1954), whose work was subsequently followed by Naomi Egnami's more extensive excavations on behalf of the University of Tokyo (Fukai et al. 1973). More recently the site was excavated for a short season in 2003 under the direction of Abbas Alizadeh (cf. Alizadeh et al. 2005). Two ^{14}C date sets are available for Tal-i Mushki: one set was conventionally measured by the University of Tokyo (laboratory code prefix TK) from samples collected during the 1960s excavation; the other from samples collected and submitted for AMS dating by Alizadeh (2003) to NSF (prefix AA) and Beta Analytic.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
TK-34	Level 2A	Soil/ charcoal	8460 ±120	7595-7355	7752-7175	Questionable	Measured in 1960s
TK-35b	Level 2A	Bone (organic)	6800 ±600	6382-5078	7133-4460	Unreliable	Error of >150
TK-35a	Level 2A	Bone (carbonate)	3610 ±110	2137-1781	2292-1687	Unreliable	Too late
AA-56409	Level 3a	Bone	7347 ±71	6339-6062	6381-6065	Acceptable	Known material & context
Beta-210984	Level 12	Charred bones	7250 ±40	6207-6062	6219-6032	Acceptable	Known material & context
Beta-207563	Level 17	Charred seeds	7220 ±40	6202-6021	6211-6013	Reliable	Known material & context
AA-63493	Level 22 (basal)	Bone	7707 ±76	6600-6470	6681-6431	Acceptable	Known material & context

(1969, R. Vol. 11: 513; Alizadeh 2006: 121)

In terms of The University of Tokyo's measurements, TK-35a is clearly too late and should be ignored, and TK-35b has an error of 600 ^{14}C years and should also be ignored. Its high error lays testament to the problems of ^{14}C dating bone in the early days of ^{14}C measurement. TK-34 is acceptable, with a degree of caution, as it was measured before 1980. In terms of the AMS measurements, Beta-207563 is from a known material and context and can be treated as reliable, whilst AA-56409, -63493 and Beta-210984 should all be treated with a degree of caution, as the bone fraction from which they were measured is not stated. There are some internal inconsistencies between the

AMS dates, however as all the dates lie relatively close together, this may be due to the rapid accumulation of deposits at the site.

Tal-i Jari A, 29º56' N 52º53' E, Marv Dasht Plain

Tal-i Jari A (see pp. 132-3) was excavated by a Japanese expedition in the 1960s, the findings of which have yet to be fully published. The site was briefly re-excavated in 2004 under the direction of Abbas Alizadeh, and it is from the latter excavation that carbon samples were collected for AMS dating.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-207564	B1, Feat. 13	Charred seed	6170 ±40	5208-5062	5221-4999	Reliable	Known mat. & context
Beta-210982	B1, Feat. 9	Charred seed	6010 ±40	4951-4841	5000-4769	Reliable	Known mat. & context
AA-63492	20 cm above virgin soil	Bone	6280 ±69	5359-5082	5465-5052	Reliable	Known mat. & context

(Alizadeh 2006: 220)

The ^{14}C dates for Jari A have errors within the accepted limits, are from known materials and contexts, and are in stratigraphic support; they are reliable enough to be used without further questioning.

Tal-i Jari B, 29º56' N 52º53' E, Marv Dasht Plain

Tal-i Jari B (see pp. 133) lies 200 metres south of Jari A. A Japanese expedition first excavated it in the 1960s, but their findings were never fully reported. More recently, the site was excavated under the direction of Abbas Alizadeh for a short season in 2004. Carbon samples collected by both excavation teams were submitted for AMS dating in 2004: AA-65264, AA-56413 and Beta-207565 were collected in 2004; while AA-56410 to -56415 are from samples that were collected in the 1960s (Alizadeh 2006). The bone fraction from which the samples were extracted is not stated, and as such the dates should be treated with a degree of caution. This aside, the dates are from known contexts and in stratigraphic agreement, with the sample from the lowest level (AA-65264) yielding one of the earliest dates. Although Beta-207565 is the only sample measured by Beta laboratory, it is in stratigraphic

agreement with the ^{14}C dates from NSF-Arizona AMS laboratory (prefix-AA) and can be accepted with a degree of caution.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
AA-56413	Area A III, Level 1-2	Bone	6867 ±50	5835-5707	5877-5659	Acceptable	Known material & context
AA-56412	Area C, Level 2	Bone	6969 ±72	5971-5771	5991-5725	Acceptable	Known material & context
AA-56415	Area WT, Level 2, Room 1	Bone	7127 ±69	6066-5917	6206-5845	Acceptable	Known material & context
Beta-207565	165 cm depth	Charred seeds	7140 ±40	6050-5990	6075-5920	Reliable	Known material & context
AA-56411	Area A III Level 5, Room 7	Bone	7259 ±74	6213-6064	6334-5991	Acceptable	Known material & context
AA-56410	Area WT, Level 6, Room 5a	Bone	7173 ±71	6202-5931	6219-5911	Acceptable	Known material & context
AA-65264	50 cm above virgin soil	Charred bone	7297 ±45	6216-6103	6237-6062	Acceptable	Known material & context

(Alizadeh 2006: 221)

Tal-i Bakun A, *33º10 N, 68º20 E, Marv Dasht Plain*

Langsdorff excavated Tall-i Bakun A in the 1930s, and was closely followed by McCown who excavated there in 1942. More recently the site was excavated in 2004 by Abbas Alizadeh, who submitted three carbon samples for AMS dating (Alizadeh 2006).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-207562	Sq. BB27, Level 3	Charred seeds	5560± 40	4447-4357	4462-4338	Reliable	Known mat. & context
Beta-210983	Sq. BB27, Level 4 (basal)	Charred seeds	5570± 40	4448-4362	4488-4342	Reliable	Known mat. & context
AA-63491	Sq. BB27, Level 3	Bone	5162± 63	4044-3814	4226-3793	Accept.	Known mat. & context

(Alizadeh 2006: 120)

Beta-207562 and -210983 are from known materials and contexts, and are reliable enough to be used without further questioning. AA-63491 was the only measurement made by NSF-Arizona AMS laboratory. Although from the same level as Beta-207562, AA-63491 is somewhat earlier, possibly because two different materials were dated. It is not stated what bone fraction the sample was extracted from, and the measurement is of questionable confidence.

Tal-i Bakun B, 33º10 N, 68º23 E, Marv Dasht Plain

Tal-i Bakun B was originally excavated in the 1960s by a Japanese expedition, but their findings were never fully published. It was re-excavated in 2004 under the direction of Abbas Alizadeh (Alizadeh 2006). Two sets of ^{14}C dates are available: one set was collected and submitted for conventional dating by R.H. Dyson during the original excavation of the site; the other was collected and submitted for AMS measurement in 2004 by Alizadeh.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-438	300 cm depth	Charcoal & dirt	5990± 80	4987-4790	5204-4691	Unreliable	Bulk sample
P-931	Same area as P-438	Ash	6264± 70	5320-5079	5462-5030	Question.	Known mat. & context, but meas. before 1980
Beta-210985	190 cm above natural	Charred seeds	6160± 40	5207-5054	5217-5000	Acceptable	Known mat. & context
AA-63489	140 cm above natural	Bone	6234± 72	5302-5076	5356-5001	Acceptable	Known mat. & context

(1962, R. Vol.. 5: 90; 1966, R. Vol.. 8: 350; Alizadeh 2006: 120)

P-438 is from a bulk sample and should be ignored. P-931 is from a known material and context, but should be treated as questionable due to its measurement in the formative years of ^{14}C dating. AA-63489 and Beta-210985 are from known materials and contexts, but are not in stratigraphic agreement; perhaps because of the different sample materials used. They are acceptable with a degree of caution. Unfortunately, due to the different

stratigraphic descriptions given for the two date sets (depth below present & height above natural respectively) it is impossible to compare them.

Tal-i Gap, 29º55' N, 53º00' E, Marv Dasht Plain

Tal-i Gap is a round mound measuring some 120 metres in diameter, and 5 metres in height. The second Tokyo University Iraq-Iran Archaeology Expedition excavated the site in 1959, but their findings remain unpublished. It was more recently excavated for a brief season in 2004 under the direction of Abbas Alizadeh (Alizadeh 2006).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
GaK-197	GAT-I, Layer 17	Charcoal	5870±160	4934-4546	5207-4371	Unreliable	Error of >150
GaK-198	GAT-II, Layer 6	Charcoal	5540±120	4521-4260	4684-4060	Questionable	Before 1980

(1963, R. Vol. 5: 115).

Gak-197 has an error of more than 150 ^{14}C years and should be ignored; GaK-198 is from a known material and context and has an acceptable context, but due to its measurement in the formative period of ^{14}C dating, should be treated as of questionable confidence.

Tol-e Baši, Kor River Basin, Fars

Tol-e Baši lies in the eastern Ramjerd Plain, Fars. It was identified in archaeological surveys of the Kor River Basin by Louis Vanden Berghe, Paul Gotch and William Sumner, and excavated in 2003 by an American-Iranian project (cf. Pollock, Bernbeck & Abdi 2010). The site is comprised of two mounds: Mound A measuring roughly 3.8 hectares and Mound C measuring roughly 3.1 hectares (Bernbeck 2010a: 21).The Neolithic occupation of the site is thought to be restricted to the northwestern part of Mound A. To date the site represents the oldest attested evidence for agrarian lifeways in the area. Twelve samples were submitted by the excavators for ^{14}C dating using the AMS method.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
AA-56341	Unit A Loc. 74, Level I	Charred plant material	6028 ±44	4989-4849	5040-4800	Unreliable	Wide discrepancy with other determination for Level 1
AA-56338	Unit A Loc. 49, Level I	Charred plant material	7037 ±46	5986-5888	6013-5811	Unreliable	Wide discrepancy with other determination for Level 1
AA-56342	Unit B Loc. 24, Level II	Charred plant material	6702 ±39	5659-5567	5706-5546	Reliable	AMS date from known material & context
AA-56343	Unit D Loc. 17, Level IV	Charred plant material	6977 ±43	5969-5802	5981-5147	Reliable	AMS date from known material & context
AA-56353	Unit D Loc. 13, Level IV	Charred plant material	7082 ±39	6010-5916	6031-5886	Reliable	AMS date from known material & context
AA-56340	Unit C Loc. 40, Level IV	Charred plant material	7123 ±49	6051-5927	6072-5899	Reliable	AMS date from known material & context
AA56355	Unit D Loc. 11, Level IV	Charred plant material	7157 ±42	6059-6001	6096-5921	Reliable	AMS date from known material & context
AA56339	Unit C Loc. 71, Level V	Charred plant material	6949 ±47	5886-5766	5975-5732	Reliable	AMS date from known material & context
AA56354	Unit C Loc. 54, Level V	Charred plant material	7132 ±40	6049-5986	6072-5917	Reliable	AMS date from known material & context
AA56351	Unit C Loc. 61, Level V	Charred plant material	7283 ±43	6213-6089	6230-6061	Reliable	AMS date from known material & context
AA56352	Unit C Loc. 68, Level VI	Charred plant material	5830 ±42			Unreliable	Possible contamination
AA58025	Unit C Loc. 70, Level VI	Charred plant material	5837 ±40			Unreliable	Possible contamination

(Pollock et al. 2010: table 19.1.)

It is immediately apparent that in several respects the sequence of dates does not reflect the expected ordering based on the stratigraphic positioning of the samples. AA-56352 and -58025, for example, although from the earliest level of the dated sequence, are actually the latest in date. It is probable both samples are contaminated or intrusive. They are from isolated pockets within a deep deposit in Unit C, and Pollock (2010b: 262) reports that although no rodent holes were recognised at the time of excavation, it was recognized that the general character of the deposits was suspicious. Although the remaining

dates do not yield a sequence that corresponds exactly to their stratigraphic position – some Level V dates are later than some from Level IV – overall, they fall relatively closely together, and are reliable enough to be used without further questioning. The lack of clear chronological distinction between Level VI and V samplers may be indicative that these two phases are so close together in time that the ^{14}C determinations cannot reliable separate them (Pollock 2010: 263).

Hajji Bahrami or TB75, Tang-e Bolaghi

TB75 is located in the Bolaghi Valley, Fars. The site was excavated in 2004 and 2006 by an Iran-Japan joint expedition to the Savant dam salvage area (cf. Tsuneki & Zeidi 2008). Ten charcoal samples (although one proved too small to be dated), were collected from TB75 during the 2004 excavation and submitted to Nagoya University, Japan, for AMS measurement (Nakamura & Minami 2008: 159).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
NUTA 2-12455	Tr. D, basket no. 4, layer 3	Samp. No. 2: charcoal	8480± 45	7577-7528	7589-7490	Reliable	Known context & material; stratigraphically supported
NUTA 2-12456	Tr. D., basket no. 9, layer 4	Samp. No. 7: charcoal	9265± 45	8599-8353	8621-8337	Reliable	Known context & material; stratigraphically supported
NUTA 2-12457	Tr. D, basket no. 12, layer 4	Samp.no. 13: charcoal	9965± 45	9648-9318	9665-9301	Reliable	Known context & material; stratigraphically supported
NUTA 2-12459	Tr. D, basket no. 14, layer 4	Samp. No. 22: charcoal	10190 ±45	10042-9825	10116-9762	Reliable	Known context & material; stratigraphically supported
NUTA 2-12460	Tr. D, basket no. 19, layer 5	Samp. No. 24: charcoal	12640 ±50	13200-12851	13282-12614	Question.	Possible contamination
NUTA 2-12461	Tr. D, basket no. 19, layer 5	Samp. No. 25: charcoal	12255 ±50	12264-12043	12856-11959	Reliable	Known context & material; stratigraphically supported
NUTA 2-12462	Tr. D, basket no. 19, layer 5	Samp. No. 28: charcoal	12225 ±50	12264-12043	12856-11959	Reliable	Known material & context; stratigraphically supported

NUTA 2-12463	Tr. D, basket no. 23, layer 6	Samp. No. 34: charcoal	16330 ±60	17592-17470	17879-17357	Reliable	Known context & material; stratigraphically supported
NUTA 2-12464	Tr. D, basket no. 24, layer 6	Samp. No. 35: charcoal	16650 ±70	17951-17626	18191-17581	Reliable	Known context & material; stratigraphically supported

(Nakamura & Minami 2008: tab. 10.2.)

Four charcoal samples (nos. 2, 7, 13 & 22) were collected from excavation layers attributed to the Proto-Neolithic, and dated to 8480±45 to 10190±45 ^{14C} years BP, or 7589-7490 to 10116-9762 calibrated years BC within the two-sigma age range. Five samples (nos. 24, 25, 28, 34 & 35) were collected from Epipalaeolithic layers and dated to 12225±50 to 16650±70 ^{14}C years BP, or 12856-11959 to 18191-17581 calibrated years BC with the two-sigma age range. According to the excavators the ^{14}C ages and calibrated dates for the two groups of samples are quite consistent with the respective age classifications, Proto-Neolithic and Epipalaeolithic, based on archaeological contexts (Nakamura & Minami 2008: 160, tab. 10.1). NUTA2-12460, -12461 and -12462 are from the same layer.

The dates for NUTA2-12461 and -12462 are consistent with each other, but -12460 is a bit older. The excavators suggest that this may be as a result of the contamination of sample no. 24 by foreign older carbon during sample preparation at the laboratory (ibid.: 160). All of the other ^{14}C dates get older as the sample collection layers become deeper, and are quite consistent. They are reliable enough to be treated without further questioning.

Ten charcoal samples (one of which proved to be too small to be dated) were collected from the 2006 excavation at TB75 and submitted for AMS measurement (Yoneda 2008). Samples no. 3 to 12 are from layers assigned to the Proto-Neolithic and samples no. 18 to 29-1 are from the Epipalaeolithic.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
TERRA-070407a30	Tr. D, basket no. 6, layer 4	Samp. no: 3, charcoal	8403± 43	7537-7385	7571-7356	Unreliable	Unknown lab.
TERRA-070407a33	Tr. D, basket no. 7, layer 4	Samp. no: 5, charcoal	9421± 47	8753-8637	8813-8569	Unreliable	Unknown lab.
TERRA-070407a34	Tr. D, basket no. 8, layer 4	Samp. no: 6, charcoal	9452± 47	8796-8641	9116-8616	Unreliable	Unknown lab.
TERRA-070407a35	Tr. C, basket no.13, layer 4	Samp. no: 9, charcoal	1368± 33	641-676	605-764	Unreliable	Unknown lab.
TERRA-070407a36	Tr. C, basket no.13, layer 4	Samp. no: 11, charcoal	1448± 33	589-645	557-654	Unreliable	Unknown lab.
TERRA-070407a37	Tr. C, basket no.13, layer 4	Samp. no: 12, charcoal	1407± 36	614-657	575-670	Unreliable	Unknown lab.
TERRA-070407a04	Tr. C, basket no.15, layer 5	Samp. no: 19, charcoal	11930 ±56	11916-11771	12007-11667	Unreliable	Unknown lab.
TERRA-070407a05	Tr. C, basket no.17, layer 5	Samp. no: 27, charcoal	14774 ±61	16478-15867	16535-15714	Unreliable	Unknown lab.
TERRA-070407a30	Tr. C, basket no.17, layer 5	Samp. no: 29-1, charcoal	13231 ±56	14598-13972	14741-13534	Unreliable	Unknown lab.

(Yoneda 2008: tab. 10.3, 10.5)

The laboratory code TERRA is not listed in the *Radiocarbon* list of current and past lad codes (see www.radiocarbon.org/info/labcodes.html which is based on the list to be published in *Radiocarbon* **54**(4)). The credibility of the laboratory is therefore questionable, and the dates cannot be treated as reliable.

Tal- Nokhodi, 30º20' N, 38 º10' E

Tal-Nokhodi lies beneath the Achaemenid capital of Pasargadea. Only one 14 C date is available for the site. It is from a sample collected in 1961 by D.B. Stronach and submitted by M.E.L. Mallowan. It is stratigraphically unsupported and should be ignored.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
BM-171	Tr. B, Level 4C	Charcoal	5050±150	3982-3662	4238-3527	Unreliable	Single ^{14}C date

(1968, R. Vol. 10: 3-4)

Tol-e Nurabad, Mamasani Plain, 51°30' E, 30°07' N

Tol-e Nurabad (see pp. 129-40) is located in Dasht-e Nurabad, on the outskirts of the modern town of Nurabad-e Mamasani. It lies on the main communication route between the Kur River Basin and lowland Khuzistan, and is situated next to the perennial Korr-e Sangan stream; both of these factors probably influenced the site's location (Weeks et al. 2006: 31). Nurabad measures some 90,000 square metres, and currently stands 24 metres above the plain surface. It was excavated for two seasons in 2003 and 2004 under the direction of D.R. Potts (Potts et al. 2005; Potts & Roustaie 2006). The Neolithic occupation of the site was substantial, and eight occupational phases (A26-20) are recognised (Weeks et al. 2006: 68). In all, 10 AMS ^{14}C determinations are available for the Neolithic-Chalcolithic deposits at Nurabad (Weeks et al. 2006: 67, table 3.2).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
WK-13989	Tr. A., Ph. A27	Charcoal	6488±54	5490-5375	5542-5328	Unreliable	Too late
WK-13990	Tr. A, Ph. A26	Charcoal	6977±56	5972-5792	5984-5741	Reliable	AMS date from known mat. & context
OZI-128	Tr. A, Ph. A25	Charcoal	6950±50	5887-5765	5976-5731	Reliable	AMS date from known mat. & context
WK-13991	Tr. A, Ph. A24b	Charcoal	6952±61	5892-5753	5982-5726	Reliable	AMS date from known mat. & context
WK-13992	Tr. A, Ph. A23	Charcoal	6938±54	5878-5748	5977-5723	Reliable	AMS date from known mat. & context
WK-13993	Tr. A, Ph. A20	Charcoal	6810±56	5733-5645	5833-5622	Reliable	AMS date from known mat. & context
WK-13994	Tr. A, Ph. A19	Charcoal	5850±49	4791-4619	4835-4556	Reliable	AMS date from known mat. & context
OZI-	Tr. A,	Charcoal	5910±	4837-	4933-	Reliable	AMS date from

129	Ph. A19		50	4772	4688		known mat. & context
OZI-130	Tr. A, Ph. A18	Charcoal	6290± 60	5341-5212	5465-5064	Reliable	AMS date from known mat. & context
WK-13996	Tr. A, Ph. A16	Charcoal	5785± 51	4706-4560	4770-4502	Reliable	AMS date from known mat. & context

(Weeks et al. 2006: table 3.2.)

WK-13989, from the earliest level of Nurabad (A27), is considered by the excavators to be contaminated or intrusive (Weeks et al. 2006: 67), and given its somewhat younger date than the other samples, I concur with this, and the date should be ignored. The excavators comment that the rest of the dates, are, "consistent with their stratigraphic position and…more-or-less reliable indicators of the age of the deposits from which they have come" (Weeks et al. 2006: 67). I would agree with this interpretation of the data: the dates are from known sample materials and contexts, and internally consistent; they are reliable enough to be used without further questioning.

5.2d. Central Iranian Plateau

The Central Iranian Plateau incorporates the Tehran, Qazvin and Kashan Plains. Prior to recent work on the Central Iranian Plateau (e.g. Coningham et al. 2004; 2006; Fazeli et al. 2005; 2009) (see Chap. 6), the Neolithic period of the region was defined at the sites of Cheshmeh Ali, Zagheh and Sialk, with Zagheh reportedly the earliest of the three (e.g. Voigt & Dyson 1992: 165). Although ^{14}C dates for Zagheh have been published since the 1970s, until recently only one ^{14}C date was available for Sialk, and none had been made for Cheshmeh Ali, despite the chronological importance of the latter two sites.

Tepe Sialk, 34º23' N, 51º38' E, Kashan Plain

Tepe Sialk lies in the suburbs of the modern city of Kashan. The site consists of two mounds, located some 600 metres apart, of which the North Mound is the earlier. Roland Ghirshman excavated both mounds during the 1930s, identifying two distinct Neolithic phases on the North Mound: Sialk I and II.

Ghirshman's extensive studies were followed by excavations directed by D.E. McCown, V. Majidzadeh and P. Amieh, after which the site was neglected for more than 20 years. In the early 2000s, the Iranian Cultural Heritage Organization (ICHO) reviewed the site, and five season of excavation were subsequently undertaken (Malek Shahmirzadi 2002; 2003; 2004; 2006a; 2006b). A joint collaboration between the University of Tehran, Durham University and ICHO is currently excavating the North Mound as part of a five-year project initiated in 2008 (see pp. 363-73). Prior to their work, only one ^{14}C date (Gx-949) existed for the site, measured from a carbon sample taken from the surface of a bowl more than 30 years after it was excavated (Böhner & Schyle 2008). It is probably contaminated, and even if it is not, as the only date available for the site it is stratigraphically insecure site and cannot be treated with any confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Gx-949	Sialk I2: balk	Organic material (barley?)	5700±90	4681-4456	4726-4354	Unreliable	Only 1 date for site

(Voigt & Dyson 1992: 135)

Zagheh, 35º48'57 N, 49º56'49 E, Qazvin Plain

Zagheh is an oval mound, measuring some 300 metres by 200 metres in extent that contains 6.5 metres of deposits, 6 metres of which are buried below the present plain surface (Schmidt & Fazeli 2006: 39). E.O. Neghaban (1974; 1977; 1979) first excavated the site from 1970-9, after which it was excavated under the direction of a team of staff from the Iranian Department of Archaeology, including Malek, Mostof, Golzarim Daneshpoor, Frirozmandi and Salehi. The site was more recently excavated under the direction of Hassan Fazeli (Fazeli et al. 2005). Prior to Fazeli's excavations, two date sets existed for Zagheh, measured from charcoal samples submitted by Neghabad to Tehran University Nuclear Centre (laboratory code prefix TUNC) in the 1970s; and from bone samples submitted by Mashkour (Mashkour et al. 1999) to Gif sur Yvette (laboratory code prefix Gif) for AMS dating..

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
TUNC-10	Test Tr. Fx, Level 1	Charcoal	4909 ±73	3773-3640	3941-3526	Unreliable	Unadjusted for fractionation
TUNC-12	Tr. Fx, 289 cm depth	Charcoal	7147 ±90	6098-5902	6221-5845	Unreliable	Unadjusted for fractionation
Gif-10343	Tr. A8/4, 33 cm depth	Bone (coll. 1994)	5930 ±70	4899-4721	4998-4618	Questionable	Known mat. & context
Gif-10344	Tr. DIX, 110-30 cm depth	Bone (coll. 1973)	5885 ±75	4876-4620	4938-4553	Questionable	Known mat. & context
Gif-10226	Tr. FGX, 323-35 cm depth	Bone (coll. 1973)	6100 ±60	5206-4936	5213-4849	Questionable	Known mat. & context
Gif-10345	Tr. FIX	Bone (coll. 1973)	5900 ±55	4837-4714	4934-4618	Questionable	Known mat. & context

(1972, R. Vol.. 14: 459; Mashkour et al. 1999: 69)

Neither of the samples measured at Tehran University were adjusted for fractionation (1972, R. Vol.. 14: 459), and the dates cannot be treated with any confidence. The dates obtained by Mashkour are from known sample materials and contexts. However, three of the samples were from bones which were originally collected in 1973, and thus may have become contaminated. Consequently, Gif-10344, -10266 and -10345 must be treated as of questionable chronometric hygiene. Gif-10343 is measured from a sample collected in 1994, but as there are no other dates of 'acceptable' or 'reliable' hygiene with which to insure its stratigraphy, and in light of more recent dates for the site (see pp. 349-50), it must be treated with questionable confidence

5.2e. Northeastern Iran

Damghan/Khurasan

Information for the prehistoric period of northeastern Iran comes primarily from: the Damghan Plain, south of the Alburz Mountains; and the Atrek and Darreh Gaz Valleys which lead north towards Turkmenistan. The Neolithic

sequence of the region has traditionally been based on the excavations carried out by the Japanese-Iranian Joint Archaeological Mission at the double mound of Sang-i Chakhmaq, just to the east of the Damghan Plain (Voigt & Dyson 1992: 169).

Sang-i Chakhmaq, *36º23'N, 55º06'E*

Sang-i Chakhmaq lies near the modern city of Sahrud, and was excavated in the 1970s under the direction of Seiichi Masuda, although the findings remain unpublished. It consists of two low mounds, of which the western mound (Sang-I Chakhmaq West) is the earlier. Five levels of occupation are identified on the west mound – Levels 2-5 (aceramic) and Level 1 (ceramic) – for which two ^{14}C determinations are available. Unfortunately neither is published with its lab code, context or sample material, and they cannot be treated with any confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
n.d.	*n.d.*	*n.d.*	7270±125	6249-6010	6415-5911	Unreliable	No lab. code etc.
n.d.	*n.d.*	*n.d.*	7240±150	6331-5929	6246-5841	Unreliable	No lab. code etc.

(Voigt & Dyson 1992: 222.)

Mazandaran/Gurgan

This region consists of the coastal plain lying at the southeastern corner of the Caspian Sea, and the adjacent plain. The Neolithic period of the region has traditionally been defined by Belt Cave, Levels 10-8, and the 'sub-Neolithic' levels at Hotu Cave (Coon 1951: 30-1; 1957: 149-51).

Belt Cave (Ghar-i-Kamarband), 36º39' N, 53º27' E, Mazandaran

Belt Cave and neighbouring Hotu Cave (see pp. 147), lie in the foothills of the Alburz Mountains overlooking the Caspian Sea, just east of the modern village of Turnjan, and were excavated by Carleton S. Coon (1951; 1952; 1957) in the 1950s. Nineteen ^{14}C dates are available from Belt Cave, five of

which were measured by Willard Libby (1955) in the 1950s. None of Libby's measurements were adjusted for fractionation or assigned laboratory (they are cited with numbers allocated by Libby), and they cannot be treated with any confidence. The remaining ^{14}C dates for Belt Cave were measured by the University of Pennsylvania (laboratory code prefix P). All of these measurements have high error terms and should be ignored. The two sets of measurements are listed separately, as the stratigraphy descriptions are inconsistent, and the two date sets cannot be reconciled.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
494, 495, 523	NL	Bone (burnt)	8085±720	7961-6239	9157-5666	Unreliable	No lab. code & high error term
524	Layer 10, 125-140 cm depth	Bone (burnt)	10,560±610	11,145-9461	11,814-8714	Unreliable	No lab. code & high error term
574	Layer 15-16, 125-215 cm depth	Bone (burnt)	8485±500	8257-6846	9119-6416	Unreliable	No lab. code & high error term
525	Same context as No. 574	Bone (burnt)	1130±300/ 1260±430	646-1207/ 349-1213	259-1404/354-1453	Unreliable	No lab. code & high error term
492 & 547	Level 21-8, 300-405 cm depth	Bone (burnt)	8004±415	7455-6497	8168-6066	Unreliable	No lab. code & high error term

(Libby 1955: 71-2)

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-19a	Strip C, 95-105 cm depth	Charcoal	7015±405	6354-5553	6901-5076	Unreliable	High error term
P-19b	Same as P-19a	Charcoal	7395±495	6814-5742	7541-5390	Unreliable	High error term
P-19c	Same as P-19a	Charcoal	7430±460	6897-5812	7475-5536	Unreliable	High error term
P-26	Strip C, 160 cm depth	Charcoal	7680±470	7137-6069	7717-5664	Unreliable	High error term
P-26a	Same as P-26	Charcoal	7905±475	7466-6391	8197-5908	Unreliable	High error term

P-24	Strip C, 175-90 cm depth	Charcoal	8785± 575	8711-7180	9660-6503	Unreliable	High error term
P-24a	Same as P-24	Charcoal	8360± 510	8165-6691	8762-6236	Unreliable	High error term
P-27	Strip C -200-30 cm depth	Charcoal	12,775 ±825	Date out of range	Date out of range	Unreliable	Date out of range

(Ralph 1955: 149-51)

Hotu Cave, 36º47' N, 53º24' E, Mazandaran

Hotu Cave was excavated in the 1950s under the direction of C.S. Coon (1951; 1952; 1957). Seven ^{14}C dates are available for Hotu Cave, which were measured in the 1950s in the formative years of ^{14}C dating. All have very high error terms, and there is a risk of contamination: P-34 and P-35 were contaminated with bat dung, and the excavators suspect that Trench D was also contaminated (1971, R. Vol.. 13: 372). All the dates should be treated as highly unreliable.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-45	Tr. B, 535 cm depth	Charcoal	6515± 425	5877-4995	6342-4533	Unreliable	High error term
P-34	Tr. A, Level 34-8, 520-90 cm depth	Charcoal	4830± 480	4226-2941	4771-2350	Unreliable	High error term
P-35	Tr. B, Level 39-41, 590-660 cm depth	Charcoal	4730± 320	3926-3028	4258-2668	Unreliable	High error term
P-36	Tr. B, 580 cm depth	Charcoal	6386± 425	5715-4846	6205-4373	Unreliable	High error term
P-37	Tr. D, Level A-49, 765 cm depth	Charcoal	8070± 500	7590-6447	8318-5996	Unreliable	High error term
P-12	Tr. D, 950 cm depth	Charcoal	9190± 590	9246-7615	10,430-7081	Unreliable	High error term
P-38	Tr. D, 1015 cm depth	Charcoal	9220± 570	9259-7682	10,430-7179	Unreliable	High error term
P-1623/I-635	Tr. D	Charcoal & soil	10,730 ±370	11,128-10,192	11,412-9457	Unreliable	High error term

(*1971, R. Vol. 13: 372; Ralph 1955: 149-51)*

5.2f. Southeastern Iran

Kerman

Kerman province incorporates the fertile Soghun Valley, which lies approximately 200-kilometres south of regional capital. The largest mound in the Soghun valley is Tepe Yahya, which has been the major focus of research, although the earliest settlement in the area is reported from Tepe Gaz Tavila (ibid.: 147-8).

Tal-i Iblis, 32º12' N, 48º13' E, Mashiz

Tal-i Iblis or 'Devil's Mound' lies in the Mashiz Valley, 12 kilometres southeast of Mashiz, and 70 kilometres southwest of Kerman city. The site has been badly damaged, and in its truncated state measures 118 metres by 100 metres in extent, and stands approximately 11 metres above the present plain surface. J.R. Caldwell (1967) directed excavation at the site in the 1960s, and identified six cultural periods at the site, of which the earliest (Iblis 0) represents pre-mound occupation, and Iblis 1-2 represent the Iblis period, which is reported to be roughly contemporary with Sialk III. However, Caldwell's cultural periods have subsequently been questioned, and Voigt and Dyson have argued that based on the available evidence (including ^{14}C dates for the site), "Iblis 0 cannot stand as a time unit distinct from Iblis I, and this 'period' should be rejected" (1992: 143). Ten ^{14}C dates are available for the site, from samples submitted by Caldwell to the University of Pennsylvania, USA (laboratory code prefix P); and Geochron Laboratories, Germany (laboratory code prefix GX).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
P-924	Level 0/Iblis 0	Charred seeds & bits of charcoal	5706 ±70	4652-4460	4713-4371	Unreliable	Bulk sample
P-925	Level 1/Early Iblis II	Charred seeds & small bits of charcoal	5865 ±72	4832-4618	4929-4545	Unreliable	Bulk sample
Gx-869	Level 1, House G	*n.d.*	6210 ±130	5311-5004	5468-4848	Unreliable	Material unknown

Gx-867	Level 1, Area B	*n.d.*	6180 ±160	5315-4939	5474-4771	Unreliable	Material unknown
Gx-863	Level 1, House F	*n.d.*	5780 ±160	4827-4457	5050-4333	Unreliable	Material unknown
Gx-868	Level 1, Area B,	*n.d.*	5460 ±110	4451-4082	4520-4004	Unreliable	Material unknown
P-926	Level 2/Late Iblis II	Charcoal	5857 ±73	4826-4616	4908-4540	Questionable	Measured before 1980
Gx-864	Level 2, Area A	*n.d.*	6060 ±140	5207-4801	5320-4619	Unreliable	Material unknown
Gx-865	Level 2, Area E	*n.d.*	5880 ±150	4933-4555	5207-4405	Unreliable	Material unknown
Gx-870	Unknown	*n.d.*	5580 ±110	4542-4333	4707-4181	Unreliable	Material unknown

(1966, R. Vol. 8: 351; Voigt & Dyson 1992: 131)

In terms of the University of Pennsylvania measurements, P-924 and -245 are from bulk samples and should be ignored. It is unclear whether P-926 is from a bulk sample or not, and given its measurement in the 1960s it should be treated with questionable confidence. The sample material for all of the Geochron dates is unreported, and subsequently the determinations cannot be treated with any confidence

Tepe Langar, 30º55' N, 57º34' E, Dasht-e Kavir

Tepe Langar is located approximately 30 kilometres southeast of Kerman, near the village of Langar. The site measures ca. 50,000 metres squared, and was identified during survey by C.C. Lamberg-Karlovsky, working on behalf of the Peabody Museum, Harvard University. It is unexcavated, but pottery in the form of a handmade coarse ware, similar to that recovered from Tepe Yahya, is reported (Goff Meade et al. 1968: 167-8). Only one ^{14}C date is available for Tepe Langar, and as it is consequently stratigraphically unreliable, it should be ignored.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
WSU-671	*n.d.*	*n.d.*	6050±270	5300-4692	5510-4369	Unreliable	Single date for site

(Voigt & Dyson 1992: 131)

Tepe Gaz Tavila/R37 (co-ordinates Daulatabad 33°36' N, 52°11' E)

Tepe Gaz Tavila, located near Daulatabad in the Soghun Valley, and was identified during survey of the Rud-i Gushk area by Martha Prickett (1976). Five phases of mudbrick architecture are recognized, for which three ^{14}C determinations are available for the site. Unfortunately, all of the determinations have errors of 150 ^{14}C years or more, and should be ignored.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
PRL-744	Tr. 1, Layer 4.3, 96-100 cm depth	Charcoal	6670± 150	5717-5481	5879-5327	Unreliable	Error of >150
PRL-748	Main sect. Layer 14, 340-50 cm depth	Wood twig Charcoal	6640± 180	5730-5382	5971-5227	Unreliable	Error of >150
PRL-749	Main sect., Layer 19.1, 444 cm depth	Charcoal	6650± 180	5737-5383	5977-5230	Unreliable	Error of >150

(1985, R. Vol. 27: 102)

Tepe Yahya 28º12' N, 55º59' E, Soghun Valley

Excavations were carried out at Tepe Yahya from 1976-75 by the Harvard University Yahya Project, under the direction of C.C. Lamberg-Karlovsky (1968; 1969; 1970; 1971; 1972l 1974; 1976). The mound stands 19.8 metres high, measures 187 metres in diameter, and is reported to have a sequence spanning from the Late Neolithic to the third millennium BC (Potts 2004).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
PRL-748	Tr. R37, Level 1, Ft. 4	*n.d.*	6640 ±180	5730-5382	5971-5227	Unreliable	Unknown material
PRL-749	Tr. R37, Level 1 Ft. 9.1	*n.d.*	6650 ±180	5737-5383	5977-5230	Unreliable	Unknown material
PRL-744	Tr. R37, Test Tr. 1, Level 3, Ft. 3	*n.d.*	6670 ±150	5717-5481	5879-5327	Unreliable	Unknown material
TUNC-37	Tr. R37, Test Tr. 1, Lvl3, Ft, 3	*n.d.*	4817 ±120	3711-3378	3941-3355	Unreliable	Unknown material
Beta-6561	Tr. D, Test Tr. 2, L. 14	*n.d.*	5680 ±200	4777-4338	5003-4052	Unreliable	Unknown material

Beta-6659	Tr. D, Test Tr. 6, L. 1-2	*n.d.*	5550 ±80	4463-4333	4552-4238	Unreliable	Unknown material
Beta-6477	Tr. C, Test Tr. 3, L 1, Feat. 2	*n.d.*	6870 ±550	6402-5230	7078-4618	Unreliable	Unknown material
Beta-6476	Tr. C, Test Tr. 1, L. 5	*n.d.*	5210 ±130	4223-3818	4333-3715	Unreliable	Unknown material
Gx-1509	Tr. D, Level 3	*n.d.*	6070 ±180	5217-4787	5461-4550	Unreliable	Unknown material
Gx-1737	Tr. D, Level 4	*n.d.*	5570 ±160	4609-4252	4777-4045	Unreliable	Unknown material
Gx-1728	Tr. D, Test Tr. 1, Level 7	*n.d.*	5610 ±140	4682-4329	4827-4054	Unreliable	Unknown material
WSU-871	C Test Tr. 1, 3-4	*n.d.*	5610 ±140	4682-4329	4827-4054	Unreliable	Unknown material
WSU-872	Tr. C, Test Tr. 7, level 1	*n.d.*	5580 ±280	4726-4055	5205-3797	Unreliable	Unknown material

(Lamberg-Karlovsky 1970: 197-9; Voigt & Dyson 1992: 131-2)

The sample material for all of the measurements is unreported, and a number of the determinations have error terms of over 150 ^{14}C years; Beta-7477, which has an error of 550 ^{14}C years, is of particular concern. The dates should all be treated as unreliable.

5.3. Neighbouring regions

5.3a. Turkmenistan

Jeitun, 37°57'N, 58°14'E

Jeitun (see pp. 143-7) is situated in southwestern Turkmenistan, at the interface which marks the northern edge of the Iranian Plateau, and the southern edge of the Kara Kum desert. The site measures 7000-square metres in size, stands 5.5 metres above the present plain surface, and contains some 3 metres of cultural deposits. It originally identified and extensively excavated by V. M. Masson (1961) in the 1950s, but no carbon samples were collected during this period. Renewed excavation and palaeoenvironmental research was conducted at the site from 1989-92 by the Djeitun Project, a British-Soviet collaboration (Harris et al. 1993), who

collected samples for ^{14}C dating. Recently, further carbon samples were collected from the site by a British Project (Harris 2010).

The five samples that were originally submitted for AMS dating at the Oxford Accelerator Unit (OxA-2912, -2913, -2914, -2915, -2916) lack stratigraphic information, and "their relationship with Masson's building phases is inferred, and cannot be substantiated" (Harris 2010a: 122). Given this, and the relatively high error terms of the dates for AMS measurements, they should be ignored. Dates OxA-4690, -4691. -4692, -4693, -4694 and -4695 were measured from samples submitted by Harris (1996: 437) from known contacts from his excavation. However, despite the fact that the samples were collected from successively deeper levels, they fail to demonstrate any chronological order, and can only be treated as of acceptable hygiene. Harris (Harris et al. 1993; Harris 2010) suggests that the stratigraphic inconsistency is because Jeitun was only occupied for a relatively short period of time, "at most 300–400 years, and possibly only 100–200 years" (2010: 122-3).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
OxA-2912	Ph. I?	Einkorn wheat (*Triticum Monoccocum*)	7100 ±90	6061-5889	6208-5772	Unreliable	Context inferred
OxA-2913	Ph. II/III?	*T. monoccocum*	7180 ±90	6207-5984	6236-5881	Unreliable	Context inferred
OxA-2914	Ph. III/IV?	*T. monoccocum*	7270 ±100	6230-6032	6378-5985	Unreliable	Context inferred
OxA-2915	Ph. IV?	*T. monoccocum*	7200 ±90	6208-5997	6246-5891	Unreliable	Context inferred
OxA-2916	Below Ph. IV?	*T. monoccocum*	7190 ±90	6207-5989	6241-5887	Unreliable	Context inferred
OxA-4690	12	Wheat (*Aegilops* sp.)	7035 ±65	5990-5846	6023-5762	Accept.	Known mat. & context
OxA-4691	17	Indeterminable. seeds	6850 ±65	5794-5665	5879-5633	Accept.	Known mat. & context
OxA-4692	37	*Aegilops* sp.	7025 ±70	5987-5844	6019-5749	Accept.	Known mat. & context
OxA-4693	Test pit 4	*Aegilops* sp.	7000 ±70	5982-5810	6003-5741	Accept.	Known mat. & context
OxA-4694	111	*Aegilops* sp.	7125 ±70	6065-5916	6206-5844	Accept.	Known mat. & context
OxA-4695	Test pit 7	Cereal grain & chaff	6127 ±70	5207-4992	5291-4848	Accept.	Known mat. & context

(1992, Archaeometry 32: 352; 1996, Archaeometry 36: 202)

Three further samples were collected and submitted for dating from off site at Jeitun (OxA-4914, -4915, -4916), where it appeared that two artificially cut ditch-lie features had been cut adjacent to the site (Harris 2010a: 214).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
OxA-4914	160-200 cm dpth	Charcoal	6940 ±100	5970-5720	6016-5650	Questionable	Error of ±100 or more
OxA-4915	510-650 cm dpth	Charcoal	7080 ±65	6020-5890	6070-5800	Acceptable	Known material & context
OxA-4916	850-100 cm dpth	Charcoal	7140 ±220	6230-5800	6450-5600	Unreliable	Error of ±100 or more

(Harris 2010a: table 9.2.)

OxA-4916 has an error of 220 ^{14}C years and cannot be treated with any confidence. The error of OxA-4914 is also high, and the measurement should be accepted with caution. Harris (2010: 124) attributes the high errors to the presence of relatively low amounts of carbon in the samples. OxA-4915 is from a known material and context, and is in stratigraphic agreement with OxA-4914; it is of acceptable hygiene.

5.3b. Afghanistan

Darra-i-Kur (Baba Darwish), 36°47' N, 70°00' E

Darra-i-Kur is a cave site, located just northeast of Kalafgan, near the village of Chinar-i Gunjus Khan, Badakhshan Province, northeastern Afghanistan (Ball 1982: 245). The cave is high up on the side of a valley, near the hamlet of Baba Darwish. The rock shelter is well stratified in silt deposits laid down by a stream. Both Middle Mesolithic and Late Neolithic deposits are reported from the site, although only details of the dates for the Late Neolithic occupation are given here. Dupree reports that the site has a distinctive Neolithic culture, which he refers to as the 'Goat Cult' Neolithic (1980: 264).

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Gx-0910	'Goat Cult' Neolithic	Collagen/ carbonate	3780±130/ 3425±125	2454-2034/ 1893-1538	2577-1833/ 2112-1441	Unreliable	Same lab. code for 2 dates

(Dupree 1980: chart 19)

Two dates are reported from Darra-i-Kur with the same laboratory code; their chemistry is uncertain, and they should be ignored.

Ghar-e Mar (Ak Kupruk I) and Ghar-e Asp (Aq Kupruk II) (co-ordinates Aq Kupruk, 36°05' N, 66°50' E)

The two neighbouring cave sites of Aq Kupruk I and Aq Kupruk II (see pp. 148-9) are located on a river bank above the modern town of Aq Kupruk, northern Afghanistan. The material is unknown for both of the measurements, and given that the two dates are separated by more than 2000 years, they should be treated with no confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Hv-425	Non-ceramic Neolithic	*n.d.*	8650±100	7816-7579	8170-7520	Unreliable	Material unreported
Hv-1335	Non-ceramic Neolithic	*n.d.*	10,210±235	10,431-9461	10610-9297	Unreliable	Material unreported

(Dupree 1980: chart 19)

5.3c. Baluchistan

Mehrgarh, 29º25' N, 67º35' E

Mehrgarh (see pp. 149-54) is located at the foot of the Bolan Pass, in the Kachi Plain, western Pakistan. It is a spatially and temporally extensive site measuring some two kilometres squared; although the entire area was never occupied simultaneously. It was discovered in 1974 by a French archaeological team, and was excavated by the latter and their counterparts

at the Pakistan Department of Archaeology for 11 seasons from 1974 to 1986 (Jarrige et al. 1995), although a full report was never published. Excavation was resumed at the site in 1997, and continued for four seasons until 2000 (Jarrige et al. 2005). The Neolithic at Mehrgarh is divided into four periods: IA, IB, IIA, and IIB, of which IA is pre pottery. There is a problem with the ^{14}C dates for Mehrgarh, which has been attributed to a range of factors that include bitumen contamination, exposure of samples to the Bolin River, tree root contamination, and/or the use of the area for animal grazing (Jarrige et al. 1995: 1995: 282, 456; Jarrige 2000: 282). Consequently, many of the ^{14}C dates for Mehrgarh show little coherence with the archaeological stratigraphy and context (Jarrige et al. 1995: 59; C. Jarrige 2005: 27), and they are of questionable, if not unreliable, confidence.

Lab. code	Context	Sample type	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
Beta-1407	Period IA, MR3T 550; 580 cm depth	Charcoal mixed with ash	6925± 80	5889-5730	5983-5670	Question.	Possibly contaminated
Beta-1408	Period IA, MR3T 545; 620 cm depth	Charcoal mixed with ash	7115± 290	6327-5720	6567-5488	Unreliable	High error
Ly. 1948	Period IA, MR3T 537; 340-70 cm depth	Charcoal	5720± 730	5467-3808	6222-2939	Unreliable	High error & too late
Ly. 1949	Period IA, MR3T 537; 340-70 cm depth	Charcoal	5530± 180	4586-4078	4777-3977	Unreliable	High error & too late
Ly. 1947	Period IA, MR3T 536; 340-70 cm depth	Charcoal	5830± 190	4931-4464	5208-4342	Unreliable	High error & too late
Beta 1721	Period IA, MR3T 534	Charcoal	9385± 120	9105-8459	9134-8314	Question.	Possibly contaminated
Beta-7316	Period IA, MR3D D9E, Level 2	Charcoal	5990± 70	4978-4762	5056-4712	Question.	Possibly contaminated
Beta-2686	Period IA, MR3S 811	Charcoal	5869± 70	4827-4618	4906-4543	Question.	Possibly contaminated
Lv. 993	Period IB, MR3 Bolan foyer S	Charcoal	6110± 90	5207-4943	5296-4805	Question.	Possibly contaminated
Lv. 994	Period IB, MR 3 N	Charcoal	6290± 70	5367-5208	5467-5059	Question.	Possibly contaminated

Beta-1719	Period IB, MR3 D10A, Level 5	Charcoal	13,340 ±125	14,803-14,142	14,895-13,596	Unreliable	Too early
Ly. 1946	Period IB, MR3 AIA 433	Charcoal	32,650 ±3000	39,536-32,773	45,076-30,223	Unreliable	High error & too early
Ly. 1950	Period IB, MR3 AIA 433	Charcoal	8440± 250	8247-7653	8638-7376	Unreliable	High error
Lv. 906	Period IB, MR3 D10A	Charcoal	5950± 65	4932-4729	4998-4694	Question.	Possibly contaminated
Lv. 907	Period IB, MR3 A1A	Charcoal	6020± 80	5011-4798	5207-4722	Question.	Possibly contaminated
Lv. 908	Period IB, MR3 locus II	Charcoal	6090± 70	5205-4856	5216-4836	Question.	Possibly contaminated
Lv. 909	Period IB, MR3 103	Charcoal	5940± 100	4952-4707	5196-4549	Question.	Possibly contaminated
Lv. 910	Period IB, MR3 A1A	Charcoal	5880± 100	4895-4612	4997-4504	Question.	Possibly contaminated
Beta 7315	Period IIA, MR3/4 M91, F	Charcoal	5620± 100	4546-4351	4707-4268	Question.	Possibly contaminated
Beta 2688	Period IIA, MR4 B61, Level 3, 813	Charcoal	5490± 70	4446-4262	4493-4081	Question.	Possibly contaminated
Beta 7314	Period IIB, MR3/4 F2, locus 14	Charcoal	5400± 90	4344-4072	4446-3996	Question.	Possibly contaminated
Beta 1720	Period IIB, MR4 F6B 5	Charcoal	7115± 120	6094-5843	6225-5747	Unreliable	Too early
Beta 2687	Period IIB, MR4 F5F, Level 4, 812	Charcoal	5240± 110	4230-3966	4328-3804	Question.	Possibly contaminated
Ly. 1945	Period IIB, MR4 F5F, Level 4	Charcoal	5360± 310	4519-3802	4940-3524	Unreliable	High error

(Jarrige et al. 1995: 555-6)

5.4. Spatial analysis

A set of spatial-temporal analyses was carried out using the ^{14}C determinations from the earliest level at each site. In accordance with Ammerman and Cavalli-Sforza's (1984) 'Wave of Advance' it would be expected that the earliest Neolithic sites in Iran would be situated in the central Zagros – the area closest to the origin of farming in the Fertile Crescent – and that sites would progressively decrease in age in an easterly direction from this region. Sites were classified as 'Neolithic' or 'Chalcolithic'

on the basis of conventional assignment. It is recognised that while in principle it is important to distinguish the spatial and chronological distribution of different elements of the 'Neolithic' package (Gkiasta et al. 2003: 48), it is not currently possible to do this with the level of available information.

The single, earliest date was taken from each site. Following Ammerman and Cavalli-Sforza (1971: 677) at sites for which there were multiple ^{14}C dates, only the earliest determination was taken, and where the information was available the date from the earliest stratigraphic level was used. The visual techniques employed in the analysis were similar to those used by Clark (1965a, 1965b) and Ammerman and Cavalli-Sforza (1971, 1984). Dates were grouped into temporal categories of 1000-year intervals from ca. 10,000 to 4000 cal. BC. Where the distribution of a calibrated date straddled two temporal intervals it was grouped in the period which it fell into the most. For example, 4800-5300 BC would be assigned to the interval ca. 5000–6000 BC, whilst 4800–5100 would be placed in the interval ca. 4000–5000 BC. In order to define the main lines of expansion, varied symbols were used to express degrees of age of the sites. Where the methods employed in this research differ from those of Clark (1961a, 1961b) and Ammerman and Cavalla-Sforza (1984), is in the use of calibrated, rather than raw ^{14}C dates, and the employment of chronometric hygiene selection criteria.

Two sets of spatial analyses were conducted. In the first set, only calibrated dates for which the chronometric hygiene of the original ^{14}C determinations had been classed as 'reliable' or 'acceptable' were used. In the second set, the earliest calibrated date from each site was used, regardless of the hygiene of the original ^{14}C determination. The second set of spatial analyses was conducted in order to emphasise the importance of assessing the chronometric hygiene of ^{14}C determinations before conducting further analysis. For, as is clear from the two different sets of maps produced in this research (see Fig. 5.0-5.13), the use of ^{14}C determinations with poor chronometric hygiene can create a very different pattern, to that which is observed when only 'acceptable' and 'reliable' determinations are used. In this study, the earliest ^{14}C dates for sites, where they have not been

chronometrically ‘cleaned’, are generally much earlier, than the earliest ‘clean’ ^{14}C dates for the same sites.

The earliest site with a ‘clean’ date is the cave site of TB75 in the Bolaghi Valley, Fars, which falls into the 10,000-9000 BC interval. However, the evidence for the practice of agropastoralism at TB75 is controversial, and the site is currently classed as Proto-Neolithic. Until further evidence becomes available, it will be ignored in the consideration of the spread of farming in Iran in this research.

The first Neolithic sites, for which there is evidence of animal domestication and/or cultivation, do not appear in Iran until the 9000-8000 BC temporal interval. During this period there is an efflorescence of Neolithic sites in the Central Zagro, which continues into the following period (e.g. Sheikh-e Abad, Asiab, Ganj Dareh &Tepe Guran). This is followed by dispersal down onto the southwestern lowlands 8000-7000 BC, evidenced by the founding of Ali Kosh and Chogha Bonut. During 7000–6000 BC, Neolithic sites are found further to the southeast in Fars Province (e.g. Tell-e Mushki, Tall-e Jari B & Tol-e Băsi), and in southwestern Turkmenistan at Jeitun. During the period 6000–5000 BC settlement continued to flourish in Fars, with the establishment of Tol-e Nurabad, and a subsequent settlement expansion occurred to the southeast, with the founding of Tepe Yahya and Tall-i Iblis in the Kerman Province. This period also witnessed the establishment of the first Neolithic sites in the Ushnu-Solduz Valley, northwestern Iran (e.g. Hajji Firuz Tepe, Yanik Tepe). In the following period, 5000–4000 BC, further expansion occurred to the southeast, with the settlement of Tepe Langar and Tall-e Iblis in the Gorgan and Damghan region, Kerman province.

The spatial analysis of the earliest dates for Neolithic sites in Iran, when no account is made for chronometric hygiene of the ^{14}C determinations, exhibits a clearly different pattern. The distribution of the 'uncleaned' dates suggests that Neolithic settlement begun much earlier and, indeed, a new temporal period of ca. 10,000–9000 BC had to be introduced in the spatial analysis. The ‘unclean’ dates also suggest that Early Neolithic settlement was much

more widely dispersed, evidencing Early Neolithic occupation at ca. 10,000-9000 BC in the highland Zagros (Ganj Dareh, Sheikh-e Abad & Asiab), the southwestern lowlands (Ali Kosh & Chogha Sefid) and on the Caspian littoral lowland (Hotu Cave). The sites dating to the next period (ca. 9000-8000 BC) show a similar distribution, suggesting a long period of occupation at a number of sites (e.g. Asiab, Ganj Dareh, Ali Kosh, Chogha Sefid). During 8000–7000 BC, the number of sites in the highland Zagros and neighbouring lowland plains increased, and settlement on the Caspian Sea Plain continued with the occupation of Belt Cave. Settlement on the Marv Dasht Plain, southwestern Iran, occurred for the first time with the establishment of Tel-e Mushki. During 7000–6000 BC, further settlement occurred in Fars with the occupation of Tall-e Jari B and Tol-e Băsi, and Neolithic sites appear for the first time in northwestern Iran, in the Ushnu-Solduz Valley (e.g. Yanik Tepe). On the Qazvin Plain, Neolithic settlement is evidenced at Zagheh, and Neolithic sites are also found in northeastern Iran at Sang-i Chakmaq West and in southeastern Turkmenistan at Jeitun. In the 6000–5000 BC period settlement continues in Fars with the occupation of Tol-e Nurabad, and there is further expansion southeast, represented by the occupation of Tepe Langar, Tall-e Iblis and R-37 in Kerman. During ca. 5000–4000 BC, there is no evidence of highland occupation, with instead the emphasis placed on lowland situations.

The results of the spatial analysis using 'unclean' ^{14}C dates can be queried in a number of ways. Firstly, it suggests that the Neolithic settlement of the highland Zagros and southwestern lowlands was contemporaneous, when the use of 'clean' dates suggests that there was actually a temporal gap in the occupation of the two regions, and that the highland Zagros settlements were earlier than those on the southwestern lowlands. Secondly, the dates suggest that Hotu Cave was also occupied during the period 10,000-9000 BC. However, given that the dates for this site were measured in the 1950s, in the formative years of ^{14}C dating, this is highly debatable. The 'uncleaned' determinations also imply that many sites (e.g. Asiab, Ganj Dareh, Ali Kosh, Chogha Sefid), were occupied for hundreds of years, however, given that none of the dates have been assessed for chronometric hygiene, it is

probable that this is just an outcome of the high error terms of the dates. The unclean dates also point to the earliest Neolithic settlement of the Central Plateau having been the occupation of Zagheh, during the period 7000-6000 BC. However, the dates for this site are of poor chronometric hygiene, and more recent ^{14}C dates for the site (cf. Fazeli et al. 2005) have thrown them into complete disrepute.

5.5. Discussion

The first section of this chapter inVol.ved the calibration and chronometric hygiene evaluation of the currently available ^{14}C determinations for Neolithic sites in Iran and neighbouring regions. The list is by no means exhaustive, and there is plenty of scope for the inclusion of new dates as, and when, this material becomes available. In the second section, the spatial and temporal distribution of the Neolithic sites for which dates were available was assessed, by plotting the earliest date for each site onto a geographical map of Iran. This was done using both: the earliest 'clean' date; and the earliest date regardless of chronometric hygiene from each site. The two sets of analyses reveal remarkably different patterns in the distribution of Neolithic sites. The temporal and geographical distribution of the dates for which no chronometric hygiene selection criteria had been applied, suggests that the Neolithic of Iran began ca. 10,000-9000 BC in three different regions: the Central Zagros; lowland southwestern Iran; and the Caspian Sea Plain. In comparison, when dates which had been chronometrically assessed were used, these show that the Neolithic of Iran did not begin until 9000-8000 BC, and that settlement during this period was restricted to the Central Zagros. The 'clean' dates indicate that it was not until the subsequent period, ca. 8000-7000 BC, that the first Neolithic sites were occupied in the southwestern lowlands (e.g. Ali Kosh, Chogha Bonut), and that the history of Neolithic settlement in the Caspian Sea Plain is unclear, due to the poor hygiene of the ^{14}C dates from Hotu and Belt Caves. The discrepancy between the analysis of the 'clean' and the 'uncleaned' ^{14}C dates, emphasizes the need to employ stringent chronometric hygiene procedures in the analysis of ^{14}C dates, in order to avoid misleading

results. In this example, the large variation between the 'clean' and 'unclean' dates, is partially due to the fact that the majority of the ^{14}C dates available for Iran were made between the 1950s and 1970s, in the formative years of the ^{14}C dating method. Due to the high potential for error in the use of ^{14}C determinations which have not been evaluated for their chronometric hygiene, in the remainder of this thesis only 'cleaned' ^{14}C determinations will be used.

5.6. Conclusion

The temporal and spatial distribution of the Neolithic sites of Iran and neighbouring regions, as revealed by the earliest date from each site for which ^{14}C dates are available, exhibits distinct regional clustering. The earliest Neolithic occupation of Iran is represented by the occupation of Asiab and Sheikh-e Abad, in the Central Zagros, ca. 9000-8000 BC. In the subsequent period, ca. 8000-7000 BC, there is an increase in the number of Central Zagros sites, as attested by the occupation of Tepe Abdul Hosein, Ganj Dareh Tepe and Tepe Guran. It is also during this period that the first southwestern lowland sites were occupied, i.e. Ali Kosh and Chogha Bonut. During the period ca. 9000-7000 BC, then, the Neolithic occupation of Iran was restricted to central western and southwestern Iran. In the following period, ca. 7000-6000 BC, Neolithic settlements expanded further into southwestern Iran, were they are represented at Tal-e Jari B, Tal-e Mushki and Tol-e Băsi, Fars Province. The site of Jeitun, southwestern Turkmenistan, for which the precedent(s) are unknown, was also founded during this period. The period ca. 6000-5000 BC witnessed an efflorescence of settlement, with as well as the aforementioned regions, settlements also appearing for the first time in the Ushnu-Solduz Valley of northwestern Iran, a pattern which continued into the period 5000-4000 BC.

It appears, then, that various regions of Iran were occupied at different periods of time during the Neolithic, with the central Zagros Mountains and southwestern lowlands occupied first, followed by lowland Fars and southwestern Turkmenistan, and subsequently northwestern Iran. This

distribution pattern is not what would be expected if farming had spread by a Wave of Advance, and is more in keeping with zonal models for the dispersal of early farmers, such as those of Sherratt (1980; 2007) and van Andel and Runnels (1995), where distinct locations were targeted by early farmers, whilst others were deliberately ignored.

In light of the temporal and geographical distribution of the Neolithic sites, some refinements need to be made to the chronology for the Neolithic of Iran, which was proposed in Chapter Three (see p. 86). It was suggested, on the bases of the material assemblages, that the following periods should be recognized: the Early Neolithic (ca. 8000-6500 BC), characterized by the absence of pottery; the Middle Neolithic (ca. 6500-6200 BC), marked by the introduction of chaff-tempered software; and the Late Neolithic (ca. 6200-5500 BC), which was a period of increasing trade networks and complexity in anticipation of the development of metallurgy. Reviewing the definitions of these periods in respect to the ^{14}C evidence, it is apparent that the Early Neolithic period needs to be proceeded by a proto-Neolithic or Neolithic transitory stage from ca. 9000-8000 BC, as evidenced at Asiab, Sheikh-e Abad and possibly Tang-i Bolaghi, and that the Late Neolithic period should be expanded to 6200-5000 BC, to incorporate a transitory period between the Late Neolithic and the Early Chalcolithic.

As is evident from the maps of the earliest ^{14}C dates for sites in Iran, the Central Iranian Plateau represents a large lacuna in our knowledge of the Neolithic of Iran. To date, no Early Neolithic sites are known in the region. This is either because the Early Neolithic sites have been buried by alluvial deposition (Brookes 1982; Brookes et al. 1982), which is well attested in the area (Gillmore et al. 2007); or because there was no Early Neolithic occupation of the Central Plateau, due to the inhospitableness of the region. The Central Plateau has witnessed relatively little archaeological attention compared to other regions of Iran, and using the available published material neither explanation can be ruled out. Consequently, in the next chapter new archaeological research from the Tehran, Qazvin and Kashan Plains, of which

I was part, is reviewed in order to establish the pattern of Neolithic settlement on the Central Plateau.

Site	Date from earliest stratigraphic level regardless of hygiene		Earliest acceptable date from earliest stratigraphic level (where available)	
	^{14}C yrs BP	Cal. BC	^{14}C yrs BP	Cal. BC
Hajji Firuz Tepe	7926±86	7059-6610	6870±100	5983-5621
Dalma Tepe	5986±87	5207-4687	-	-
Pisdeli Tepe	5460±160	4681-3966	5638±85	4685-4341
Sayid Hammandani	7800±210	7296-6241	-	-
RY-2	5445±72	4450-4057	-	-
Yanik Tepe	7035±69	6026-5752	7035±69	6026-5752
Tepe Abdul Hosein	6359 8655±240	8322-7142	-	-
Tepe Sarab	7800±60	6817-6477	7800±60	6817-6477
Sheikh-e Abad	9810±60	9436-9179	-	-
Jani	8140±60	7344-6867	-	-
Ganj Dareh Tepe	10,400±150	10,676-9771	8840±50	8210-7756
Tepe Asiab	9775±85	9449-8839	9775±85	9449-8839
Seh Gabi	6220±80	5362-4964		
Tepe Guran	8410±200	8170-6831	8280±40	7419-7184
Bog-i-No	6200±140	5470-4836		
Zagheh	7147±90	6221-5845	6100± 60	5213-4849
Sialk North	5700±90	4726-4354	-	-
Belt Cave	6785±575	9660-6503	-	-
Hotu Cave	10,730±370	11,412-9457	-	-
Sang-i Chakhmaq	7270±125	6415-5911	-	-
Ali Kosh	9900±200	10,141-8790	8540±90	7793-7356
Chogha Sefid	10,245±40	10,179-9866	-	-
Tepe Sabz	9050±160	8699-7732	6070±100	5286-4727
Chogha Bonut	10, 980±100	11,151-10,702	8120±40	7296-7043

Chogha Mish	8300±60	7519-7176	6600±50	5621-5481
Tall-e Gap	5870±160	5207-4371	5540±120	4684-4060
Tall-e Jari A	6280±69	5465-5052	6280±69	5465-5052
Tall-e Jari B	7297±45	6237-6062	7297±45	6237-6062
Tall-e Bakun A	5570±40	4488-4342	5570±40	4488-4342
Tol-e Nurabad	6977±56	5984-5741	6977±56	5984-5741
Toll-e Băsi	7283±43	6230-6061	7283±43	6230-6061
TB75 (Proto-Neolithic lyrs)	10190±45	10116-9762	10190±45	10116-9762
Tall-e Mushki	8460±120	7752-7175	7720±40	6211-6013
Tal-i Iblis	6210±130	5468-4848	5857±73	4908-4540
Tepe Langar	6050±270	5510-4369	-	-
Tepe Yahya	6670±150	5879-5329	-	-
R-37	6650±180	5977-5230 BC)	-	-

Table 5.0: *The earliest ^{14}C determination (BP) and calibrated age (BC) for each site. All calibrated dates are given at the 95.4% confidence interval.*

Temporal interval (yrs BC)	Site
5000-4000 BC	Pisdeli Tepe, Tal-i Gap, Tal-i Bakun A, Tal-i Iblis
6000-5000 BC	Hajji Firuz Tepe, Yanik Tepe, Zagheh, Chogha Mish, Tal-i Jari A, Tal-i Bakun B, Tepe Gaz Tavila/R37, Tepe Sabz, Tepe Yahya, Tole- Nurabad
7000-6000 BC	Tal-i Jari B, Tal-i Mushki, Jeitun, Tol-e Băsi
8000-7000 BC	Tepe Abdul Hosein, Ganj Dareh Tepe, Tepe Guran, Ali Kosh, Chogha Bonut
9000-8000 BC	Asiab
10,000-9000 BC	TB75
10,000+ BC	

Table 5.1: *Sites assigned to temporal groups according to the earliest 'clean' ^{14}C date.*

Temporal interval (yrs BC)	Site
5000-4000 BC	Pisdeli Tepe, RY-2, Sialk, Tal-i Gap, Tal-i Bakun A, Dalma Tepe
6000-5000 BC	Yanik Tepe, Seh Gabi, Bog-i-No, Tal-i Jari A, Tal-i Bakun B, Tal-i Iblis, Tepe Langar, Tepe Gaz Tavili/R37, Sang-i Chakhmaq West, Tol-e Nurabad
7000-6000 BC	Hajji Firuz Tepe, Sayid Hammadani, Tepe Sarab, Tepe Guran, Zagheh , Tal-i Jari B, Jeitun, Jani, Tol-e Băsi
8000-7000 BC	Tepe Abdul Hosein, Belt Cave, Chogha Mish, Tal-i Mushki, Tepe Guran
9000-8000 BC	Tepe Sabz
10,000-9000 BC	Sheikh-e Abad, Ganj Dareh, Asiab, Ali Kosh, Chogha Sefid, TB75
10,000+ BC	Hotu Cave, Chogha Bonut,

Table 5.2: *Sites assigned to temporal groups according to the earliest ^{14}C date, regardless of chronometric hygiene.*

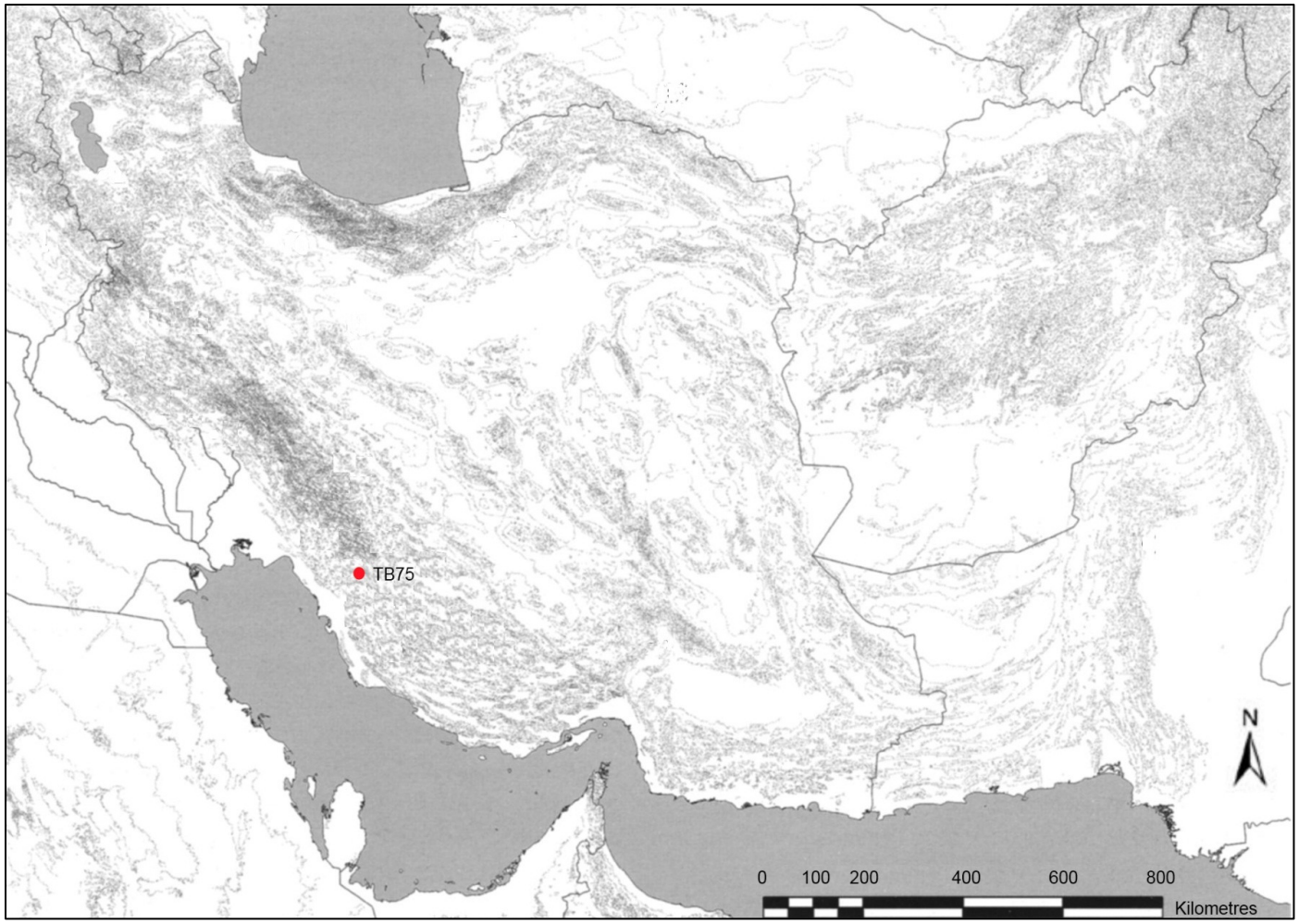


Figure 5.0: *Distribution of sites ca.10,000-9000 BC using cleaned dates.*

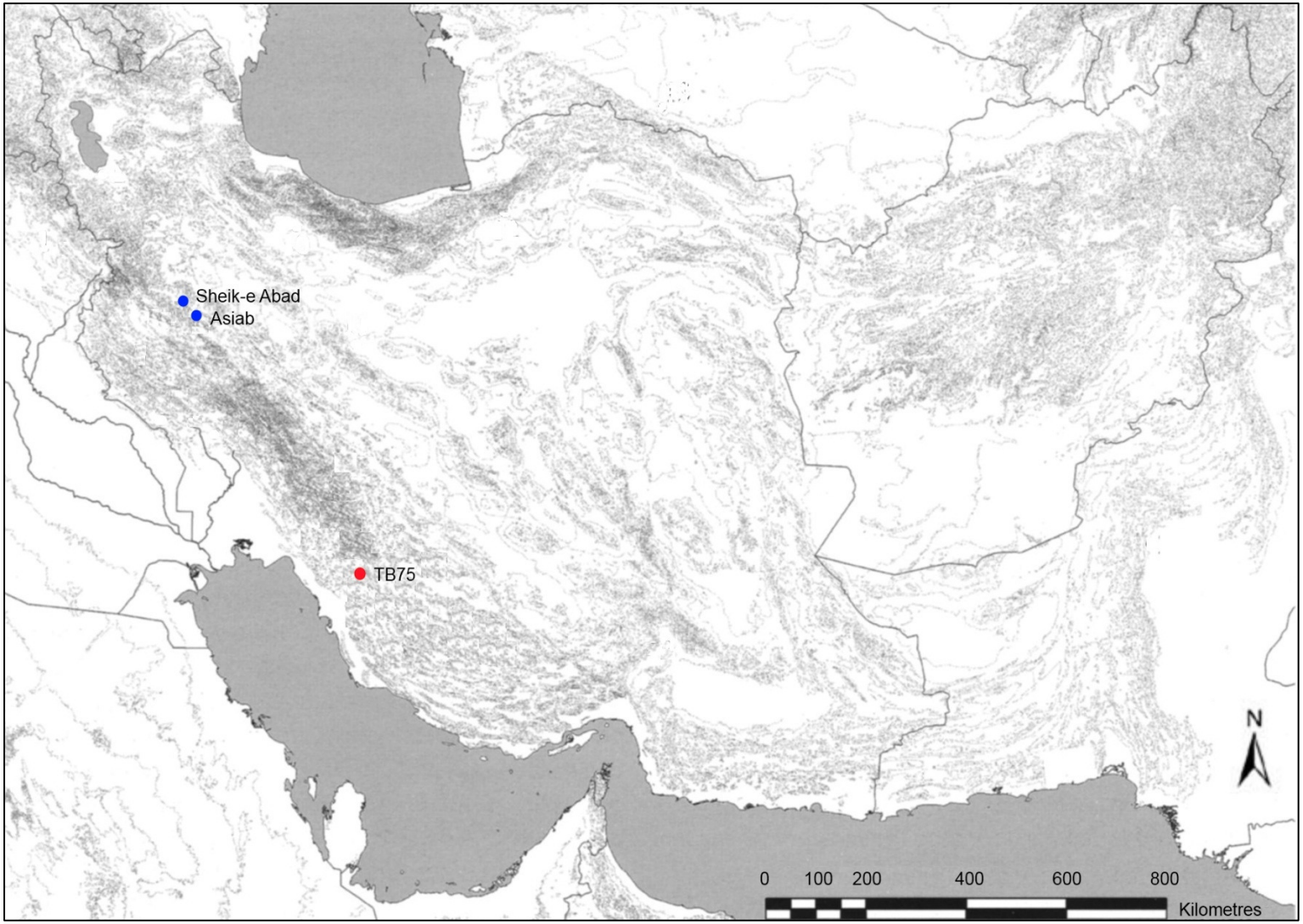


Figure 5.1: *Distribution of sites ca. 9000-8000 BC using cleaned dates.*

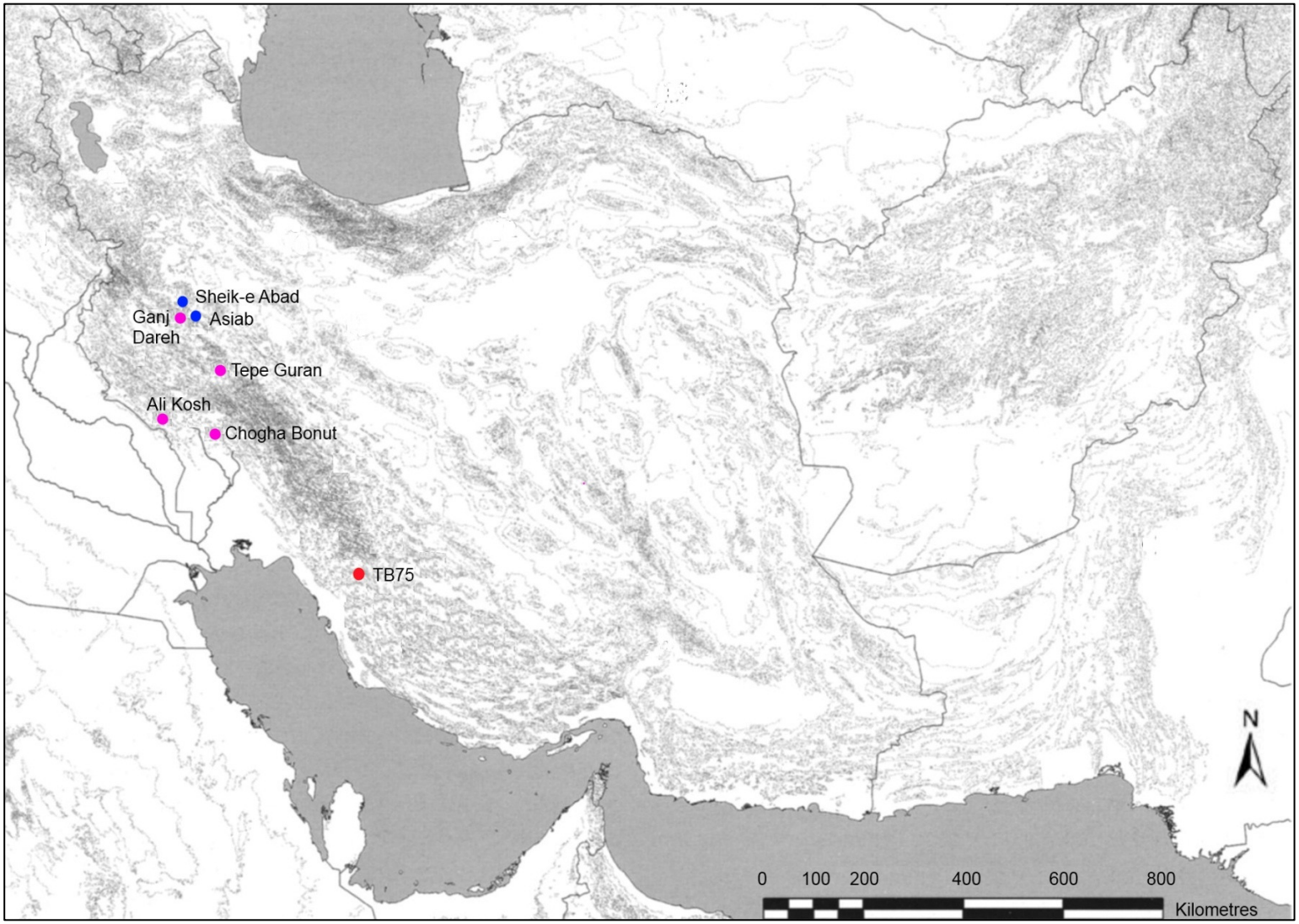


Figure 5.2: *Distribution of sites ca. 8000-7000 BC using cleaned dates.*

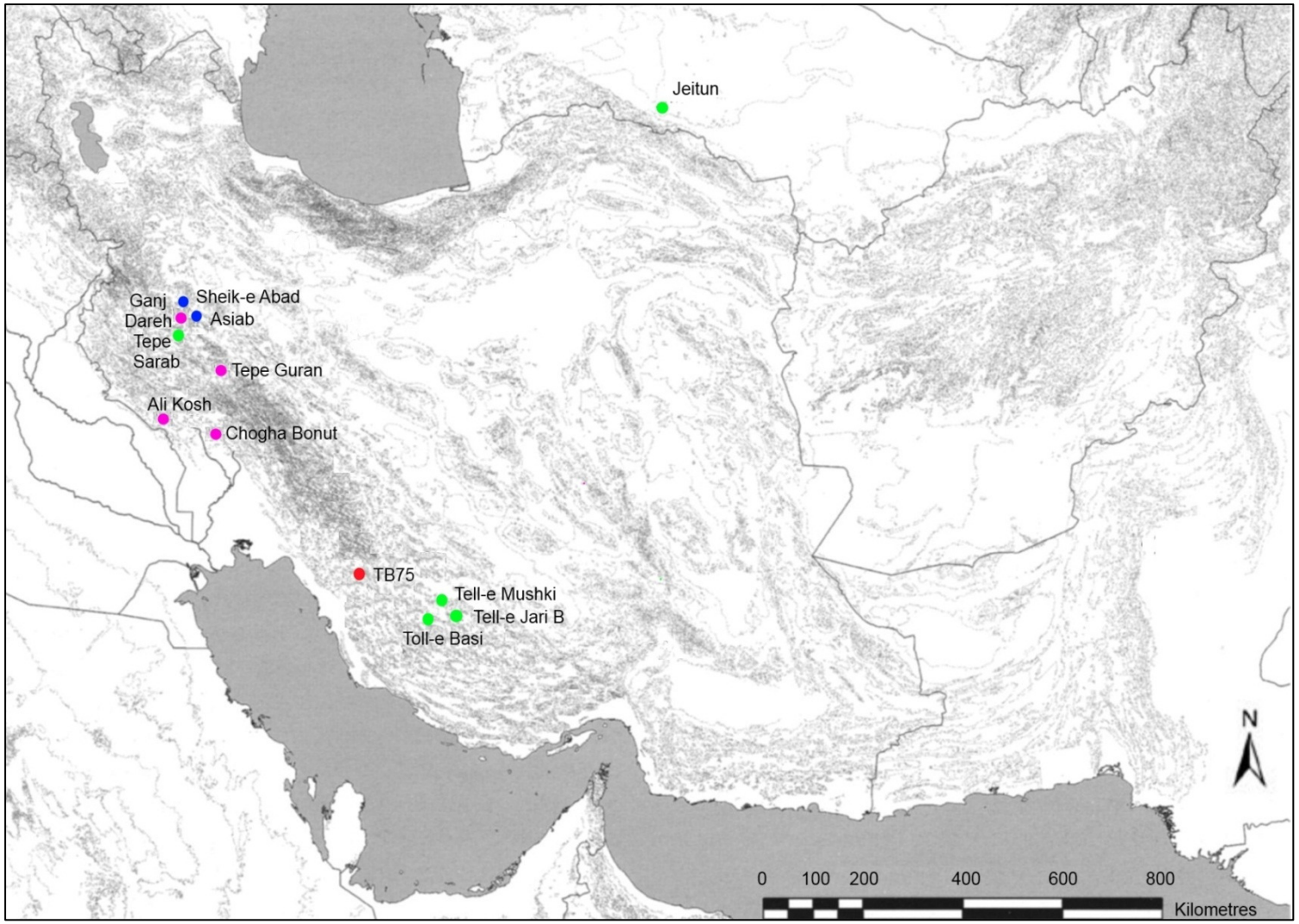


Figure 5.3: *Distribution of sites ca. 7000-6000 BC using cleaned dates.*

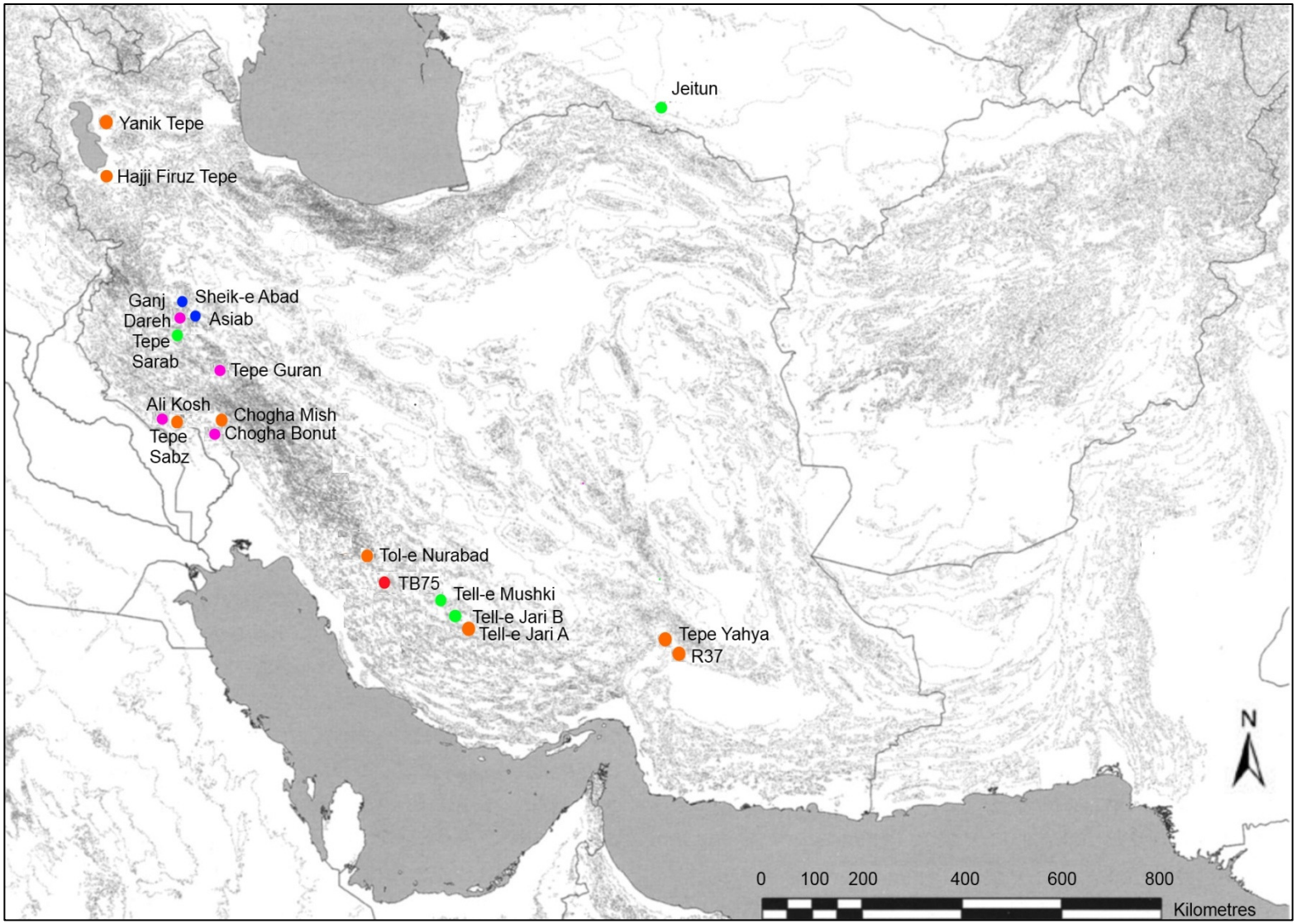


Figure 5.4: *Distribution of sites ca. 6000-5000 BC using cleaned dates.*

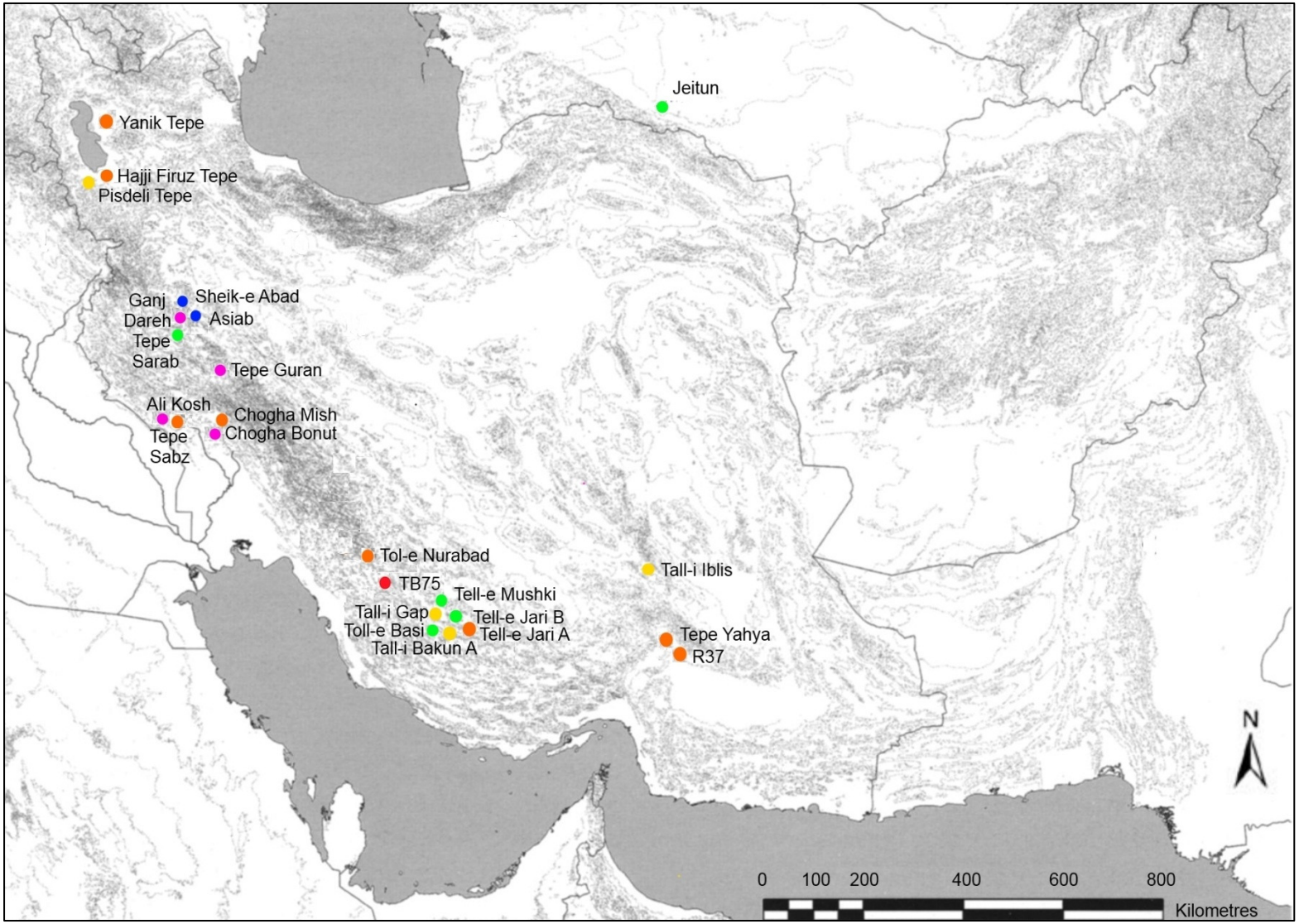


Figure 5.5: *Distribution of sites ca. 5000-4000 BC using cleaned dates.*

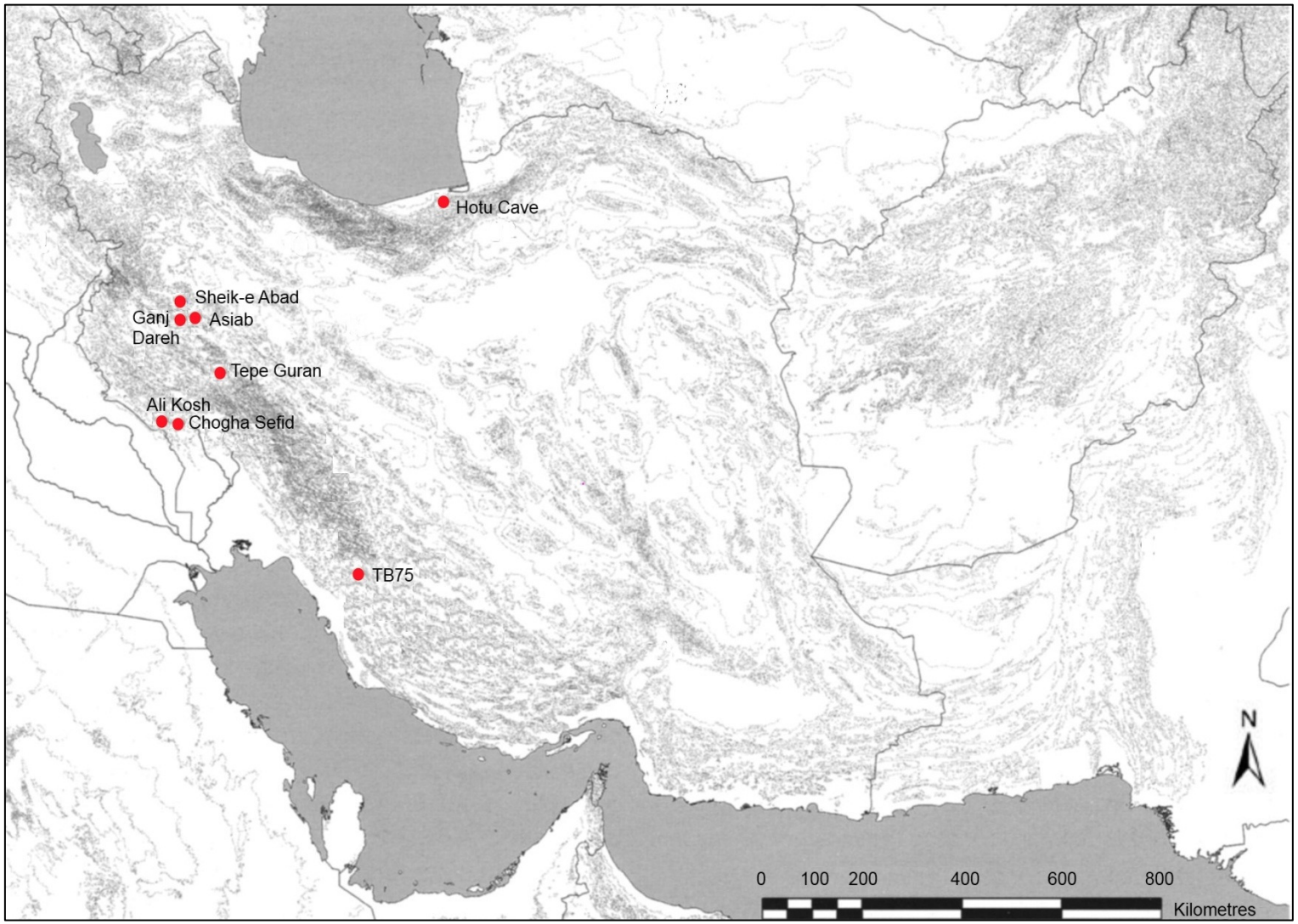


Figure 5.6: *Distribution of sites ca. 10,000-9000 BC (no chronometric hygiene).*

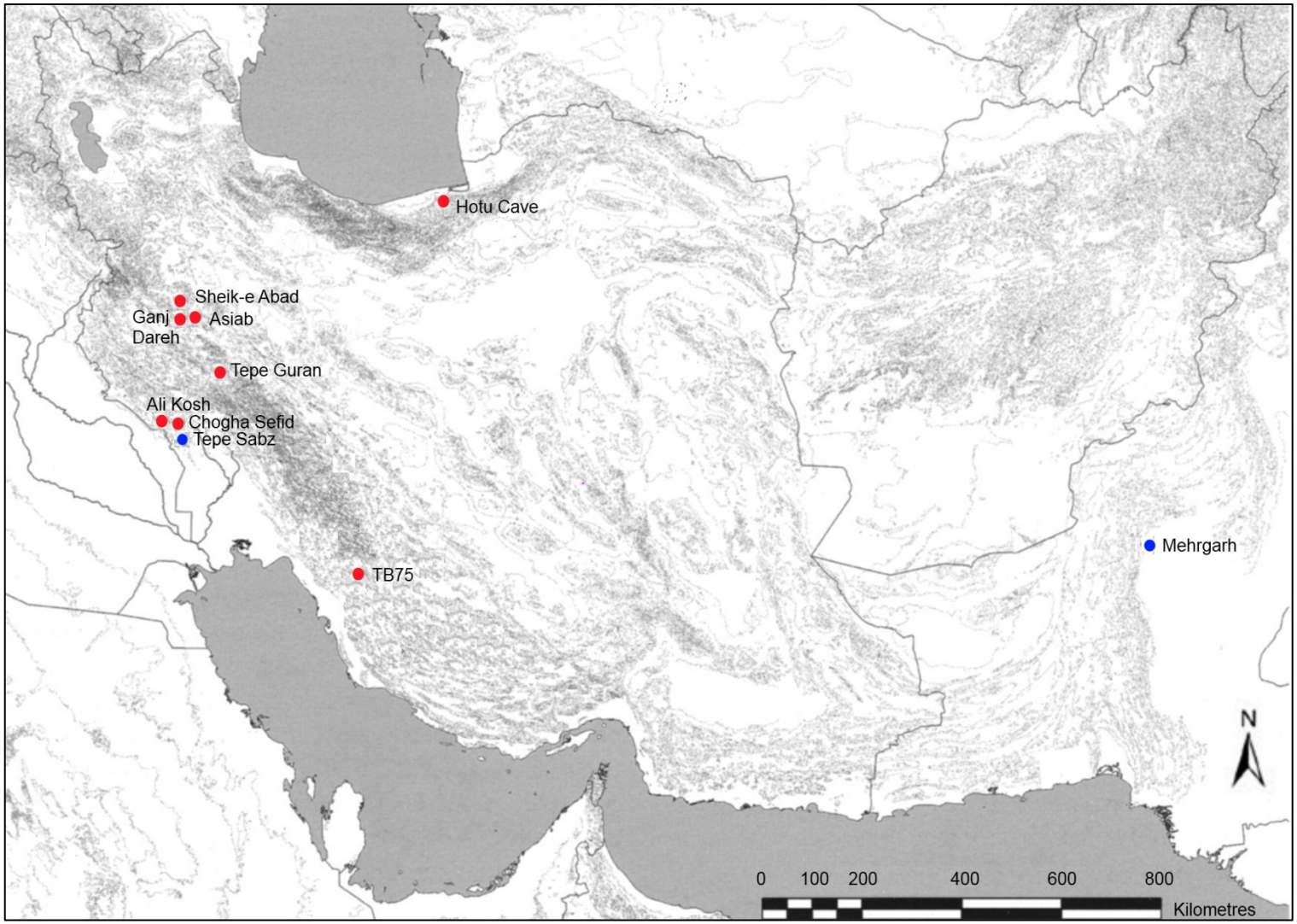


Figure 5.7: *Distribution of sites ca. 9000-8000 BC (no chronometric hygiene).*

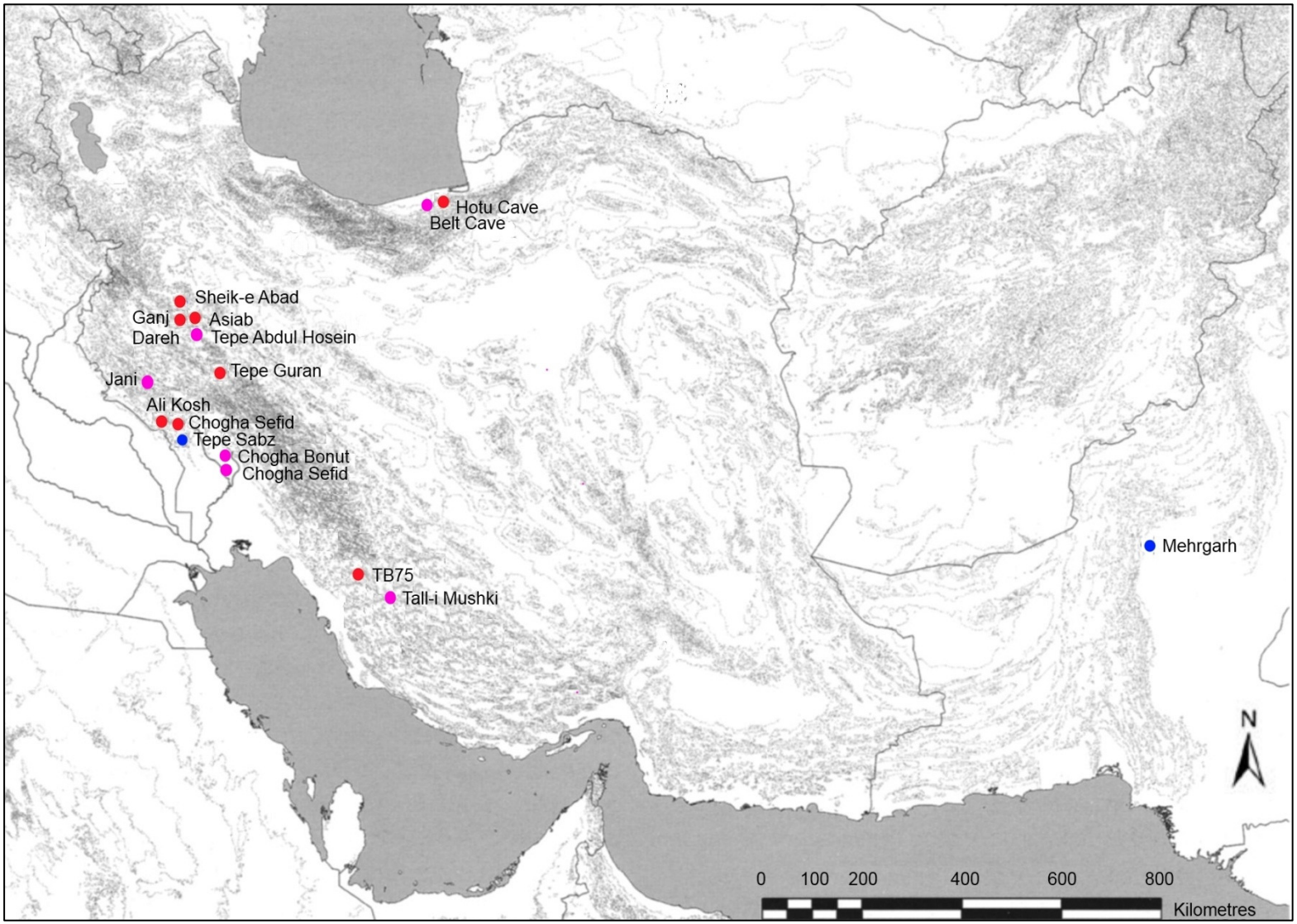


Figure 5.8: *Distribution of sites ca. 8000-7000 BC (no chronometric hygiene).*

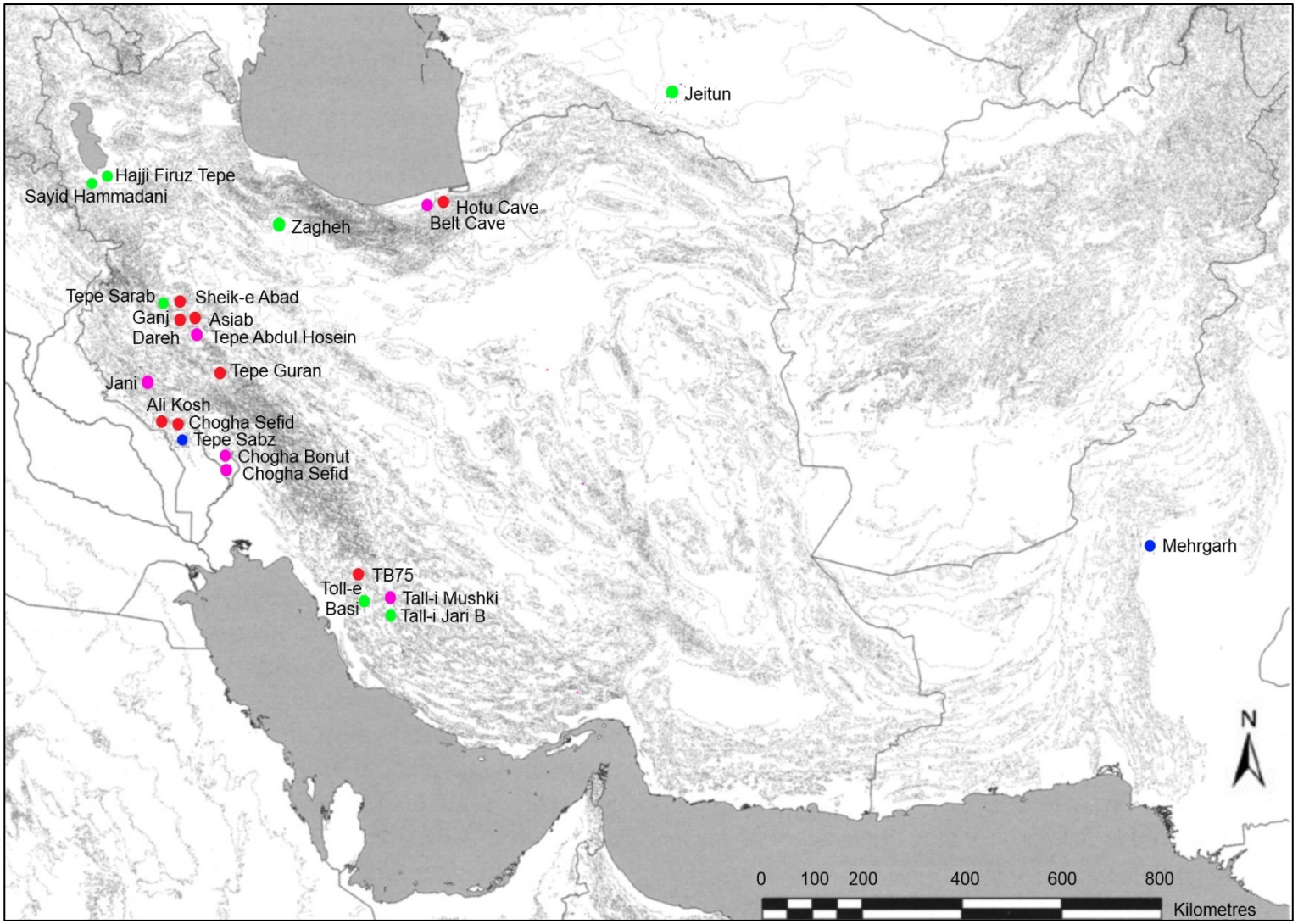


Figure 5.9: *Distribution of sites ca. 7000-6000 BC (no chronometric hygiene).*

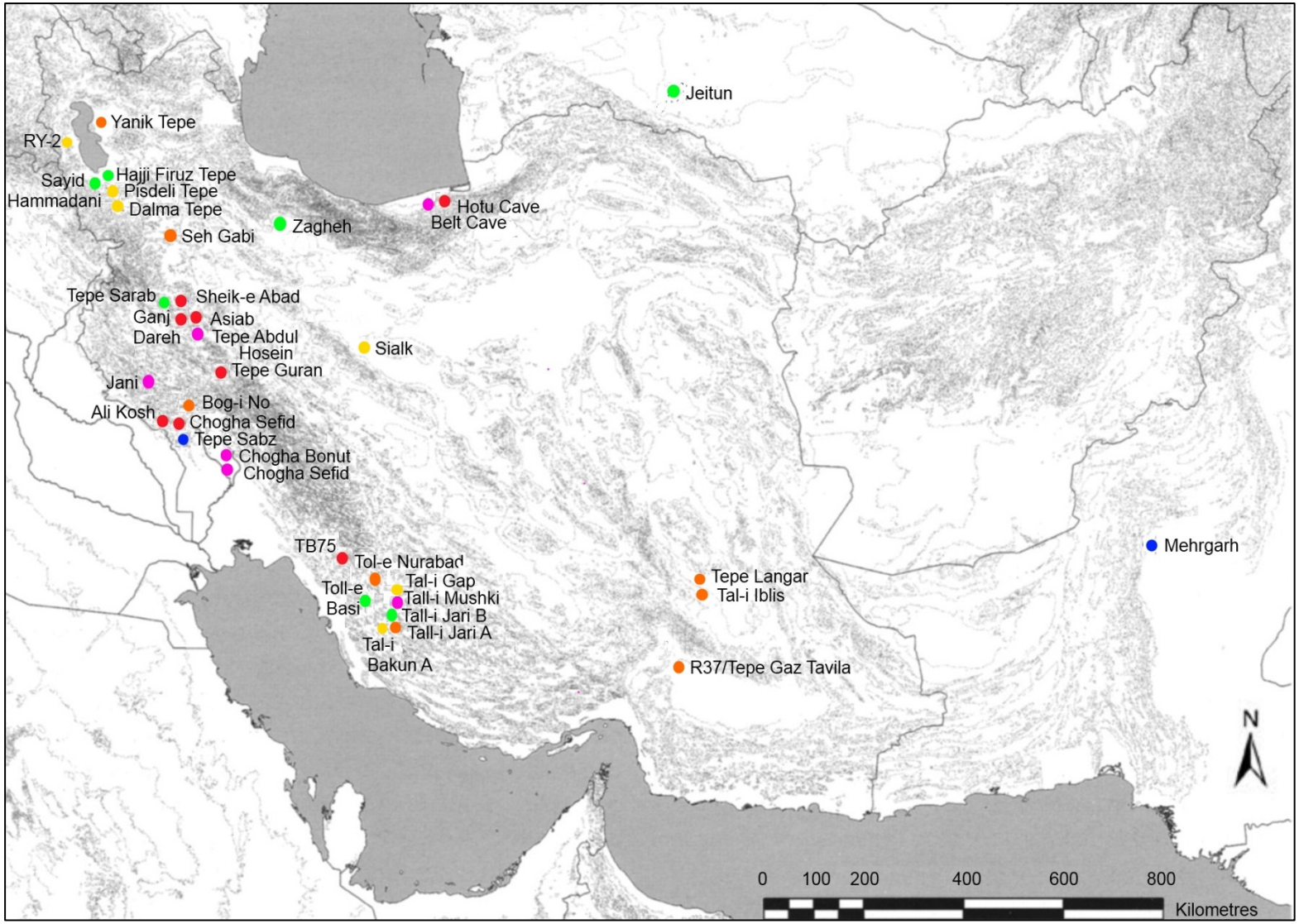


Figure 5.10: *Distribution of sites ca. 6000-5000 BC (no chronometric hygiene).*

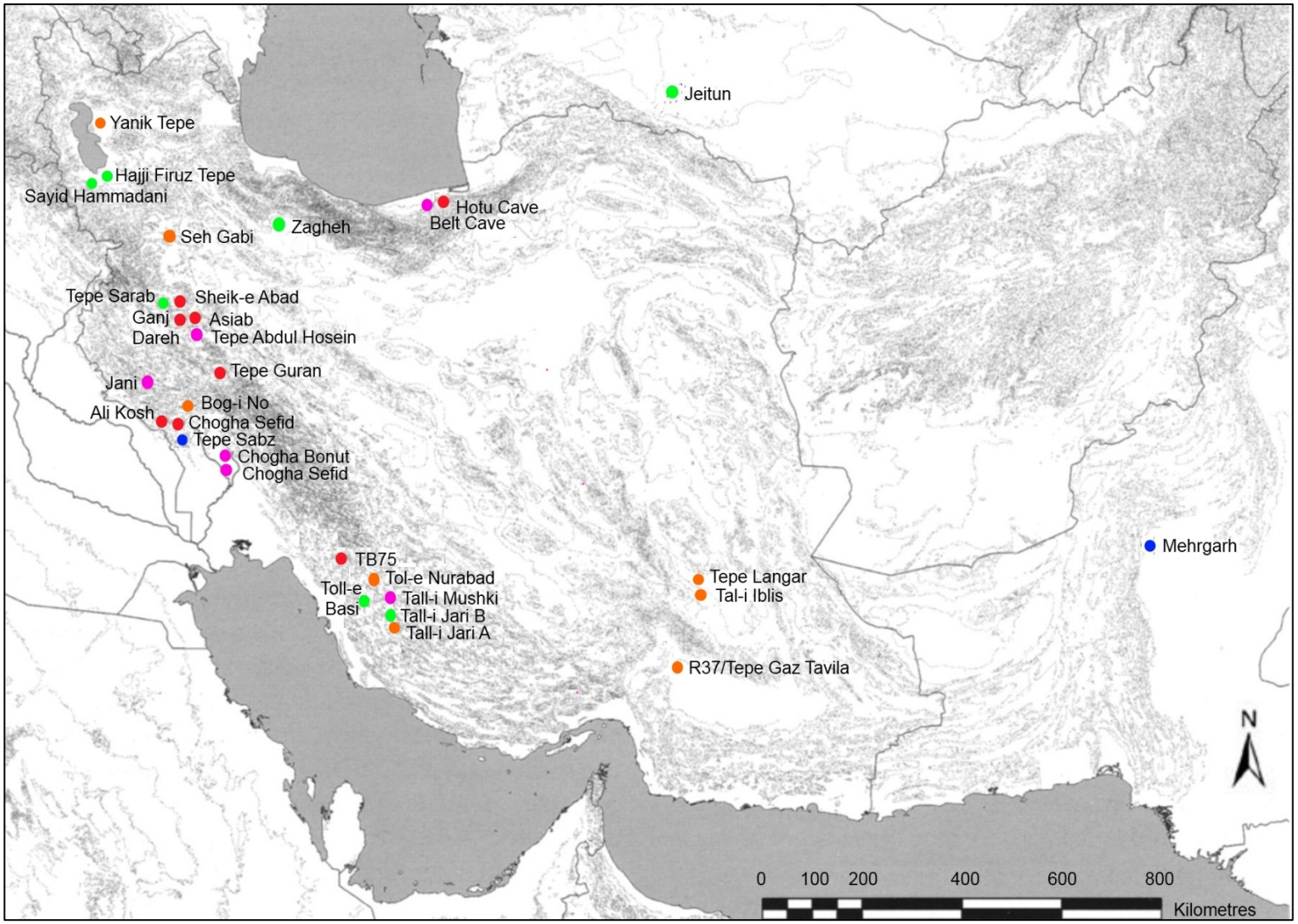


Figure 5.11: *Distribution of sites ca. 5000-4000 BC (no chronometric hygiene).*

Chapter Six

The Central Iranian Plateau: the Tehran, Qazvin and Kashan Plains

6.0. Introduction

As identified in Chapter 3, Iran has long been the focus of archaeological studies which have examined the development and spread of the Neolithic (e.g. Stein 1940; McCown 1942; Ghirshman 1954; Hole et al. 1969; Malek Shahmirzadeh 1979; Voigt 1983). These studies, however, have been largely restricted to western Iran, and other regions, particularly the Central Plateau, have been largely ignored. To date, although a number of Early Neolithic sites (ca. 8000-6500 BC) are known from western Iran, none have been recorded on the Central Plateau. There are two plausible explanations for this. Either the sites have been buried by alluvial deposition and now lie below the present plain surface (Brookes et al. 1982; Gillmore et al. 2007; 2011); or there was no Early Neolithic occupation of the Central Plateau as a direct result of the development of farming. It is a major objective of this research to establish whether there are any Early Neolithic sites on the Central Plateau. To this end, this chapter focuses specially on the Central Plateau. In the first section a detailed study of the geography and environmental context of the Central Plateau is given, which is essential in order to contextualise the region. In the second section the results from new archaeological research on the Tehran, Qazvin and Kashan Plains is reviewed, and our current knowledge of the Neolithic development of these three regions assessed.

6.1. Geography of the Central Iranian Plateau

As discussed in Chapter 2, the Central Plateau covers nearly one third of Iran, measuring some 3200 kilometres in length, and forms a distinct geographic entity, bounded to the north, south and southwest by the high peaks of the Alburz and Zagros Mountains (Bobek 1968: 280; Fazeli 2001: 8). This entity, however, is far from uniform, ranging in elevation from 2500 to 5000 metres above sea level, and encompassing mountains and foothills, other hills, lake basins and several alluvial plains (Fisher 1968: 90–1). It can be divided into four major geomorphological units: the high plateau of northwest-central Iran (including the Urmia basin), at 1200–2500 metres elevation; the Isfahan-Saidabad basin at 1000–1200 metres elevation; the salt desert basin (*Masileh-Kavir*) at 600–1000 metres elevation; and the Lut desert basin (*Dasht-i Lut*) at 500–600 metres elevation (Dewan & Famouri 1968: 22-3). These basins are dissected; surrounded and partly subdivided by mountain ranges along which extend large outwash fans, and alluvial plains grading into the desert proper (ibid.: 23).

The term ‘plateau’ is applied in a general way by several American and British writers to the whole upland mass; whereas French and German geographers consider the term to cover the inner central basin of Iran only, and regard the surrounding highland ring as a distinctive, somewhat separate mountain zone. However, such purely physical descriptions can be unhelpful due to their disregard of modern political boundaries, and W.B. Fisher restricts the use of the term ‘Central Plateau’ to the upland area, actually territorially within the boundaries of the present state of Iran (Fisher 1968: 5). It is his definition that is used in this thesis.

In terms of geology, a great tectonic line separates the Central Plateau from the geological deposits to the south (Dewan & Famouri 1968: 26). In the Upper Cretaceous and Tertiary Periods, eruptive rocks, such as andesite, were formed in different places on this tectonic line. Along this line there are many springs which have caused deposition of travertine – a form of limestone – and sediments of Palaeozoic, Mesozoic and Tertiary are also

present (ibid.). The gypsiferous and saline series of Eocene to Miocene age characterize this unit, and are made up of salt, gypsum, clays, mudstones, siltstones and sandstones. Much of the present area of the Central Plateau was once occupied by large lakes, but today only the lowest parts of the plateau are occupied by residential salt lakes (*kavirs*) or marshes (Fisher 1968: 92).

The plateau can be broadly divided into three geographical regions: the mountains, the plain proper and desert. The Zagros Mountain chain flanks the north–west to south–east of the plateau for nearly 1000 kilometres, measuring over 190 kilometres in width at its broadest, and rising 1000–1700 metres above sea level (Ghirshman 1954: 21). The Zagros are extremely rich in mineral resources, and enclose valleys that "are well suited to small scale agriculture and/or large-scale pastoral lifestyles" (Thornton 2009: 306). The Alburz Mountains encircle the northern edge of the Central Plateau, flanking the Caspian Sea littoral and continuing eastwards to the northern highlands (*Kopet Dagh*) (Fisher 1968: 38). They are currently undergoing uplift and denudation, ensuring an abundant supply of gravels and sands to the alluvial fans of the rivers which drain them. This has created a highly unstable geomorphological environment, where "river channels are in constant flux and episodes of sedimentation and erosion are highly variable" (Gillmore et al. 2011: 51). The mountains bordering the Central Plateau are completed by the southern chain, the Makran, which is pierced by two passes: the Bander Abbas on the Gulf of Oman; and the other leading east to Baluchistan and Quetta (Ghirshman 1954: 23).

The plain itself is covered by water-transported alluvial sediment, and it appears that the shifting of river systems over time may have had a considerable effect on the fluctuation of human settlement patterns since prehistory (Tehrani-Mogaddam 1996 [in Persian] in Fazeli 2001: 14). It also contains a number of inter-montane areas and small *kavirs* which can be divided into different micro-environmental zones (Fazeli 2001: 14). Important in the context of this research, are the alluvial fans, the presence of which Brookes describes as "ubiquitous and extensive" (Brookes 1989: 20). Alluvial

fans are fan-shaped deposits formed where a fast-flowing stream flattens, slows and spreads, typically at the exit of a canyon or valley onto a flatter plain. They are the main site of deposition in an erosional-deposition system, in which mountains tend slowly to wear away, and basins to fill with sediment, through geological time (Wilkinson 2003). On the Central Plateau, they range in size from less than 1-kilometre squared, to massive fans such as the Jaj Rud which measure over 2500-kilometres squared (Beaumont 1972: 251). At the base of alluvial fans occurs a seepage zone, where groundwater approaches the soil surface and sometimes forms springs. The hydraulic conductivity of alluvial fans is high. For example, the Garmsar alluvial fan, located on the southern fringe of the Alburz Mountains, 120 km southwest of Tehran, discharges water at a rate of at least 10-metres-per day (Oosterbann 2000: 4). Consequently, alluvial fans, particularly in arid and semiarid regions, are often the principle groundwater source for farming and the sustenance of life. They also contain rich soils, suitable for agriculture (ibid.).

The exact phasing of alluvial fan sedimentation on the Central Plateau is not clear, although sedimentological and geomorphological evidence (e.g. gullying, fan-head trenching, the occurrence of large areas of desert varnish) suggests that for at least the last 750 years, the fans have been relatively stable (Beaumont 1972: 258, 267; Gillmore et al. 2011: 51). The optimum conditions for fan formation are thought to have occurred mainly during the glacial phases of the Pleistocene, and two major phases of alluvial deposition in Iran are recognized (Vita-Finzi 1968: 951; Beaumont 1972: 269). An earlier phase, which began no more than 50,000 years ago and probably, had ended by the fourth millennium BC; and a second phase of deposition that occurred during the Middle Ages. The thickness of the alluvial fans is difficult to determine, due to a lack of data, but limited boring on the Jaj Rud fan, at a point 19-kilometres south of Veramin, revealed up to 275 metres of deposits, but greater thickness than this might occur elsewhere (Beaumont 1972: 255-6). Such findings have important implications for the visibility of archaeological sites from the surface, particularly those from the earlier periods (cf. Brookes et al. 1982; Coningham et al. 2004; 2006).

The third geographical region, the desert or *kavir*, is an inhospitable region, parts of which are completely inhabitable (Fazeli 2001: 19). The topography is characterized by a landform assemblage of bare, steep, rugged mountains, with debris-strewn pediments, compound fans, and basin floors underlined by mud, salt crusts or marshlands (Brookes 1982: 192). Salt crusts cover areas of mud, which conceal deep subterranean channels, and the fragile structure of the surface is extremely dangerous. These render cultivation impossible, indeed, in places even travel is hazardous (Fazeli 2001: 19). Some surfaces of the desert are nearly 10-centimetres thick and are covered by a salty viscous mud. Summer is often cloudless, and consequently temperatures are very high during the day (over 50°C); while the winter temperature can drop below freezing. Because of the lack of cloud, the elevation, and the dryness of the air, there is a rapid radiation of heat from the surface at night leading to temperature extremes (Fisher 1968: 93). Although the region is generally unfit for human habitation, it is favourable for wildlife, especially seasonal birds, which migrate from Siberia during the winter, and the Iranian zebra, which look like wild ass, and live on the edge of the central desert (Fazeli 2001: 20).

The climate of the Central Plateau is heavily influenced by the Zagros and Alburz Mountain systems, which form climatic barriers separating it from the warm, moist Mediterranean weather systems to the west, and the coastal weather system of the Caspian Sea to the north. As a result, the Central Plateau is characterized by a semi-arid/arid climate, which becomes highly arid in its large and depressed centre (Bobek 1968: 280). Summers are often virtually cloudless, and consequently temperatures are very high during the day, though there is wide diurnal variation due to the high elevations, dryness of air, and lack of clouds (Ganji 1968: 220). In winter, temperatures are generally low. For example, temperatures as low as -16ºC have been reported from Tehran for January, the coldest month of the year (Ganji 1968: table 1). From February onwards, the land begins to warm up, and temperatures as high as 36ºC have been recorded in July and August (ibid.: table 2). Precipitation is limited, averaging ca. 25–150 mm annually, with an incidence sharply confined to the winter months (Fisher 1968: 91); and

decreases from north (average rainfall over 200 mm per annum) to south (average less than 120 mm per annum) (Dewan & Famouri 1968: 250) (Tables 6.0–6.2).

The history of vegetation and climate change in the Near East is poorly understood, and only a few palaeoclimate proxy data exist for the Holocene in Iran (Djamali, Beaulieu et al. 2008: 413; Schmidt et al. 2011: 587). These are mainly from studies located in the Zagros Mountains (Wright 1966; van Zeist 1967; van Zeist & Wright 1963; van Zeist & Bottema 1977; Bottema 1986; 1993; Djamali, Beaulieu et al. 2008), and more proxy information and geochronological data are needed for other areas, particularly central and southern Iran (Kehl 2009: 2).

The best proxies for the Central Plateau come from lake cores from Lake Urmia and Lake Zeribar which are located in the Zagros Mountains, approximately 300 kilometres apart. Both pollen and sedimentological studies have been published from Lake Urmia (Bottema 1986; Kelts & Shahrabi 1986) and proxy palaeoclimate records are available from Lake Zeribar, based on sediment chemistry (Hutchinson & Cowgill 1963), pollen (van Zeist & Wright 1963; van Zeist & Bottema 1977), palaeoliminological indicators (Griffiths et al. 2001; Wasylikowa et al. 2006), diatoms (Snyder et al. 2001) and stable isotope patterns (Stevens et al. 2001; 2006). These studies generally suggest that during the Late Glacial-Early Holocene transitional period, an increase in temperature enabled the establishment of a grass-dominated savannah, with few oak trees and varying pistachio abundance (Stevens et al. 2001: 451-2; Kohl 2009: 10; Schmidt et al. 2011: 587). (Pistachio is more drought resistant than oak, the main limiting factor of which is total moisture availability; Schmidt et al. 2011: 588.) This was followed by a period of temperature and aridity amelioration throughout the Early to Mid Holocene, which had resulted in a marked decrease in pistachio by ca. 6200 yr BC, and a gradual, then sharp, increase in oak (Wright et al. 1967: 441; Smith et al. 2001: 453; Schmidt et al. 2011: 587). At Lake Zeribar, oak forests reached their greatest distribution at 4750 BC, and then steadily declined from 4450 BC to enter a pronounced depression in 2550 BC; while at Lake Mirabad, oak pollen rose

later and more slowly, only reaching the levels of Lake Zeribar at 4000 BC (Schmidt et al. 2011: 588). By the early fourth millennium BC, modern climatic conditions had been established (Wright et al. 1967: 441; Vita-Fenzi 1968: 967; Smith et al. 2001: 453; Djamali, Beaulieu et al. 2008: 128; Kehl 2009: 10).

The seasonality of the climate of the Zagros Mountains is determined by the interactions of rain-bearing westerlies from the Mediterranean, the Siberian high in winter that blocks their progress, and hot winds which emanate from the Central Plateau in summer and deflect the westerlies along the western foothills and mountain range (Schmidt et al. 2011: 588; Stevens et al. 2006). Due to this the palynological analysis from Lake Zeribar, which lies along a track of westerlies to the north of the Zagros, is more relevant for the Central Plateau than Lake Mirabad, which is located in the southwest flanks of the Zagros Mountains (Schmidt et al. 2011: 588). When the palynological record from Lake Zeribar is compared with the archaeological chronology of the Central Plateau, the onset of the Transitional Chalcolithic (ca. 5000 BC) generally coincides with an increase in oak pollen, and by proxy moisture, after ca. 5500 BC (ibid.).

Lake cores also allow for the reconstruction of past vegetation patterns. Pollen analysis of cores from Lake Zeribar and Lake Mirabad (also in the Zagros Mountains), suggests that at the beginning of the Holocene, the catchment area of both lakes was dominated by an *Artemisia* steppe (Wright et al. 1967: 441). Around 9500 BC, the climate became warmer and wetter, allowing for the expansion of oak-pistachio savannah, and by ca. 3500 yr BC this had thickened to become the oak woodland that still prevails in the region today (Wright et al. 1967: 441; Vita-Fenzi 1968: 967; Kehl 2009: 10). In northeastern Iran the analysis of cores from Lake Urmia indicates a similar pattern (Bottema 1986: 241; Djamali, Kürschner et al. 2008: 68). Until around 7000 BC the area around Lake Urmia was dominated by *Artemisia* steppe; between 7000–6000 BC the steppe vegetation was gradually succeeded by forest-steppe; and by ca. 5000 BC this had developed into open forest (Bottema 1986: 241, 256; Djamali, Beaulieu et al. 2008: 419).

Bobek (1968: 288) broadly divides the modern vegetational cover on the Central Plateau into two groups: that within the 250-300 mm precipitation isohyet (the minimum for rainfed agriculture; Oates & Oates 1976: 111); and that in areas which receive less than 250 mm precipitation annually. Within the 250-300 mm precipitation isohyet, two main groups of associations can be distinguished: : tragacanthic or *astragaleta* types, with spiny bushes or brushwood of tragacanthic or other *astragalus* and *acantholimon* species, together with other dwarf bushes and many grasses and herbaceous types; and *artemisieta*-type associations, which include scrub composed predominantly of worm wood (*Artemisia*, mostly *Herba alba*) (Bobek 1968: 288-9). Outside the limits of potential rainfed agriculture, the steppe thins out, without greatly changing composition. There is an intermediate zone, the 'desert-steppe', where patches of bare-ground become considerable, before finally the true desert (largely confined to depressions below 1000 metres), in which bare ground predominates.

In terms of the fauna, carnivores include: wolves, hyenas, various foxes and ichneumon, cats, leopards and lynxes (Misonne 1968: 295). Ungulates include Iranian onager, which live on the edge of the central desert, fellow deer, gazelles, wild boar, wild goat and red sheep. There is a wide variety of lagomorpha and rodents. The great majority of rodents (ca. 90%) are jirds and gerbils, while other rodents are of small numerical importance (ibid.: 296). Insectivora have been poorly studied, but include several species of hedgehog and bat (ibid.: 300). Domesticated species include Iranian saddle horses, numerous donkeys, cattle, sheep, goat, dromedaries and dogs (ibid.: 301-2). It is of interest to note, in regards to the origins and spread of agriculture, that domesticated cattle on the Central Plateau are generally large and without a hump, while those found on the Caspian Sea Plain are of a smaller stature, and have a hump like Zebu cattle, suggesting the possibility of two different origins.

There is a lack of perennial, and even seasonal streams, on parts of the Central Plateau, and the availability of water, both surface and underground, has always been a major defining feature in human activity (Dewan & Famouri

1964: 40; Oberlander 1968: 265; Goldsmith 1984; Fazeli 2001: 11). Roland Ghirshman writes, for example, that “at all times on the Plateau, the question of water has been vital”, arguing that “despite the extremes of climate, intense cold in winter and heat in summer, the ground yields abundantly wherever man can bring water” (Ghirshman 1954: 25). Annual surpluses of water and seasonal surpluses occur in the Zagros and Alburz mountains (Oberlander 1968: 265). Their perennial rivers are maintained throughout the rainless summers and early autumn by snowmelt, which also contributes to seasonal springs. Major permanent rivers of the region include the Karaj, Talegan, Abhor, Kan, Solequn, Qazvin and Shour, of which the Karaj, which flows through the Alburz Mountain range, is the longest (Fazeli 2001: 11).

The limitation of available agricultural land in combination with annual rainfall and topography, has significantly affected the distribution of modern settlement, which is largely confined to the plain, although particular areas of the mountains, intermountain valleys and desert are also important (Fazeli 2001: 8, 13). For example, the highland valleys receive more rain than the plain, and provide excellent vegetation for pasturage during the summer months, and this may have facilitated seasonal movements of the earliest pastoral communities of the plain (ibid.: 13). Like many settlements in Iran (both past & present), those on the Central Plateau are generally situated on active alluvial fans, which pose flood and sediment inundation hazards, but provide fertile soil for agriculture (Schmidt et al. 2011: 585).

Historically, there have existed two main types of pastoral groups on the plateau, defined by their migratory activity (Fazeli 2001: 14). One type inhabit a permanent village in the winter, with members from the group migrating in the summer up to higher pastures in the Alburz Mountains to pastoral camps at considerable distances (up to 25 km away) from the village. The other type followed a traditional route of vertical migration from the north to the south of the plains during the autumn and spring. Nowadays, both types of movement have greatly declined (ibid.).

Contemporary agricultural settlements can be broadly divided into upland and lowland settlements. Although the situation is rapidly changing, upland settlements are in the form of unfortified hamlets or small-scale clustered houses grouped alongside a few fields (Fisher 1968: 46). They are generally situated on the first rocky slopes rising above the valley floors, with terraced slopes roughly divided into meadows by low dry-stone walls or willow hedges (Deplanhol 1968: 419). In areas with sufficient rainfall, fertile and cultivable patches of soil allow for the cultivation of winter wheat, spring barley, alfalfa, fruit and vegetables, although crops can be grown extensively only one year out of every two or three; the intervening seasons being used for grazing animals (Fazeli 2001: 13). In areas with insufficient rainfall, irrigation is possible on a very small scale (ibid.). In the late 1960s, many villages in the central Alburz still had seasonal settlements in the highland occupied from May until August/September by pastoral groups from the permanent villages (Fisher 1968: 54). However, today this economic life has decreased and most villagers have migrated to Tehran or other cities to the north and south of the Alburz (Fazeli 2001: 13-4).

Lowland or 'landlord' villages are mudbrick walled, largely self-contained settlements, which consist of a landlord's house and associated outbuildings, farmers' houses and animal yards (Planhol 1968: 425; Fazeli & Young 2008: 348; Fazeli et al. 2009: 149). They are usually surrounded with high walls and corner towers, the purpose of which is ambiguous. Ethnographic sources claim that they were there to protect the villages from wild animals and thieves, but that they were also there because the structure was a 'castle' (Fazeli et al. 2009: 157). Analysis of the actual structures provides no further elucidation, with some of the corner towers entered from outside the village, others having no entrances, and yet others having been used for penning animals (Fazeli & Young 2008; Fazeli et al. 2009). Landlord villages played a major role in rural life in Iran for many centuries, although they were abandoned following the 'White Revolution' of the 1960s and 1970s (Fazeli et al. 2009: 149). The antiquity of the villages is thought to be rooted in the early Islamic period (Lambton 1953: 4), although their origins and actual dates remain largely conjecture (Fazeli et al. 2009: 149). What is clear from a range

of records, is that landlord villages were an accepted and extensive form of social and economic organisation for large segments of Iran's rural population for centuries leading up to the radical changes of the 1960s and 1970s (ibid.).

6.2. Prehistoric sites

The current level of information does not indicate the presence of Early Neolithic (ca. 8000-6500 BC) or Middle Neolithic (ca. 6500-6200 BC) period settlements on the Central Plateau (Coningham et al. 2004; 2006; Fazeli et al. 2004; 2005; 2009; Malek Shahmirzadi 2002; 2003; 2004; 2006a; 2006b). The earliest recorded settlements are Late Neolithic (ca. 6200–5500 BC) in origin, and include Cheshmeh-Ali, Sadeghabadi and Tepe Pardis on the Tehran Plain; Chahar-Boneh and Ebrahim Abad on the Qazvin Plain; and Tepe Sialk and Ghabristan on the Kashan Plain.

Following the Late Neolithic, a 'Transitional Chalcolithic' period (ca. 5500-4700 BC) is recognized on the Central Plateau (Fazeli 2001; Coningham et al. 2004; 2006; Fazeli et al. 2004). The Transitional Chalcolithic is defined primarily by the presence of Cheshmeh Ali Ware. It was a period of both continuity and change, which was not restricted to ceramic production, but included general transformations within the lithic industry, inter-site and intra-site patterns and long-distance contact (Fazeli 2001; Fazeli et al. 2001; 2002; 2004). It was also marked by a substantial increase in the number of sites, which is attributed to "an increasing human population and economic achievements" (Fazeli 2001: 42). Transitional Chalcolithic settlements include: Cheshmeh-Ali, Tepe Chouqali, Tepe Sadeghabadi, Tepe Pardis, Mehdikani, Kara Tepe Sharyae, Fakrabad, Mafinabad, Poeinak, Tepe Mortezagerd, Ismailabad and Ozbaki on the Tehran Plain; Zagheh, Cheshmeh Bolbol and Akbarabad on the Qazvin Plain; and Sialk on the Kashan Plain. The Early Chalcolithic period (ca. 4700–4000 BC) settlements on the Tehran Plain comprise: Cheshmeh-Ali, Tepe Pardis, Mehdikani, Mafinabad, Fakrabad, Tepe Sadeghabadi, Tepe Chouqali, Kara Tepe Sharyar, Mortezagerd and

Poeinak on the Tehran Plain; Zagheh on the Qazvin Plain; and Tepe Sialk on the Kashan Plain.

6.3. The Tehran Plain

Archaeologically, the Tehran Plain is the area that lies immediately below the southern slopes of the central Alburz Mountains (Fazeli 2001: 10). It is a region characterized by steep topographic relief, arid or semi-arid climates, and absence of vegetation (Gillmore et al. 2007: 40), which is formed by the massive alluvial fan of the Jaj Rud (more than 2500 square kilometres in extent), which drains the main ridge of the Alburz Mountains (Beaumont 1972: 251; Gillmore et al. 2009: 287). The Alburz Mountains to the north and east are currently undergoing active uplift and denudation, and this ensures a very abundant supply of gravel and sands to the plain, creating a highly unstable geomorphological environment, “where the river channels are in constant flux and episodes of sedimentation and erosion are highly variable through time and space” (Gillmore et al. 2011: 51). As a consequence alluvial deposition on archaeological sites is a major issue. For example, at Tepe Pardis (see Fig. 6.12) around 1.5 metres of sediments have been deposited since the Iron Age (ibid.: 52).

The Tehran Plain is a microcosm of the Central Plateau, encompassing three major environmental zones: the southern foothills of the Alburz Mountains; the central plain proper; and the desert fringe (Coningham et al. 2006: 54). Modern settlements are largely confined to the plain, but the physical characteristics of the mountains, intermountain valleys and desert are also important (Fazeli 2001: 8). For example, the highland valleys receive more rain than the plain, and provide excellent vegetation for pasturage during the summer months, which may have facilitated seasonal movements of the earliest pastoral communities of the plain (ibid.).

Precipitation, which averages less than a few 100 mm per annum, is confined to the winter months (Gillmore et al. 2009: 40). Most of the water on the plain

comes from the rivers draining the highlands to the north and west, where the maximum discharge is associated with spring snowmelt (Gillmore et al. 2011: 50). Temperatures in the summer are amongst the hottest in the world for the elevation with highs of over 40ºC recorded in Tehran for July, while winter temperatures can reach as low as -20ºC (Gillmore et al. 2011: 42; Ilkhani-Moghadam et al. in press). Moreover, the duration of periods of coldness and hotness is relatively long, and as a result few perennial plants – with the exception of desert and semi-desert scrub plants – can survive. No information is currently available about the palaeobotany of the Tehran Plain. Today, the remains of woodland dominated by Juniper and Ponderosa Pine are mostly located between 2000–4500 metres above sea level (Ilkhani-Moghadam et al. in press). In the low hills the main taxa are *A. Scoporra*, *Fraxinus* spp., *Crataegus* spp., *Fircus carica* and *Cotoneaster* spp., whilst in lowland areas, because of the arid climate and the high level of soil salinity, salt-tolerant shrubs make up most of the plant cover (ibid.). In total 39 different botanical species are recognized on the Tehran Plain. The dominant taxa are the low shrub species *Artemisia sieberi* (accounting for 34% of the vegetation cover) and *A. aucheri*, larger shrubs of *Tamarix* sp. sub shrub *Salsola* (Chenopodiaceae), and a variety of wild grasses (ibid.). The best time for growing crops is in the relatively milder spring and autumn, when plants such as thorny bushes, poppy, alfalfa, gum, camel thorn and different types of tamarisk and triticum grow (Fazeli 2001: 15). The main crops of the region are cereals, cotton, and sugar beet. Wild animals species found on the plain include caprine, gazelle, suids (especially equids), fox, camelids, small herbivores and different species of migratory birds (ibid.). Domestic animals consist of pig, caprines, equids (horse & ass), cattle and dog (Mashkour et al. 1999: 74).

Today, owing to the presence of both the Jaj Rud and its rich alluvial deposits, and the *qanat* irrigation system, the Tehran Plain is one of the key centres of agriculture in Iran (Coningham et al. 2006: 54; Ilkhani-Moghadam et al. in press). Farmers both in the past and present have preferred to settle on the alluvial fans that fringe the mountain ranges, due to the advantage of the water supplies in these areas. Although such areas are hazardous to live in –

Melville (1984: 131-2) reports that villages are often abandoned following a disaster that permanently affected the water supply – the advantage of the water supply in the years when no disastrous flood events occurs more than compensates the risk (ibid.).

6.3a. History of archaeological investigation

Hassan Fazeli, from Tehran University, has been largely responsible for bringing the prehistory of the Central Plateau to the forefront of archaeological research in Iran, and has published extensively on the region (Fazeli 2001; Fazeli & Djamali 2002; Fazeli et al. 2001; 2002; 2004; 2005; 2007; 2009). Since 1997, Fazeli, in cooperation with Robin Coningham, has carried out surface collection for sampling purposes on prehistoric settlement mounds on the Tehran Plain. Beginning in 2003, soundings in selected sites were also conducted, in order to obtain stratified typological assemblages and carbon samples for establishing an absolute chronology for the Tehran Plain.

Three types of survey strategy were implemented. As an extension of Fazeli's (2001) earlier work, non-random survey was implemented, although the main form of survey was random transect survey, and a total of 147 kilometres (discontinuous) of 100-metre wide transects were walked. *Qanat* survey, a new form of survey – first piloted on the Tehran Plain in 2003 (Coningham et al. 2004) – was also used, and a total of 35 kilometres (discontinuous) of *qanat* lines were surveyed (Coningham et al. 2006: 55). Work such as this is vital, for, owing to the rapid rise of population in the area (Iran's population has almost doubled since 1979), the Tehran Plain is highly susceptible to site damage and loss through urban and agricultural expansion, and illegal excavations are also a continuing problem (Coningham et al. 2004; 2006: 55; Azamoush & Helwing 2005: 192). Indeed, Coningham et al. (2004: 10) report that considerable damage had been inflicted to near 90 per cent of the registered sites that they surveyed.

6.3b. Settlement survey

The 2003, 2006 and 2008 expedition survey teams recorded a total of 32 prehistoric sites, of which 13 were assigned to the Chalcolithic period (Table 6.3). It should be noted that none of the sites were radiocarbon dated, and cultural periods, where they are assigned, were on the basis of the surveyor's discretion. The majority of the sites were pottery scatters, which were followed in number by tells and low mounds. This is unsurprising, given that pottery is one of the more enduring and distinctive features of the archaeological record, and tells are highly visible and long lasting (Coningham et al. 2006: 55). It is apparent from the poor state of preservation of most of the sites, that agricultural and urban encroachment poses a major threat. This emphasizes the need for conducting survey and excavation in the region now, before this important resource is destroyed. A significantly large number of prehistoric sites were recorded from *qanat* survey compared to transect survey: 6 sites from 35 kilometres of *qanat* survey; compared to 12 from 147 kilometres of transect survey (ibid.). This result emphasizes the problems alluvial deposition can cause to archaeological visibility (cf. Brookes et al. 1989), which can render sites invisible on the plain surface. In such circumstances the spoil heaps to *qanat* lines provides a valuable way of accessing evidence of early occupation.

Seventeen Late Neolithic and Chalcolithic sites were recorded by Coningham et al. (2004; 2006) three seasons (2003, 2004 & 2006) of settlement survey on the Tehran plain. Of these 10 were tell sites. The remainder were pottery scatters, one of which (BO28) is thought to represent the remains of a ploughed out tell. Details of the tell sites, followed by that of the pottery scatters, are given below.

A03/Chaleh Khakesary is a Middle Chalcolithic, ploughed out tell, which measures approximately 350 metres by 80 metres in size. Surface finds from the site include chalcolithic pottery and bone. A06/Tepe Pardis has subsequently been excavated (see pp. 340-5). It is a large tell site, which is badly damaged, and has been encroached on three sites by a brick quarry. It

currently stands some 7 metres above the surrounding ground level, and covers an area of 4200 metres squared (Coningham et al. 2006: 34). It has a combined depth of occupation of 10.5 metres above and below the surface, which spans the Late Neolithic-Chalcolithic periods. The site is badly damaged, and is being encroached on three sites by a brick quarry. A20/Deh Mohesen is a tell site, which measures 70 metres by 70 metres in extent. Chalcolithic, Iron Age and glazed (Islamic) ceramics were collected from the surface. The site is currently situated on agricultural land, and the edges have been ploughed out. A31/Farakhabad is an 80-metre wide by 80-metre long tell, which stands 4 metres above the current plain surface. Finds include Early Chalcolithic pottery, bones and lithics. The site is not in good condition: it has been heavily eroded; is partially cut by a road; and is being encroached by agriculture. A50/Tepe Davoudabad is an Early Chalcolithic and Iron Age tell, measuring 150 metre by 350 metre in size. Surface finds include Early Chalcolithic and Iron Age ceramics. The site has been badly damaged: the edges are ploughed out, salination is a problem and there is evidence of illegal excavation. A117 is a tell site that was occupied during the Late Neolithic-Late Chalcolithic period and again during the Islamic period. Finds include chalcolithic and glazed (Islamic) ceramics. The site is in a poor state of conservation: the edges have been ploughed out and there are signs of illegal excavation. Taherabad/B005 is a low mound, measuring 45 metres by 45 metres and standing 0.5 metres above the present plain surface. It is a Chalcolithic period site. The tepe has been ploughed- out, and the surrounding area has been intensively farmed. B006 represents another low mound/ploughed out tepe. It measures 500 metres by 100 metres and stands 0.5 metres high. Finds include Chalcolithic pottery and brickbats. B118/Tepe Tar is a 65-metre by 50-metre tell which, despite being heavily eroded, stands 10 metres above the current plain surface. Finds include Chalcolithic and glazed (Islamic) pottery. B223 is a low mound, which measures 100 metres by 200 metres in area. It is thought to have been occupied in the Middle-Late Chalcolithic and again in the Iron Age. Finds include Chalcolithic and Iron Age pottery, brick and slag.

The largest pottery scatter was DV1, which was discovered off transect within *qanat* spoil in the Damavand Valley. Finds include Neolithic pottery and 14 lithics: 9 flakes; 3 blades; 1 polyhedral core; and 1 piece of shatter. Six other pottery scatters were recorded. A114 is a pottery scatter that was discovered in a *qanat* spoil heap. The extent of the scatter measures 10 metres by 10 metres, and finds include Chalcolithic, glazed (Islamic) and modern ceramics, mudbrick and slag. B002 is a pottery scatter measuring five metres by 10 metres. The pottery is entirely Chalcolithic. The scatter is located at the edge of a ploughed field, and is cut by an irrigation channel. B007 represents a lithic find plus pottery, which were found in and around a *qanat* spoil heap. The area of the scatter measures 40 metres by 30 metres. The pottery is thought to be Chalcolithic in date. B027 is Chalcolithic pottery scatter, measuring 150 metres by 100 metres in area. B028 is a pottery scatter that is thought to represent the remains of a ploughed out mound or tell. It measures 50 metres by 25 metres. Surface finds include Chalcolithic pottery. B205 is a pottery scatter found within *qanat* spoil. It measured one metre by one metre in area, and contains Chalcolithic pottery.

6.3c. Archaeological sites

Yan Tepe (Late Neolithic)

In the vicinity of an abounding stream, next to the village of Ozbaki in the Savojbolag district, lie a cluster of one major and nine smaller settlement mounds, which are collectively known as Tepe Ozbaki. Between 1998 and 2002, Youssef Majidzadeh excavated several of these mounds on behalf of the Iranian Centre for Archaeological Research (hereafter ICAR). The oldest mound, Yan Teppe, dates to the Neolithic (Azamoush & Helwing 2005: 196). No information on the botanical or faunal remains from the site is available, but five architectural levels were distinguished. The buildings were constructed from handmade mudbrick, and generally had very small rooms, which did not exceed 2.5 to 3.5 square metres, and subfloor burials under living floors were common. One building had walls and floors covered with red ochre and an L-shaped platform, and perhaps served a special function. The

pottery assemblage is similar to that found at Sialk Periods I and II (ibid.). The site was abandoned at the end of the Neolithic period, and settlement shifted to another small mound, Jeyrān Tappe, located 300-metres away (ibid.).

Sadeghabadi (Late Neolithic to Middle Chalcolithic)

Sadeghabadi lies in the southern foothills of the Alburz Mountains between the villages of Mahammadabad and Ashtazon, some 20 kilometres from the outskirts of Tehran. It measures some 90 by 90 metres in extent, and stands at a height of 5–6 metres above the present plain surface (Fazeli 2001: 78). The site was recorded on survey by Hassan Fazeli, and has not been excavated. A small area to the northwest has been disturbed, and Late Neolithic ceramics exposed in the section. Today, the nearest water source is the Karaj River, located nearly one kilometre away.

Fakrabad (Early Chalcolithic)

Fakrabad (Fig. 6.) is located around eight kilometres from Sadeghabadi, south of the modern town of Veramin, and was recorded by Hassan Fazeli (2001). It is one of the few sites on the Central Plateau that was occupied during the Early Chalcolithic. It currently measures around two hectares in size, but has been badly disturbed by ploughing and road construction. Today, the nearest water source today is the Karaj River, ca. one kilometre away.

Mafinabad (Middle Chalcolithic)

Mafinabad (Fig. 6.2) is located to the southwest of Veramin, in the Sharyar region, and was recorded by Hassan Fazeli in the late 1990s. The site, which appears to have been occupied throughout has been badly damaged in recent years, but the analysis of a deep cut in the southeast section suggested that it used to measure at least 5.5 hectares in extent, and that there some 6 metres of Middle Chalcolithic deposits (Fazeli 2001: 79). A palaeochannel, 30-metres across, was exposed in excavations for building work, approximately 300 metres from the site (Gillmore et al. 2009: 299). In one horizon occurred an abundance of Middle Chalcolithic pottery, with covered another pottery layer below (ibid).

Mehedikani (Early to Late Chalcolithic)

Mehedikani (Fig. 6.3) is situated close to one of the branches of the Karaj Rud. It was recorded during survey by Fazeli in the late 1990s, who reported that it to stand nearly 5 metres above the modern plain surface and measure 90 by 122 metres in extent (Fazeli 2001: 79).

Chakhmak Tepe (Middle Chalcolithic)

Chakhmak Tepe (Fig. 6.4) is located to the west of Tehran, and was recorded by Fazeli during survey in the late 1990s. It stands one to two metres above the modern plain surface, and covers an area (including lithic & ceramic scatters) of over two and a half hectares (Fazeli 2001: 80). Two obsidian flakes were recovered from the site, which is of considerable interest as, with the exception of from Tepe Pardis from which one flake was recovered, obsidian is not known from any other Chalcolithic sites on the Tehran Plain (Fazeli et al. 2007). The source of the obsidian is unknown, but the closest potential sources are around the peak of Damavand in the Alburz Mountains, and Sareh in the western part of the plain (Fazeli 2001: 185).

Cheshmeh-Ali (Late Neolithic to Middle Chalcolithic & Parthian)

Cheshmeh Ali is a seven-metre high mound, which abuts a rocky ridge at the edge of the Islamic city of Rayy (Fazeli et al. 2004: 13). It is located beside a spring (from which it gains its name), which was probably an important contributory factor in selecting the site's location. Indeed, before the widespread drilling of deep wells, the spring at Cheshmeh Ali was one of the most important sources of water for both domestic use and irrigation in the area (Alizadeh 1990). Originally, the site covered an area of more than 3500 square metres, but today it is hemmed in by houses (Alizadeh 1990).

Cheshmeh Ali has been the focus of archaeological research since the 1920s, due to its visibility and close proximity to Tehran. De Morgan, the director of the French Archaeological Mission, was the first to excavate the site between 1912 and 1913, and his excavations were closely followed by those of Dayat, a diplomat from the French embassy in Tehran. In 1924 Erich F. Schmidt conducted the first systematic campaign at Cheshmeh Ali, directing

excavations at the site between 1934 and 1936 (Fig. 6.5 & 6.6). Schmidt's excavations were extensive, and during this period he opened an area of more than 600 square metres, using a workforce of 200 workmen (Schmidt 1936: 79). From his findings, Schmidt was able to successfully identify the presence of two historic periods, Islamic and Parthian; and two major prehistoric levels, Chalcolithic and Neolithic, but was unfortunately killed in a plane crash before his findings were ever published. Following Schmidt's death, interest in Cheshmeh Ali lapsed, and urban encroachment substantially reduced the tell. Archaeological research was resumed in 1997, after a break of 61 years, by a collaborative team from ICHO, the University of Tehran and the University of Bradford (Fazeli et al. 2004). Two trenches were excavated – E4-5 on the western side of the tell; and H7 on the eastern side – exposing 11 metres of archaeological deposits, spanning the Late Neolithic, Transitional Chalcolithic and Early Chalcolithic periods (Fig. 6.7 & 6.8). A total of 10 ^{14}C samples were selected for dating purposes from the excavation: 1 from Trench E4-5 (Fig. 6.9) and a further 9 from Trench H7 (Fig. 6.10).

Lab. code	Context	Sample material	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
OxA-9996	Tr. H7, context 56	Charcoal	6155± 45	5207-5050	5221-4963	Reliable	Known mat. & context
OxA-9995	Tr. H7, context 55	Charcoal	6160± 40	5207-5054	5217-5000	Reliable	Known mat. & context
OxA-9994	Tr. H7, context 50	Charcoal	6175± 45	5211-5060	5291-4997	Reliable	Known mat. & context
OxA-9997	Tr. H7, context 33	Charcoal	5875± 45	4795-4695	4846-4613	Reliable	Known mat. & context
OxA-9956	Tr. H7, context 32	Charcoal	5965± 45	4928-4791	4957-4725	Reliable	Known mat. & context
OxA-9955	Tr. H7, context 16	Charcoal	5815± 45	4725-4602	4780-4550	Reliable	Known mat. & context
OxA-9954	Tr. H7, context 15	Charcoal	5865± 45	4789-4691	4841-4609	Reliable	Known mat. & context
OxA-9937	Tr. H7, context 15	Charcoal	5940± 55	4897-4729	4962-4705	Reliable	Known mat. & context
OxA-9905	Tr. H7, context	Charcoal	5885± 40	4795-4713	4874-4620	Reliable	Known mat. & context

	14						
OxA-9855	Tr. E4-5, context 50	Charcoal	6075± 70	5199-4851	5211-4808	Accept.	Known mat. & context, but rel. high error

(After Fazeli et al. 2004: table 2.)

All of the dates were submitted for AMS dating at Oxford Accelerator Unit. They are from well-recorded contexts and known sample materials; have error terms of less than 100 ^{14}C years; and are in loose stratigraphic agreement. They are consequently reliable enough to be used without further questioning. Unfortunately, dates are only available for the middle part of the sequence, for the upper and lower parts did not yield suitable material for AMS dating (Fazeli et al. 2004: 13).

No information is available on the botanical remains from Cheshmeh Ali. The faunal assemblage evidences the presence of domesticated sheep, goats, cow and dog, and possibly domesticated pig (Fazeli & Young 2009). The amount of pig represented is unusually high compared to other contemporary sites on the Central Plateau, although it is not clear if it was wild or domesticated (ibid.: 241). Unfortunately the amount of animal remains recovered was too small for any statistical analysis to be significant.

The architecture recovered from Late Neolithic contexts, was limited to a small mudbrick wall built on a fine-sand foundation (Fazeli 2001: 76). In comparison, in the succeeding Transitional Chalcolithic period, many architectural units and installations were identified, including ovens and burials, although no architectural remains were recovered from the Early Chalcolithic levels.

The generally poor preservation of low-fired ceramics, combined with the unsuitable burial conditions at the site (there are high levels of permanent moisture in the lower levels), has resulted in the recovery of only a small amount of Late Neolithic wares. All were handmade, probably by the sequential-slab technique, chaff tempered, and had a thick, pale-brown slip; they are classified by Fazeli as a “coarse to medium-fine software” (2001:

121). Decoration, where present, was in the form of simple close-patterned and linear geometric designs, and hatched and crosshatched rows of diamonds and triangles were particularly common. Vessel types were restricted to a limited range of thick-based containers, which may have been used for utilitarian purposes, such as food storage and cooking (Fazeli 2001: 121). There is a general lack of homogeneity in ceramic production, suggesting that during the Late Neolithic it was probably “a non-specialized, household industry” (Fazeli 2001: 124).

The transition from the Late Neolithic to the Transitional Chalcolithic period was a gradual process, marked by the appearance of ‘Cheshmeh-Ali’ black on-red ware (Dyson 1991; Fazeli 2001; Matney 1995). ‘Cheshmeh-Ali’ Ware was handmade, highly burnished and elaborately decorated with geometric designs in a dark brown or black paint (Fazeli 2001: 127). Common forms included small round-bottomed cups with flared rims, large spherical bowls, and pedestalled vases (Matney 1995: 30). During the Early Chalcolithic Period there occurred a substantial increase in the standardization and specialization of pottery manufacture, represented by the progressive replacement of the sequential-slab technique by the coil technique; the introduction of wheel throwing; the use of new motifs; and the introduction of new ceramic forms (Fazeli 2001: 136). Fazeli (2001: 143) suggests that by the Early Chalcolithic period, pottery production at Cheshmeh Ali had become a standardized and specialized industry; a development that is observed across the Central Plateau during this period.

Fazeli (2001: 189) reports that the chipped-stone tools were predominantly manufactured from a local grey chert, and that an increase in blade production occurred throughout the prehistoric occupation of the site, with blade tools increasing from 16 per cent of the total assemblage in the Late Neolithic, to 36 per cent in the Transitional Chalcolithic, and 50 per cent in the Early Chalcolithic (Fazeli 2001: 189). Accompanying the increase in blade production was an increase in the processing of cores off site, possibly indicating an increase in specialization, similar to that exhibited in ceramic

production. A number of metal artefacts were also recovered from Cheshmeh Ali, but have yet to be studied (Thornton 2009: 311).

Two sets of limited information are available on the burial practices: Schmidt's excavation photos and notes, as reported by Matney (1995); and two adult burials recorded from the 1997 excavation (Fazeli 2001). Matney (1995: 28) describes a single internment excavated by Schmidt, in which the body lies on the right side, in a flexed position, with the hands near the pelvis. The two skeletons from the 1997 excavation were both recovered from under house floors (Fazeli 2001: 217). The skeletons bore traces of red ochre, and grave goods included a small bowl and a large, possibly imported, trapezoid blade.

Tepe Pardis (Late Neolithic–Late Chalcolithic)

Besides Cheshmeh Ali, the other well-recorded, excavated site on the Tehran Plain is Tepe Pardis (Fig. 6.11). It is located besides a natural deposit of clay, in the lower stretches of the Jaj Rud fan, on the western outskirts of Garchek, to the southeast of Cheshmeh Ali (Coningham et al. 2006: 68; Gillmore et al. 2009: 287). The site has been badly damaged by quarrying, and in its truncated state stands 7 metres in height, with a combined depth of occupation of 10.5 metres above and below the plain surface, and measures ca. 4200 square metres in extent (Fig. 6.12 & 6.13) (Coningham et al. 2006: 34). Tepe Pardis was first identified by N. Pazuki of ICHTO, and was visited at his request by a survey team comprised of members from the universities of Durham, Leicester, Kingston and Bradford, who returned to excavate it for three seasons in 2004, 2006 and 2007 (Coningham et al. 2006: 49–50; Fazeli et al. 2007).

Ceramic analysis and ^{14}C dating has shown the sequence at Tepe Pardis to be continuous from the Late Neolithic (ca. 6200-5500 BC), through the Transitional Chalcolithic (ca. 5500-4700 BC), to the Early Chalcolithic (ca. 4700-4000 BC), with a break then occurring before the resumption of settlement in the Middle Chalcolithic, ca. 3960–3770 BC (Coningham 2006: 33, 49-50). The main deposits are from the Transitional Chalcolithic period

(ibid.: 39). Fifteen ^{14}C determinations are available for the site from carbon samples submitted by Robin Coningham.

Lab. code	Context	Sample material	^{14}C age (BP)	Cal. date (BC/AD)		Hygiene	Reason
				68.2%	95.4%		
OxA-14736	Tr. I, Context 4	Bone: thoracic spine (cattle?)	1967 ±31	AD 3-70	43 BC-AD 115	Unreliable	Too late
OxA-14739	Tr. I, Context 4	Bone: calcaneus (sheep)	5894 ±37	4769-4719	4845-4690	Reliable	Known mat. & context
OxA-14738	Tr. I, Context 5	Charcoal, *tamarix* sp. (short-lived type)	5156 ±37	4038-3946	4043-3810	Quest.	Rather late
OxA-14737	Tr. I, Context 8	Long bone fragment	5050 ±35	3942-3794	3957-3767	Quest.	Rather late
OxA-14740	Tr. I, Context 8	Charcoal (too small to identify)	6004 ±38	4944-4842	4993-4797	Reliable	Known mat. & context
OxA-14741	Tr. I, Context 14	Charcoal, *Populus* sp. (short-lived type)	5928 ±35	4842-4729	4903-4717	Reliable	Known mat. & context
OxA-14742	Tr. I, Context 18	Charcoal (too small to identify)	5978 ±38	4932-4801	4984-4775	Reliable	Known mat. & context
OxA-14743	Tr. II, Context 1003	Charcoal (too small to identify)	5976 ±36	4909-4800	4981-4748	Reliable	Known mat. & context
OxA-14744	Tr. II, Context 1008	Bone (long bone fragments)	6000 ±38	4941-4841	4990-4795	Reliable	Known mat. & context
OxA-14745	Tr. II, Context 1014	Charcoal (too small to identify)	6100 ±39	5194-4950	5209-4912	Reliable	Known mat. & context
OxA-14746	Tr. II, Context 1015	Bone fragments (bird)	6226 ±37	5295-5079	5304-5061	Reliable	Known mat. & context
OxA-14747	Tr. II, Context 1017	Long bone fragment, small mammal	6230 ±45	5298-5079	5309-5057	Reliable	Known mat. & context
OxA-14748	Quarry Context G1	Bird	1018 ±29	992-1027	904-1148	Unreliable	Too young
OxA-14749	Quarry irrigation channel NX	Sheep teeth, young animal	6152 ±40	5207-5046	5216-4994	Reliable	Known mat. & context
OxA-14750	Quarry irrigation channel DX	Long bone fragment (cattle?)	6153 ±38	5207-5048	5214-5000	Reliable	Known mat. & context

(Coningham et al. 2006: 46-7.)

None of the charcoal was identifiable to species; and there was a high failure rate among the bone samples due to their low collagen yield (Coningham et al. 2006: 45). OxA-14736 was rejected by the excavator as clearly too late, with which the author agrees. There are some internal inconsistencies with the dates for Trench I. For example, OxA-14740 is older than both -14741 and -14742, which are from earlier contexts. However, the majority of the dates from Trenches I and II are in loose stratigraphic order, are from known materials and well-secured contexts, and are reliable enough to be accepted within reason. In terms of the Quarry irrigation channels, OxA-14749 and -14750 compare favourably to each other, and are reliable enough to be accepted within reason.

Many carbonized plant remains were recovered, primarily from ash deposits in pit structures. The identified remains mostly comprised cultivated plants (Ilkhani-Moghadam et al. in press). Cultivated hulled barley (*Hordeum vulgare*) was the most abundant species. A few examples of six-row barley (*H. vulgare* L. subsp. *vulgare*) were also present, but wheat grains, in the form of free-threshing (*Triticum astivum/ T. turgidum* subsp. *durum*) and emmer wheat, were less common (ibid.). In terms of pulses, lentil (*Lens culinaris*), pea (*Pisum*) and *Vicia* (vetch) were all probably cultivated. Grape seeds (*Vitis vinifera*) were recovered from a Chalcolithic period context, although whether they were cultivated remains ambiguous. Wild plant seeds occur in small numbers in all of the sampled contexts, and include ruderal and field weed taxa. It is unclear if the weeds are from cereal fields, or represent wild plants eaten by domestic animals. *Vicia*/*Lathyrus* is the most common wild seed, followed by grass grains (*Gramineae*), none of which were identifiable to species; *Astragalus* (Fabaceae family) was also very abundant. Other taxa include *Lithospermun* (Boragnaceae family), *Galium* (Rubiaceae family), *Chenopodiaceae* (goosefoot family) and *Solanaceae* (nightshade family) (ibid.).

In general the animal bones were very fragmented, rendering identification difficult. The vast majority of the identifiable bone is tentatively assigned to domesticated sheep and goat, but due to the small size of the assemblage it

is difficult to distinguish between wild and domesticated animals (Coningham et al. 2006: 45). A much smaller number of bones were attributable to cattle and pig, and a very few to gazelle, equid, fowl, fish and dog. The low number of bones attributed to wild species contrasts with that recorded from other contemporary sites, for example Zagheh on the Qazvin Plain (see p. 317) (Mashkour et al. 1999), but is in keeping with a pastoral economy, possibly linked with long-distance, transhumant activity (Coningham et al. 2006: 45).

Complementary information about the agriculture practices at Tepe Pardis is provided by geoarchaeological evidence for water management, in the form of a triangular cross-section channel, measuring 1.0 metre in width by 0.24 metres in depth (Gillmore et al. 2009: 285). The antiquity of the channel is supported by ^{14}C measurements from strata directly above and below, association with ceramic sherds, and correlation with Late Neolithic levels. To date, the artificial water channel represents the earliest evidence of the human manipulation of water or irrigation agriculture on the Central Plateau (Gillmore et al. 2007; 2009; 2011). It correlates well with the irrigation agriculture reported by Oates and Oates (1976) from the sixth millennium BC site of Choga Mami, Iraq, and that reported by Hole et al. (Hole 1977; Hole et al. 1969; Neely & Wright 1994) on the Deh Luran Plain. The practice of irrigation agriculture at Tepe Pardis is significant. Not only does irrigation agriculture require a greater investment in labour – in terms of the construction and maintenance of channels – but it also has a significant social impact. Hole and Flannery (1967: 181) argue that irrigation systems add a new dimension to the alteration of the natural landscape, in which fields become improved property on which labour has to be regularly spent.

In the three seasons of excavation at Tepe Pardis, more than 70 square metres of mudbrick structures of Transitional Chalcolithic date, including 5 kilns and associated wall alignments, were exposed (Fazeli et al. 2007: 269). Indeed, most of the architecture recovered is thought to relate to industrial installations, and the remains of domestic structures were few. A terracotta slow wheel – measuring 36 centimetres in diameter and 12 centimetres thick – was recovered from one of these kilns (ibid.: 270). It represents a unique

discovery in Iran, and is one of the earliest slow wheels known in the Middle East. The presence of five large kilns at Tepe Pardis, and the unique terracotta slow wheel, attests to a large investment in the technological infrastructure at the site during the Transitional Chalcolithic, which Fazeli (2007: 270) reports is unlike anything else that has previously been seen for this period. Excavation has shown the craft area to have been separated from the domestic/residential sections of the site which, in conjunction with the site's situation next to a rich clay deposit (which is still quarried), suggests the presence of a specialized pottery production site (Coningham et al. 2006: 68). This represents a "significant change in the organization of production during the Transitional Chalcolithic" (ibid.: 19) on the Tehran Plain compared to earlier periods.

Late Chalcolithic ceramics were identified during the exploratory survey in 2003 (Coningham et al. 2004). However, only examples from the Late Neolithic, Transitional, Early and Middle Chalcolithic periods were recovered from excavation, possibly because of a major rebuilding phase (Coningham et al. 2006: 39). Late Neolithic examples are limited to two coarse, buff-coloured body sherds, which conform well with contemporary examples from Cheshmeh Ali (ibid.). The Transitional Chalcolithic ceramics are represented by 'Cheshmeh Ali' Ware, "surface treatment, colour, temper, manufacturing technology and paint [of which] are remarkably different from those sherds at the site from the Late Neolithic period" (Coningham et al. 2006: 40). Cheshmeh Ali Ware was highly fired, with a fine organic and inorganic grit temper, and the surfaces were highly smoothed or burnished. The exteriors were decorated in black paint in geometric and naturalistic designs, which included goats and birds. Coningham (2006: 40) believes that both the Late Neolithic and the Transitional Chalcolithic wares from Tepe Pardis exhibit strong parallels with Cheshmeh Ali, as well as with surface materials from other sites on the Tehran and Kashan Plains. Of the Early and Middle Chalcolithic pottery, Coningham comments that it is "not remarkable" (Coningham et al. 2006: 39), although there are some changes in the technology of production, and in the use of new forms of painting.

Lithics include various tool forms, cores, blades, flakes, and miscellaneous debris (Coningham et al. 2006: 43). The majority of the lithics were of chert, varying in colour between brown, green, grey, honey, red and tan. A small number were of while or milky quartz, and one obsidian blade was recovered (Fazeli et al. 2007: 270). The latter is of considerable note, as obsidian is rare on the Tehran Plain, with the only other known example found at Chakhmak Tepe (see p. 303) (Fazeli 2001: 185). It appears that while the majority of the lithics were manufactured on site, probably from a single local source (represented by the tools produced from red, brown & grey cherts), the presence of an obsidian blade, and four imported blades of honey chert, suggests the existence of specialist blade manufacture and long-distance trade (Coningham et al. 2006: 43). Two burials were encountered, the grave goods from which include cowrie shells and turquoise, agate, shell and lapis lazuli beads (Fazeli et al. 2007: 269), thus, providing further evidence of existence of long-distance trade networks. Other notable small finds from Tepe Pardis include terracotta beads, spindle whorls and slingshots, and clay tokens (Fazeli et al. 2007).

6.3d. Summary of settlement pattern on the Tehran Plain *(Table 6.4)*

The archaeological evidence suggests that the Tehran Plain was not occupied until the Late Neolithic (ca. 6200-5300 BC), and that during this period the settlement distribution was spare, with settlement only attested at Cheshmeh Ali, Tepe Pardis and Sadeghabadi. During the Transitional Chalcolithic (ca. 5300-4300 BC), a dramatic increase in the number of sites occurred, and nine sites are known from this period (Parandak, Poeinak, Kara Tepe, Chouqali, Mehdikani, Mafinabad, Sadeghabadi, Tepe Pardis, Cheshmeh Ali). The growth in site number continued into the Early Chalcolithic (ca. 4300-4000 BC) for which 16 sites are known (Parandak, Poeinak, Kara Tepe, Mortezagerd, Chouqali, Ozbaki, Tepe Siah, Tepe Surk Khub, Ismailabad, Barkin, Mehdikhani, Mafinabad, Farakhabad, Sadeghabadi, Tepe Pardis, Cheshmeh Ali). There was also continuity in site occupation between these two periods, with all of the Transitional Chalcolithic period sites continuing to

be occupied during the Early Chalcolithic. During the succeeding period there is an abrupt decrease in site number, and only eight sites are reported for the Middle Chalcolithic period (ca. 4000-3700 BC) (Mortezagerd, Chouqali, Ozbaki, Tepe Chakhmah, Mehdikani, Mafinabad, Sadeghabadi, Tepe Pardis). The decline in site numbers continued into the Late Chalcolithic period (ca. 3700-3000 BC) for which only six sites are known (Chouqali, Maymonabad, Ozbaki, Mehdikani, Mafinabad, Tepe Pardis). The evidence, thus, points to a cycle of growth and collapse in settlement on the Tehran Plain during the Late Neolithic to Late Chalcolithic periods (ca. 6200-3000 BC). After the initial occupation of the plain in the Late Neolithic, a period of settlement growth ensued in the Transitional and Early Chalcolithic periods. This appears to have been a period of relative stability, and all of the settlements that were occupied in the Transitional Chalcolithic, continued to be inhabited in the Early Chalcolithic. An apparent period of decline follows this, during which the number of settlements steady decreased through the Middle to Late Chalcolithic periods. The settlements at most sites were generally short-lived, with occupation at most sites tending to last no more than one or two cultural periods. Only five sites appear to have been longer lived, and these are Cheshmeh Ali, Tepe Pardis, Sadeghabadi, Mafinabad and Mehdikhani. Two of these sites were associated with springs or water channels (Cheshmeh Ali & Mafinabad), and at Tepe Pardis there is evidence of the human manipulation of water (Coningham et al. 2006; Gillmore et al. 2007). There appears, then, to have been a rather dynamic, shifting pattern of settlement and population on the Tehran Plain during the Late Neolithic and Chalcolithic periods, which can perhaps be attributed to the braided channel regime that is known to have been operating in the region during this period (Gillmore et al. 2009: 299). This thesis is further supported by the fact that three of the five longest-lived settlements on the plain (Cheshmeh Ali, Mafinabad, Tepe Pardis), are associated with permanent water sources.

6.4. The Qazvin Plain

The Qazvin Plain forms the northwestern part of the Central Plateau, and is enclosed to the north by the Alburz Mountains, to the west by the Zagros

Mountains, and to the immediate south by the Raymond Mountains; to the southeast lies the Dasht-i-Kavir, which is connected to the plain by a valley in the Karaj Basin (Malek Shahmirzadi 1977: 462). Since prehistoric times downwash from the mountains has led to considerable deposition on the plain. Armin Schmidt and Hassan Fazeli (2007: 38-9) report that at the Iron Age site of Sagzabad more than five metres of alluvium has been deposited since the third millennium BC.

The plain has an average elevation of 1175 metres above sea level, although the plain gently slopes from the north and south towards a flat flood plain in the centre, and covers an area of 443,200 hectares, of which ca. 310,000 hectares is cultivable (Malek Shahmirzadi 1977: 16). In the southwest and southeast sections, it is divided into two parts by mountains (e.g. Mount Raymond & Mount Jaru), creating a larger, wider area to the north; and a narrower, geomorphologically more diverse region to the south (ibid.: 18). Important trade and communication routes traditionally crossed the Qazvin Plain, most prominently the ancient Silk Road from east to west, but also north to south links from the Caspian Sea to Rudbar and Manjil (Voigt & Dyson 1992: 164).

The plain lies in a semi-steppe/arid zone, and summers are dry and hot, with temperatures reaching up to 35ºC, whilst winters are cool, with temperatures as low as 2.5ºC, and relatively wet (Malek Shahmirzadi 1977: 32). The maximum annual rainfall is reported as 339.1 mm (Ganji 1968: 248), but this is misleading as it decreases from north to south. The average annual rainfall in the north is over 200 mm, while in comparison, that of the south and southeast is less than 120 mm (Dewan & Famouri 1964: 80; Malek Shahmirzadi 1977: 48). As the plain is enclosed on three sides by mountain ranges, but open to the Dasht-i-Kavir to the east-southeast, most of the time a strong current of wind blows across the plain, and the two principle winds (one are the Bad-i-Meih, a cold, dry wind from the northwest; and the hot, dry Bad-i-Raz, which blows from the southeast (Malek Shahmirzadi 1977: 32-3).

The vegetation varies according to climate and the texture and organic content of the soil (ibid.: 35). Two main soil types dominate the plain, scattered patches of fine-textured alluvial soil and 'Brown Soil' (Dewan & Famouri 1964: 142). Today, when irrigated, the former can sustain extensive agriculture, and Malek Shahmirzadi (1977: 29) has suggested that this may also have been practiced in prehistoric times. Some dry farming is also reported.

6.4a. History of archaeological investigation

Archaeological investigations on the Qazvin Plain focusing on the Neolithic have been underway since the 1970s (e.g. Negahban 1977; 1979). Yet, decades after these first studies, "there is still no evidence for a Mesolithic period in this region, nor any new information about the origins of agricultural societies" (Fazeli 2001: 1).

6.4b. Settlement survey

Under the direction of Hassan Fazeli, in 2001 a five-year archaeological excavation and settlement survey was begun, with the objective of investigating the socioeconomic development of Neolithic to Bronze Age societies on the plain. As part of this project, in 2003 an extensive archaeological survey was conducted. Twenty-three new Neolithic, Chalcolithic and Bronze Age sites were found (Fig. 6.15), of which two (Tepe Chahar Boneh & Ebrahim Abad) were selected for subsequent excavation (Fazeli et al. 2009: 1-2). Unfortunately, no further information is presently available for any of the other sites.

6.4c. Archaeological sites

Zagheh (Transitional Chalcolithic)

Zagheh lies 10 kilometres north-northwest of the village of Sagzabad, in the Bluk-i-Zahra microregion of the southern Qazvin Plain. The region is easily

accessible from the south along the western fringe of the desert, and serves as a crossroad connecting the south, southwest, northeast and northwest of Iran (Malek Shahmirzadi 1977: 463). The only water source in the area today is the Hajji Arab, the seasonal floods of which are reported to reach an area a few kilometres south of the site (ibid.) Zagheh is an almost circular mound, which although only standing one-metre above the modern plain surface, contains seven metres of cultural deposits (Neghaban 1977: 34; Schmidt 2006: 39). It has been badly damaged by villagers carrying soil away to cultivate their fields, rainwater and illegal excavations, and in its current state measures some 15,000 square metres in extent, including pottery scatters (Malek Shahmirzadi 1977: 49). Zagheh was first excavated under the direction of E.O. Neghaban in the 1970s, who exposed more than 1350 square metres, although only 1 deep trench (TTFGX) was dug (Fig. 6.12) (Malek Shahmirzadi 1980: 14). In 2001, a further eight trenches were opened at the site, under the direction of Hassan Fazeli (Fig. 6.13) (Fazeli et al. 2005).

The dating of Zagheh is controversial. Neghaban originally assigned the site to the late seventh millennium-early sixth millennium, on the basis of the pottery typology and two ^{14}C dates (pp. 282-3). However, 10 recent AMS measurements for the site, made from samples submitted from the 2001 excavation, repudiates Neghaban's chronology:

Lab. code	Context	Sample material	Comm.	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
					68.2%	95.4%		
WK-12854	Trench A, Context 1, 2 cm depth	Carbon particles	Directly sub-surface	6154 ±49	52008-5047	5222-4953	Unreliable	Possibly disturbed &/or contaminated
WK-12855	Trench A, Context 7, 44 cm depth	Carbon particles	Secure context	5489 ±45	4436-4266	4449-4257	Acceptable	Known material & context
WK-12856	Trench A, Context 11, 50 cm depth	Carbon particles	Secure context	5936 ±69	4901-4723	5001-4619	Acceptable	Known material & context
WK-12857	Tr. A, Context 16, 95 cm depth	Carbon particles	Secure context: sand floor	6152 ±46	5207-5046	5220-4961	Acceptable	Known material & context

WK-12858	Tr. A, Context 17, 111 cm depth	Carbon particles	Secure context: oven	6124 ±46	5207-4991	5211-4946	Acceptable	Known material & context
WK-12859	Tr. A, Context 35 cm depth	Carbon particles	Secure context: ash layer	5991 ±65	4956-4794	5043-4722	Acceptable	Known material & context
WK-12860	Tr. A, Context 38, 170 cm depth	Carbon particles	Secure context: ash layer	6233 ±48	5300-5079	5311-5056	Acceptable	Known material & context
WK-12861	Tr. A, Context 45, 255 cm depth	Carbon particles	Secure context: ash layer under collapsed wall	6169 ±78	5217-5011	5311-4912	Acceptable	Known material & context
WK-12862	Tr. A, C. 45, 305 cm depth	Carbon particles	Security of context equivocal: unsealed ash pit	6140 ±50	5207-5006	5217-4947	Quest.	Possibly contaminated
WK-12863	Tr. A, C. 47, 4 cm above virgin soil	Carbon particles	Secure context: large broken storage jar	6295 ±47	5314-5223	5375-5078	Acceptable	Known material & context

(Fazeli et al. 2005: table 13.)

The measurements were made by New Zealand's Waikato University. There are some issues with the measurements. The security of the context from which WK-1284 was extracted is equivocal as the sample is from directly subsurface, and given the early age of the measurement compared to WK-1285 and -1286, which were taken from contexts beneath it, it should be treated as unreliable. The security of WK-12862 is also questionable, as the sample was taken from an unsealed ash pit. The remainder of the dates are reported to come to be from secure contexts (Fazeli et al. 2005: 46), and are of acceptable hygiene. Collectively, they suggest that Zagheh was settled sometime between 5370-5070 BC, and was abandoned around 4460-4240 BC (ibid.: 20), placing the site firmly in the Transitional Chalcolithic period.

The botanical remains have yet to be published. Many of the faunal remains were fragmented, which rendered identification difficult. Of the bones that could be assigned to species, the majority (70%) are from domesticated

sheep (*Ovis aeries*) and goat *(Capra hircus*), which were kept in similar numbers (Young & Fazeli 2008: 159–60). The herd demography (nearly 40 per cent of the caprines survived for 4 or more years), suggests a diversified herd management strategy, which possibly utilized milk, meat and wool (ibid.: 159-60, 166). Bovines (6%) and wild caprines (1%) were the next most significant types in the faunal assemblage; and gazelle (*Gazella subguttorods*), pig (*Sis* sp.) (possibly domesticated) and deer (*Cervus* sp.) are present in small amounts. In total wild types account for 20 per cent of the assemblage, indicating that they too were an important component of the diet (ibid.: 160). Young and Fazeli suggest that the inhabitants of Zagheh probably practiced "small scale, mixed farming keeping a range of animals in order to spread risk, management and so forth, and regular hunting to supplement the domesticates occurred" (ibid.: 166).

Both domestic and craft/industrial areas were identified. Domestic areas contained mudbrick walls, floors, ovens, pits, animal bones, stone tools and ceramics; while the latter were distinguished by the presence of kilns associated with a highest concentration of sherds (31.8% of the total assemblage), but no ovens, walls or floors (Young & Fazeli 2008: 155–6). Of particular note is the 'Painted Building', an L-shaped building, which is larger than the others, has walls decorated with red and black motifs, and was found to contain thirty-nine clay figurines (Negahban 1974: pl. II-III, VI-VIII).

Fazeli (ibid.: 156; Fazeli et al. 2009) suggests that it may have had a special function, perhaps serving as a temple or other public building. In contexts related to the pottery kilns, occur fragments of finished, unfinished, and deformed figurines, and unworked lumps for pottery production. Textile production is evidenced by the presence of hundreds of spindle whorls (Matthews & Fazeli 2004: 63), and a number of flint cores showing signs of heating suggests that lithic production may also have taken place here (Young & Fazeli 2008: 156).

Pottery is the most abundant type of artefact, and is broadly divided into 'Zagheh' and 'Cheshmeh Ali' wares (Malek Shahmirzadi 1977; Fazeli et al.

2005). The Zagheh wares are divided into three types, ‘Simple’, ‘Painted’ and ‘Crusted’, of which ‘Simple’ Ware was the most abundant. It is characterized by a coarse sand, sand and straw, or organic temper, poorly levigated clay, and surfaces which were either smoothed with a wet hand or washed (Fazeli et al. 2005: 19). Concave-based bowls with tapered rims are the most common form (Malek Shahmirzadi 1977: 404). ‘Painted’ Ware was very similar, but with the addition of geometric motifs in red paint, and ‘Crusted’ Ware is thick walled, with an exterior crusted with fine grains of sand and highly burnished insides. Signs of scorching on some of the outer surfaces, suggests that the ware was probably used for cooking, a conclusion supported by the use of a similar ware region for baking today (Fazeli et al. 2005: 26). ‘Cheshmeh Ali ‘Ware is technologically more advanced, and the painted decoration is typically more complex (Malek Shahmirzadi 1977: 18104, 279; Fazeli et al. 2005: 26). A greater variety of overall forms exist, of which bowls with oblique or concave walls, and concave or trumpet vases were particularly common (Malek Shahmirzadi 1977: 404).

Based on Neghaban’s investigations, Malek Shahmirzadi (1977: 404) proposed that the lower levels at Zagheh contained only ‘Zagheh’ wares, and he assigned these levels to the ‘Archaic Plateau’ or Neolithic period, and that the upper levels, which were characterized by both ‘Zagheh’ and ‘Cheshmeh Ali’ ware, belonged to the ‘Early Plateau’ or Transitional Chalcolithic period. However, the results from the more recent excavation refute Shahmirzadi’s proposed chronology, by evidencing the coexistence of both wares from the earliest levels (Fazeli 3002: 27, 41-2). Indeed, Fazeli found there to be little change in the technological production of the ceramics and their forms throughout the occupational sequence (Fazeli et al. 2005: 43). This indicates that the technology for the production of both types of wares were known from the beginning of the settlement, and that rather than representing technologically development, as originally advocated by Majidzadeh (1981: 141), the production of the two different wares was most likely related to function (Fazeli et al. 2005: 43).

The figurines recovered from the Painted Building include both realistic portrayals of seated females with heavy legs and stalk-like upper bodies (some of which appear to be pregnant); and more stylized forms with fingernail impressed bodies, similar to those reported from Chogha Sefid (Hole 1977: 299; Voigt & Dyson 1992: 165). Other small artefacts of note are clay, stone and bone ornaments, copper pins, awls and palettes, which were all recovered from grave contexts. Non-local materials are represented by lapis lazuli, turquoise and shell. The geographic distribution of lapis lazuli in Iran has been poorly studied, and the origin of that used in the Central Plateau is unknown, although Fazeli (2005: 16) suggests it may have been imported from eastern Iran. The turquoise was probably sourced from Kerman, and the shell from the Persian Gulf or Caspian Sea (Fazeli 2001: 216-7). Zagheh, then, was evidently part of an active, wide-reaching trade, and presumably communication, network. In terms of funerary practice graves were located within the village (Malek Shahmirzadi 1988: 10-12). Infants of less than three years were buried under the floors of houses, with very small infants sometimes placed in holes dug into the walls, and no grave goods accompanied these burials. Adults were buried in open areas such as courtyards, or entirely outside living areas in alleys or other open sites. The bodies were covered in red ochre, and many of the graves were topped with piles of elongated mudbricks. A few examples had low brick walls aligned in the same way as the bodies beneath, which Malek Shahmirzadi (1988: 12) interpreted as early forms of tomb construction.

Tepe Chahar Boneh (Late Neolithic)

Chahar Boneh (Fig. 6.18) was identified during settlement survey in 2003, and excavated in 2006 (Fazeli et al. 2004; 2009). It covers an area of 2000 square metres (or 4000 square metres if the surrounding scatters are included), and lies in a small depression at an elevation of 1279 metres, some 3.3 kilometres southeast of Zagheh (Fazeli et al. 2009: 2). Before the site was excavated it was tentatively assigned an Early Neolithic (ca. 6500-4500 BC) date (Fazeli et al. 2009: 7), but excavation and ^{14}C dating has proven the site to be of solely Late Neolithic date.

Lab. No.	Context	Sample material	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
OxA-17744	Tr. IV, Context 403, 64 cm depth	Charcoal	6835 ±37	5740-5672	5792-5642	Reliable	Known material & context
OxA-17704	Tr. V, Context 508, 64 cm depth	Charcoal	6210 ±35	5222-5071	5296-5056	Reliable	Known material & context
OxA-17745	Tr. V, Context 508, 64 cm depth	Charcoal	6345 ±34	5371-5299	5465-5222	Reliable	Known material & context
OxA-17746	Tr. V, Context 508, 64 cm depth	Charcoal	6241 ±34	5303-5028	5380-5072	Reliable	Known material & context
OxA-17752	Tr. VIII, Context 702, 82 cm depth	Charcoal	6289 ±37	5307-5226	5353-5211	Reliable	Known material & context
OxA-17747	Tr. V, Context 10, 140 cm depth	Charcoal	6267 ±34	5229-5221	5321-5080	Reliable	Known material & context
OxA-17748	Tr. V, Context 510, 140 cm depth	Charcoal	6311 ±36	5322-5226	5362-5217	Reliable	Known material & context
OxA-17749	Tr. V, Context 512, 140 cm depth	Charcoal	6308 ±35	5320-5226	5358-5217	Reliable	Known material & context
OxA-17750	Tr. V, Context 512, 191 cm depth	Charcoal	6355 ±35	5374-5302	5467-5277	Reliable	Known material & context
OxA-17742	Tr. III, Context 306, 246 cm depth	Charcoal	7123 ±35	6031-5930	6063-5919	Reliable	Known material & context
OxA-17743	Tr. III, Context 306, 246 cm depth	Charcoal	7035 ±36	5983-5892	5998-5843	Reliable	Known material & context

(Fazeli et al. 2009: tables 1 & 2)

The ^{14}C measurements from Chahar Boneh can be considered reliable enough to be used without further question. The dates are all from charcoal samples, from well-recorded contexts, and have errors of below 40 ^{14}C years. The samples from virgin soil in Trench III (OxA-17742 & 017743) provide dates of 6063–5919 BC and 5998–5843 respectively, placing Chahar Boneh firmly in the Late Neolithic, an assignment which is supported by the ceramic typology (Fazeli et al. 2009: 11).

A small number of seeds and charcoal residue were recovered. Domesticates include *Triticum-dicoccum*, *Triticum* free threshing, *Hordeum* sp., six-row barley and small legumes (Fazeli et al. 2009: 15). Other cereals were

obtained, but have been too badly damaged by burning and breaking to identify. A larger amount of wild plants were recorded, and in total with 93 species identified including: *Gramineae*, *Chenopodiaceae*, large *Compositea*, Crucifera and *Aegilops* (ibid.: 16). In terms of the faunal remains, the bones were quite fragmented, and only 10 per cent were identifiable to species. There is also a bias towards larger bones, as systematic sieving was not implemented (Fazeli et al. 2009: 17). Caprines are the most numerous species represented, accounting for 59 per cent of the identified bones, while wild cattle, equid, gazelle, boar and goat collectively account for the remaining 35 per cent. It appears, then, that the inhabitants of Chahar Boneh exploited a range of different animal types for economic purposes, although the limited amount of identified bone makes it difficult to make anything other than tentative conclusions.

Occupation was primarily represented by a series of cultural contexts interspersed with natural deposit, and no architectural remains and very few coherent contexts were defined (Fazeli et al. 2009: 2). In terms of artefacts, only pottery, lithics and animal bones were recovered. The pottery is characterized by ‘Simple Buff’ and ‘Painted Buff’ wares, both of which are handmade, chaff tempered and covered with a fine slip (Fazeli et al. 2009: 11). The vessels are generally coarse and thick, although some medium and fine wares are present, and there is a general lack of consistency in form. Painted decoration was generally applied to the interior surfaces, and motifs include triangles, lozenges, cross hatchings, basket impressions and checkers. The chipped stone industry is represented by blades, debitage and cores, with a notable lack of agricultural tools (Fazeli et al. 2009: 3). This, in conjunction with and the absence of architectural phases, the limited evidence of occupation at the site, the small amount of cereal and food plant remains and the predominance of caprines in the faunal remains, suggests that Chahar Boneh was a short-lived, seasonal settlement, that was probably used by pastoralists (ibid.: 9, 15).

Tepe Ebrahim Abad (Late Neolithic–Transitional Chalcolithic)

Tepe Ebrahim Abad (Fig. 6.19) lies close to the foothills of the Alburz Mountains, 20 kilometres southeast of the modern town of Qazvin, and is surrounded by agricultural fields. It measures 240 by 250 metres in area, stands 8 metres above the modern plain surface, and contains 5 metres of archaeological deposits (Fazeli et al. 2009: 3). It was identified by survey in 2003, and excavated in 2006 under the direction of Hassan Fazeli (Fazeli et al. 2004, 2009). It was originally anticipated that the site would provide evidence of the Early Neolithic (ca. 6500-4500), but excavation and ^{14}C dating place the site firmly in the Late Neolithic–Transitional Chalcolithic (Fazeli et al. 2009: 7).

Lab. code	Context	Sample material	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
OxA-17602	Tr. II, Context 214, 304 cm depth	Charcoal	6265± 33	5299-5220	5321-5080	Reliable	Known mat. & context
OxA-17604	Tr. II, Context 238, 384 cm depth	Charcoal	6266± 33	5299-5220	5321-5080	Reliable	Known mat. & context
OxA-17605	Tr. II, Context 239, 413 cm depth	Charcoal	6291± 33	5308-5226	5327-5212	Reliable	Known mat. & context
OxA-17606	Tr. II, Context 241, 434 cm depth	Charcoal	6335± 35	5366-5231	5463-5219	Reliable	Known mat. & context
OxA-17603	Tr. II, Context 244, 486 cm depth	Charcoal	6493± 34	5463-5219	5519-5372	Reliable	Known mat. & context
OxA-17607	Tr. II, Context 266, 722 cm depth	Charcoal	6579± 33	5548-5486	5613-5479	Reliable	Known mat. & context
OxA-17736	Tr. III, Context 325, 257 cm depth	Charcoal	6176± 35	5208-5068	5221-5011	Reliable	Known mat. & context
OxA-17737	Tr. III, Context 341, 323 cm depth	Charcoal	6191± 35	5221-5011	5291-5032	Reliable	Known mat. & context
OxA-17738	Tr. III, Context. 355, 533 cm depth	Charcoal	6201± 34	5217-5073	5293-5051	Reliable	Known mat. & context

(Fazeli et al. 2009: table 3)

Nine charcoal samples were submitted to The Oxford Accelerator Unit for AMS measurement. The samples are from secure, well-recorded contexts, and the measurements have associated errors of less than 40 ^{14}C years and

are in general stratigraphic agreement. The dates, thus, are reliable enough to be used without further questioning, and firmly place Ebrahim Abad in the Late Neolithic (ca. 6200-5500 BC) and Transitional Chalcolithic (ca. 5500-4300 BC) periods, a conclusion supported by the relative chronology of the site (Fazeli et al. 2009).

A great number of domesticated plant remains were recovered, and identified species include *Triticum dicoccum*, *Triticum* free threshing, hulled *Hordeum*, *Hordeum vulgare*, *Triticum* sp., lens, *Vicia*, *Pisum*, *Triticum hexaploid* rachis, *Hordeum vulgare* rachis, *Hordeum* sp. rachis, small legume, *Gramineae*, *Chenopodiaceae*, large *Compositea*, *Cyperaceae*, medicago, fumaria, *Rubiaceae*, *lithospermum*, *Vicia lathyroides*, *polygonum* sp., as well as many small legumes (Fazeli et al. 2009: 15). A transition in plant type occurs during the occupation of Ebrahim Abad, and while the lower levels are dominated by wild species, in the upper levels domesticated species outnumber those of wild plants, attesting to an increasing reliance on subsistence agriculture (ibid.: 16). The faunal remains were very fragmented, and it was only possible to identify nine per cent of the bones to species. Of these 74 per cent were attributable to domesticated caprines, 12 per cent to domesticated cattle, and 10 per cent equids (Fazeli et al. 2009: 17). The low number of wild types in conjunction with the abundance of caprines led Fazeli et al. (2009: 18) to suggest that Ebrahim Abad was a relatively specialized pastoral site, but the faunal assemblage is too small to make a firm interpretation.

Four distinct architectural phases of mudbrick and *pisé* were recorded (Fazeli et al. 2009: 4). One living floor was found paved with 1641 sherds, while another contained a large amount of dung from sheep and goats, as well as straw and grass, suggesting the area was used for housing animals (ibid.: 5). The ceramics can be divided into five Late Neolithic ('Simple Buff', 'Simple Red', 'Ebrahim Abad Painted', 'Black-on-Red', Sialk I) and three Transitional Chalcolithic ('Cheshmeh Ali', 'Zagheh Crusted', 'Zagheh Painted') wares (Fazeli et al. 2009: 12). The Sialk I ware is of particular note, for although it is known to be regionally distributed across the Kashan and Tehran Plains, it has not previously been recorded on the Qazvin Plain (ibid.: 3). Other small

finds include awls, sling stones, beads, stone vessels, spindle whorls and softly-fired animal figurines, and one burial of an adult laid in a foetal position, with the hands raised in front of the face (ibid.: 5-6).

Tepe Cheshmeh Bolbol (Transitional Chalcolithic)
Cheshmeh Bolbol lies five kilometres south of Zagheh. It has not been excavated, but Neghaban during his 1970 field season on the Qazvin Plain collected a sample of sherds from the site. The sherds have been analysed by Malek Shahmirzadi, who reported them to be “exactly similar” (1977: 423) to the Transitional Chalcolithic Ware at Zagheh.

Ismailabad (Late Chalcolithic)
Ismailabad is located in the hilly flanks of the southern Alburz Mountains. Although much later than the other sites reviewed in this section, it is included, as to date, it represents the only recorded Chalcolithic site from the foothills, rather than plain. It is a tepe site, standing 10- metres in height, and covering an area of approximately 300 square metres, which contains 4.2 metres of cultural deposits. It was excavated in 2003 under the direction of Hassan Fazeli (Fazeli et al. 2007). No ^{14}C dates are available for the site, and it is classified as Late Chalcolithic (ca. 3500-3000 BC) purely on the basis of the ceramic typology

The majority of the faunal remains were fragmented, rendering identification difficult. Of the bones that can be assigned to species, the majority are from domesticated caprines (60%), with sheep and goat represented in equal numbers (Young & Fazeli 2008: 159–60). The herd demography suggests a specialized herd management strategy directed towards meat production, with few of the animals lasting beyond four years in age (ibid.: 166). Bovines and wild caprines were the next most significant types, with gazelle (*Gazella subguttorods*), possibly domesticated pig (*Sis* sp.), and deer (*Cervus* sp.) present in smaller amounts. Collectively, the percentage of wild types is 19 per cent, implying that they were an important component of the diet, and that a diversity of species was exploited (ibid.: 160).

Sixteen archaeological contexts are identified. No mudbrick or *pisé* architecture is apparent, and settlement is represented by the remnants of stone walls, which may have been parts of circular foundations for temporary structures (Young & Fazeli 2008: 157, 168). Other features include stone walls, pits and ovens or hearths (Fazeli & Ajourli 2007).

The pottery assemblage is described as "characteristic Late Chalcolithic" (Young & Fazeli 2008: 157). Intriguingly, one of the main identified ceramic types is 'Burnished Grey' Ware, which is usually associated with the earliest Kura-Araxes Transcausians assemblages to the northeast, rather than with other Chalcolithic ceramics on the Central Plateau (Young & Fazeli 2008: 157). The primary economic base of Kura-Araxes Transcausians is mobile pastoralism, and this affinity in economy and pottery type between them and the inhabitants of Ismailabad, suggests that there was contact between them. The majority of the lithics are flakes and blades, which were primarily used for non-agricultural tasks such as butchering; agricultural tools are noticeably lacking (ibid.).

6.4d. Summary of settlement distribution on the Qazvin Plain *(Table 6.5)*

Similar to the situation on the Tehran Plain, no Early or Middle Neolithic sites are known on the Qazvin Plain, and settlement does not appear until the Late Neolithic, where it is represented at the sites of Chahar Boneh and Ebrahim Abad. However, unlike on the Tehran Plain, in the ensuing Transitional Chalcolithic, there is no apparent growth in settlement numbers, and only three sites are known from this period (Ebrahim Abad, Cheshmeh Bolbol & Zagheh). Of these only Zagheh remains occupied during the Early Chalcolithic, following which there is a hiatus in settlement, with no further settlements known in the region until the Late Chalcolithic period, when Ghabristan and Ismailabad were founded. The prehistoric sites on the Qazvin Plain are not as well published as those on the Tehran Plain, and this may have contributed to creating the apparent differences in the occupation sequences of the two regions. However, using the current information available, it would appear that the Qazvin Plain was much more sparsely

occupied in the Chalcolithic than the Tehran, particularly during the Middle Chalcolithic, for which no settlements are known.

6.5. The Kashan Plain

The Kashan Plain, which is located to the west of the Dasht-e Kavir, is comprised of three major environmental zones: the Markazi Mountains to the west, the plain proper, and the desert. The Markazi Mountains are effectively the eastern fringes of the larger Zagros range. Reaching a maximum elevation of 3900 metres above sea level, they form the western boundary of the plain. They are rich in mineral resources, including copper, which have been exploited since prehistory (Danti 2006: 68).

The plain itself is formed by a series of alluvial fans, which are fed by several wadi systems that drain the easternmost range of the Markazi Mountains (Tenberg 2003: 9; Danti 2006: 72). The arid climate of the plain is greatly affected by the close proximity of the *Dasht-e Kavir*. Temperatures can range from -3 ºC to 40 ºC and it has an annual rainfall of up to ca. 230-300 mm per year, which is largely confined to the winter and early spring (Kourampas et al. in press). Today, cultivation in the region has to be aided by *qanat* systems and electric pumps. Sedimentation is a major issue, and survey work has shown that some 7 metres of sediments have been deposited over the last 6500 years (Malek Shahmirzadi 2004: 14). The principal city on the plain today is Kashan, which is one of a series of oasis cities along the western edge of the Dasht-i Kavir, and also lies on a major trade route running from Qazvin in the northwest to Kirman in the southeast (Voigt & Dyson 1992: 165).

The desert proper, lies at altitude of ca. 1000 metres above sea level, and is characterized by mountain ridges, fans and marshy basins of mud and salt. Its lack of water, swift evaporation and high temperature extremes make it unsuitable for cultivation. Summers are scorching, with temperatures in July and August reaching 45–50ºC in the shade, and winters are harsh

(Ghirshman 1938: 4). Precipitation is relatively rare, and as a result the vegetation coverage is poor.

6.5a. History of archaeological investigation

Since the turn of the last century, archaeological research on the Kashan Plain has focused on Tepe Sialk. Tepe Sialk was first excavated by Roland Ghirshman, who directed excavations at the site for four seasons between 1933 and 1937. He published his findings in two monumental volumes (Ghirshman 1938), and his chronology for the site has come to be used to define that of the Central Plateau at large (e.g. McCown 1942b; 1954; Majizadeh 1976; Voigt & Dyson 1992). Sialk was then largely abandoned until the 2000s, when investigation was renewed at the site by The Sialk Reconsideration Project, whose remit also included settlement survey in the surrounding plain and foothills (Malek Shahmirzadi 2002; 2003; 2004; 2006a; 2006b). The most recent archaeological investigations on the Kashan Plain have been conducted by a joint Irano-British team, of which I was a member.

6.5b. Settlement survey

Archaeological research in the Kashan Plain has focused on Tepe Sialk, and little is known about prehistoric settlement elsewhere on the plain. To date, no Early Neolithic (8000-6500 BC) sites have been recorded, and the earliest evidence of prehistoric occupation comes from the Mid-Late Neolithic (ca. 6500-5500 BC) levels at Sialk North. To test for prehistoric occupation elsewhere on the Kashan Plain, in 2009 I piloted a settlement survey of the region. The Kashan Plain is aggrading, and in many places all but the largest of archaeological sites have been buried (Brookes et al. 1982; Gillmore et al. 2007; 2009). To determine whether the absence of Early Neolithic sites, along with the absence of small-scale sites from other periods, was a function of alluvial deposition, or whether settlement was confined to larger sites from the Mid Neolithic period (ca. 6500 BC) onwards, *qanat* survey, similar to that

successfully employed by Coningham et al. (2004; 2006) to identify prehistoric sites on the Tehran Plain, was implemented.

Five days of *qanat* survey were conducted. Although I had originally planned to survey for 10 days, political circumstances meant that the period had to be curtailed. The aim of the survey was to survey *qanat* lines in a range of different geographical environments, to establish where archaeological sites were concentrated. Following Coningham et al. (2006: 55), sites were defined by the presence of a feature, a single lithic find spot, a ceramic scatter of more than five-per-square metre or fire-cracked rocks, and were recorded using handheld GPS (Global Positioning System) unit, photographed and sketched. Samples of ceramics and lithics were collected and catalogued at the project base in Kashan for subsequent analysis by specialists. In addition to features and finds relevant to each site, information was also recorded on the topography, the type of terrain, the availability of local water sources, land use and any potential or actual threats to the site. A total of 18.5 kilometres was walked, and 15 sites recorded, of which 2 were prehistoric (Table 6.6). Of these, one (DK005) was previously unknown. Compared to the success of Coningham et al.'s (2004; 2006) *qanat* survey on the Tehran Plain, relatively few prehistoric sites were identified on the Kashan Plain. In part, this is probably due to the short period of survey. It may also reflect modern use patterns, as the majority of the area surveyed on the Kashan Plain was currently being used for agricultural purposes, and due to the modern use of electric pumps for irrigation it was found that many of the *qanat* lines had been abandoned or in-filled.

Qomrud survey, Qom

Mir Abedin Kaboli, by permission of ICAR, between 1988 and 1995, undertook a survey of the valley of the Qom Rud. Although technically not on the Kashan Plain, the results of his survey are included in this section, due to the close proximity of the survey area to the Kashan Plain. (The same reasoning also applies to the inclusion of the Arisman survey, the results of

which are given below.) In total, Kabouli recorded 93 archaeological sites, including 2 Palaeolithic, 6 Neolithic and 15 Chalcolithic period sites. Settlement continuity in the region seems to have been extremely low. For example, only three Neolithic sites continued to be occupied in to the Chalcolithic (Azamoush & Helwing 2005: 197). Excavation at the major prehistoric site in the area, Qara Tappe, uncovered a sequence of domestic architecture comprised of *pisé* walls, associated with Transitional Chalcolithic 'Cheshmeh Ali' Ware (ibid.).

Arismān survey, Esfahan

One season of settlement survey was conducted in the Arismān region, in relation to the Joint Iranian-German excavation at Alismān. In total, 38 archaeological sites were registered, including a group of 4 small Neolithic mounds, located between 1-2 kilometres from each other along a small stream. The two earliest sites contained monochrome pottery and a flake industry that seems to correlate with Tepe Shurabad in the vicinity of Sialk, while the third yielded a few pottery fragments that seem to belong to a tradition of biconical vessels, such as those known from Fars, and the fourth had pottery of a Sialk II-lie type (Azamoush &Helwing 2005: 199). Azamoush and Helwing suggest that the widespread distribution pattern of the sites may be due to the continuous shifting of settlement along the stream (ibid.).

6.5c. Archaeological sites

Tepe Sialk (Late Neolithic–Early Chalcolithic)

Tepe Sialk (Fig. 6.20-6.22) is located in the outer suburbs of Kashan, and consists of a North and South Mound situated several hundred metres apart. It lies within the eastern margins of a constellation of prehistoric settlements that extended from the domestication centres of Upper Mesopotamia and the Zagros Mountains, to the salt desert of the Iranian Plateau and the southern shores of the Caspian Sea (Kourampas et al. in press). Until about 30 years ago, Sialk was located in a rural agricultural field area, around 4 kilometres

south of Kashan. Today, however, due to the recent rapid growth of Kashan, it lies within the main city, and is threatened by urban encroachment. The North Mound, which measures ca. 2.5 hectares, is the older, and emerged in the Late Neolithic, between ca. 6000 BC and 5700 BC, and was abandoned at the beginning of the Chalcolithic period (ca. 4900 BC) (Kourampas et al. in press). After an apparent occupation hiatus of 400-600 years, the larger (ca. 4.5 hectares) site of Sialk South emerged, and continued to be occupied throughout the Chalcolithic, Bronze Age and Iron Age period.

As a result of the decades of neglect that followed Ghirshman's excavations in the 1930s, Sialk has been badly damaged, and until the intervention of the ICHTO in 2002, the area was used as a dumping ground for domestic waste and construction garbage, the surfaces of the mounds were used for motorcycling, and in order to build a football field for local residents a vast area of the southeastern part of the South Mound had been levelled by bulldozers (Malek Shahmirzadi 2006b: 17). Indeed, despite the recent recognition of the South Mound as a national heritage site, both mounds are still threatened by illegal constructions and excavations (Malek Shahmirzadi 2006b: 27; http://www.cais-soas.com/News/2006/July2006/25-07.htm).

Sialk's setting is liminal. To the south lies a gravel fan, supporting an even spread of vegetation of dwarf shrubs, which gradually merges into the foothills of the Markazi Mountains; while to the north lies a zone of sand dunes, characterized by psammophilous taxa (e.g. *Calligonum* & *Haloxylon*), that form part of the extensive desert plain that links the Zagros highlands to the west with the Central Asian steppe to the east (Tenberg 2003: 9; Kourampas et al. in press). Geomorphological study has revealed the existence of a relic palaeochannel, lying between the North and South Mounds, which would have probably supported a gallery forest, with hygrophilous trees (e.g. tamarisk, poplar, willow), and palaeoenvironmental evidence suggests the environment around Sialk 6000 years ago, would have been much greener and wetter than today (Malek Shahmirzadi 2003: 7, 9; Tenberg 2003: 9; Kourampas et al. in press).

Ghirshman's original excavations opened three trenches on Sialk North (Operations I, II & III), of which Operation I, measuring 15 metres by 10 metres, was the largest (Fig. 6.23) (Ghirshman 1938: 9). Based on his findings from these three trenches, Ghirshman divided the occupation of the North Mound into two phases: Sialk Period I1-5 (Late Neolithic) and Period II1-3 (Transitional Chalcolithic), which have become paradigmatic in Iranian prehistory. Between 2002 and 2007, the Sialk Reconsideration Project opened three trenches on the North Mound: Test Trench B, a five metre by three metre trench, the location of which is unclear; a stratigraphic section cut into the southeast corner of Ghirshman's Operation I; and a section on the 'pinnacle', which reputedly traced a mudbrick fortification wall (Malek Shahmirzadi 2006b). Commencing in 2008, the most recent archaeological investigations at Sialk, a joint Irano-British project, of which I was a member, cut back a section into Ghirshman's Operation II (Fig. 24) in order to establish a relative and absolute chronology for the site; and opened a 10 metre by 10 metre horizontal trench in order to sample the structural and architectural sequence of the deposits.

The Irano-British project (2009) collected charcoal samples from Trench V and VI on the North Mound, and Trench B on the periphery of the North Mound, which Trench VI; 3 Trench B), which they submitted for AMS measurement.

Lab. code	Context	Sample material	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
n.d.	Tr. V, Lyr 5195	Charcoal	6185 ±33	5212-5072	5282-5026	Unreliable	No lab. code
OxA-22347	Tr. V, Lyr 5127, SKZ 5114	Charcoal	6263 ±33	5298-5220	5320-5079	Reliable	Known material & context
OxA-22505	Tr. V, Lyr 5123, SKZ 5110	Charcoal	6149 ±34	5207-5041	5211-5003	Reliable	Known material & context
OxA-22504	Tr. V, Lyr 5105, SKZ 5104	Charcoal	6185 ±33	5212-5072	5283-5026	Reliable	Known material & context
OxA-22503	Tr. V, Lyr 5095, SKZ 5093	Charcoal	6251 ±35	5298-5214	5314-5076	Reliable	Known material & context
n.d.	Tr. V, Lyr	Charcoal	6256	5298-	5316-	Unreliable	Known

	5089		±31	5216	5078 (95.3%)		material & context
OxA-22502	Tr. V, Lyr 5087, SKZ 5082	Charcoal	6364 ±35	5461-5306	5470-5231	Reliable	Known material & context
OxA-22501	Tr. V, Lyr 5085. SKZ 5080	Charcoal	6141 ±32	5207-5017	5210-5000	Reliable	Known material & context
OxA-22500	Tr. V, Lyr 5080, SKZ 5072	Charcoal	6163 ±33	5207-5056	5215-5011	Reliable	Known material & context
n.d.	Tr. V, Lyr 5078	Charcoal	6364 ±35	5461-5306	5470-5231	Unreliable	No lab. code
OxA-22499	Tr. V, Lyr 5073, SKZ 5073	Charcoal	6179 ±34	5209-5069	5221-5019	Reliable	Known material & context
OxA-22498	Tr. V, Lyr 5051, SKZ 5061	Charcoal	6188 ±34	5212-5071	5286-5029	Reliable	Known material & context
OxA-22497	Tr. V, Lyr 5046, SKZ 5042	Charcoal	6201 ±31	5216-5075	5292-5052	Reliable	Known material & context
OxA-22496	Tr. V, Lyr 5037, SKZ 5037 (508)	Charcoal	6191 ±33	5213-5072	5289-5035	Reliable	Known material & context
OxA-22495	Tr. V, Lyr 5033, SKZ 5046	Charcoal	6112 ±31	5201-4986	5208-4945	Reliable	Known material & context
OxA-22494	Tr. V, Lyr 5026, SKZ 5033	Charcoal	5984 ±34	4932-4808	4982-4786	Reliable	Known material & context
n.d.	Tr. VI, Lyr 6038	Charcoal	6830 ±34	5735-5672	5774-5642	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6037	Charcoal	6828 ±32	5733-5673	5764-5642	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6035	Charcoal	6925 ±40	5841-5747	5894-5725	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6031	Charcoal	6417 ±33	5468-5366	5472-5328	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6028	Charcoal	6497 ±33	5509-5383	5523-5374	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6022	Charcoal	6322 ±31	5338-5227	5363-5222	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6021	Charcoal	6279 ±32	5302-5226	5321-5212	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6019	Charcoal	6280 ±33	5303-5226	5322-5211	Unreliable	No lab. code
n.d.	Tr. VI, Lyr 6018	Charcoal	6275 ±33	5300-5226	5325-5207	Unreliable	No lab. code
OxA-22508	Tr. VI, Lyr 6017, Z6018	Charcoal	6333 ±36	5365-5230	5463-5218	Reliable	Known material & context
OxA-22507	Tr. VI, Lyr 6009, Z6008	Charcoal	6344 ±35	5371-5234	5465-5222	Reliable	Known material & context
OxA-22506	Tr. VI, Lyr 6006, Z6001	Charcoal	6290 ±34	5308-5226	5339-5212	Reliable	Known material & context

	(Z6000)						
n.d.	Tr. VII, Lyr 7024	Charcoal	6172 ±31	5207-5068	5217-5031	Unreliable	No lab. code
n.d.	Tr. VII, Lyr RRF	Charcoal	6055 ±33	5004-4859	5047-4848	Unreliable	No lab. code
n.d.	Tr. VII, Lyr RR2	Charcoal	5926 ±31	4839-4746	4896-4719	Unreliable	No lab. code

(Coningham et al. in press)

The dates are arranged in chronological sequence (Fig. 6.25). Trench VI is thought to be the earlier, and the sequence of layers for each trench is arranged oldest to youngest. The ^{14}C dates which have been assigned laboratory codes can be treated as of reliable confidence. They are AMS measurements of charcoal samples, from a known context, with errors of fewer than 50 ^{14}C years. Unfortunately, the other ^{14}C dates cannot be treated with confidence until they have published with laboratory codes, for their chemistry is uncertain. Using the evidence currently available, it appears that Sialk North was occupied between ca. 6000 to 5700 BC, and abandoned ca. 5700 BC. Three ^{14}C dates are available from Trench B, on the periphery of the North Mound.

Lab. code	Context	Sample material	^{14}C age (BP)	Cal. date (BC)		Hygiene	Reason
				68.2%	95.4%		
GU-21012	Tr. B, Unit 4	Charcoal	5610 ±40	4490-4360	4520-4350	Reliable	Known mat. & context
GU-21013	Tr. B, Unit 10	Charcoal	5590 ±45	4455-4365	4510-4340	Reliable	Known mat. & context
GU-21014	Tr. B, Unit 12	Charcoal	5970 ±40	4910-4790	4960-4720	Reliable	Known mat. & context

(Kourampas et al. in press)

The dates are AMS measurements from charcoal samples, taken from well recorded contexts and have error terms of below 45 ^{14}C years. They are thus, reliable enough to be used without further questioning. GU-21012 and -21013 are almost isochronous, and appear to fall in the occupation hiatus between the abandonment of Sialk North (ca. 5700 BC) and the occupation of Sialk South (ca. 4100 BC) (Kourampas et al. in press). They suggest that people may have remained in the vicinity of Sialk even after the abandonment of the North Mound. The implications of this are that the abandonment of the North Mound may have involved decentralisation of settlement, perhaps consistent

with more mobile practises (e.g. pastoralism &/or shifting agriculture), or that people may have settled elsewhere, but nearby on the adjacent plain (ibid.).

No botanical remains were recovered by Ghirshman's excavations, but he inferred the practise of cereal cultivation, from the presence of sickles and grinding stones (Ghirshman 1938: 74). The botanical remains from the Sialk Reconsideration Project were analysed by M. Tenberg (2003; 2004). Unfortunately, no data was recovered from the earliest levels, and nothing can be said about the beginning of agriculture at Sialk. The bulk of the sample from the higher levels was comprised of cereal remains, of which hulled barley was the predominate type. Emmer was the principal wheat species, and a single grain of free-threshing wheat (*durum* sp. or bread wheat) was also identified. Einkorn was not identified with any certainty although its presence cannot be ruled out (Tenberg 2004: 27). The presence of numerous grains of chaff among the botanical remains suggests that some crop processing activities, notably the dehusking of hulled cereals, was undertaken at the site, perhaps directly in connection with the preparation of food. No cultivated pulses (Fabaceae family) were identified with any certainty, despite their presence at most prehistoric sites in Iran (Miller 2003: 11), although Tenberg (2003: 28) suggests that this may be a hazard of sampling. In terms of other species, several varieties of wild Fabaceae were recorded, including vetches (*Vivia* spp.) and *Medicago* or *Astragalus* types, and a limited number of Atriplex (Chenonpodiaceae) and Galium (*Rubiaceae*), which were all probably collected accidently alongside the crops during harvesting (Tenberg 2003: 28). Several wild grass species (*Poaceae*) were noted, but could not be identified further due to their limited number and sometimes poor state of conservation (ibid.).

Although finding no evidence of it, Ghirshman believed that irrigation agriculture would have been inevitable at Sialk (Ghirshman 1938: 74). Some 60 years later, his observation has been substantiated by the interpretation, in the field, of sharp-based stratigraphic units on the fringe of the North Mound as irrigation canal fill (Simpson & Nejad 2008). This interpretation is consistent with reports of irrigation canals around Late Neolithic villages elsewhere in

Iran (e.g. Choga Sefid, Tepe Pardis: Hole 1977; Gillmore et al. 2009) and Upper Mesopotamia (e.g. Choga Mami; Oates & Oates 1977). However, it is also possible that the 'channel-like' feature at Sialk represents an enclosed depression or linear hollow, as have been observed at many Levantine and Mesopotamian tell sites, and which results from repeated human and animal traffic from and to the site (Wilkinson 2003). Further study is needed, then, before the practise of irrigation agriculture at Sialk North can be verified. One potential form that this could take would be through identifying species in the botanical remains, which could only have been grown with irrigation.

Domesticated sheep, goat and cattle were evidenced in Ghirshman's excavations (Ghirshman 1938: 74). No wild animal remains were found, but Ghirshman believed the remains of many clay slingshot balls to imply the hunting of wild animals which, on the basis of the ceramic decorations of Period II, he suggested included wild cattle and gazelles (ibid.). The analysis of the faunal remains from the Sialk Reconsideration Project excavations evidences the presence of both domesticated and wild caprines; onager, dog, hyena, leopard/cheetah and turtle (Mashkour 2004). The assemblage is dominated by caprines, with sheep slightly outnumbering goats (ibid.: tables 1 & 2). Gazelle comprise the next biggest group, followed by bovids, with other species present in only limited numbers. The combined results from Ghirshman's excavations, The Sialk Reconsideration Project, and the recent work of the Irano-British team, indicate that the inhabitants of Sialk had an economy based on intensive mixed farming, which Kourampas et al. (in press) argue may have been produced and maintained by "the perpetual interdependence of the livestock herding, cultivation, and settlement".

Ghirshman found no evidence of architecture in the earliest levels at Sialk, which he reported were comprised of a series of ash layers, alternating with bands of clay (Ghirshman 1938: 10, 74), and suggested that permanent structures did not appear until Period II_1, during which houses were constructed with mudbrick floors and *pisé* walls (ibid. 1954: 29). The interior of the houses were plastered, and decorated in a red-ochre paint, and fitted with *crapandines* ('door sockets') and large containers and jars for storing

provisions (Ghirshman 1938: 76). In contrast to Ghirshman's findings, Malek Shahmirzadi reports evidence of architecture from the earliest levels, during which he suggests that Sialk's inhabitants lived in small *pisé* huts, roofed with twigs and leafs coated with mud plaster (Malek Shahmirzadi 2004: 10). Malek Shahmirzadi also reported that both house walls and floors were built of mudbrick from the beginning of Period II, while Ghirshman had suggested that this was a later development. At present there is no way of reconciling these two accounts. Ghirshman reported there to be an ancient wall located to the west of the site, the defining feature of which, the 'pinnacle', is a cylindrical-shaped mudbrick structure, which can still be seen today (Fig. 6.26). Malek Shahmirzadi believes this wall to represent the "remains of the oldest fortification wall at a Neolithic village in Iran" (Malek Shahmirzadi 2006b: 33), but this remains unsubstantiated.

Recent micromorphological and microstratigraphic analysis (Kourampas et al. in press) has identified the present of putative 'preoccupation' deposits that contain small quantities of silt sized microcharcoal, which may or may not have resulted from human-induced fires. If it is human induced, Kourampas et al. suggest that the microcharcoal may have been reworked from domestic hearths, associated with domestic dwellings dispersed on the landscape, or could reflect agricultural-related activities, such as wood clearance or post-harvest burning of straw etc. However, they argue that more direct evidence is needed, before either of these hypotheses can be substantiated.

Ghirshman's chronology for Sialk North was based on ceramic typology. He identified four Period I wares, which loosely translate as 'Black-Painted', 'Red Monochrome' or 'Decorated', 'Black' and 'Plain' wares. Following the Neolithic software tradition of the Central Plateau, all of the wares were handmade from poorly levigated clay, chaff-tempered and irregularly fired. 'Black-Painted' and 'Red' Ware were present from the earliest levels. 'Black Painted' Ware was decorated with decorated with large horizontal bands of crosshatches, triangles or straight lines with festoons, applied in a pattern which Ghirshman (1938: 13-14; 1954: 29) believes to be derived from basketry, and common forms include large, wide-mouthed storage jars designed to be embedded into

house floors (Ghirshman 1938: 12-13). Ghirshman reports that 'Red' Ware was finer, and that the vessels generally smaller in size, with common forms including wide-mouthed bowls with straight or slightly flared sides; goblets; and from Period I_4 onwards, deep dishes with wide, flat bases (ibid.: 15). The earliest vessels were undecorated, while the designs used on later vessels were similar to those applied to 'Black-Painted' Ware. Only 10 sherds of Black Ware, provenanced to Period I_{1-3}, were found, and it is impossible to comment any further on the ware besides that it was well fired and undecorated (ibid.: 16). 'Plain' Ware was made from a dark clay paste with a vegetable and/or grit temper and was fired in an open kiln (ibid.: 16). Common forms include large terrines with openings up to 0.75 metres in diameter. Period II is characterized by the presence of Cheshmeh Ali Ware, which Ghirshman referred to as 'Black-on-Red' Ware (1938: 28). It had a finer paste than the Period I wares, was better fired, probably in a purpose built kiln (Ghirshman 1938: 77), and the vessels were generally smaller. The painted decoration was more advanced: several registers were used and both geometric and naturalistic motifs, including plants, birds, boars and goats, were employed (ibid.: 29).

Baked and unbaked clay was also used to make beads, pendants, and slingshot balls (Ghirshman 1938: 22-4, 32). A large number of clay spindle whorls were recovered, evidencing the "commencement of the textile industry" (ibid.: 74). Small pestles in baked clay were used for crushing pigments in small groundstone mortars, which may have been used for tattooing (ibid.: 21, 23). Ghirshman found no evidence of clay figurines, although one carved stone sculpture, possibly of a dog, was reported (Ghirshman 1938: 31, 75). However, while I was excavating at the site several animal figurines, possibly of caprines, were recovered.

The chipped-stone tool industry included flint blades, sickles, saws, borers, scrappers and piercers (Ghirshman 1938: 22). White marble was also occasionally used, and one obsidian blade was recovered. Distinct to Period I, was the mounting of flint blades in carved bone handles to form a composite tool, which Ghirshman (1938: 16) refers to as '*porte-silex*'. The carving of the handles was particularly fine, and designs included animal heads (e.g.

caprines, hares) and an upright man wearing a loin cloth (ibid.: 16-17, 1954: 29). *Porte-silex* are not known from anywhere else on the Central Plateau, although similar carved bone tools are reported from Sang-i Chakmaq West, northeastern Iran (Thornton 2010). Bone was also used for manufacturing awls, and burnishing tools used in pottery production. The groundstone tool assemblage included maces, awls, axes and small mortars (Ghirshman 1938: 32). Carved stone bowls were relatively rare in Period I, although they increased in number in Period II, which Ghirshman (1938: 31) attributed to the development of better tools. Stone was used for manufacturing jewellery including bracelets made from slate, black volcanic stone and, from Period II, alabaster and white and green marble; rings in alabaster; and cylindrical beads of slate, white marble diorite, turquoise and carnelian (ibid.: 20, 30-1). Shell was also used to produce decorative elements. Three shell pieces of *Conus* and *Cerithiide* were recovered from Period I, and several pieces of large *Pterocera* shell were found in Period II contexts, where they had been used for manufacturing beads (Ghirshman 1938: 24, 32). Hundreds of dentillium shells were also used in Period II for forming necklaces.

The abundance of non-local materials implies that Sialk was an important node in trade and communication networks across the Central Plateau and beyond. The turquoise and carnelian were probably sourced from the Meshed region of eastern Iran, and the shell from the Persian Gulf (Ghirshman 1938: 24, 31-2). The obsidian, the use of which is rare on the Central Plateau, was probably from sources in the Lake Van region of eastern Turkey, while the presence of Cheshmeh Ali Ware, which is found distributed across the Central Plateau from the Gurgan Plain in the east, to the Qazvin Plain in the west (Wong et al. 2010), suggests wide-spread contact across this vast region. Small, cold-hammered copper objects, including small balls, pin heads and needles, were also recorded from Period I_3 onwards (Ghirshman 1938: 75.), and although the copper was probably locally sourced from the Markazi Mountains (Negatati 2004: 63), the practise of early metallurgy, and the technological 'know how' associated with it, can also be interpreted as evidence of expanding trade and social networks (cf. Thornton 2009).

Individual subfloor burials were recorded in all levels at Sialk North. The orientation of the burials was not strict, and bodies were interred lying on either side in a flexed position, and generally aligned east to west (Ghirshman 1938: 10). The majority of the skeletons bore traces of red ochre. With the exception of one burial from Period I, which contained a mace head and two sheep's mandibles, none contained grave goods, although Ghirshman (1938: 76) has suggested that perishable items may have been offered. Infants were buried in the ground or in small jars, and their bones were often burnt and covered in red ochre (ibid.: 11). Similar infant burials were recovered from the 2009 excavation at Sialk.

Tepe Shurabeh (Neolithic)

Tepe Shurabeh (Fig. 6.27 & 6.28) is a small settlement site, located about five kilometres to the southwest of Sialk, in the foothills of the Markazi Mountains, which was identified during survey by members of the Sialk Reconsideration Project (Danti 2006: 73). The site was in the process of being bulldozed, and on the basis of the surface pottery, Malek Shahmirzadi dated the site to before the beginning of the Neolithic sequence at Sialk (Malek Shahmirzadi 2006: 13). However, the site's chronology was never confirmed, and it has now been completely destroyed (Coningham pers. comm.).

Ghabristan (Late Neolithic)

Ghabristan (Fig. 6.29) is located 10 kilometres northwest of Sialk. It is a shallow mound that has been badly damaged by erosion and bulldozing to provide soil for agricultural activities. The site was identified during survey by members of the ICHTO, who tentatively assigned the site an Early Neolithic date (ca. 8000-6500 BC), but subsequent excavation in 2008 by a joint Irano-British project, of which I was a member, established the site to be entirely Middle to Late Neolithic. Unfortunately, no ^{14}C dates are available for the site, but the assignment of a Late Neolithic date is supported by the ceramic typology, which is of the Neolithic software tradition.

No information is available on the botanical or faunal remains, and no architecture was recorded. The absence of architecture suggests that the site

was ephemeral or semi-permanently occupied, and that it may have represented a specialized site for lithic production, or a pastoralist camp. However, more information is needed, particularly on the nature of the faunal assemblage, before either of these claims can be substantiated.

Three types of decorated ceramics were identified ('Red-on-Buff', 'Black-on-Red' & 'Black-on Buff' wares), which were decorated with geometric motifs including horizontal waved lines; zigzags; lozenges; rectangles; horizontal bands; checkers; and chevrons. According to the excavators, the assemblage represents a local ceramic tradition, which bears little resemblance with the lowest levels of Sialk (Coningham et al. in press). This implies that chronologically, Ghabristan is earlier than the Late Neolithic period at Sialk (ca. 5500–4500 BC).

A total of 1085 lithics were recovered, ranging from debitage and flakes to bullet cores and blades. Initial analysis suggests 11.5 per cent of the collected lithics are obsidian. Although the use of obsidian has been widely documented at Neolithic sites in southwestern Iran (e.g. Ali Kosh; Hole et al., 1969, Chogha Bonut; Alizadeh 2004), it is rare on the Central Plateau, and it has only been found in small amounts at Tepe Pardis, Chakhmak Tepe and Tepe Sialk (Ghirshman 1938; Coningham et al. 2004; Fazeli et al. 2007). The comparatively large amount recovered from Ghabristan, implies that its inhabitants were connected to part of a larger regional trade network that extended beyond the Central Plateau. This hypothesis is further supported by the recovery of a mother-of-pearl pendant at the site, the shell for which probably came from the Persian Gulf.

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A small number of other prehistoric sites have been recorded, or briefly excavated, on the Kashan Plain. Malek Shahmirzadi (1977: 410) has reported the presence of Sialk I and II and Cheshmeh Ali-type Transitional Chalcolithic wares at Meshreh, which lies near the modern town of Sareh. This suggests that the site, which lies about halfway between Zagheh and Sialk, was possibly in contact with groups both to the north (on the Tehran & Qazvin

Plains and the south (on the Kashan Plain). Cheshmeh Ali-style ware has also been described at Kale Dasht, which was commercially excavated in 1937 (ibid.: 410), and Mohammadabad, which lies on the road to Qum, 50 kilometres from Tehran, at the very fringe of a salt desert (ibid.: 410-1). Ghirshman reported another site from near Qum, which allegedly also contained Cheshmeh Ali-style and Sialk II wares, but this has not been corroborated (Ghirshman 1938: 91-2). Tahen Abad has also been identified as a Chalcolithic period site by Ms Saroukhani of the Sialk Archaeological Research Centre, but no further information is currently available for this site.

6.5d. Summary of the distribution of settlement on the Kashan Plain

(Table 6.7)

With the exception of Sialk, the evidence of Late Neolithic and Chalcolithic period settlements on the Kashan Plain, is much more fugitive than that for the Qazvin and Tehran Plains, and the sites for which firm chronologies exist are limited to Ghabristan and Tepe Sialk. It is possible that Neolithic settlement began on the Kashan Plain, earlier than on the Tehran and Qazvin Plains, at Tepe Shurabeh. However, the Early-Middle Neolithic period assignment of this site has not been substantiated.

Five potentially Transitional Chalcolithic sites have been identified on the basis of ceramic surface scatters, indicating that perhaps there was an increase in the number of settlement during this period, roughly corresponding with the abandonment of Sialk North, but further research is needed before this can be ascertained. The most marked feature of the settlement pattern on the Kashan Plain is the large-scale, enduring occupation of Sialk North, which is unknown from the Tehran and Qazvin plains. Sialk North has a massive 12 metres of Late Neolithic cultural deposits, which is unprecedented on the Central Plateau, and contrasts sharply with the 1 metre reported for Cheshmeh Ali, and the ephemeral deposits at Tepe Pardis. This suggests that the Neolithic-Chalcolithic period occupation of the Kashan Plain was regionally distinct, and different to that of the Tehran and Qazvin Plains. One

possible explanation for this is the nature of the Kashan plain itself. The Kashan alluvial fan is much smaller than that of the Tehran and Qazvin Plains, and thus whereas on the latter it was possible for a dispersed settlement pattern, on the Kazvin Plain people may have been forced to concentrate at Sialk. Tepe Sialk's important nodal position on both east-west and north-south trade networks, as inferred from the expanse of non-local materials evidenced the site, may also have contributed to its size and permanence (cf. Sherratt 2007).

6.6. Discussion

The most striking outcome of the recent archaeological investigations on the Central Plateau is the continued failure to recover any evidence of Early Neolithic (ca. 8000-6500 BC) settlements. Traditional explanations for the dearth of sites have emphasised the active alluvial regime on the plateau, and suggested that prehistoric sites may exist, but are buried beneath the present plain surface (Brookes et al. 1982). However, despite digging sites on the Tehran, Qazvin and Kashan plains down to virgin bedrock, transect survey, and *qanat* survey, specifically designed to avoid the problems associated with archaeological visibility on alluvial plains, no evidence of Early Neolithic settlement has been recovered. It appears, then, that the lack of Early Neolithic settlement on the Central Plateau represents a real absence of sites, rather than being an issue of site visibility, and that permanent agricultural settlement did not become established in the region until the Middle-Late Neolithic period (ca. 6500-5500 BC).

When settlements do appear, their pattern and distribution varies regionally. While on the Tehran Plain there was a cycle of rapid growth in settlement number during the Transitional–Early Chalcolithic, followed by a period of decline during the Middle to Late Chalcolithic, on the Qazvin Plain the number of sites remains relatively unchanged during the Late Neolithic–Transitional Chalcolithic, after which there actually occurred a decrease in the number of sites with Zagheh the only Early Chalcolithic site known, (Zagheh is

followed by an absence of settlement altogether in the Middle Chalcolithic, until the occupation of Ghabristan in the Late Chalcolithic. In contrast, on the Kashan Plain the Late Neolithic to Chalcolithic period occupation is restricted almost entirely to a massive agglomeration of Sialk. There is possible evidence of an earlier settlement at Tepe Shurabeh, but this is unconfirmed, and one ephemeral Late Neolithic site and a couple of potential Transitional Chalcolithic sites are known, but this is it.

One plausible explanation for the concentration of people at one site on the Kashan Plain, compared to the more dispersed Late Neolithic and Chalcolithic period settlement patterns evidenced on the Qazvin and Tehran plains, is the smaller size of the Kashan alluvial plain compared to the latter. This would have seriously limited the potential agricultural land in the region, and may have been a contributory factor in leading people to congregate at Sialk. Trade may also have played a role in encouraging people to move to and stay at Sialk, as the site occupies an important nodal position on both north–south and east–west trade routes across Iran. Social choices can also not be excluded.

6.7. Conclusion

A main objective of this research was to test for the presence of Early Neolithic (ca. 8000-6500 BC) settlement on the Central Plateau. New archaeological research on the Tehran, Qazvin and Kashan Plains has failed to identify any Early Neolithic settlements, and the current information suggests that there was no Early Neolithic occupation of the Central Plateau, and settlement did not appear in the region until the Middle to Late Neolithic period (ca. 6500-5500 BC). The distribution of settlement during this period, was not uniform across the Plateau, but instead exhibits regional differentiation. Whereas on the Tehran Plain, the settlement pattern during the Late Neolithic to Late Chalcolithic was one of boom and bust, on the Qazvin Plain the number of settlements remained low and relatively constant, and the population of the Kashan Plain appears to have been agglomerated at the site

of Sialk. The difference in the settlement patterns on the three plains suggests, that though the technology for the settlement and farming of the Central Plateau may have spread during the Late Neolithic to Chalcolithic period, how it was adopted, and subsequently adapted, varied regionally

	Month											
Element	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Max. temp. (°c)	8.9	11.1	15.1	21.8	27.8	32.8	35.8	35.1	31.4	24.3	15.0	9.8
Min. temp. (°c)	-0.9	0.4	4.0	9.9	14.6	19.2	22.1	21.7	18.1	11.9	4.8	0.2
Rainfall (mm)	31.4	29.5	34.9	34.8	13.9	3.4	1.1	2.3	1.9	8.2	37.7	24.4

Table 6.0: *Monthly climatic date for Tehran, Lat. 34°41'N, Long 51 °19'E, 1191 metres above sea level. (After Ganji 1968: table 5.)*

	Month											
Element	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Max. temp. (°c)	8.9	9.5	14.2	20.8	26.7	32.5	34.5	35.3	32.0	24.0	13.2	10.0
Min. temp. (°c)	-5.3	-5.1	-0.6	5.1	9.1	12.8	14.7	15.2	10.9	6.5	0.2	-2.5
Rainfall (mm)	37.4	22.1	60.5	51.2	36.9	9.2	3.3	0.3	0.0	38.8	65.5	13.9

Table 6.1: *Monthly climatic date for Qazvin, Lat. 36º15' N, Long 50º00' E, 1302 metres above sea level. (After Ganji 1968: table 5.)*

	Month											
Element	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Max. temp. (°c)	11.0	13.3	17.7	23.8	30.6	35.6	38.2	38.8	33.7	17.7	13.3	11.0
Min. temp. (°c)	0.2	2.7	5.6	11.3	16.1	19.4	22.2	20.4	16.7	5.6	2.7	0.2
Rainfall (mm)	25.1	11.2	26.3	20.8	14.3	0.6	1.4	0.0	0.1	26.3	11.2	25.1

Table 6.2: *Monthly climatic data for Qum (nearest reported station to Kashan Plain), Lat. 34º38' N, Long 50º53' E, 928 m above sea level (After Ganji 1968: table 5.)*

Period	Number of sites
Palaeolithic	1
Prehistoric	18
Chalcolithic	9
Chalcolithic & Iron Age	2
Chalcolithic & Islamic	2
Historic	31
Parthian	1
Sasanian	3
Islamic	58
Modern	69
No period assigned	14
Total:	208

Table 6.3: *Survey sites from the Tehran Plain, attributed to broad chronological periods. The sites labelled 'prehistoric' represent lithics which could not be given a more detailed chronological assignment. (After Coningham et al. 2006.)*

Site								
	Yan Teppe							
	Jeyran Tepe							
	Maral Tappe							
	Dosan Tappe							
	Cheshmeh Ali							
	Tepe Pardis							
	Sadeghabadi							
	Fakrahabad							
	Mafinabad							
	Mehdikani							
	Tepe Chakhmah							
	Barkin							
	Ismailabad (Karaj)							
	Tepe Surk Khub							
	Tepe Siah							
	Ozbaki							
	Maymonabad							
	Chouqali							
	Mortezagerd							
	Kara Tepe (Sharyar)							
	Poeinak							
	Parandak							
	Period	Early Neolithic (ca. 8000-6500 BC)	Middle Neolithic (ca. 6500-6200 BC)	Late Neolithic (ca. 6200-5500 BC)	Transitional Chalcolithic (ca. 5500-4700 BC)	Early Chalcolithic (ca. 4700-4000 BC)	Middle Chalcolithic (ca. 4000-3700 BC)	Late Chalcolithic (ca. 3700-3000 BC)

Table 6.4: *The occupation sequence of Neolithic-Transitional Chalcolithic period sites on the Tehran Plain. The period boundaries are based on Fazeli et al. (2004: table 3) absolute chronology for the Tehran Plain.*

			Site											
Period	Mansurābād	Miān Pālān	Zagheh	Ghabristan	Čahār Boneh	Ebrāhim Ābād	Cheshmeh Bolbol	Ismailabad (Qazvin)	Mahmudiyan	Zahir Tappe	Qara Qobād	Za'farān Tappe	Bahrāmi	Kamālābād
Early Neolithic (ca. 8000-6500 BC)														
Middle Neolithic (ca. 6500-6200 BC)														
Late Neolithic (ca. 6200-5500 BC)														
Transitional Chalcolithic (ca. 5500-4700 BC)														
Early Chalcolithic (ca. 4700-4000 BC)														
Middle Chalcolithic (ca. 4000-3700 BC)														
Late Chalcolithic (ca. 3700-3000 BC)														

Table 6.5: *The occupation sequence of Neolithic-Transitional Chalcolithic period sites on the Qazvin Plain. The period boundaries are based on Fazeli et al. (2004: table 3) absolute chronology for the Tehran Plain*

Site no.	Site name	Terrain	Finds, features etc.	Preservation
DK001		Plain	ca. 700-year fortified site	Very few standing remains, used for dumping rubbish
DK002		Plain	Caravanserai	Eroding mudbrick, robber pits
DK003	Ghabristan	Plain	Late Neolithic site excavated 2008	Has been bulldozed in the past, but condition today is stable
DK004		Plain	Modern coins in *qanat* soil	Disused *qanat*
DK005		Plain	Chalcolithic ceramics	Number of robber pits
DK006		Plain	Caravanserai	Located at edge of town; risk of urban encroachment
DK007		Plain	Disused bridge	Collapsing
DK008		Plain	Caravanserai	Eroding mudbrick
DK009		Plain	Caravanserai	Eroding mudbrick
DK010		Plain	Large mound surrounded by other smaller mounds & decaying mudbrick structures in an area rich with Islamic ceramics	Mounds stable; mudbrick structures decaying
DK011		Plain	Caravanserai	
DK012		Plain	Modern shrine ca. 100-200 yrs old	Well-maintained
DK013		Plain	Ceramic sherd from *qanat* spoil	Disused *qanat*
DK014		Plain		Currently used for penning livestock
DK015		Plain		Eroding mudbrick

Table 6.6: *Finds from 2009 pilot qanat survey. Due to the problem of systematic looting in the area the GPS coordinates of the sites are not provided here.*

Period	Site										
	Sialk South	Sialk North	Ghabristan	Tepe Shurabeh	DK005	Mesreh	Kale Dasht	Mohammadabad	Qal'ah-i Dukhtar	Tahen Abad	Qara Tappe
Early Neolithic (ca. 8000-6500 BC)				??							
Middle Neolithic (ca. 6500-6200 BC)											
Late Neolithic (ca. 6200-5500 BC)											
Transitional Chalcolithic (ca. 5500-4700 BC)						??	??	??	??	??	
Early Chalcolithic (ca. 4700-4000 BC)					??						
Middle Chalcolithic (ca. 4000-3700 BC)											
Late Chalcolithic (ca. 3700-3000 BC)											

Table 6.7: *The occupation sequence of Neolithic-Transitional Chalcolithic period sites on the Kashan Plain. Sites for which the period assignment is only tentative are marked ??. The period boundaries are based on Fazeli et al. (2004: table 3) absolute chronology for the Tehran Plain.*

Site	Date from earliest stratigraphic level regardless of hygiene		Earliest acceptable date from earliest stratigraphic level (where available)	
	^{14}C yrs BP	Cal. BC	^{14}C yrs BP	Cal. BC
Tepe Pardis	6230±45	5309-5057	6230±45	5309-5057
Zagheh	6295±47	5375-5078	6295±47	5375-5078
Tepe Chahar Boneh	7123±35	6063±5919	7123±35	6063±5919
Ebrahim Abad	6201±34	5293-5051	6201±34	5293-5051
Sialk North	6364±35	5470-5231	6364±35	5470-5231

Table 6.8: *The earliest ^{14}C determination (BP) and calibrated age (BC) for each site. All calibrated dates are given at the 95.4% confidence interval.*

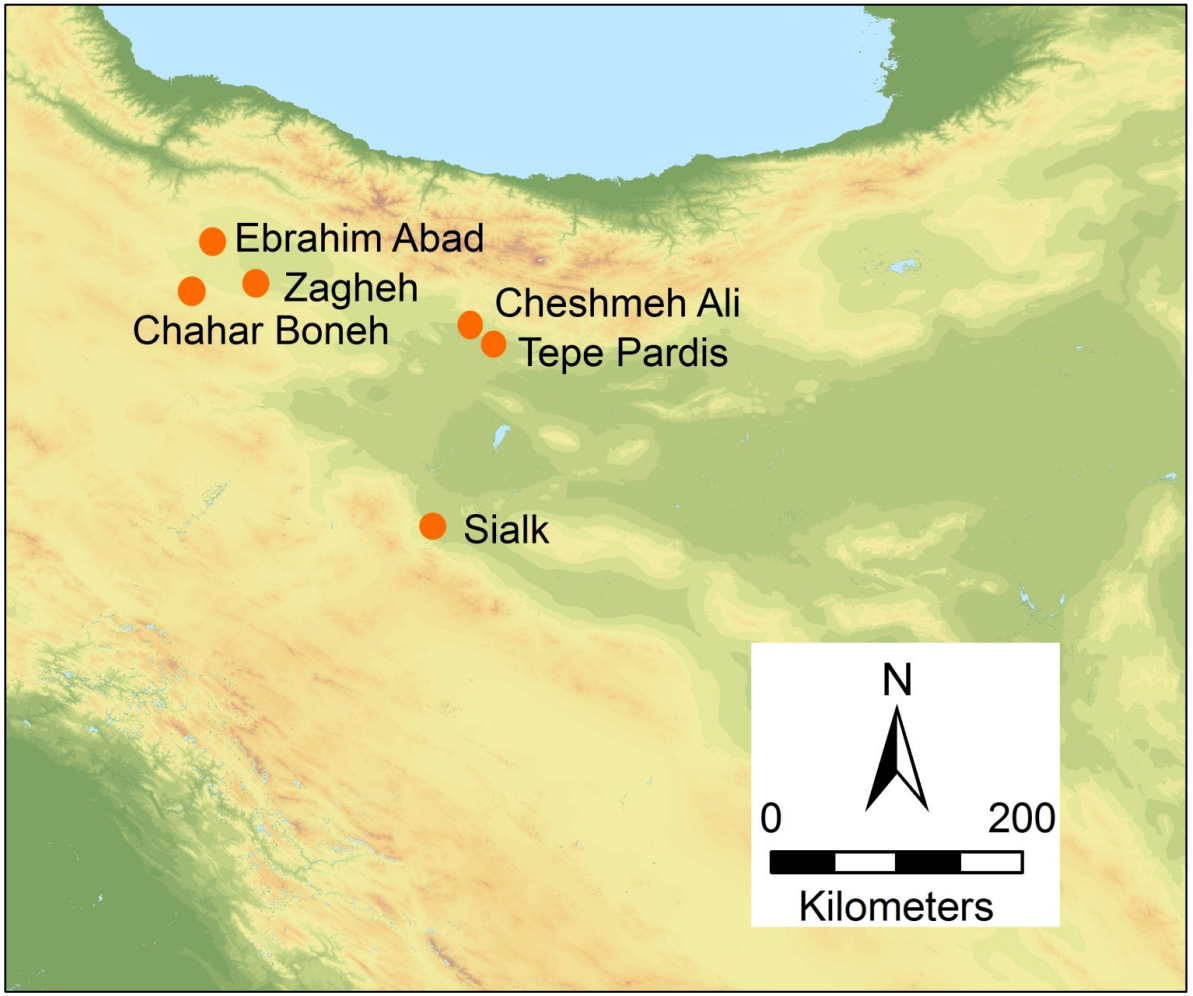


Figure 6.0: *Map of the Central Iranian Plateau showing key Late Neolithic and Chalcolithic sites.*

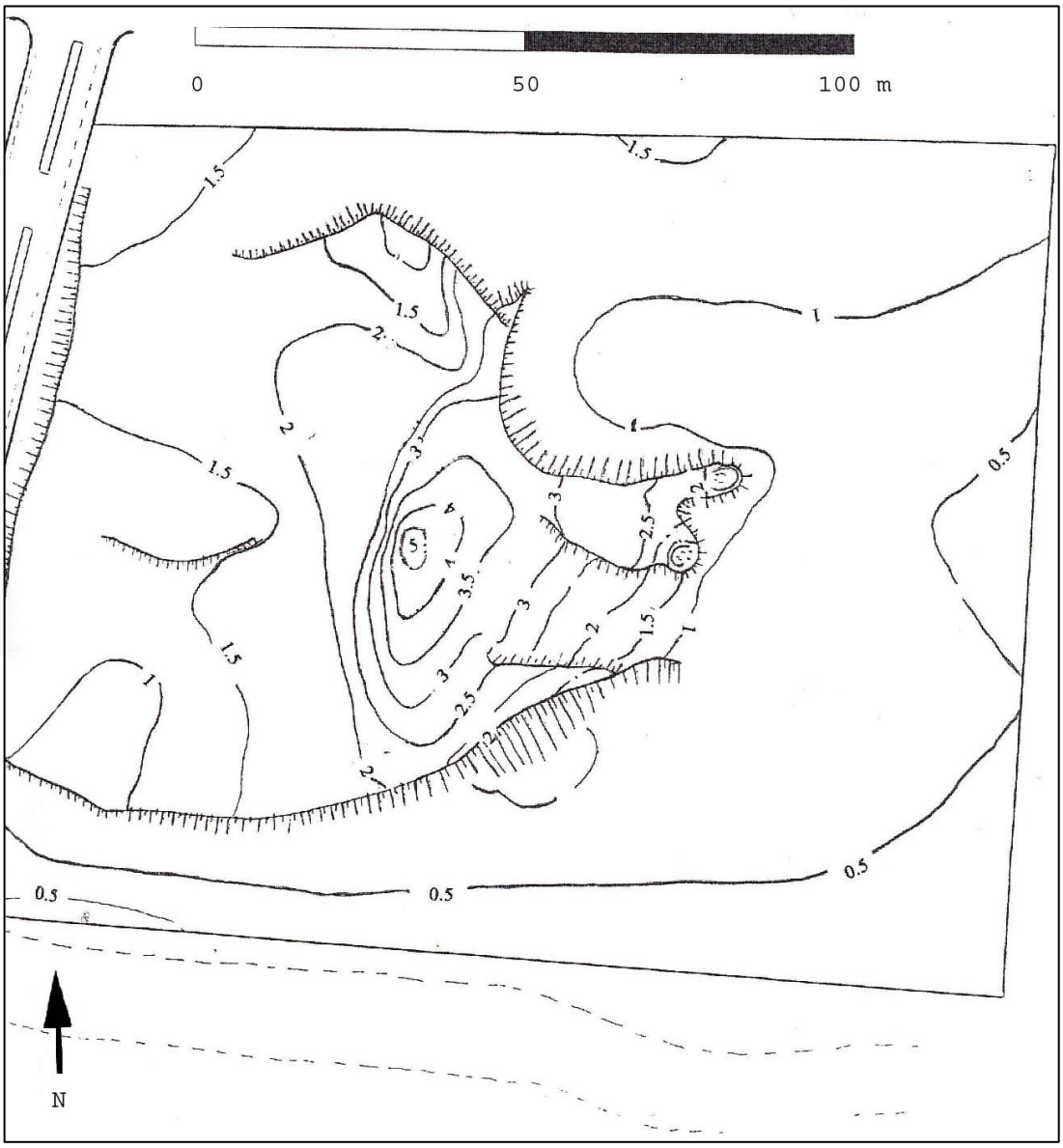


Figure 6.1: *Topographic map of Fakrabad. Scale 1: 200. (After Fazeli 2001: fig. 5.8.)*

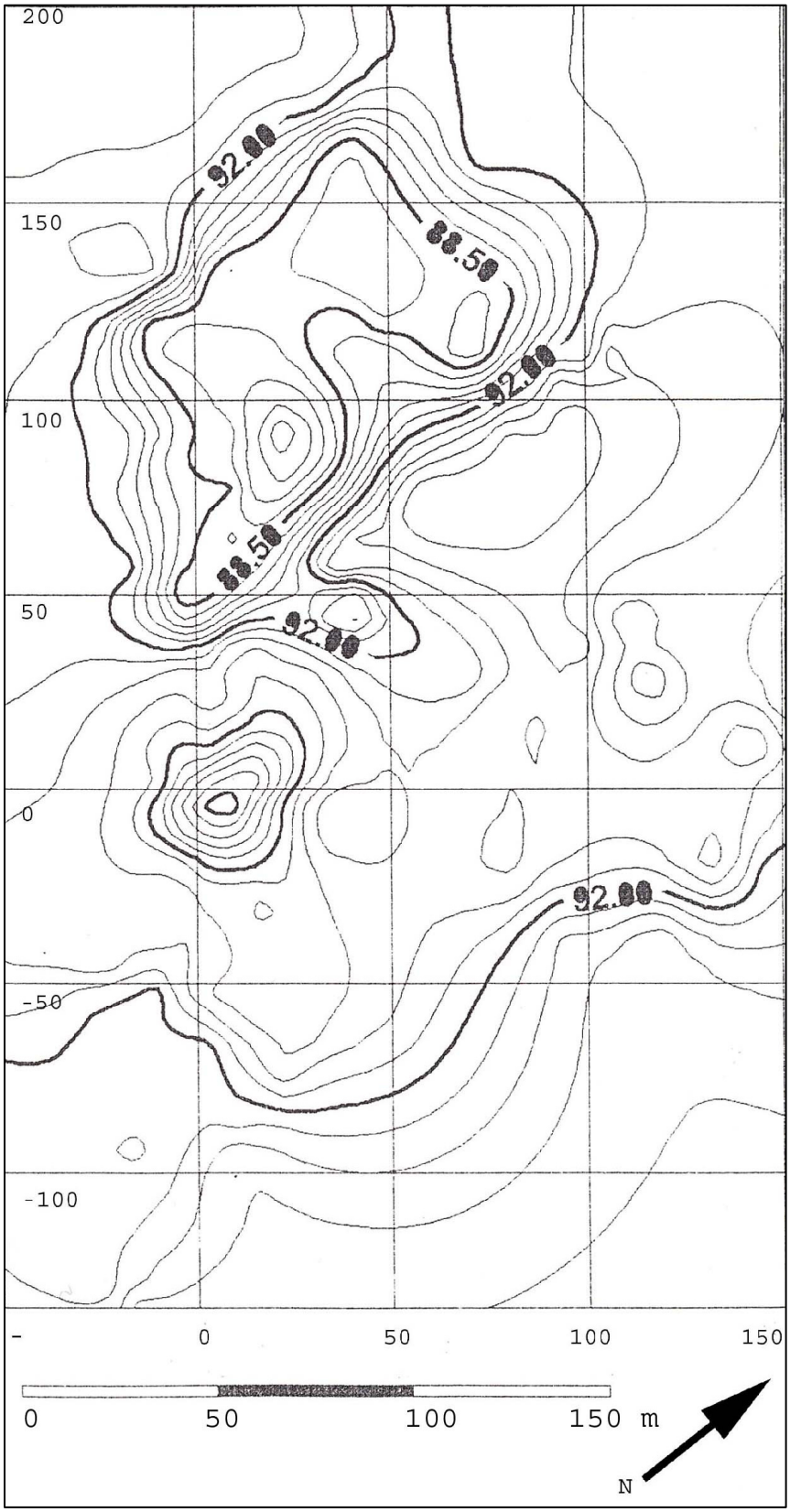


Figure 6.2: *Topographic map of Mafinabad. Scale 1: 250. (After Fazeli 2001: fig. 5.10.)*

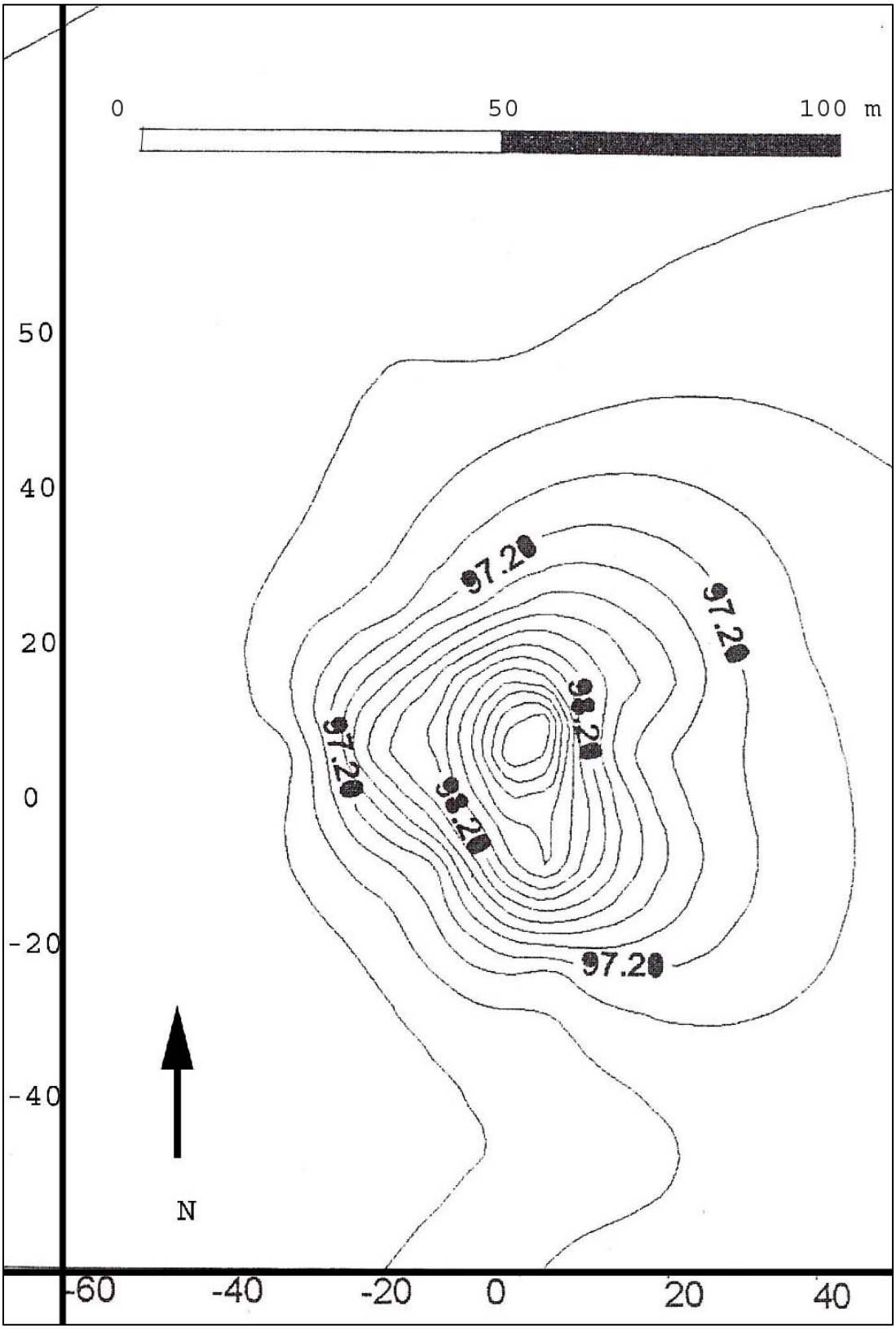


Figure 6.3: *Topographic map of Mehedikani. Scale 1: 250. (After Fazeli 2001.)*

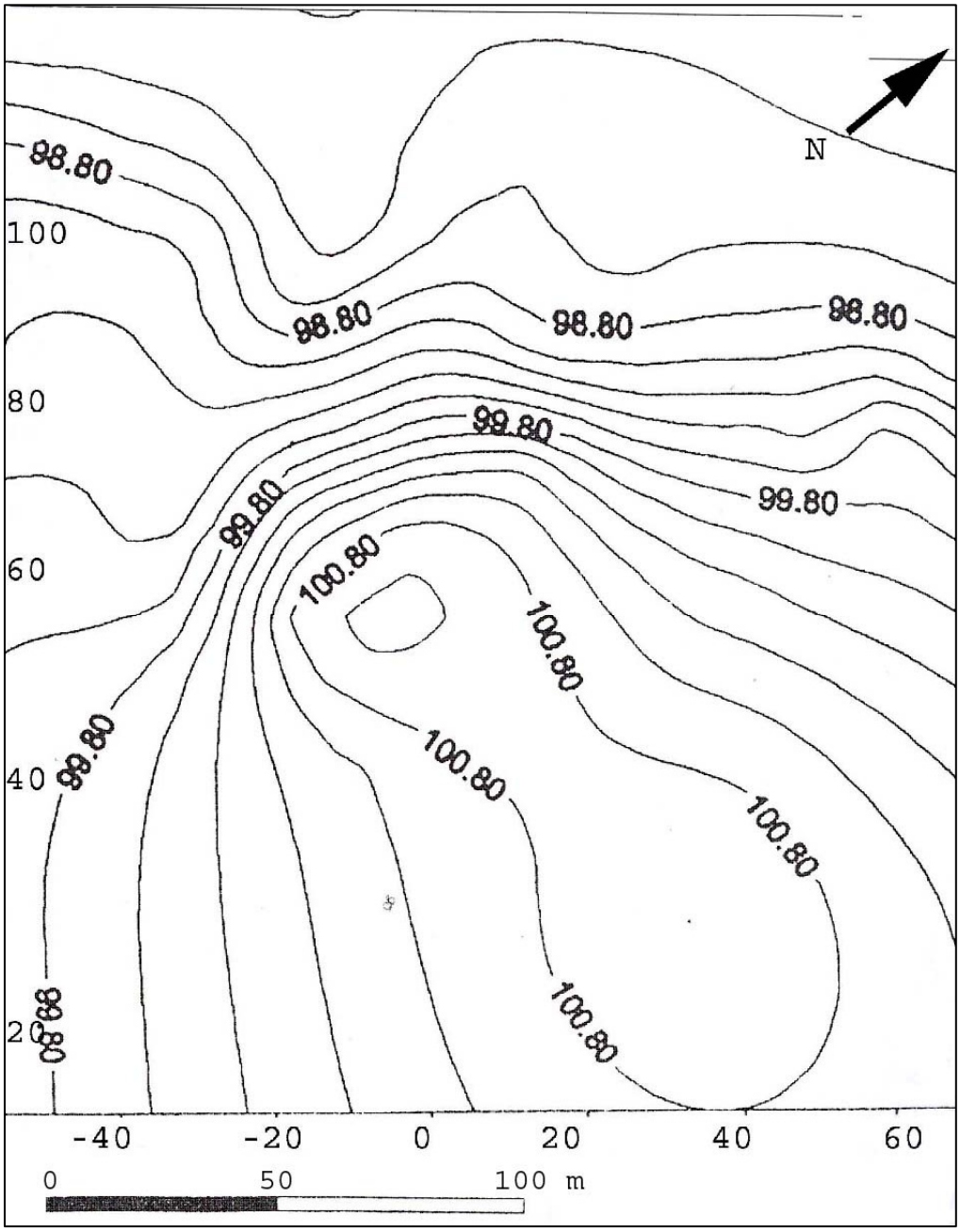


Figure 6.4: *Topographic map of Chakmahk Tepe. Scale 1: 250. (After Fazeli 2001.)*

Figure 6.5: *The south slope of Chesmeh Ali showing the beginning of excavation in 1934. (Photo: Schmidt,*

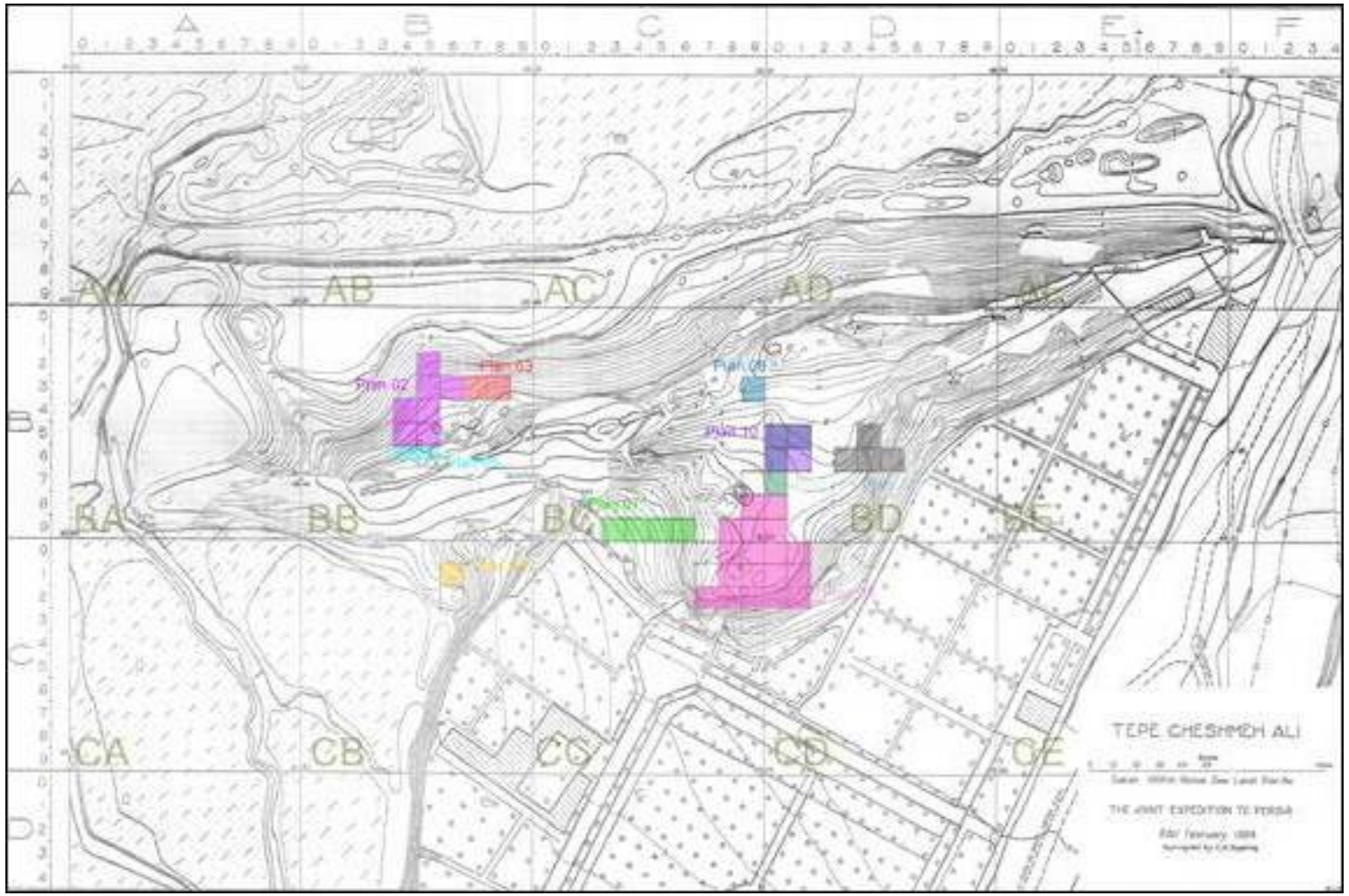
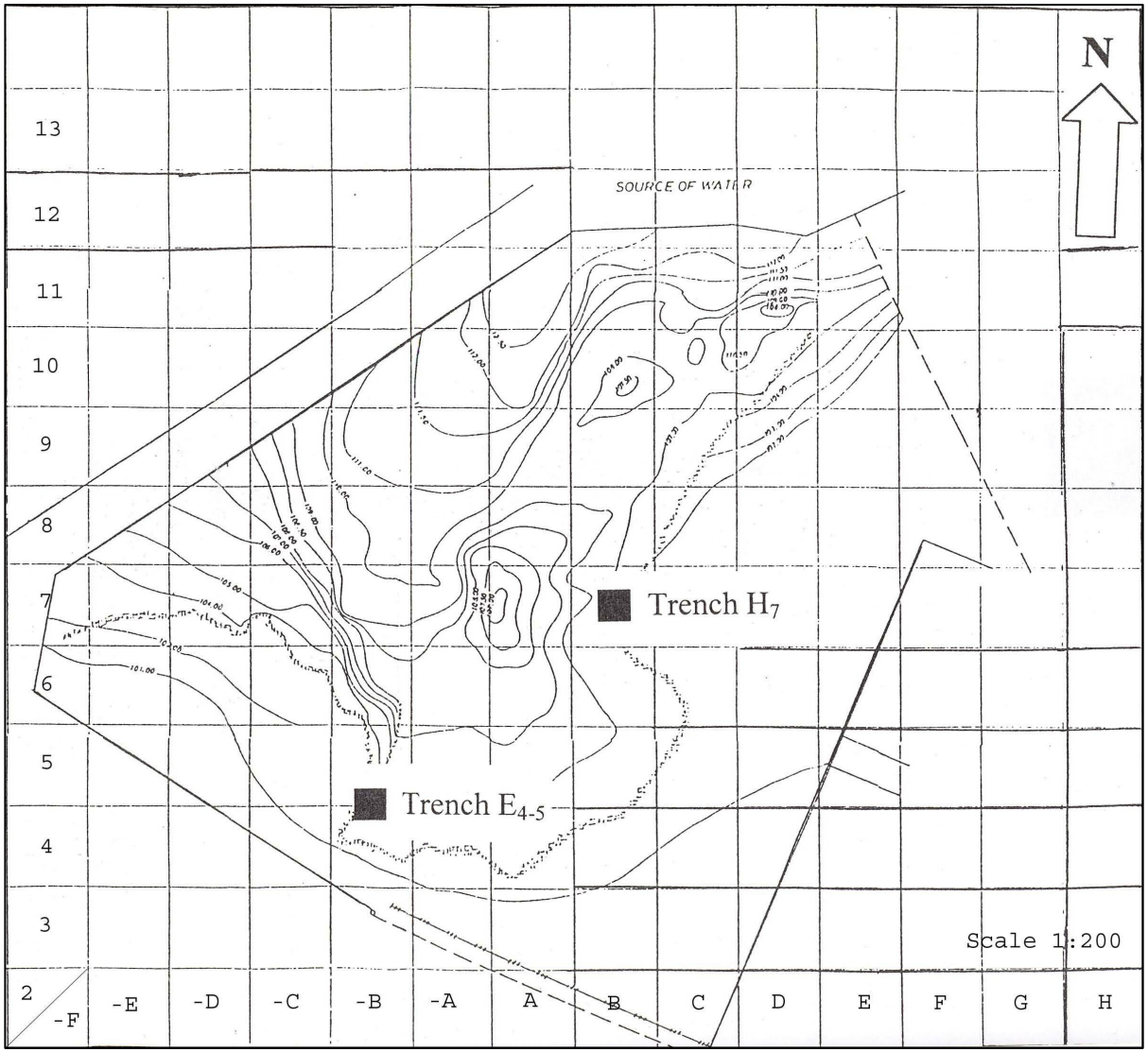


Figure 6.6: *Topographic plan of Cheshmeh Ali showing the areas excavated by Schmidt's expedition. (After http://gozips.uakron.edu/~matney/RChMaps.htm.)*

Figure 6.7: *Topographic map of Cheshmeh-Al showing areas excavated by Fazeli. (After Fazeli 2001: fig. 5.1.)*



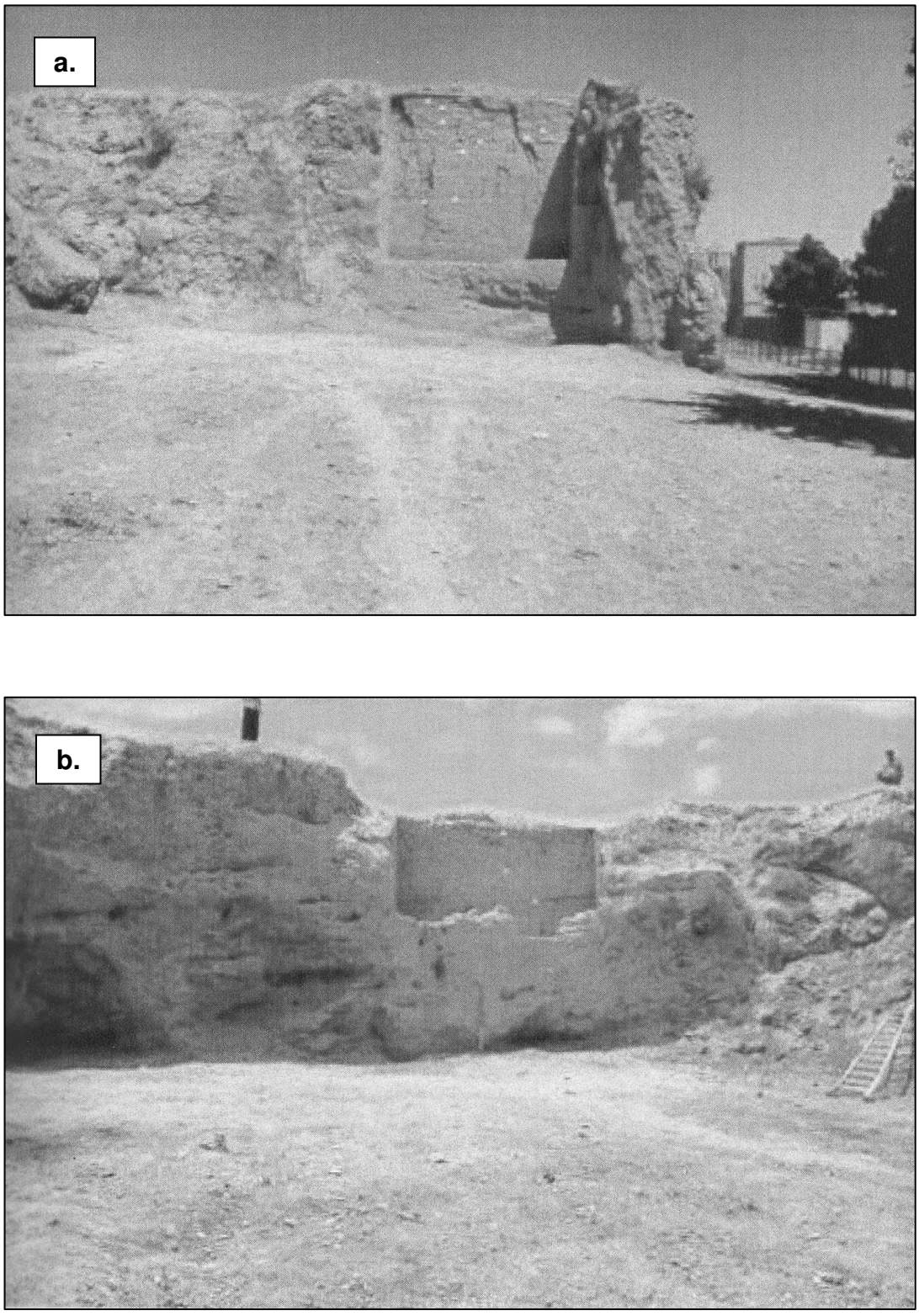


Figure 6.8: *Trenches E4-5 & H7 from the 1997 excavation at Cheshmeh Ali: (a) Trench E4-5; & (b) Trench H9. (After Fazeli 2001: fig. 5.3.)*

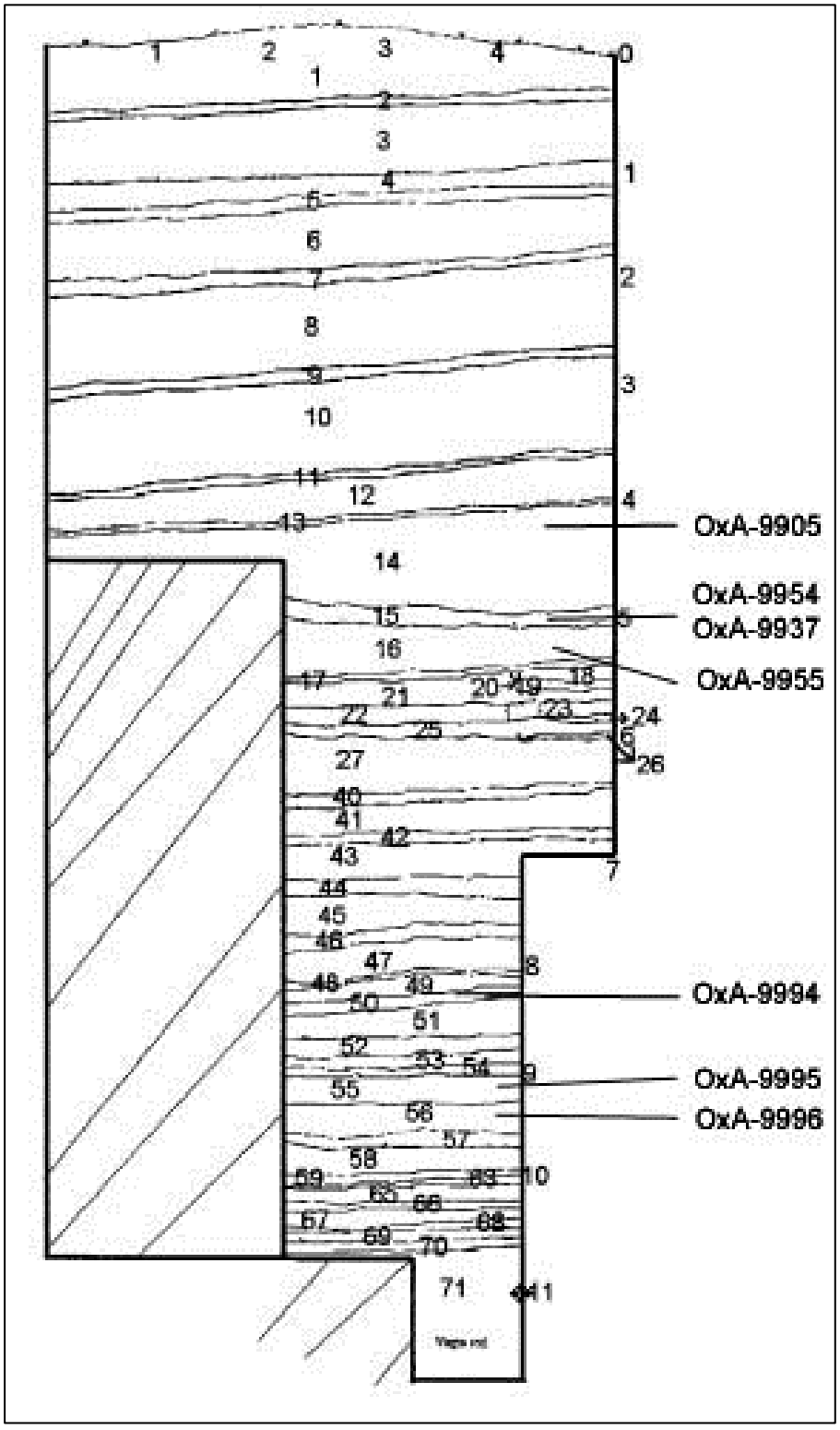


Figure 6.9: *East facing section of Cheshmeh Ali Trench H7, showing contexts carbon samples extracted from. (After Fazeli et al. 2004: fig. 6.)*

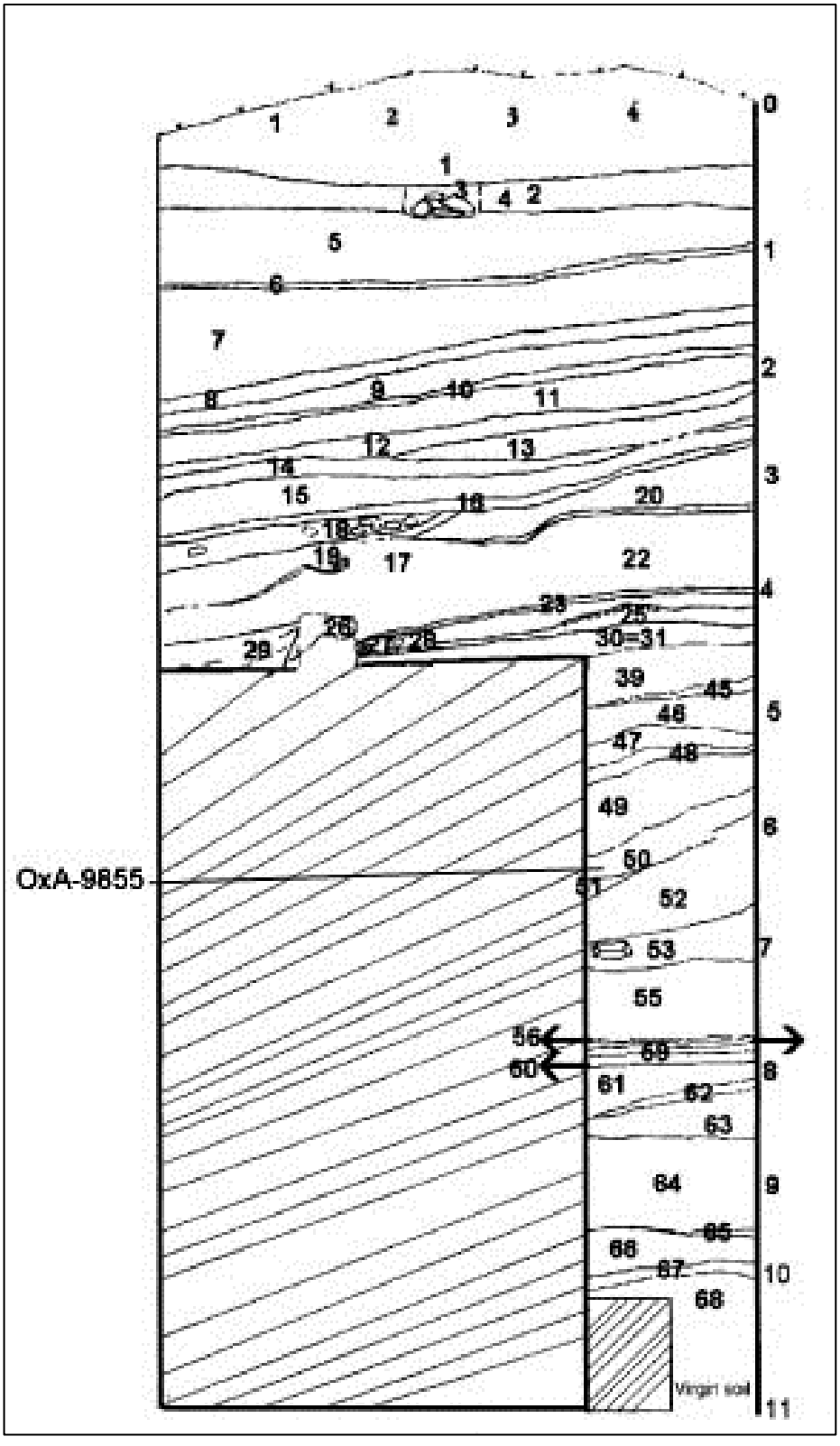


Figure 6.10: *West facing section of Cheshmeh Ali Trench E4-5, showing contexts carbon samples extracted from. (After Fazeli et al. 2004: fig. 5.)*

Figure 6.11: *General view of Tepe Pardis (photo Coningham).*

Figure 6.12: *Tepe Pardis Trench I (photo: Coningham).*

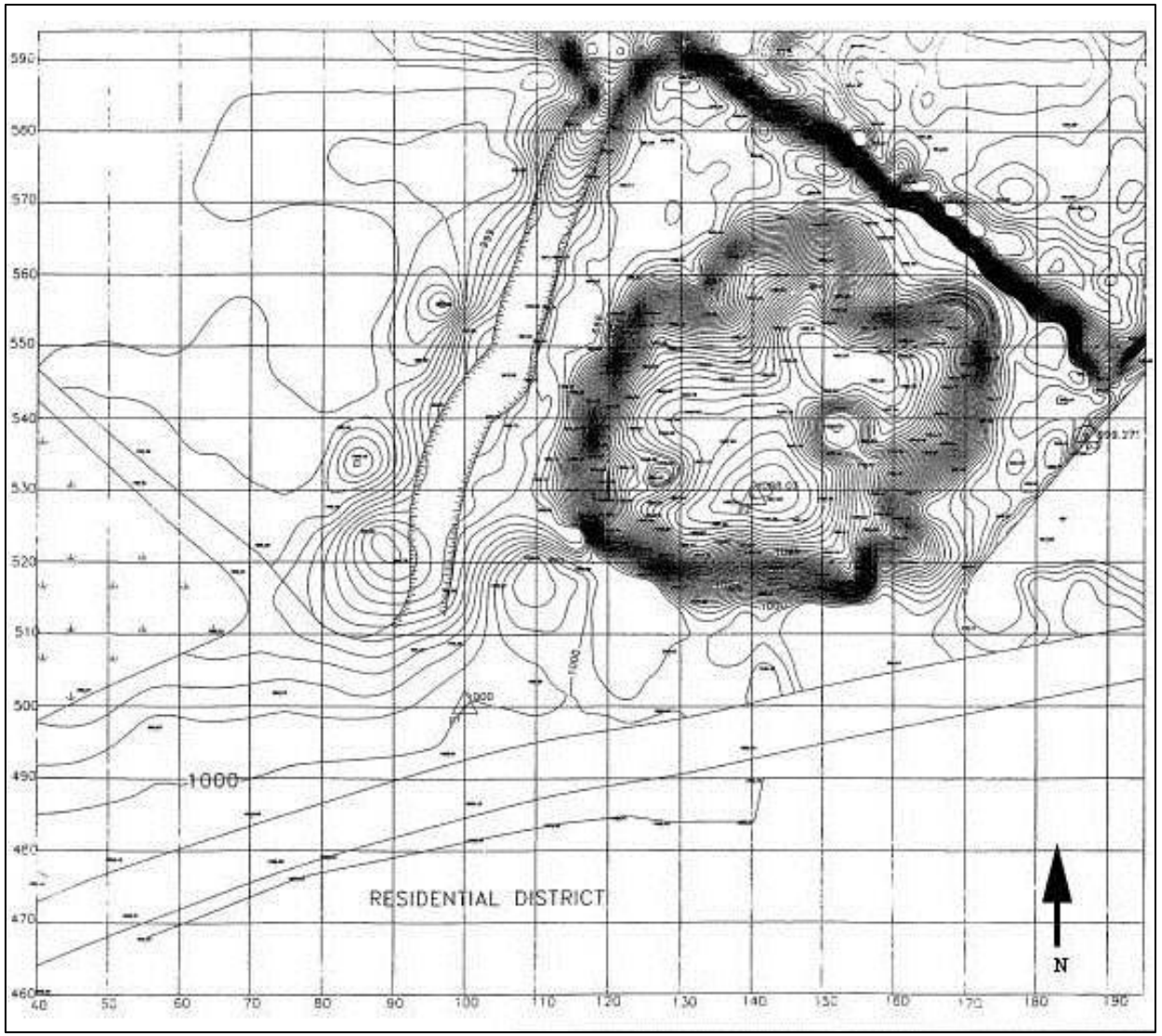


Figure 6.13: *Topographic drawing of the exposed north section of Tepe Pardis. (After University of Tehran, Institute of Archaeology, 2003.)*

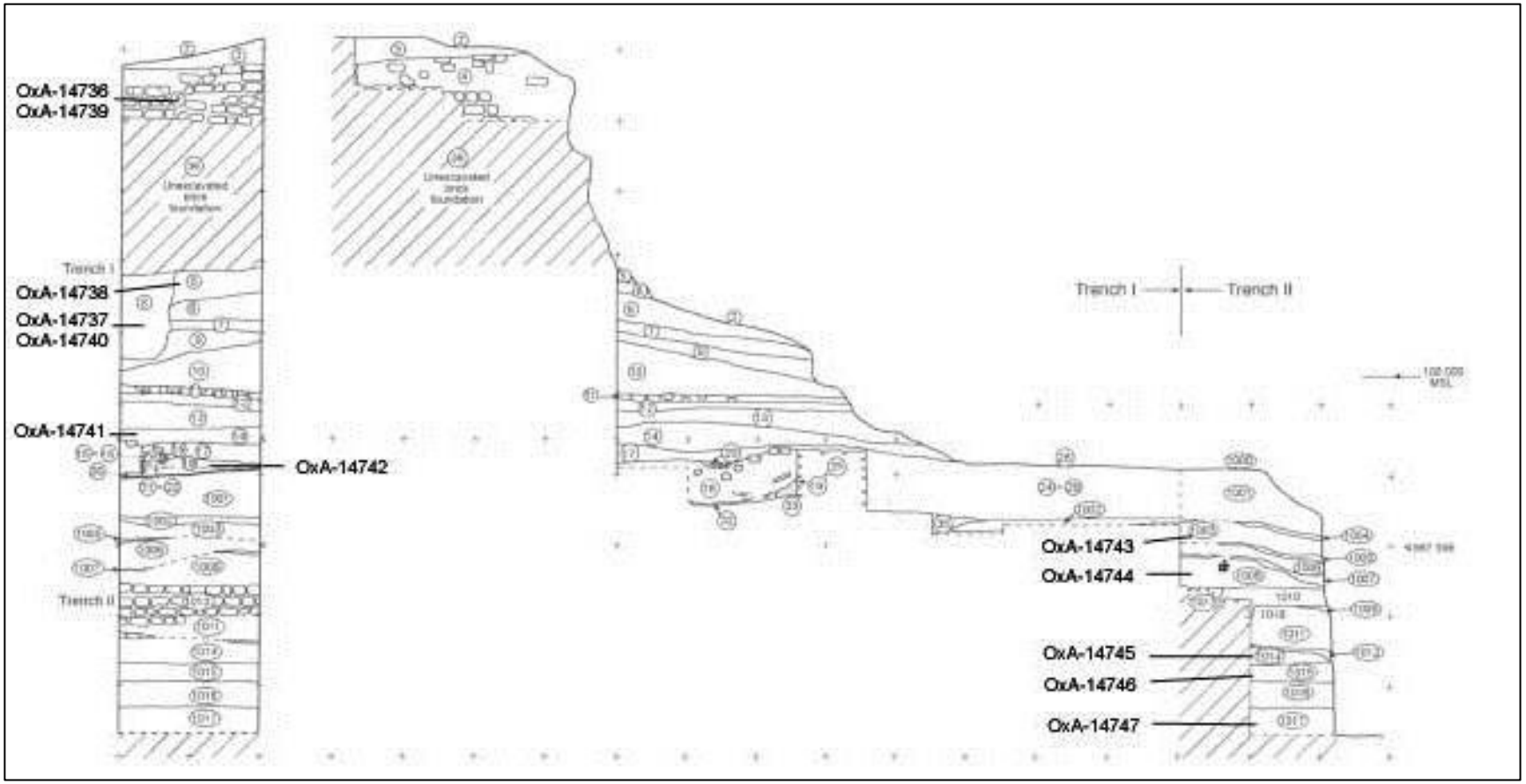


Figure 6.14: *North-south section and northern elevation of Tepe Pardis showing contexts from which carbon samples extracted. (After Coningham et al. 2006: fig. 12.)*

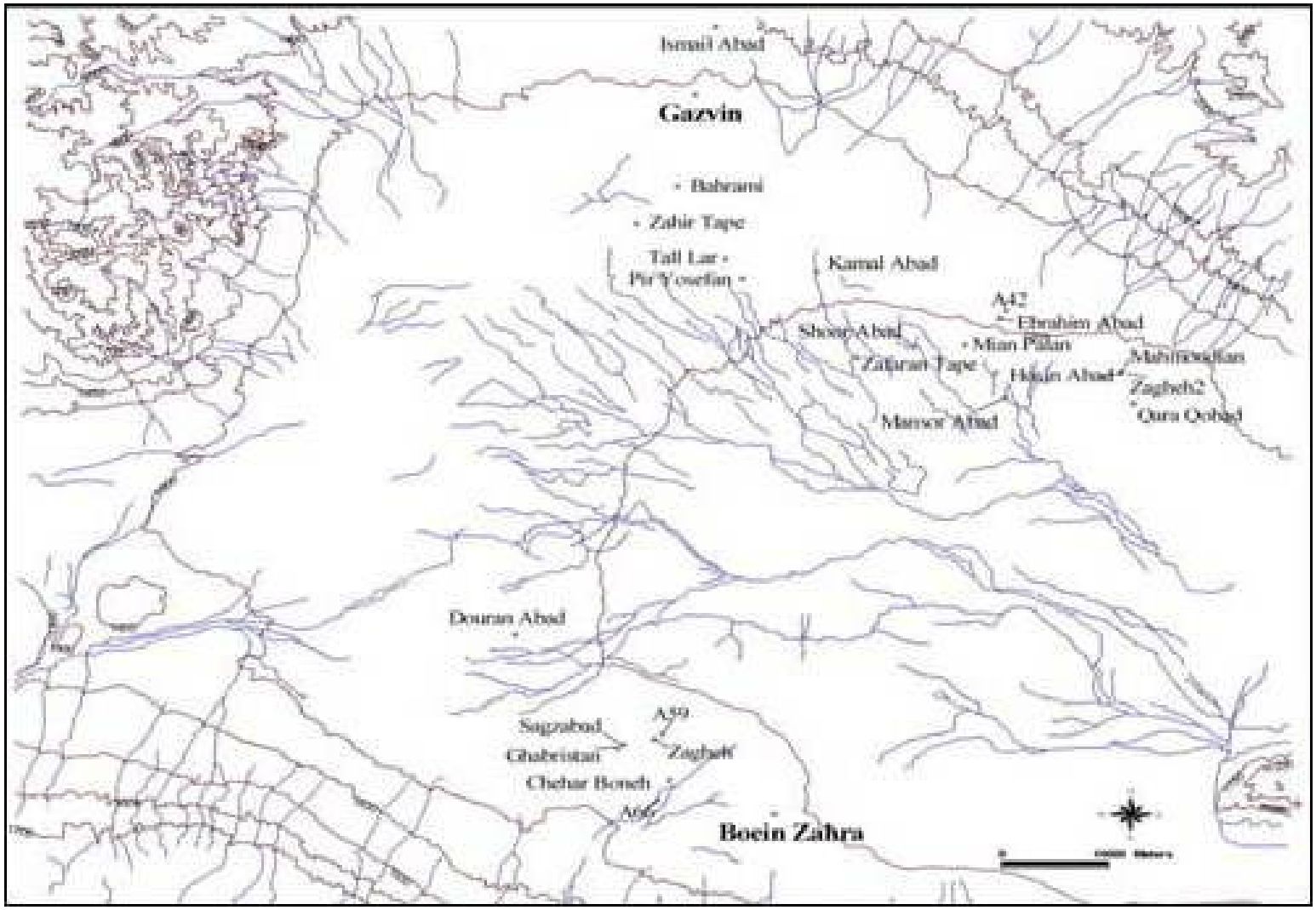


Figure 6.15: *Distribution of prehistoric sites on the Qazvin plain. (After Fazeli et al. 2009: fig. 1.)*

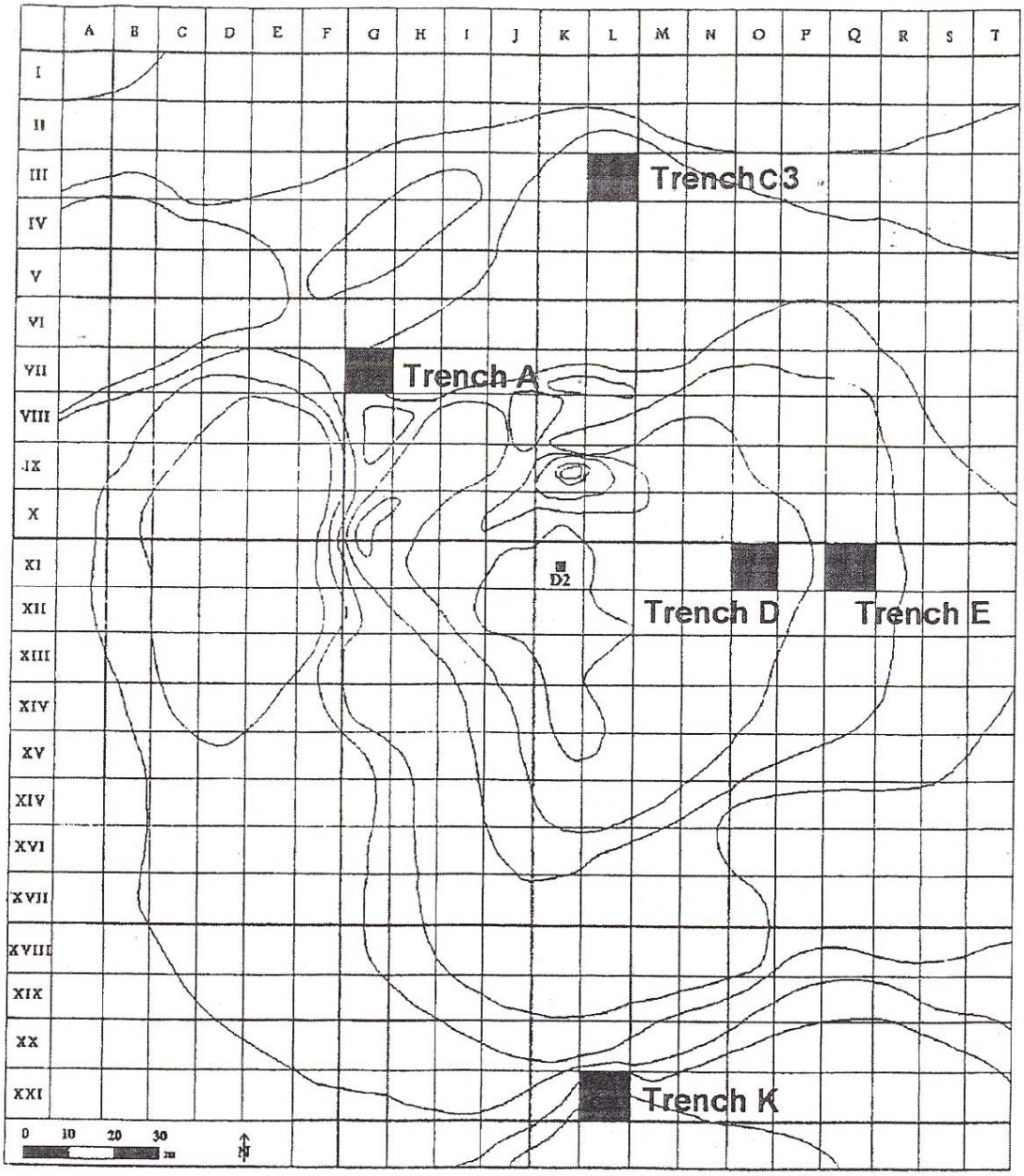


Figure 6.16: *Topographic map of Zagheh, showing the location of the trenches of the 2001 excavation. (After Fazeli et al. 2001: fig. 1.)*

Figure 6.17: *General view of Chahar Boneh. (After Fazeli et al. 2009: fig. 2.)*

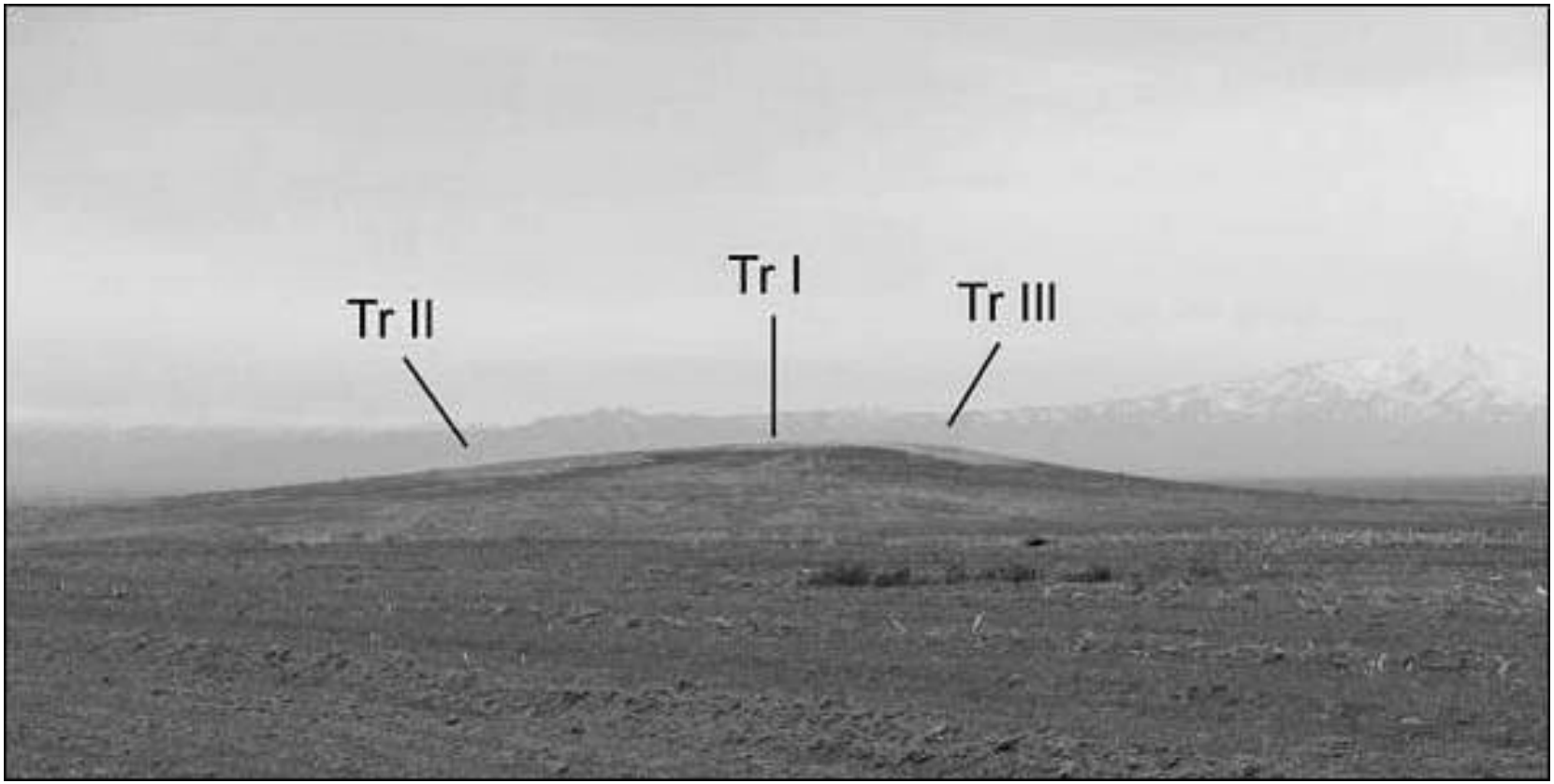


Figure 6.18: General view of *Ebrahim Abad showing the location of Trenches I-III. (After Fazeli et al. 2009: fig. 5.)*

Figure 6.19: *Aerial view of Kashan and surrounding alluvial plain. Tepe Sialk marked with red dot.*

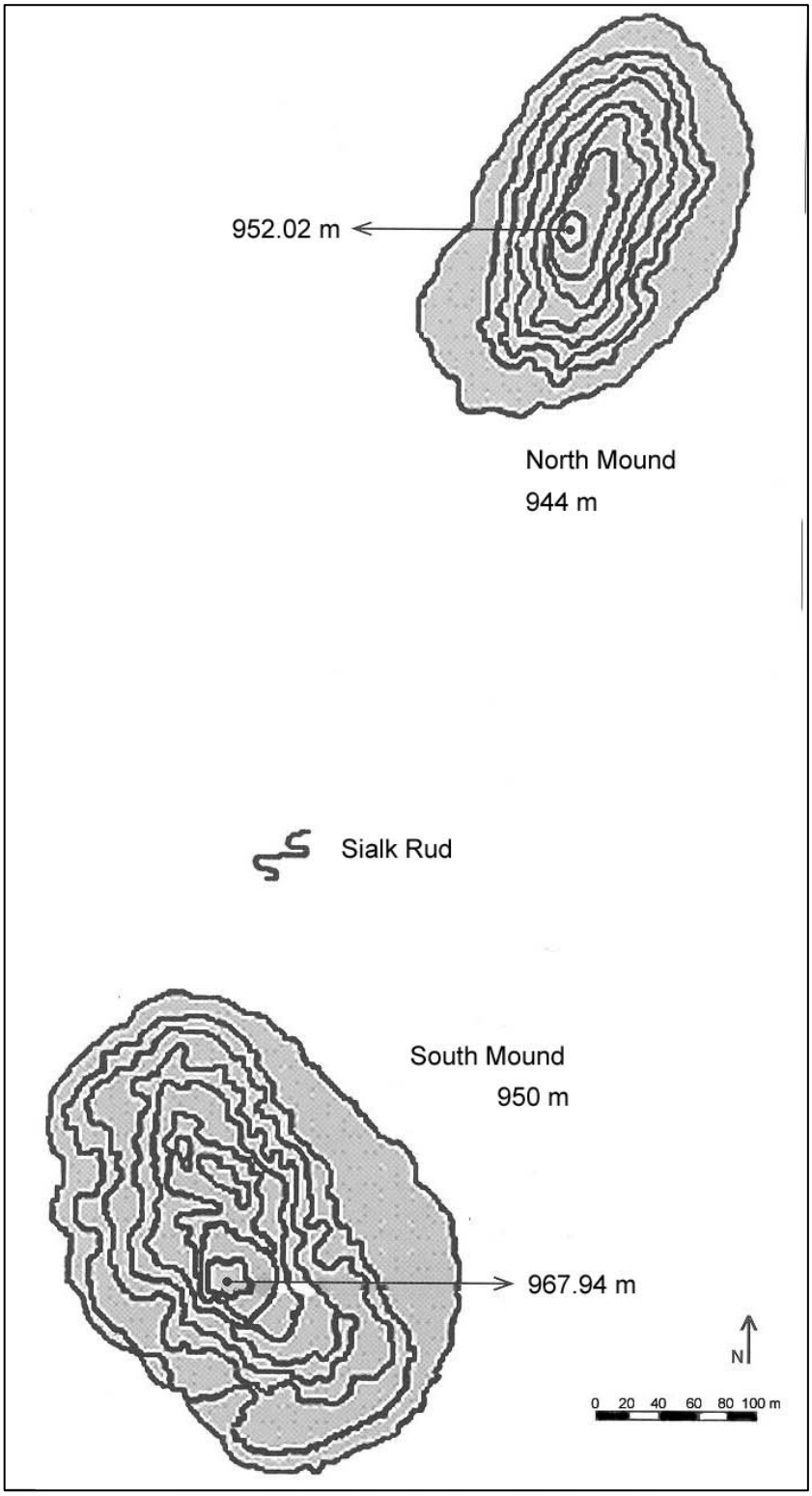


Figure 6.20: *Topographic map of Sialk North and South and the Sialk Rud, showing the orientation of each one. (After Malek Shahmirzadi 2006b: map 2.)*

Figure 6.21: *General view of Sialk North Mound (photo: Coningham)*

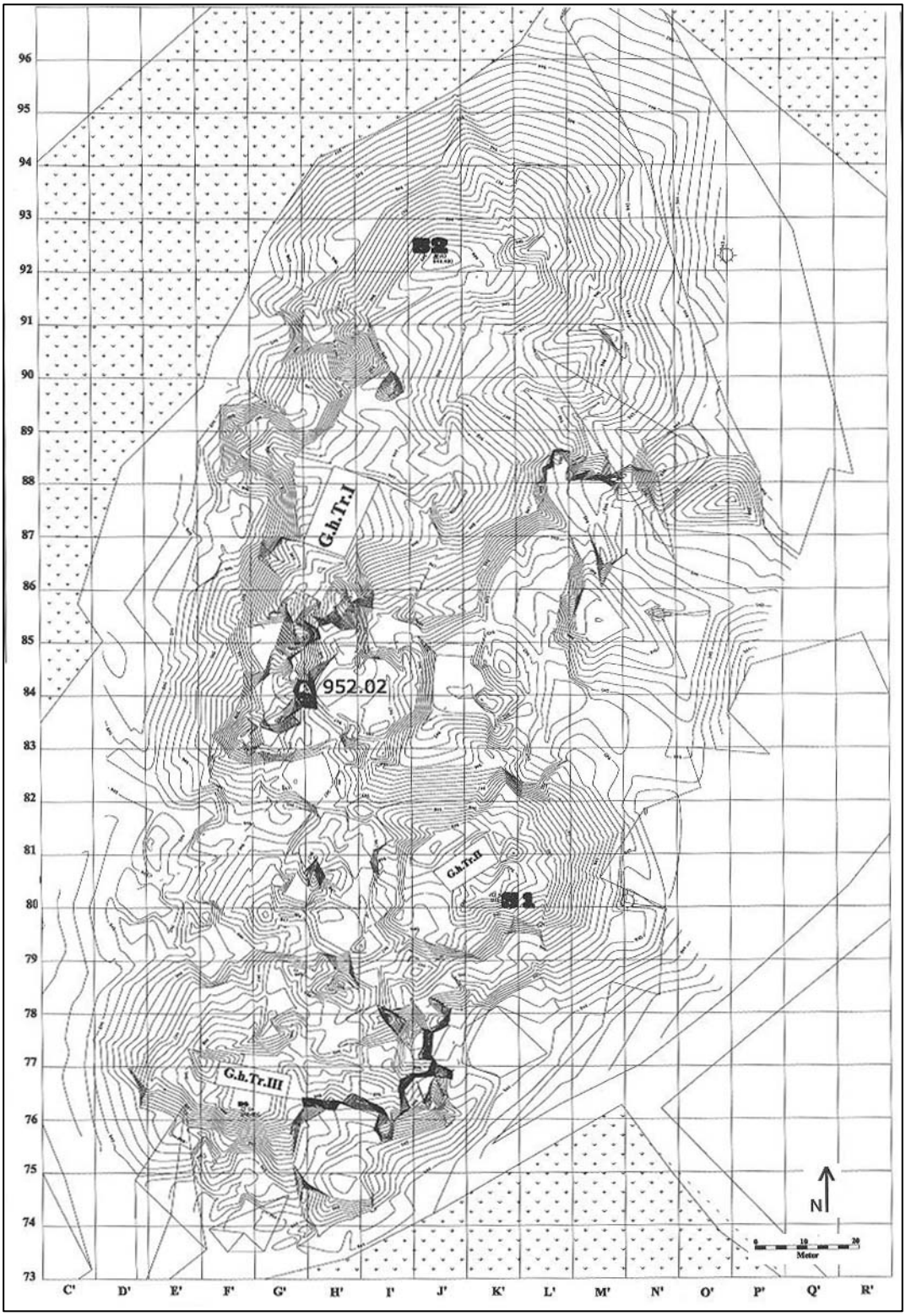


Figure 6.22: *Contour map of the North Mound of Sialk showing the position of Ghirshman's Operations Number 1-3. (After Malek Shahmirzadi 2006b: map 3.)*

Figure 6.23: *Cutting in Trench II, Sialk North (photo: Coningham).*

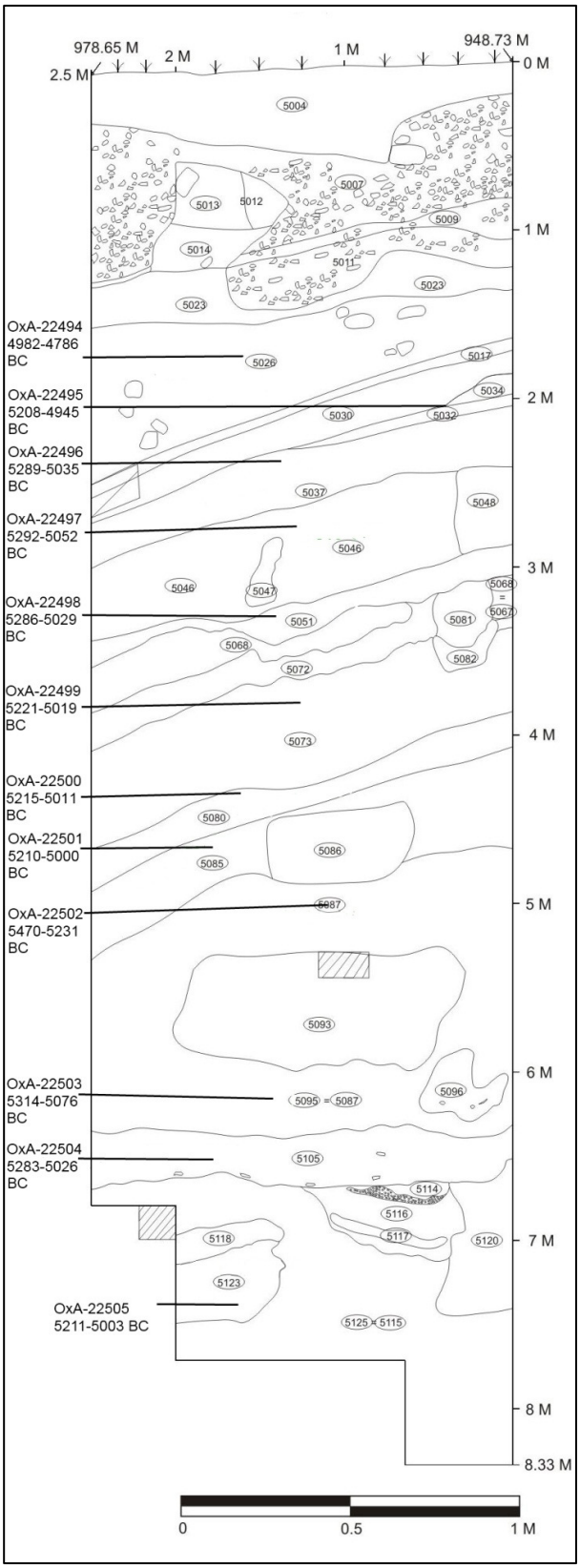


Figure 6.24a. Section drawing of *Sialk North Trench 5 showing contexts of* ^{14}C *dates.*

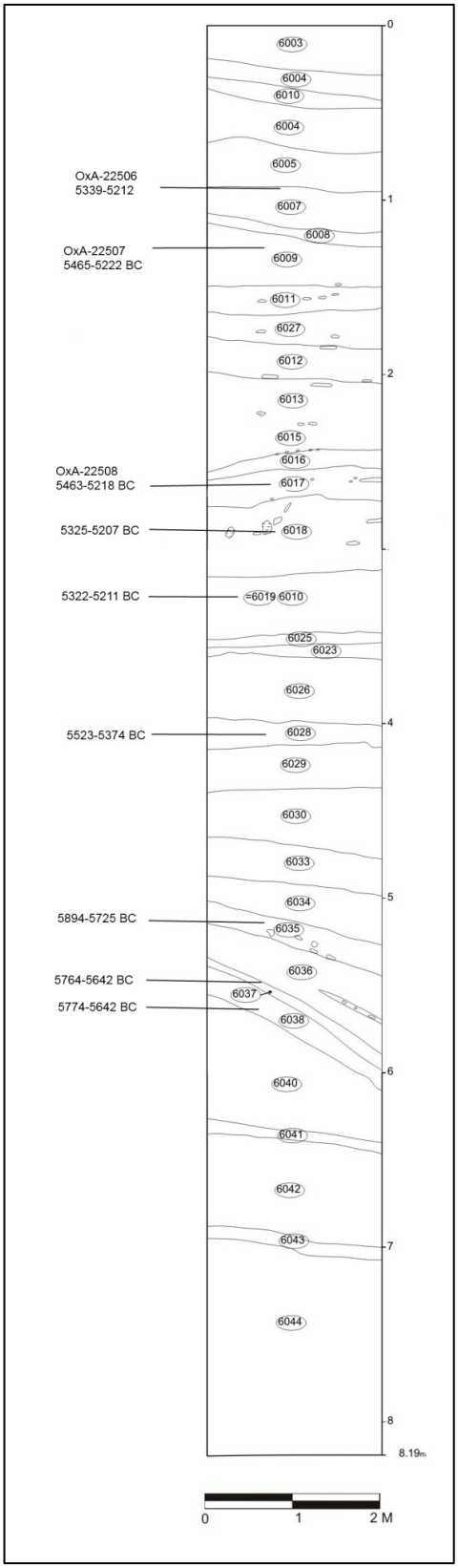


Figure 6.24b. Section drawing of *Sialk North Trench 6, showing contexts of ^{14}C dates.*

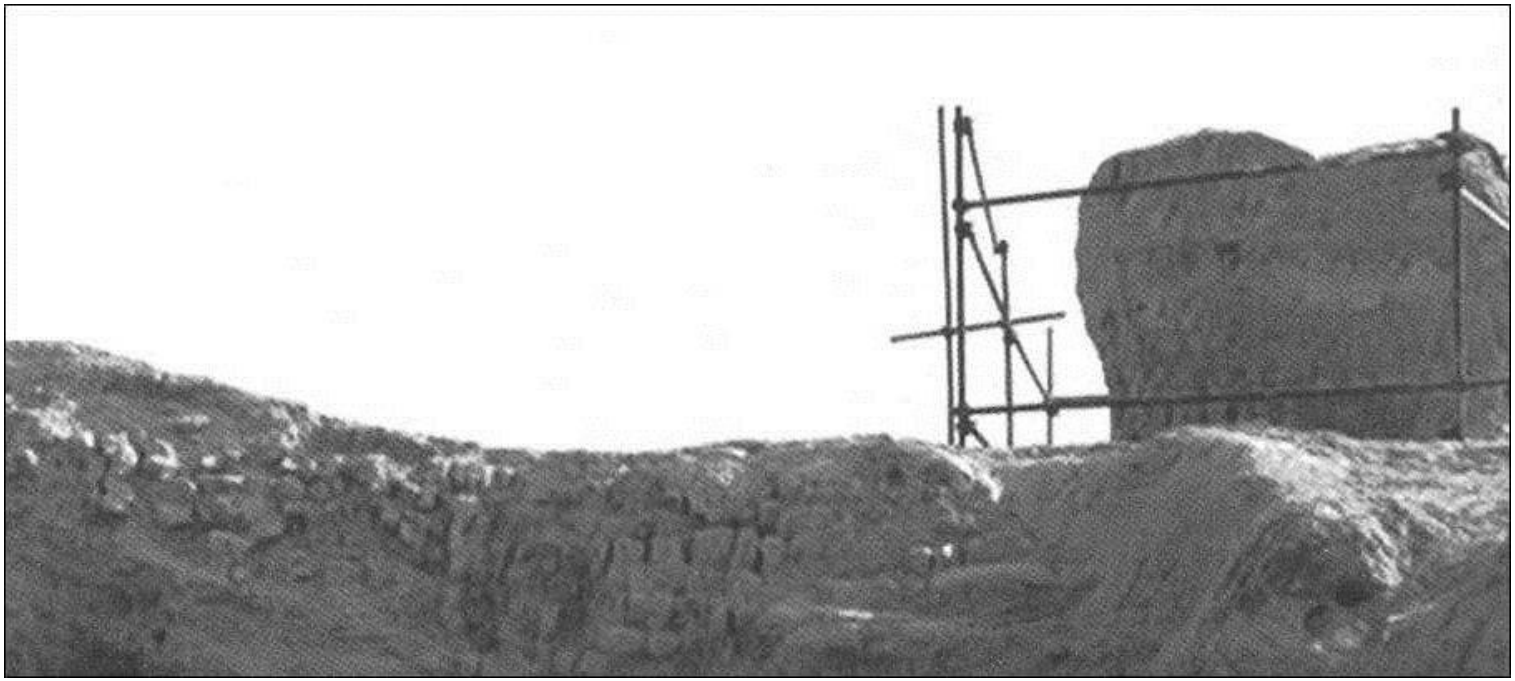


Figure 6.25: *General view of part of the mudbrick 'fortification' wall looking from west to east. The 'pinnacle' is to the right of the picture. (After Malek Shahmirzadi 2006b: fig. 104.)*

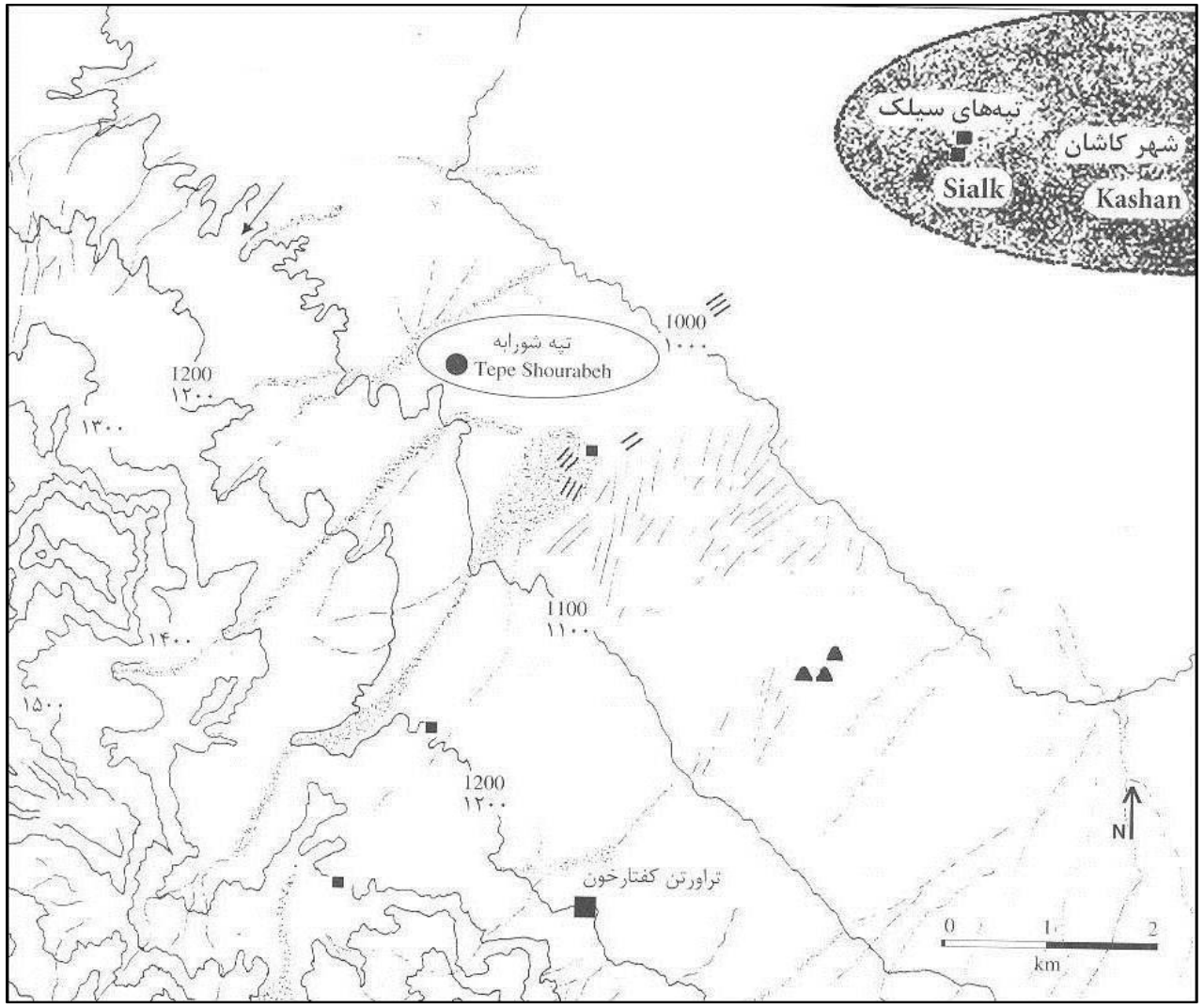


Figure 6.26: *Map showing location of Tepe Shurabad in the piedmont of the Karkas Mountains. (After Malek Shahmirzadi 2006b: map 5.)*

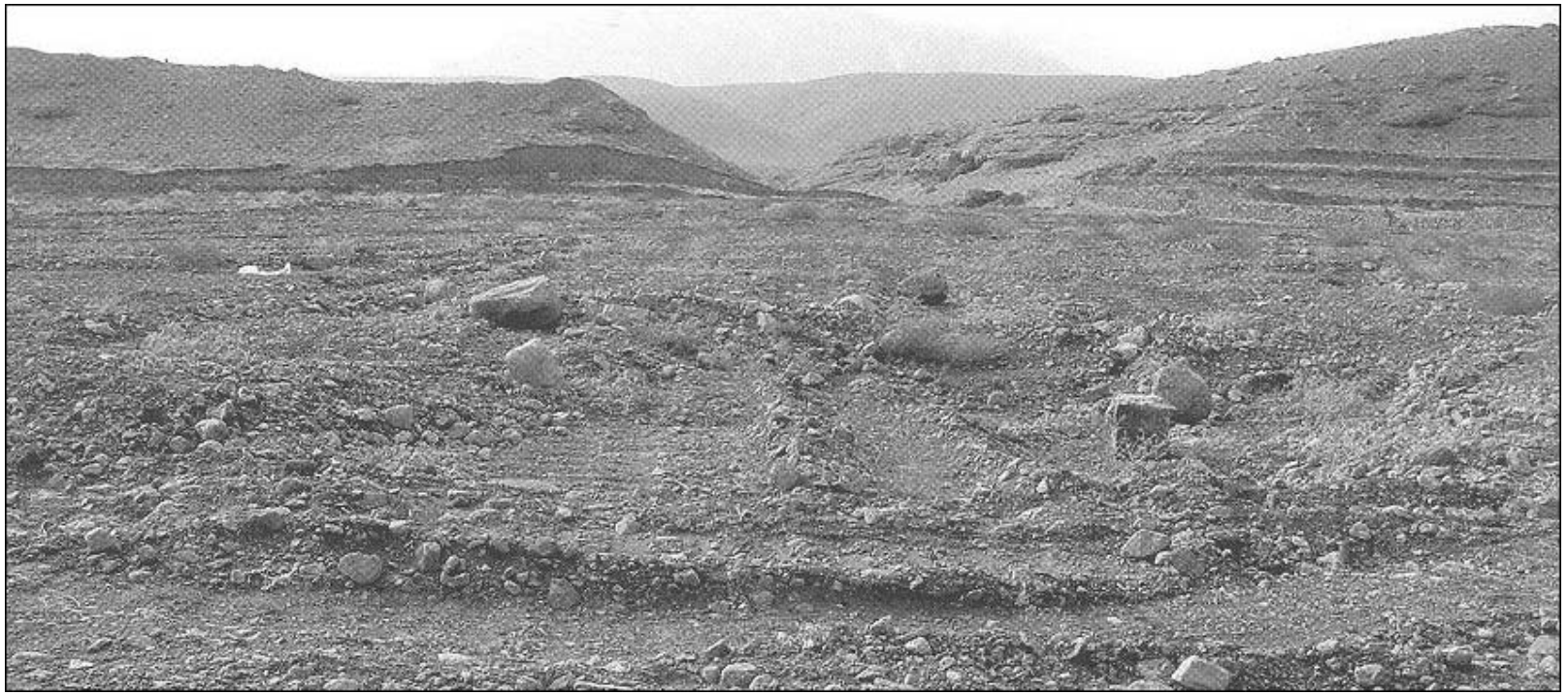


Figure 6.27: *Tepe Shurabeh and natural hill to the right, in the process of being levelled. (After Malek Shahmirzadi 2006b: fig. 31.)*

Figure 6.28: *General view of Ghabristan (photo: Coningham).*

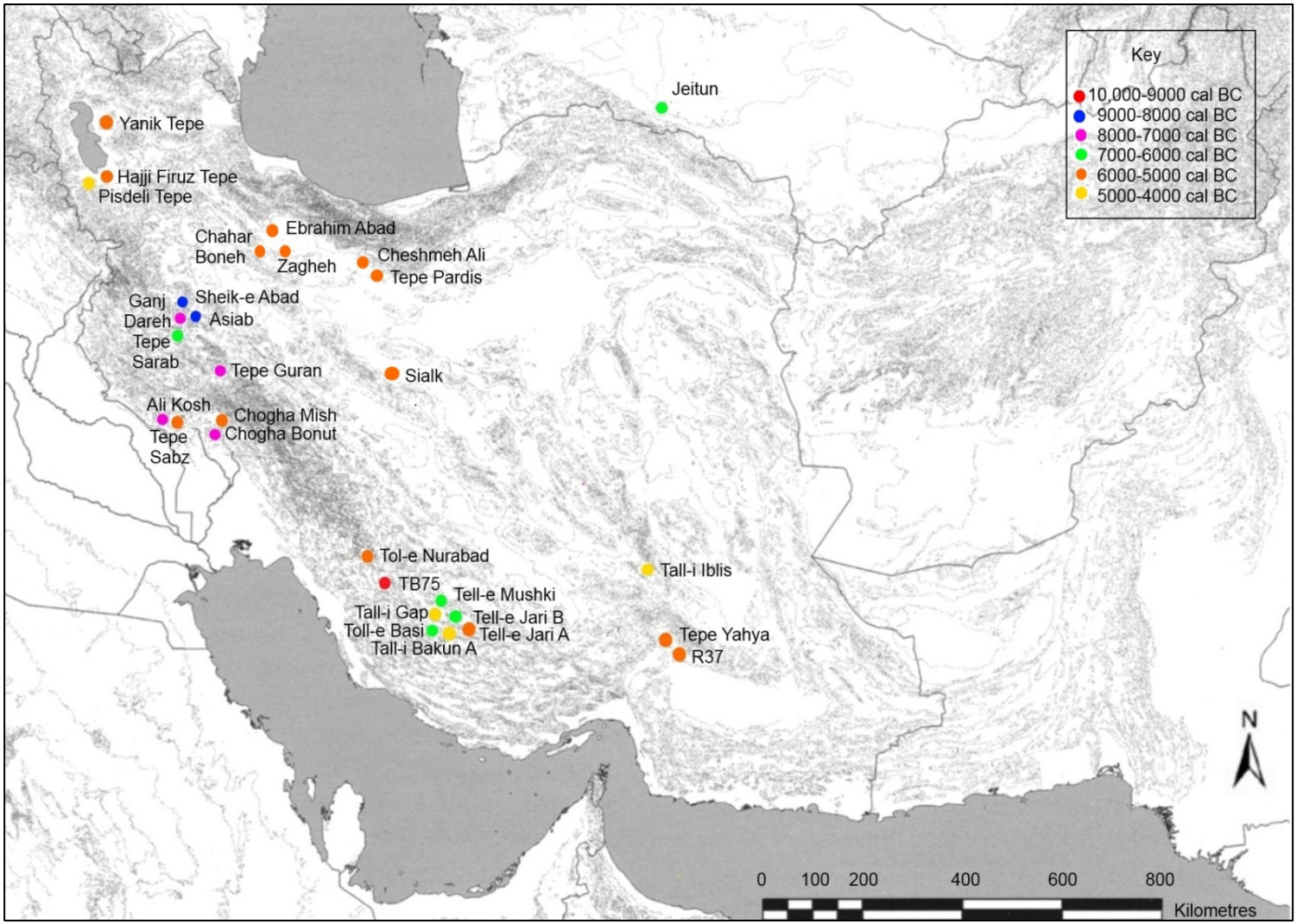


Figure 6.29: *Map of Iran showing the temporal distribution of early farming sites in Iran including new sites on the Central Iranian Plateau, using 'clean' dates.*

Chapter Seven

Discussion

7.0. Introduction

The two main aims of this research were to chronometrically evaluate and recalibrate existing ^{14}C dates for Neolithic sites in Iran and neighbouring regions, and to test for the presence of Early Neolithic settlement on the Central Plateau. To this end, in the proceeding chapters, models for the origins and spread of food production and the current state of knowledge of the Iranian Neolithic were reviewed; existing ^{14}C determinations for Iranian Neolithic sites were chronometrically assessed and recalibrated using OxCal (Brook-Ramsey 2009), and the spatial-temporal distribution of the sites evaluated; and the results of recent and new archaeological investigations on the Central Plateau were reported. In this chapter, the results and different strands of evidence that have emerged from these studies are brought together and discussed. Of particular importance, is the implication that these findings have for the development and spread of agriculture in Iran, and how it accords with the prevailing model for the spread of agriculture, the 'Wave of Advance' (Ammerman & Cavalli-Sforza 1984).

7.1. ^{14}C dates for the Iranian Neolithic

A main objective of this research was to recalibrate the existing ^{14}C determinations for Neolithic sites in Iran and neighbouring regions, assess their 'chronometric hygiene' (Spriggs 1989), and to map the cleaned dates to investigate their spatial and temporal distribution.

The robustness of a ^{14}C chronology is "dependent on the quality assurance procedures that underlie sample selection and treatment" (Lowe et al 2001: 176), and the benefits of applying chronometric hygiene criteria to a ^{14}C

chronology are clear in the results of this research. In Chapter Five, the spatial-temporal distribution of both 'clean' and 'unclean' ^{14}C dates for early farming sites in Iran was mapped. The distribution of the 'unclean' dates revealed a much wider geographical and temporal distribution of Early Neolithic sites in Iran than that of the 'clean' dates. Evaluation of the unclean dates, suggested not only that the Neolithic began around a thousand years earlier (ca. 10,000-9000 BC rather than ca. 9000-8000 BC), but that there were at least two homelands, in the Central Zagros and on the Caspian Sea Plain, while the 'clean' dates suggested that the earliest Neolithic sites only occurred in the Central Zagros. The contrast between conducting further evaluation on the clean and unclean ^{14}C dates, emphasises the need to employ stringent chronometric hygiene assessment criteria when analysing ^{14}C determinations, as not using it can result in the generation of potentially misleading results.

The spatial-temporal distribution pattern of Neolithic sites in Iran is not in accordance with what would be expected from a Wave of Advance. If farming had spread by a Wave of Advance, it would be expected that there would be a west to east cline in site age, caused by the eastwards spread of farmers from their homeland in the Near East at a rate of approximately one-kilometre per year (Ammerman & Cavalli-Sforza 1984: 68). However, the distribution of early farming sites in Iran shows a distinct clustering, rather than a cline. The earliest sites are found in western Iran distributed along the Zagros Mountain chain, and although this is in keeping with the Wave of Advance model, the next earliest Neolithic sites are found in the southwestern lowlands, rather than directly to the east on the Central Plateau as would be expected from a Wave of Advance. Indeed, the analysis of 'new' ^{14}C determinations for sites on Central Plateau shows that there was actually a lag of several thousand years, before the first Neolithic settlements are evidenced on the Plateau in the sixth millennium BC (e.g. Tepe Pardis, Cheshmeh Ali, Ebrahim Abad, Tepe Sialk). Prior to the establishment of Neolithic sites on the Central Plateau, early farming sites are known at Hajji Firuz Tepe, in the Ushnu-Solduz valley (Pullar 1990), Jeitun in southern Turkmenistan (Harris 2010a) and Mehrgarh, Baluchistan (Jarrige et al. 1995). Thus, the distribution of Early

Neolithic sites in Iran represents more of a ‘starburst’ pattern, than the clinal spread that would be predicted by a wave of advance.

7.2. The Central Iranian Plateau

The second main objective of this research was to test for the presence of Early Neolithic sites on the Central Plateau. Traditionally, the lack of Early Neolithic sites has been explained in terms of a lack of archaeological research in the area, and/or because the sites were buried under later settlements or alluvial deposits (Brookes et al. 1982). However, extensive study on the Central Plateau over the last decade (Coningham et al. 2004; 2006; in press; Fazeli 2001; Fazeli & Abbasnezhad 2005; Fazeli et al. 2004; 2005; 2007; 2009; Malek Shahmirzadi 2002; 2003; 2004; 2006a; 2006b) has failed to record any earlier sites, evidencing that this is not the case. Another explanation, then, for the absence of Early Neolithic settlement is needed.

The Central Plateau, by all accounts, is a hostile environment. Ghirshman wrote of it that, “the physical aspects of the Plateau were harsh and austere. The oases were dispersed over difficult country, the population was sparse and scattered. As a result the urban revolution was retarded, and society continued in its prehistoric stage for centuries” (1954: 42). He suggested, that “at all times on the plateau the question of water has been vital” (1954.: 25), a conclusion with which many other scholars concur (Bowen-Jones 1968: 571, 575; Oberlander 1968: 265; Wulff 1968: 105; Goldsmith 1984; Danti 2006). For example, Michael Danti, who conducted the geoarchaeological research for the Sialk Reconsideration Project, argues that “any intensive settlement in the area…depends on a ready source of water” (2006: 69). With this in mind, it is interesting to note that many of the Late Neolithic-Chalcolithic sites recorded on the Central Plateau were short-lived, and occupied for just one or two cultural periods before they were abandoned, presumably because of shifting water courses. That channels at this time were highly mobile and unreliable is evidenced at Mafinabad, where building work has exposed the remains of a migrating, braided watercourse, about 300 metres from the main

tepe (Gillmore et al. 2007: 299). These braided sequences had Middle Chalcolithic (ca. 4000-3700 BC) pottery in abundance, with another pottery layer below. However, there was no evidence of watercourses in the two metres of sediment exposed above, suggesting that during this later period the water flow had stopped.

The limited number of Neolithic-Chalcolithic period sites on the Central Plateau that were more enduring (e.g. Cheshmeh Ali, Tepe Pardis, Sialk), were located close to permanent water sources on alluvial fans (Fig. 7.0). For example, a spring emerges at Cheshmeh Ali (after which the site is named); and there is evidence of a palaeochannel at Mafinabad (Gillmore et al. 2007) and between the North and South Mounds at Sialk (Malek Shahmirzadi 2005; 2006a, 2006b; Simpson & Nejad 2008). The one exception is Tepe Pardis, a long-lived, substantial Late Neolithic-Early Chalcolithic period settlement, which is not associated with a palaeochannel or spring. However, instead, "there is clear evidence at this site of some form of water management or environmental exploitation and manipulation taking place in the Neolithic-Chalcolithic" (Gillmore et al. 2011: 66).

Excavation at Tepe Pardis highlighted a small channel-like feature (1 m in width & 0.24 m in depth), which was triangular in profile, possessed a very different fill from the surrounding sediments, and ran at right angles to a number of other apparently natural channels in the sequence (Gillmore et al. 2009: 285; 2011: 50). It is interpreted as an artificial irrigation canal, and is stratigraphically linked to Late Neolithic levels at the site (Gillmore et al. 2007; 2009; 2011). The antiquity of the channel is further confirmed by an OSL date for the channel at 6.7±0.4 ka (5100-4300 BC), and by ^{14}C dating of the surrounding sediments to 5220-4990 cal. BC (Gillmore et al. 2011: 52). The channel, thus, represents the earliest evidence of irrigation agriculture in Iran to date. The OSL and ^{14}C dates for the channel suggest that it was formed at about the same time as (or is even older than) a number of palaeochannels also found at the site, leading Gillmore et al. to conclude that the channel, "was constructed as a response to the availability of water from natural

channels at this point and may be considered designed to harness this resource" (2011: 64).

Prior to Gillmore and colleagues' (Coningham 2004; Fazeli et al. 2007; Gillmore et al. 2007; 2009; 2011) work at Tepe Pardis, the only direct evidence of irrigation agriculture in the Near East during the Neolithic-Chalcolithic period came from an excavated irrigation channel at Choga Mami, eastern Iraq (Oates 1969; Oates & Oates 1976). Choga Mami is a tell site, situated on an alluvial fan between the Zagros foothills and the Mesopotamian plain, near to the modern town of Mandali (Wilkinson 2003: 73). It lies within an area that receives well over 200 mm of rainfall per year, but this fluctuates, for example, varying between 192 mm per year to 549 mm per year in the period of 1935-56 (Helbaek 1972: 35). Oates and Oates (1976: 111) have argued that some form of irrigation is necessary for successful crop production in all parts of the Near East where rainfall is less than 200 mm per year, suggesting that at Choga Mami in some years, rainfall alone would have been insufficient for reliable cereal cultivation (Helbaek 1972: 39)

Excavation at Choga Mami in 1967-8 exposed a series of six channels (measuring approximately two metres wide), which were stratified within deposits on the edge of the mound (Oates 1969: 123-4). The first two channels (A & B) lay below the inferred plain level of the period and were interpreted as natural watercourses, but channels E and F lay at elevations above the contemporaneous plain level, and were identified as artificial water channels, which diverted the water supply around the settlement (Oates 1969: 125; Oates & Oates 1976: 132). The antiquity of the channels is supported by the stratification of the channels with Sammarran cultural deposits (Oates & Oates 1976), although unfortunately only one ^{14}C determination, of 6200-5325 cal BC, is available (Oates 1969: 125). Hans Helbaek who analysed the botanical remains from the site, suggested that irrigation agriculture is further inferred by the presence of six-row barley and lentils, which he argued would have been unable to grow in the region without some form of irrigation agriculture (Helbaek 1972: 36, 39; see also Field in Oates 1969: 140-1).

Apart from the new evidence reported from Tepe Pardis (Gillmore et al. 2007; 2009; 2011), there is no other direct evidence of irrigation in Iran during the Late Neolithic-Early Chalcolithic period. However, the judicious use of a range of indirect evidence, has been used to suggest that irrigation agriculture was introduced to the Deh Luran plain, southwestern Iran, in the late sixth millennium BC (ca. 5400-5200 BC) (Hole et al. 1969; Hole 1977; 1992; Neely & Wright 1994). The macrobotanical remains from Tepe Sabz (ca. 5000-4200 BC) and the Choga Mami Transitional phase at Chogha Sefid (ca. 5400-5200 BC) included the remains of several plants (e.g. flax, lentil, six-row barley, hexaploid free-threshing wheat, bread wheat) which it is argued could only have been grown in the area using some form of irrigation (Helbaek in Hole et al. 1969: 416; Neely & Wright 1994: 183-4). Neely and Wright also use the juxtaposition of a number of broad, shallow depressions with prehistoric sites to suggest the antiquity of irrigation practices in the area (ibid.). However, no channels have been found in stratigraphic contexts associated with the sites, nor have any been independently dated, and they could be much younger than the prehistoric sites (Wilkinson 2003: 73).

Later evidence of the practice of irrigation agriculture in Iran, comes from the Daultabad region in the southeast, where due to a remarkable stroke of luck in preservation, Chalcolithic period irrigation systems, dating to the latter part of the sixth millennium BC, survived until the 1970s and 1980s (Prickett 1986; Wilkinson 2003). The Daultabad is an arid region where rainfall is insufficient for agriculture, and no large perennial rivers are present. Instead, Wilkinson (2003: 74) argues, that the prehistoric communities were probably dependent on ephemeral wadis, and would have had to of made use of runoff and spates for irrigation. The irrigation system employed took the form of small fields (ca. 0.06-0.07 hectares), usually 30 to 40 metres apart, constructed on a series of gravel fans, which were bounded by low ridges and alignments of silt, cobbles and/or stones to capture floodwater (Wilkinson 2003: 75). Such practices of floodwater farming are known ethnographically. For example, tribes in Baluchistan have traditionally employed a similar system, known locally as the *Sailaba*, in which floodwater from natural watercourses is captured behind

earthen bunds built across the slopes and intercepting the fields (Oosterbaan 1983: 56).

Broadly speaking there are two possible alternatives for the origins of water management and irrigation technology in Iran. One view is that the technology spread through the migration of people from the west. For example, Hole (1977: 12) has argued based on evidence of cultural disjunction on the Deh Luran Plain, that both domesticated plants and the irrigation technology needed to grow them were introduced to the plain by the migration of people from eastern Iraq, where the same complex of irrigated crops and evidence of irrigation are found at Choga Mami from ca. 6000 BC (Oates 1969; Hole 1977; Oates & Oates 1977). Hole argued that the spread of irrigation agriculture to the Deh Luran Plain was, “part of a general expansion by people who were able to exploit intensively locales suitable for irrigation” (Hole 1998), which took place across Iran. More recently, Gillmore et al. (2011) has similarly suggested that irrigation technology was introduced to the Central Iranian Plateau from eastern Iraq. The age of the channel at Tepe Pardis is close to that proposed for the channel at Choga Mami, leading Gillmore et al. to suggest that there was a rapid diffusion of irrigation technology from the west to more arid, peripheral regions in the east, facilitated by “potentially strong links between Mesopotamia and the Tehran Plain” (Gillmore et al. 2011: 64), although they do not expand on what the evidence for these “strong links” is.

Alternatively, Neely and Wright (1994) have argued that irrigation technology developed in Iran by itself. They have described a process, in which the earliest forms of water management made use of the natural seasonal phenomena of watercourse overflow and floodplain inundation, and that building on such natural conditions, “it would seem a logical next step for the agriculturalists to envision their control of such water supply events through the excavation of small channels or ditches leading from water sources to their fields” (Neely & Wright 1994: 184-5). Tony Wilkinson proposes a similar progression for the development of irrigation agriculture at Chogha Mami, suggesting that the artificial channels appear to have been in use when the

land surface was aggrading, and were probably part of an early phase of canal irrigation that directed water down the main slope of the fan in the manner of natural drainage, but at a higher level (Wilkinson 2003: 73). Once irrigation agriculture had developed in Iran, it would certainly have had the potential to spread if the wide-spread distribution of Cheshmeh Ali Ware across the Central Plateau, and the far-reaching trade networks in obsidian, copper, turquoise, and marine shell that are known to have operated in the Neolithic and Chalcolithic periods are anything to go on.

Although it is certainly plausible that irrigation agriculture developed locally in Iran, there is currently not enough information to reach any firm conclusions, and more research on the development of irrigation agriculture in both Iran and Iraq is needed. Whether irrigation agriculture developed independently in Iran or not, the evidence suggests that irrigated landscapes were in use in Iran from the sixth millennium BC, if not earlier (Wilkinson 2003: 73; Gillmore et al. 2011). These systems were of modest size, employing only the most rudimentary technique of channelling water along existing ground slopes or down alluvial fan gradients (Wilkinson 2003: 74). Although it has traditionally been argued that irrigation agriculture represented a major department from earlier agricultural systems (cf. Hole & Flannery 1967), this is not necessarily true. Rather, early irrigation systems "followed a natural progression from the earliest surface- and groundwater-based systems through an increased management of sources of surface water and its distribution to suitable locations" (Sherratt 1980: 325). Such forms of irrigation would have required only a small input of effort, involving communal groups only within individual settlements, and were therefore achievable by Late Neolithic and Chalcolithic period groups with only limited technology (Sherratt 1980: 322; Wilkinson 2003: 74). The fact that no agricultural settlements are known on the Central Plateau until the Middle to Late Neolithic (ca. 6500-5500 BC), suggests that permanent settlement on the Plateau was not possible until the development of water manipulation technology. This is supported by the location of the sites themselves, as the longest-lived sites were all situated in areas where local water resources could be manipulated: relict palaeochannels have been identified at Sialk (Simpson & Nejad 2008) and Mafinabad (Gillmore et al.

2007), Cheshmeh Ali is situated next to a spring (Fazeli et al. 2004), and an artificial water channel is evidenced at Tepe Pardis (Gillmore et al. 2007; 2009; 2011).

When the first settlements appear on the Central Plateau during the Middle to Late Neolithic-Chalcolithic, their size and pattern of distribution varies regionally. Late Neolithic to Early Chalcolithic period settlement on the Tehran Plain shows an increase in site number throughout this period, followed by a decrease in settlement number during the Middle to Late Chalcolithic periods. Meanwhile, on the Qazvin Plain the number of settlements appears to have remained relatively constant through the Late Neolithic to Early Chalcolithic periods, after which there was a hiatus in settlement until the occupation of Ghabristan in the Late Chalcolithic; whilst on the Kashan Plain settlement was agglomerated throughout the Late Neolithic and Chalcolithic periods at Sialk, with few other sites recorded in the plain for this period. The difference in settlement patterns between the three plains, suggests that though the technology for irrigation agriculture may have spread – possibly from Iraq (Gillmore et al. 2011: 64) – how it was adopted and adapted varied locally, probably as a result of environmental and social considerations. As Chris Thornton has argued, the landscape of the Central Plateau, “has lent itself to a great diversity of localized communities and cultures in the past as well as the present” (2009: 306), and as a result the region has always been highly diversified.

Irrigation agriculture, which would have been a communal enterprise , probably at the village level (Wilkinson 2003: 74), developed at a time in which increasing complexity is evidenced on the Central Plateau, in terms of the economy, social organization, and craft industries. Markers of rising complexity in the Late Neolithic-Chalcolithic period include the development of long-distance trade (Coningham et al. 2004; Fazeli 2001; Fazeli et al. 2005; 2007), the herding of domesticated sheep, goat and cattle (Mashkour et al. 1999; Young & Fazeli 2008), complex ritual activities, specialization and standardization in craft production (Fazeli 2001; Fazeli et al. 2007) and new production technology (Fazeli et al. 2007; 2010; Thornton 2009). However,

whether the use of irrigation techniques was part of, or a result, of these changes is unclear. Intra- and inter-regional interaction was in place in the Central Plateau by at least the Neolithic-Chalcolithic transition, as evidenced by the wide distribution of Late Neolithic 'Sialk I' Ware and Transitional Chalcolithic 'Cheshmeh Ali' Ware. As well as in the Kashan region, Sialk I Ware is known from Ebrahim Abad on the Qazvin Plain (Fazeli et al. 2007); and on the Tehran Plain at Cheshmeh Ali (Fazeli et al. 2001), Tepe Pardis (Coningham et al. 2004), Tepe Sadeghabadi and Tepe Arastu (Fazeli et al. 2007: 9). The later Cheshmeh Ali Ware has a much wider spread distribution and has been recorded at sites across the Central Plateau, from the Gorgon plain to the east and the Qazvin Plain to the west (Wong et al. 2010). There is also evidence for the inter-regional trade of specialized tools and materials in the lithic industry (Fazeli 2001; Fazeli et al. 2002). Although the majority of the stone tools were made from local chert sources, a limited number were manufactured from non-local materials (e.g. obsidian, quartz, tan chert & chalcedony), which were probably imported materials. Obsidian is reported from Chaqmak Tepe and Tepe Pardis on the Tehran Plain (Fazeli et al. 2010), at Zagheh on the Qazvin Plain (Malek 1977), and at Sialk North (Ghirshman 1938) and Ghabristan (Coningham et al. in press) on the Kashan Plain. Chalcedony is found only at Sadeghabadi (Fazeli et al. 2002: 6); and a type of tan chert is found across the Tehran Plain, only in the form of pressure-flaked blades or formal tools, suggesting that the material was worked outside the region and imported only as finished tool forms (Fazeli 2001; Fazeli et al. 2002: 7). Temporal variation in the lithic industry suggests that during the Late Neolithic local craft specialists produced the lithic tools for each site, with the possible exception of the tan-chert tools, while during the Transitional-Early Chalcolithic local production was increasingly replaced by offsite, possibly centralized, production (Fazeli 2001; Fazeli et al. 2002: 8-9).

The intra and inter-regional increase in the trade of materials and finished artefacts on the Central Plateau, is associated with a dramatic increase in craft specialization and standardization of production (cf. Fazeli 2001). At Tepe Pardis there is evidence of specialized ceramic production from the end of the sixth millennium BC (Fazeli et al. 2010). From the earliest occupation of

the site, in the latter half of the sixth millennium BC, it appears that the residential areas were separated from the workshop areas, and that from ca. 5200-4600 BC the whole area was used for making vessels (ibid.: 87), and a similar spatial separation of the residential and workshop areas is reported at Zagheh (Fazeli et al. 2007: 19). The growing specialization and intensification of the ceramic industry, is also marked by the major change in pottery style. Across the Central Plateau during the Transitional Chalcolithic Period, Late Neolithic 'Buff Ware' was replaced by 'Cheshmeh Ali' Ware (Wong et al. 2010). Transitional Chalcolithic Cheshmeh Ali Ware was finer than Buff Ware, had a uniform vegetable temper, was fired more efficiently, at higher temperatures and for longer times in more controlled kilns, was carefully burnished and was decorated with painted geometric and naturalistic motifs. (Fazeli et al. 2007: 14; 2010: 87). These decorations became finer and more complex over time, suggesting a "growing specialization of the painters" (Fazeli et al. 2010: 109)

A further indicator of the growing specialization and intensification of craft production during the Late Neolithic and Chalcolithic periods on the Central Plateau, is the terracotta 'slow wheel' recovered from Transitional Chalcolithic (ca. 5500-4300 BC) levels at Tepe Pardis (Fazeli et al. 2007: 14; 2010: 89). To date, this represents not only the earliest evidence of a slow wheel on the Central Plateau, but also across the whole of South and Middle Asia, and has important implications for the development of craft specialization at Tepe Pardis (Fazeli et al. 2007: 19; 2010: 108-9).

Parallel to the development and specialization of the ceramic industry on the Central Plateau, was the emergence and spread of metallurgy (Thornton 2009). The earliest evidence of metal use in Iran comes from Ali Kosh, where a rolled bead of native copper has been dated to the late eighth/early seventh millennium BC (Hole 2000: 13), and isolated finds of native copper from late seventh/early sixth millennium contexts at Mehrgarh (Moulherat et al. 2002: 1393) suggest that native copper may have been manipulated in eastern Iran by the mid-late seventh millennium BC (Thornton 2009: 310). However, the true adoption of copper is not evidenced until the early-mid sixth millennium

BC, when native copper artefacts were utilized consistently in various parts of the Central Plateau (Thornton 2009: 308). Chris Thornton suggests that although there exist important synchronisms between the development of metallurgy in the Central Plateau and the Levant, "there are also significant chronological and technological differences" (2009: 318), leading him to conclude that the "Iranian Plateau served as one of *the* early 'heartlands' of metallurgy" (2009: 318; author's original emphasis).

Fazeli and colleagues (Fazeli 2001; Fazeli et al. 2005; 2007; 2010) argue that population growth and increasing social complexity during the Late Neolithic-Chalcolithic period is also evidenced by the increase in social ranking, as reflected in mortuary practices, ritual activities and "ideological domination" (Fazeli et al. 2007: 7). The most tangent archaeological evidence of this is the presence of the 'Painted Building' at Zagheh (Neghaban 1974; 1979; Fazeli et al. 2005). The 'Painted Building' is a large, roughly rectangular structure measuring some 11 by 7 metres, containing a small annex room, surrounded by a large U-shaped main hall with benches set against the wall. The walls were plastered with red ochre plaster, and decorated with a black and white zigzag design. Of particular significance were 18 mountain goats' skulls and horns, found in-situ below where they had fallen off a wall, and 2 hearths (Neghaban 1979: 247). It is interesting to note that a similar deposit has been recovered from the Neolithic site of Sheikh-e Abad in the Central Zagros, where four skulls of large wild goats placed in pairs, and a large sheep' skull, were found in a room which the excavators suggest may have been a ritual building (Matthews et al. 2010). This suggests that the development and growth of social complexity witnessed on the Central Plateau may have been part of a geographically wider phenomenon.

The evidence of increasing complexity and rising population numbers outlined above, suggests that the use of water manipulation techniques and irrigation on the Central Iranian Plateau during the Late Neolithic-Chalcolithic periods, was part of a larger trajectory of growing social complexity and change. Fazeli (2001) argues that the rapid growth in settlement and population during this period was due to an escalation in craft production and specialization, and

trade and exchange. Thornton agrees, suggesting that the Central Plateau provided the, “perfect setting for significant technological innovations, in that craft specialists could be supported by the community and given time to experiment” (Thornton 2009: 321). It can be envisaged, that it was the outcome of the complex interplay of this growing social and economic complexity that enabled the settlement of the Central Plateau during the Middle to Late Neolithic period and its continuity during the Chalcolithic, although a significant role has to be given to the development of water manipulation techniques. For, without it, the permanent occupation of the “harsh and austere” (Ghirshman 1954: 42) Central Plateau would not have been possible. Returning to the models for the development of agriculture that were discussed in Chapter Two, it would appear, then, that on the Central Plateau two main factors contributing to the continued development and growth of the agricultural economy during the Late Neolithic and Chalcolithic periods: population growth, in contrast to population pressure (e.g. Cohen 1977), as originally advocated by Binford (1968); and increasing social complexity. Added to this could, perhaps, be included growing networks of communication and trade, and the development of new technologies such as water manipulation (Sherratt 2007; Gillmore et al. 2007; 2009; 2011).

Cultural complexity and interaction on the Central Plateau during the Late Neolithic and Chalcolithic periods is evidenced by the presence of non-local materials, e.g. turquoise, obsidian, marine shell, and the distribution patterns of manufactured products (see Tab. 7.0). For example, ‘Cheshmeh Ali’ Ware is found at Cheshmeh Ali and Tepe Pardis on the Tehran Plain; at Ebrahim Abad and Cheshmeh Bolbol on the Qazvin Plain; and at Sialk on the Kashan Plain. In terms of the distribution of non-local materials, obsidian is relatively rare on the Central Plateau in comparison to Late Neolithic-Transitional Chalcolithic sites in western Iran (e.g. Ali Kosh, Tepe Sabz; Hole et al. 1969). One obsidian blade was found at Sialk; one at Tepe Pardis; and two were collected during surface survey at Chakhmak Tepe. The one site at which obsidian was more plentiful was at Ghabristan on the Kashan Plain, where initial analysis suggests that some 11 per cent of the lithic assemblage was comprised of obsidian (Coningham et al. in press). This suggests that unlike

the former sites, the inhabitants of Ghabristan participated in what was possibly a larger trade network, extending beyond the Central Plateau, along which the trade of obsidian was more common. The source of the obsidian is unknown, but the closest potential sources are around the peak of Damavand in the Alburz Mountains and Sareh in the western part of the plain (Fazeli 2001: 185) (see also Fig. 7.0). In comparison to obsidian, marine shells from the Persian Gulf are much more widely distributed across the Central Plateau, and have been recorded at: Tepe Pardis, Zagheh, Cheshmeh Bolbol, Sialk North and Ghabristan. This suggests that the inhabitants of these sites perhaps had a stronger link with trade networks to the north of the Plateau, rather than those to the south and east. As, with the exception of the 180-kilometre long stretch on the Karun (Fig. 3.6), none of the rivers in Iran are navigable, trade routes would have operated over land.

In terms of other non-local materials, lapis lazuli is found at Tepe Pardis and Zagheh, and turquoise is evidenced at Tepe Pardis, Zagheh and Sialk. The geographic distribution of lapis lazuli has been poorly studied, and the origin of that used on the Central Plateau is not known. Fazeli (2001: 216-7) suggests that it may have come from eastern Iran. Ghirshman (1938: 24, 31-2) suggested that the turquoise and carnelian may had been sourced from the Meshed region of eastern Iran. Another potential source area for the turquoise is Kerman Province (Beale 1972: fig. 1). Much of this interaction can be probably be interpreted as “trickle trade” (Beale 1973: 141), which included low-level, routine contact between neighbouring communities. Fazeli and Abbadbezhad (2005: 12) suggest that weapons, tools and ornaments may have changed hands as items in dowries, as elements of gift exchange between local dignitaries, or as spoil of conflicts.

Small, cold-hammered copper objects are reported from Tepe Pardis, Zagheh, and Sialk North. Although the copper found at these sites was probably locally sourced (Negatiti 2004: 63), the practice of early metallurgy and the technological ‘know how’ associated with it, can be interpreted as evidence of expanding trade and social networks (Thornton 2009).

With the exception of the visible remainders of the presence of non-local materials and the trade of manufactured products, little is known of prehistoric trade routes on the Central Iranian Plateau. One possible way of reconstructing ancient trade routes is to look at the distribution of modern caravanserai. Caravanserai "have been erected in almost all parts of the Iranian Plateau since the earliest times" (Kleiss & Kiani 1995: 778), and although their exact origin is contentious, their antiquity is in no doubt. W. Kleiss and M.Y. Kiani have conducted a comprehensive study of Iranian caravanserai, and have recorded all that are still visible (Fig. 7.1-7.2). Although the historical patterns marked by caravanserai will have been greatly influenced by the construction of *qanat* lines from the first millennium BC onwards, some will be based on ancient, perhaps prehistoric, networks. The ancient routes are most likely to be the peripheral ones which skirt the *kavirs* along the alluvial fans, where the water sources were; the regions where prehistoric sites such as Tepe Pardis, Cheshmeh Ali and Sialk were also located.

7.3. The spread of agriculture in Central and South Asia

Recent archaeological research on the Central Plateau, specifically targeted at identifying the presence of Early Neolithic sites, has failed to recover any evidence of occupation during this period (Coningham et al. 2004; 2006; Coningham et al. in press). Instead, the evidence indicates that early farming settlements were not established on the Central Plateau until the late sixth millennium BC. This is very much at odds with the pattern that would be expected from a Wave of Advance. The Wave of Advance model uses short-distance migrations to describe the expansion of early farmers by a random-walk process, which has been calculated from the dates of early farming sites in Europe to have occurred at a rate of one-kilometre per year (Ammerman & Cavalli-Sforza 1971: 685). Such a pattern of dispersal would result in a steady cline in the age of sites, with the oldest sites located closest to the homeland of farming, and the youngest sites situated furthest away.

The Wave of Advance model was originally proposed for Europe (Ammerman & Cavalli-Sforza 1984), but is has been subsequently applied to the eastern spread of agriculture (e.g. Renfrew 1987; Bellwood & Renfrew 2002; Bellwood 2005; 2009). Peter Bellwood, for example, argues that "after about 7000 BC, an efflorescence of Neolithic expansion occurred out of Anatolian and the northern Zagros, initially into Greece and Armenia by about 7000 BC, onward into the Balkans and east into Pakistan and Turkmenistan" (Bellwood 2009: 625). However, the absence of Early Neolithic settlements on the Central Plateau, and their subsequent appearance in the Middle-Late Neolithic period in conjunction with irrigation technology, calls this into question.

Andrew Sherratt has suggested that in early farming groups, the decisions on where to settle were "restricted… [and] highly selective" (Sherratt 1980: 314). He argued that rather than proceeding by a random-walk process, as described by the Wave of Advance model, early farmers chose to settle only in 'optimal' areas, with high soil fertility and moisture content. Consequently, the initial spread of farming was not uniform, involving instead the infilling of optimal areas within a region, by the spread of the daughter settlements to sites comparable to those occupied by their mother settlements (Sherratt 1972: 516). This form of spread, with early farmers 'leapfrogging' from one niche environment to another, is described by van Andel and Runnels as having a pattern, "like the tongues of the incoming tide as it first advances across the sand" (van Andel & Runnels 1995: 497), and fits more comfortably with the pattern of settlement on the Central Plateau. Early farmers would initially have avoided the generally hostile environment of the Central Plateau in favour of more optimal areas (e.g. the Ushnu-Solduz Valley, southern Iran, & perhaps southern Turkmenistan & Baluchistan?). The appearance of early farming settlements on the Central Plateau during the Middle to Late Neolithic period (ca. 6500-5500 BC), simultaneously with evidence of water manipulation and/or irrigation agriculture, suggests that the occupation of the Central Plateau by prehistoric farmers was not possible until the development of this technology.

7.4. Conclusion

This research shows, that despite extensive settlement survey and excavation on the Tehran, Qazvin and Kashan plains, including *qanat* survey specifically designed to combat potential problems in archaeological visibility (cf. Brookes et al. 1982; Coningham et al. 2004), there exists no evidence of Early Neolithic (ca. 8000-6500 BC) settlement on the Central Plateau. Instead, the results from both the relative and absolute dating of Tepe Pardis, Cheshmeh Ali, Zagheh, Chesmeh Bolbol, Ebrahim Abad and Sialk North, imply that the Plateau was not occupied until sometime during the Middle to Late Neolithic period (ca. 6500-5500 BC). In conjunction with the appearance of settlement during this period, is evidence of water manipulation and/or irrigation agriculture, suggesting that occupation of the Central Plateau was not possible until the development of this rudimentary technology.

The re-calibration and chronometric assessment of the ^{14}C dates already available for Neolithic sites in Iran and neighbouring regions, emphasises the retardation in the settlement of the Central Plateau, compared to other regions within Iran, notably the Central Zagros, the southwestern and southern lowlands and the Ushnu-Solduz Valley. Outside of Iran, the absolute dating of Jeitun, southern Turkmenistan and Mehrgarh, Baluchistan, implies that these areas too were settled before the Central Plateau. Such a pattern is not what would be exhibited by a wave of advance, where farming would have spread by a random-walk process at a uniform rate and rather, it is in accord van Andel and Runnel's (1995) model of 'leapfrog' colonization (Fig. 2.14), in which farming groups sought only optimal areas to settle, 'leapfrogging' over areas like the Central Plateau, which were unsuited for early farming technology. It was not until later, during the Middle-Late Neolithic (ca. 6500-5500 BC) period, when, in conjunction with other social and technological changes, that water manipulation techniques had been developed, that farming groups were able to settle in the region. However, even then, their distribution was limited, restricted by the need for local permanent, or manipulable, water sources. Envisioning the spread of farming to have been targeted and specific, as proposed by van Andel and Runnel's leapfrog

model, also explains for the presence of the seventh millennium BC site of Mehrgarh in Baluchistan, the existence of which cannot be explained using the conventional model of a wave of advance. In the next chapter the aims and objectives of this research, and how they were met is reviewed, and areas of future research considered.

	Site	Period	Marine shell	Pottery	Copper	Lithics	Obsidian	Other
Tehran Plain	Yan Tepe	Late Neolithic	No	Sialk I & II Ware	No	Local chert	No	
	Cheshmeh Ali	Late Neolithic-Early Chalcolithic	No	Neolithic 'Buff' Ware; 'Cheshmeh Ali' Ware	No	Local grey chert	No	
	Tepe Pardis	Late Neolithic-Transitional Chalcolithic	Yes	Neolithic 'Buff' Ware; 'Cheshmeh Ali' Ware	Cold hammered copper	Local chert; 4 imported honey chert blades	1 obsidian blade	Agate; lapis lazuli, turquoise
Qazvin Plain	Chahar Boneh	Late Neolithic	No	Neolithic 'Buff' Ware;	No	Local chert	No	
	Ebrahim Abad	Late Neolithic-Transitional Chalcolithic	No	Neolithic 'Buff' Ware; 'Sialk I' Ware; 'Zagheh' Ware; 'Cheshmeh Ali' Ware	No	Local chert	No	
	Zagheh	Transitional Chalcolithic	Yes	'Zagheh' Ware; 'Cheshmeh Ali' Ware	Cold-hammered copper	Local chert	No	Lapis lazuli; turquoise
	Cheshmeh Bolbol	Transitional Chalcolithic	No	'Zagheh' Ware; 'Cheshmeh Ali' Ware	No	Local chert	No	
Kashan Plain	Sialk North	Late Neolithic-Transitional Chalcolithic	Yes	'Sialk I' & Sialk II' Ware, 'Cheshmeh Ali' Ware	Cold-hammered copper	Local chert; occasionally marble	1 obsidian blade	White marble; alabaster; carnelian; turquoise
	Ghabristan	Late Neolithic	Yes	Neolithic 'Buff' Ware	No	Local chert	11% lithic assemblage	

Table 7.0: *Imported materials and manufactured ceramics and lithics found at sites on the Central Iranian Plateau.*

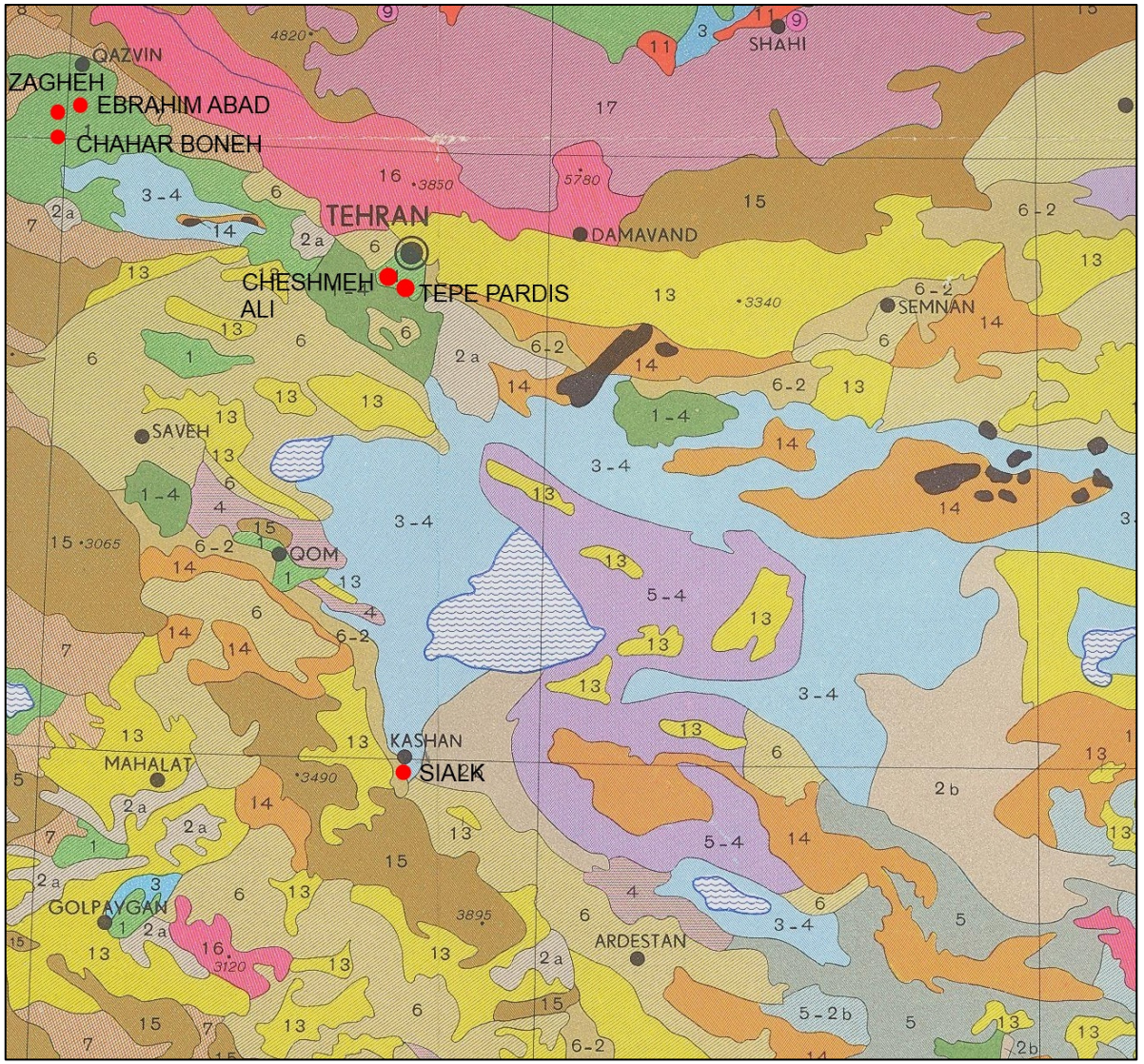
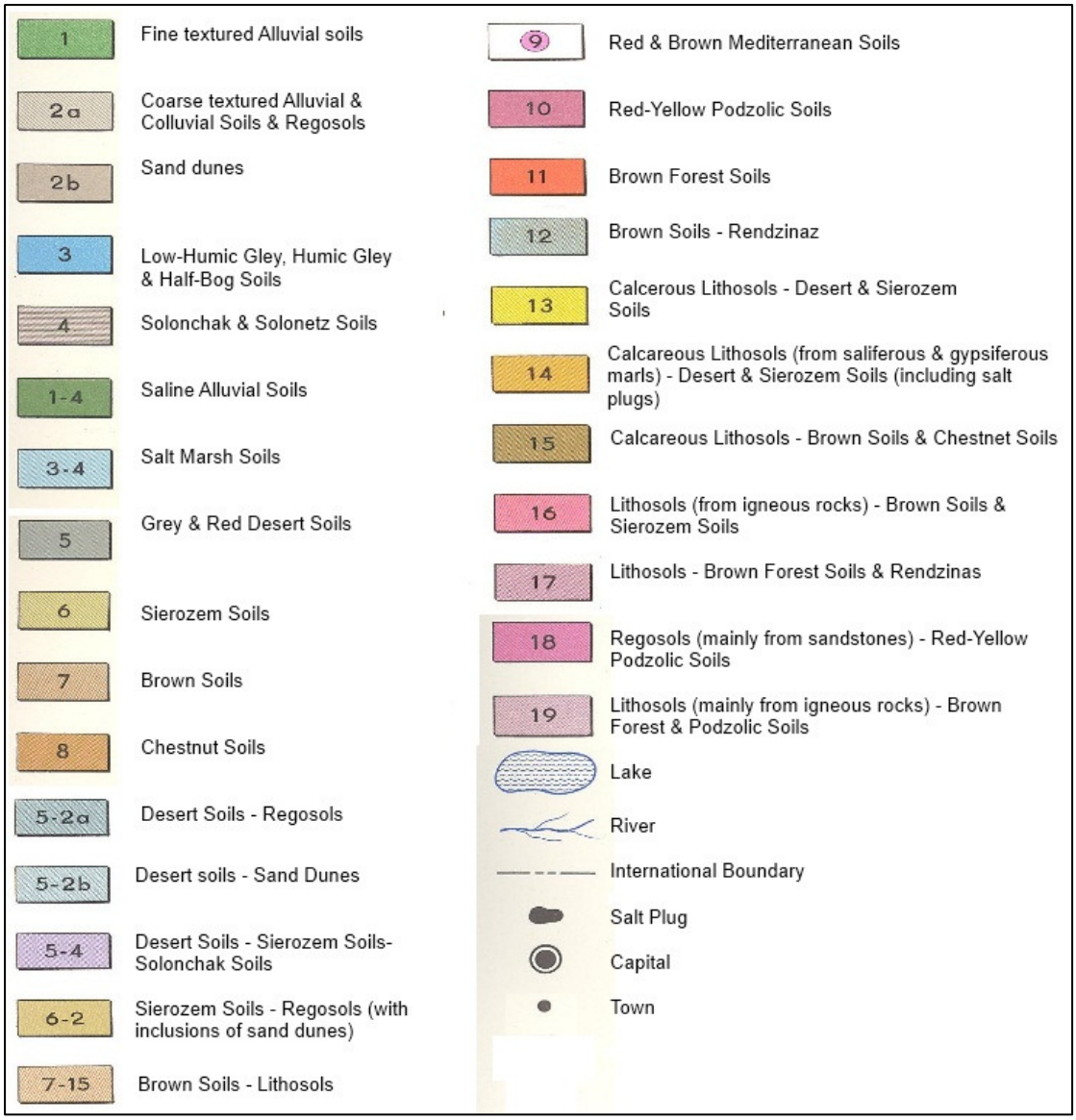


Figure 7.0: *Soil map of the Central Plateau showing key sites. Scale 1: 2,500,000. (After Dewan & Famouri 1964).*


1
Fine textured Alluvial soils
2a
Coarse textured Alluvial & Colluvial Soils & Regosols
2b
Sand dunes
3
Low-Humic Gley, Humic Gley & Half-Bog Soils
4
Solonchak & Solonetz Soils
1-4
Saline Alluvial Soils
3-4
Salt Marsh Soils
5
Grey & Red Desert Soils
6
Sierozem Soils
7
Brown Soils
8
Chestnut Soils
5-2a
Desert Soils - Regosols
5-2b
Desert soils - Sand Dunes
5-4
Desert Soils - Sierozem Soils-Solonchak Soils
6-2
Sierozem Soils - Regosols (with inclusions of sand dunes)
7-15
Brown Soils - Lithosols
9
Red & Brown Mediterranean Soils
10
Red-Yellow Podzolic Soils
11
Brown Forest Soils
12
Brown Soils - Rendzinaz
13
Calcerous Lithosols - Desert & Sierozem Soils
14
Calcareous Lithosols (from saliferous & gypsiferous marls) - Desert & Sierozem Soils (including salt plugs)
15
Calcareous Lithosols - Brown Soils & Chestnet Soils
16
Lithosols (from igneous rocks) - Brown Soils & Sierozem Soils
17
Lithosols - Brown Forest Soils & Rendzinas
18
Regosols (mainly from sandstones) - Red-Yellow Podzolic Soils
19
Lithosols (mainly from igneous rocks) - Brown Forest & Podzolic Soils
Lake
River
International Boundary
Salt Plug
Capital
Town

Key to Fig. 7.0.

Figure 7.1: *Map of some source areas and prehistoric sites in Iran. (After Beale 1972: fig. 1.)*

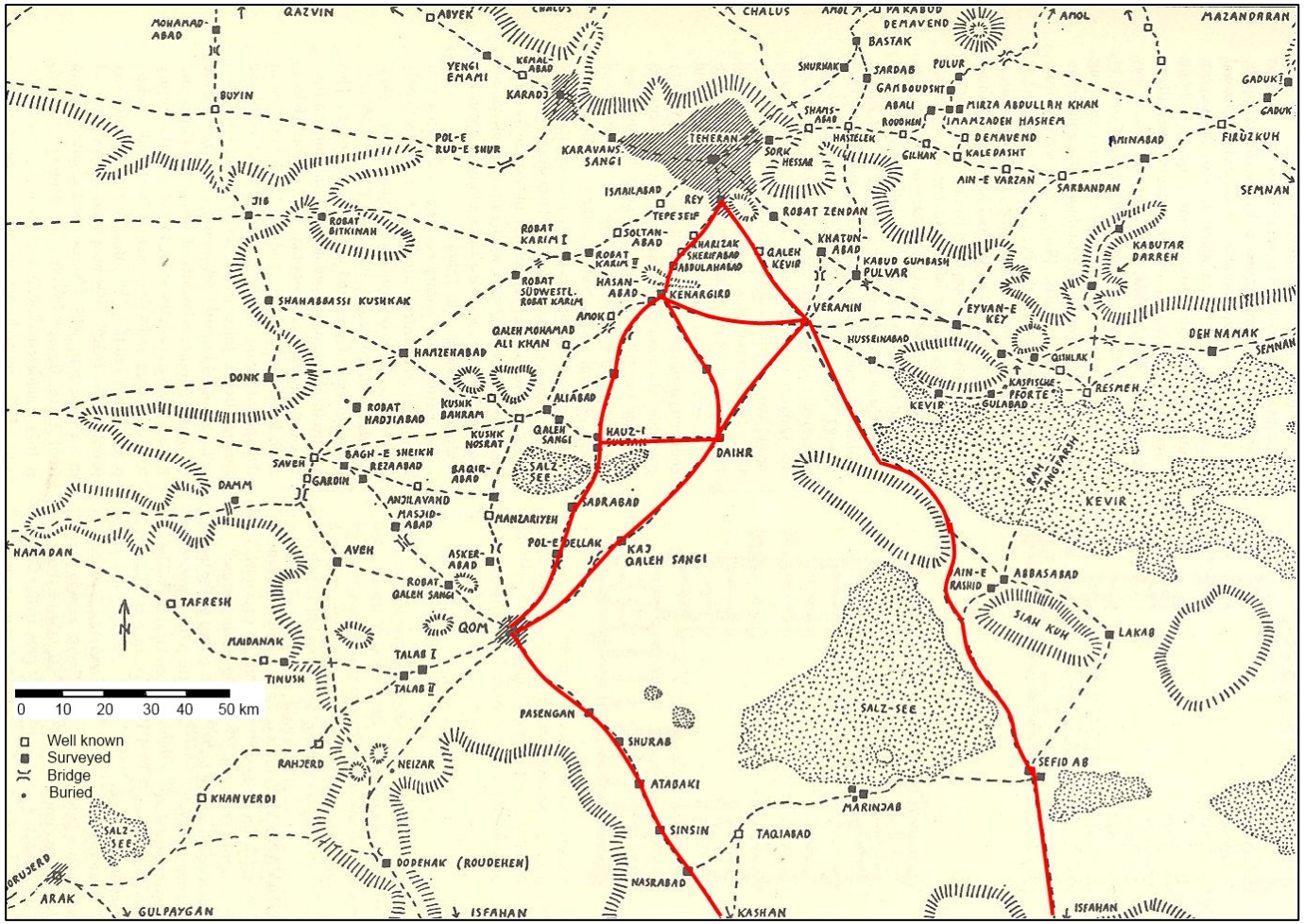


Figure 7.2: *Location of caravanserai in Central Iran. Red lines mark possible routes of interest in terms of trade on the Central Plateau during the Neolithic & Chalcolithic periods (After Kleiss & Kiani 1995: 710.)*

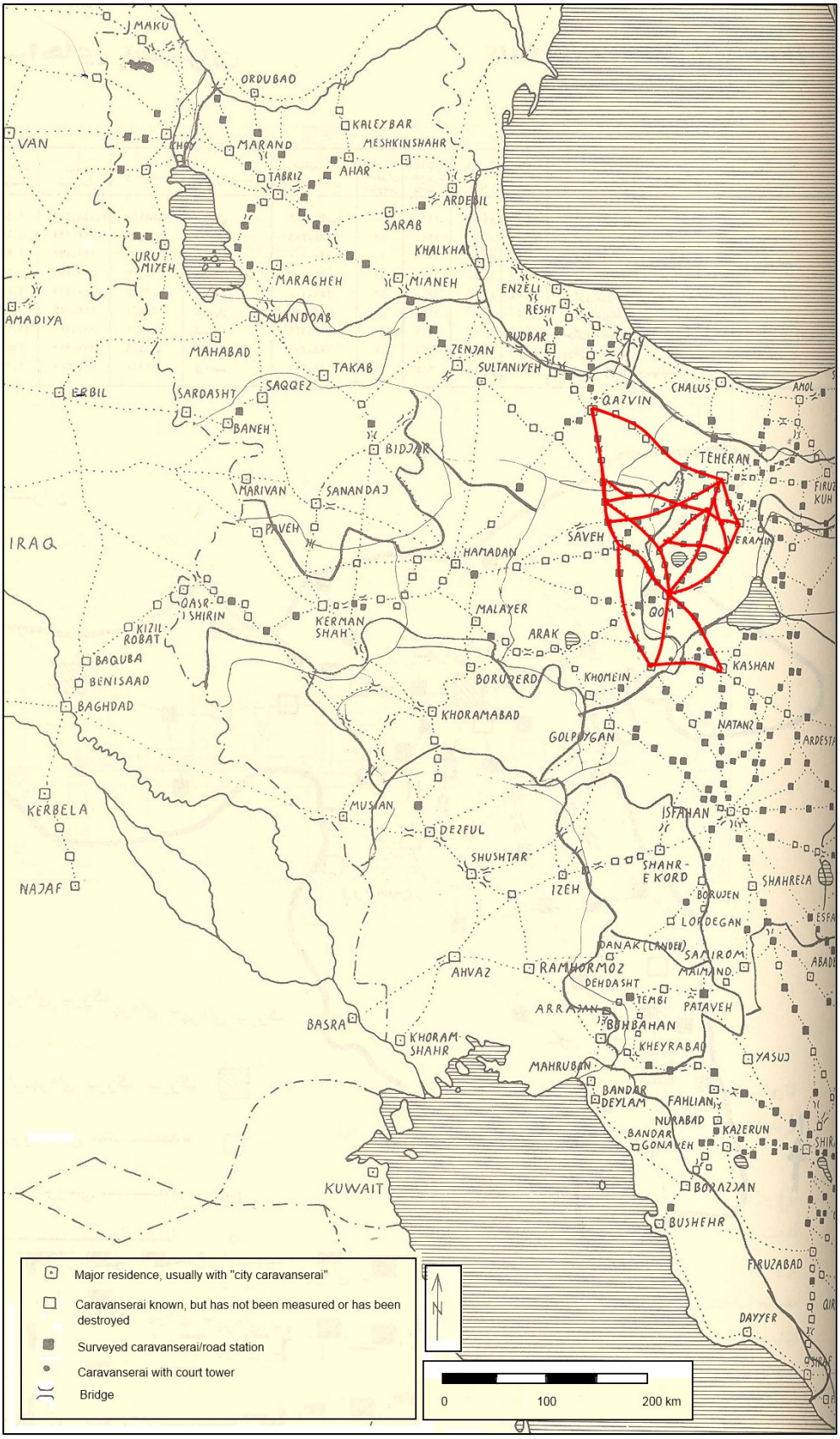


Figure 7.3: *Distribution of caravanserai in eastern Iran. Red lines mark possible routes of interest in terms of trade on the Central Plateau during the Neolithic & Chalcolithic periods. (After Kleiss & Kiani 1995: 407.)*

Chapter Eight

Conclusion and Outline of Further Research

8.0. Introduction

The aim of this research was to test for the presence of Early Neolithic occupation on the Central Iranian Plateau, with particular focus on the Qazvin, Tehran and Kashan plains. The objectives of this research were to: (1) review models of the sequential Neolithic occupation of Iran; (2) analyse published material on the earlier Neolithic of Iran and neighbouring regions; (3) recalibrate and evaluate the chronometric hygiene of published ^{14}C determinations for Neolithic sites in Iran, and neighbouring regions; (4) to spatially plot the evaluated ^{14}C determinations onto a geographic map of Iran; and (5) to review the data from recent survey and excavation work on the Tehran, Qazvin and Kashan plains.

Objective one was achieved by reviewing existing models for the origins and spread of agriculture. It was established that although it is generally accepted that agriculture first developed within the Fertile Crescent (e.g. Allaby et al. 2009; Brown et al. 2010; Zeder 2008a; 2008b; 2009; Zeder & Smith 2009), how it spread from there is more controversial. The prevailing model for the spread is the 'Wave of Advance' (Ammerman & Cavalli-Sforza 1984), which predicts that agriculture spread via demic diffusion at an average rate of one-kilometre per year, from its homeland in Central Anatolia (ibid.: 68). Ammerman and Cavalli-Sforza (1984) originally applied the Wave of Advance only to the southeast–northwest spread of agriculture across Europe. It has subsequently been applied to account for the spread of agriculture across Central Asia by Colin Renfrew (1987; 1989), but this has never been explicitly tested.

The Wave of Advance is not without its critics. In particular, scholars (e.g. Zvelebil 1986; 1993; 1998a; 1998b; 2000a; 2000b; 2002; Zvelebil & Rowley-Conwy 1984; Zvelebil & Zvelebil 1988; Dennell 1992) have stressed the role of indigenous hunter-

gatherer populations in the spread and development of food production. Furthermore, Ammerman and Cavalli-Sforza (1984) originally applied the Wave of Advance only to the southeast–northwest spread of agriculture across Europe. And although it has subsequently been applied to the eastward spread of agriculture across Central Asia by Colin Renfrew (1987) and Peter Bellwood (2002), this has never been tested.

Objective two was achieved by conducting a review of the published material on the Neolithic of Iran and neighbouring regions. The history of archaeological investigation in Iran has been sporadic (cf. Niknami 2000). In the chaos that ensued after the Islamic Revolution of 1979, all archaeological activities in Iran were indefinitely interrupted, and the situation did not improve until the founding of the Iranian Cultural Heritage Organisation (ICHO) in 1985 (Alizadeh 2004: xxxi; Azamoush & Helwing 2005: 192). The activities of the ICHO since 1990 have included the resumption of problem-based archaeological research, the registration of archaeological sites and monuments, the assignment of guards to protect archaeological sites, and the opening up of Iran to foreign archaeologists working in conjunction with Iranian teams (http://en.icar.ir/documents/document/0/11587/ICAR.aspx). For example, more than 250 field expeditions were undertaken in Iran between March 2005 and March 2006, including a dozen foreign-Iranian joint missions since 2000 (Azamoush & Helwing 2005: 192). Unfortunately, the present political unrest in Iran means that access to foreigners is currently once more restricted, and a number of archaeological projects have been put on hold.

As a result of the disjointed history of archaeological research in Iran, there exist large gaps in our knowledge of the Iranian Neolithic. Most of our information comes from sites in the Central Western Iran (e.g. Sarab, Asiab & Ganj Dareh) and the southwestern lowlands (e.g. Ali Kosh, Chogha Bonut, Tall-e Mushki), while other areas of Iran – particularly southern and northeastern Iran – although potentially important have seen little archaeological excavation (Hole 2004). Consequently, the excavated sites reviewed in this research were principally located in the Zagros Mountain valleys, and the Deh Luran and Susiana lowland plains, and further research in other parts of Iran is needed to establish whether the concentration of

Early Neolithic sites in this region is due to actual historical processes, or the result of limited archaeological research elsewhere in Iran. These limitations aside, there does appear to be a number of shared traits between the sites, including the location of sites in areas where dry farming was possible, an economy based on agropastoralism and supplemented by foraging and hunting, the use of mudbrick or *pisé* architecture, the trading of obsidian, and as of the start Middle Neolithic period (ca. 6500 BC) a shared Neolithic 'software' ceramic tradition. However, there are also important difference including the emphasis placed on different species of domesticated and wild animals and plants, how the settlements were organized and individual buildings divided, and the level of trade in non-local goods that the inhabitants of the site participated in. These contrasts suggest that even if the technology of early farming was shared, how it was used and adapted varied regionally, presumably as a result of both environmental and cultural choices.

Objective three involved the study of published ^{14}C determinations for Neolithic sites in Iran and neighbouring regions. Many of the ^{14}C dates for Iranian sites are not calibrated, and those that are, have not been calibrated with the most recent calibration curve IntCal 09 (Reimer et al. 2009). Consequently, all of the ^{14}C dates utilized in this research were calibrated using the calibration software program OxCal (Bronk Ramsey 2009). ^{14}C datasets may be "significantly weakened by questionable dates and/or questionable associations between dated samples, and the archaeological phenomena they are intended to represent" (Pettit et al. 2003: 1685). To avoid this scenario, in this research the chronometric hygiene of all the ^{14}C dates was rigorously assessed, and only those that were considered to be 'clean' (i.e. of 'acceptable' or 'reliable' hygiene) were used for subsequent analysis.

To examine the spatial and temporal distribution of Neolithic sites in Iran and neighbouring regions, the earliest 'clean' ^{14}C dates for each site was plotted onto a map of Central and South Asia. A map was also produced using the earliest ^{14}C date for each site regardless of its hygiene, in order to emphasise the need to employ stringent chronometric hygiene evaluation. The resulting maps showed a wide discrepancy. The site distribution on the map of the 'uncleaned' dates implied that the Neolithic of Iran began some 1000 years earlier than was indicated by the clean dates, and that there were three initial centres, central western Iran,

southwestern Iran, and the Caspian Sea plains. In comparison, the distribution of the 'clean' dates evidences only one early centre of agriculture in the Central western Zagros, and the development of the Neolithic sites in southwestern Iran and the Caspian Sea Plains was a subsequent development. The differences between the two sets of maps, emphasizes the importance of evaluating the chronometric hygiene of a ^{14}C determination or date set before analysing it further; to not do so can result in the inclusion of erroneous ^{14}C determinations in the analysis, potentially creating highly misleading results.

Charting the spread of the Neolithic in Iran, the distribution of the 'clean' dates shows a disjointed pattern. The earliest Neolithic sites were concentrated in the central Zagros region, followed by the appearance of settlements in the southwestern lowland around a thousand years later. Mehrgarh in Baluchistan was reputedly also occupied during this period, but there is a problem with the ^{14}C dates and the site is probably actually early seventh millennium (Jarrige 2000: 282). Later, sites appear further south on the Marv Dasht and Mamasani Plains, to the northwest in the Ushnu-Solduz Valley, and in southern Turkmenistan at Jeitun. However, it is not until the late sixth millennium BC that the first Neolithic sites are attested on the Central Iranian Plateau. This is not the pattern that would be expected if farming had spread across Central Asia by a wave of advance as Colin Renfrew (1987; 1989) suggested. The later would have resulted in a clinal pattern, with the oldest sites situated in central western Iran, closest to the homeland of agriculture in the Near East, and the youngest sites lying in the west. Instead, the distribution of Neolithic settlements in Iran is more in accordance with the model of 'leapfrog' colonization that has been described by van Andel and Runnels (1995) and Sherratt (1980; 2003).

Objective five was achieved by analysing the results of recent archaeological research projects on the Tehran, Qazvin and Kashan Plains, in conjunction with my own settlement survey on the Kashan Plain. Archaeological projects on the Central Plateau within the last decade include Hassan Fazeli's and Robin Coningham's work on the Tehran Plain, involving excavations at Cheshmeh Ali (Fazeli et al. 2004) and Tepe Pardis (Coningham 2004; 2006; Fazeli et al. 2007; Fazeli et al. 2009), and three seasons of settlement survey (Coningham et al. 2003; 2004; 2006); Fazeli and colleagues excavations on the Qazvin Plain at Zagheh, Tepe Ebrahim Abad and

Chahar Boneh (Fazeli et al. 2005; 2009), and settlement survey; and Malek Shahmirzadi's (2002; 2003; 2004; 2006a; 2006b) excavation of the North Mound at Tepe Sialk on the Kashan Plain. The most recent work to date has been by a joint Irano-British project between the University of Tehran, ICHTO and Durham University, of which I was a member, and has involved excavations at Sialk North and Ghabristan, on the Kashan Plain.

However, despite extensive archaeological investigation, including *qanat* survey specifically designed, and proven (cf. Coningham et al. 2004), to compensate for alluvial deposition restricting the archaeological visibility of prehistoric sites, no Early Neolithic (ca. 8000-6500 BC) sites were found. Rather, it would seem that settlements did not become established on the Central Plateau until the Middle to Late Neolithic period (ca. 6500-5500 BC), for which they are attested at Tepe Pardis, Cheshmeh Ali and Sialk North. In conjunction with the first appearance of settlements on the Central Plateau, is evidence of water manipulation and/or irrigation agriculture. The implication, then, is that settlement was not possible on the Central Plateau, until humans had developed the technology to manipulate local water sources. This is attested by the location of the sites, with all of the longest lived sites located either next to permanent water sources (e.g. the spring at Cheshmeh Ali; the palaeochannels at Sialk & Mafinabad) or in areas where they could control the local water supply (e.g. the canal at Tepe Pardis &, possibly, Sialk North).

Comparison of the regional distribution of settlement on the Tehran, Qazvin and Kashan Plains shows that settlement patterns varied locally, and were distinct to each plain. While on the Tehran Plain there was an efflorescence of sites in the Transitional–Early Chalcolithic period (ca. 5500-4000 BC), followed by a decline in number during the Mid–Late Chalcolithic periods (ca. 4000-3000 BC); on the Qazvin Plain the present evidence[1] indicates that there were only a limited number of sites occupied during the Late Neolithic–Early Chalcolithic (ca. 5500-4000 BC) period, following which there was a hiatus in settlement until the Late Chalcolithic (ca. 3700-3000 BC) settlement at Ghabristan. Meanwhile, on the Kashan Plain, the settlement pattern was much more agglomerated, with the majority of the plain's population

[1] Although Fazeli's 2003 settlement survey on the Qazvin Plain identified 23 'new' archaeological sites, no chronological information is currently available for these sites (Fazeli et al. 2009: 1-2).

concentrated at Sialk North during the Late Neolithic to Transitional Chalcolithic (6200-4300 BC), and then, after a short hiatus, at Sialk South for the remainder of the Chalcolithic period (ca. 4300-3000 BC).

Environmental factors probably contributed to the differences in settlement patterns between the three plains. The Kashan alluvial plain is much smaller than that of the Tehran and Qazvin plains, and this may partially explain the agglomeration of people next to the river at Sialk throughout the Late Neolithic (ca. 6200-5500 BC) and Chalcolithic periods (ca. 5500-3000 BC). However, social and cultural preferences cannot be ignored, and probably also contributed to the differences in regional settlement patterns. Population increase may also have played a role. Fazeli has suggested that the growth in settlement numbers during the Early–Mid Chalcolithic period (ca. 4300-3700 BC) on the Central Plateau was due to increasing social differentiation and economic change, with the development of full-time specialization, long-distance trade and ideological domination (Fazeli 2001: 291; Fazeli et al. 2007:7; 2010: 87). He argues that growing specialization in craft production is evidenced by the replacement of Neolithic Sialk I Ware, by the finer, more standardized 'Cheshmeh Ali' Ware of the Transitional Chalcolithic, which was mass produced by part or full-time specialists (Fazeli 2001: 290; Fazeli et al. 2010: 87, 108-9). Further evidence of increasing craft specialization and standardization during the Chalcolithic, is found at the specialized pottery production centre of Tepe Pardis, at which mass production is evidenced by the presence of a slow wheel dating to ca. 4800 BC, and the use of well-controlled, multi-chambered kilns in the firing process (Fazeli et al. 2010: 108-9).

One important aspect of prehistoric settlement on all three plains is the instability of settlement occupation. Fluctuations in the abandonment of sites, emergence of new sites, and increases/decreases of population were regularly repeated on the Tehran, Qazvin and Kashan Plains throughout the Mid-Late Neolithic (ca. 6500-5500 BC) and Chalcolithic periods (ca. 5500-3000 BC). On the Tehran Plain, for example, Cheshmeh Ali and Sadeghabadi emerged as large autonomous settlements during the Transitional-Early Chalcolithic periods (ca. 5500-4000 BC), but waned in importance during the Middle Chalcolithic (4000-3700 BC), while the nearby site of Mafinabad expanded to five hectares (Fazeli 2001: 293). Mafinabad itself, then

decreased in size during the Late Chalcolithic (ca. 3700-3000 BC), while Maymonabad, situated only two kilometres away, emerged as the new major settlement on the Tehran Plain. Very few long-lived settlements are known from the Central Plateau. The exceptions are Cheshmeh Ali, Tepe Pardis and Mafinabad on the Tehran Plain; and Tepe Sialk on the Kashan Plain, all of which are associated with permanent water sources. A spring emerges at Cheshmeh Ali; Mafinabad and Tepe Sialk are both associated with relic palaeochannels; and at Tepe Pardis there is direct evidence, in the form of an artificial water channel, of the earliest use of irrigation technology in Iran (Gillmore et al. 2007; 2009; 2011).

The distribution of Late Neolithic–Chalcolithic sites on the Tehran, Qazvin and Kashan Plains, the fact that the majority of the sites were short lived, and that the few sites that were long-lived were all located in areas with permanent water supplies and/or the potential for water manipulation, suggests that the location and longevity of late prehistoric settlements on the Central Plateau was highly dependent on the availability and accessibility of water. The earliest known evidence of irrigation agriculture in the Near East comes from Chogha Mami, northeastern Iran, where two artificial water channels have been excavated dating to the Samarran phase (ca. 6000-5400 BC) (Oates 1969; Oates & Oates 1976). It is suggested that irrigation technology – or the knowledge of it – spread from here to the Deh Luran Plain (Hole 1977; Neely & Wright 1994) and the Tehran Plain by the late sixth millennium BC (Gillmore et al. 2007; 2009; 2011); although there is no tangent evidence of irrigation technology on the Deh Luran plain during this period (Wilkinson 2003: 74). The absence of prehistoric settlement on the Central Plateau until the late sixth millennium BC, when the first evidence of irrigation technology is also attested, suggests that agriculture on the Central Plateau was highly dependent on the management and manipulation of water, and may not have been possible before the technology to do this was known.

In terms of how the Neolithic–Chalcolithic period settlement pattern of the Central Plateau fits with the Wave of Advance model for the spread of agriculture across Central Asia, the answer is, as with the ^{14}C dates from Neolithic sites from the rest of Iran, not well. Rather than the steady spread of agriculture that is predicted by the Wave of Advance, the Early Neolithic (ca. 8000-6500 BC) settlement of Iran was

patchy and piecemeal, with the settlement of the Central Plateau greatly retarded compared to that of other regions such as the Central Zagros. Indeed, rather than a 'Wave of Advance', the distribution of early farming sites in Iran, particularly that on the Central Plateau, better described by van Andel and Runnel's 'leapfrog' model, in which niche environments are targeted by early farmers, with other, less attractive areas, in-filled later when the appropriate technology (in this case water manipulation) was available or all other areas had been settled.

8.1. Limitations of this research & future prospects

A problem with linking this thesis to a current project is that more results are coming out all the time, and our understanding of prehistoric settlement on the Kashan Plain is continually evolving. This thesis, thus, presents a summary of the evidence as it stands at present. However, it is anticipated that within a few years time, when all the information from Sialk has been published, more evidence will be available, to either substantiate or refute the interpretations made here. In this vein, work is currently being prepared for publication on the micromorphology of Sialk (Kourampas et al. in press), and a geomorphological study of the Tehran Plain has recently been published (Gillmore et al. 2011). Studies such as these, in which a combined approach is taken, and micromorphological, geomorphological and archaeological data are combined, are important in elucidating further information on the development of farming and settlement in the Central Plateau during the Neolithic and Chalcolithic periods, and it is anticipated that more such studies will be conducted in the future.

The *qanat* survey of the Kashan Plain in 2009 was intended to be the first of two seasons of survey on the plain. However, political circumstances prevented a team from returning in 2010, and subsequently the survey results with which this research has had to work have been rather limited. Due to the nature of the political climate in Iran, the survey area was restricted to certain areas of the Kashan Plain, and it was not possible to survey other areas of potential interest, including the foothills of the Markazi Mountains from where members of the ICHTO have reported an Early Neolithic site. The areas of the Kashan Plain that were surveyed were all active

agricultural lands, and this may have affected the visibility of prehistoric artefacts in the spoil heaps around the *qanat* holes, many of which had been destroyed by ploughing. It was apparent that due to the widespread adoption of electric-powered water pumps many of the qanat systems in the study region were falling out of use and in need of repair, or had been abandoned all together and infilled. This emphasises the importance of doing *qanat* survey to identify prehistoric sites (a technique which has been proven to work on the Tehran Plain; cf. Coningham et al. 2004; 2006), now, before this valuable means of accessing an inverted stratigraphy of the plain is destroyed.

The Kashan Plain is flanked by the Markazi Mountains and foothills to the west, and desert to the north and northeast. However, apart from the Sialk Reconsiderations Project's limited geoarchaeological survey of some of the intermountain valleys of the Markazi (Danti 2006), no information is available about the settlement pattern of the mountain regions or desert for the Neolithic-Chalcolithic period (ca. 8000-3000 BC). This is despite the fact that both regions would have been at least suitable for pastoralism during prehistory (Fazeli 2001: 296), and the important mineral resources of the mountains, such as copper, which are known to have been exploited at Sialk.

Thus, future work could involve transect settlement survey in the intermountain valleys of the Markazi, as well as in the deserts to the north and northeast of Kashan. In terms of the plain itself, further *qanat* survey in different areas of the plain is needed. Collectively, these settlement surveys could have the potential to provide more evidence of prehistoric plant and animal raising in the region, and to further elucidate our understanding of the relationships between societies during the Neolithic and Chalcolithic periods. Survey is also necessary in the Kashan Plain due to the rapidity with which this archaeological resource is being destroyed. As on the Central Plateau in general, archaeological sites on the Kashan Plain are under threat from increased population, industrial activities, sewage, mechanized cultivation and illegal excavation (Fazeli 2001; Coningham et al. 2004), and conducting archaeological research in the region is of the upmost importance.

8.2. Conclusion

In terms of the overall results of this research, this study has shown that although Early Neolithic sites (ca. 8000-6500 BC) are known from central western and southwestern Iran, prehistoric occupation of the Central Plateau is not evident until the Middle-Late Neolithic periods (ca. 6500-5500 BC). Once settlement does emerge on the Central Plateau, the distribution of sites varied regionally. On the Tehran Plain there was a period of rapid growth in settlement from the Late Neolithic period (3 sites) through the Transitional Chalcolithic (9 sites) and Early Chalcolithic periods (16 sites), which Fazeli (2001; Fazeli et al. 2007; 2010) attributes to population expansion and increasing craft specialization and industrialization. This rapid growth was followed by a period of apparent population decline during the succeeding Middle Chalcolithic (8 sites) and Late Chalcolithic (6 sites) periods, which is associated with the de-specialization of some craft industries, such as stone tool production, which reverted from centralized to household production (Fazeli 2001: 291). The Qazvin Plain has not been as well studied as the Tehran Plain, but present evidence suggests that there was little growth in the number of settlements between the Late Neolithic (2 sites) and Transitional Chalcolithic (3 sites) periods, following which only Zagheh was occupied during the Early Chalcolithic (ca. 4300-4000 BC), and no settlements are known from the Middle Chalcolithic period (ca. 4000-3700 BC). The plain is once more settled in the Late Chalcolithic (ca. 3700-3000 BC) with the occupation of Ghabristan. Meanwhile, on the Kashan Plain settlement seems to have been concentrated on the North Mound (Late Neolithic-Transitional Chalcolithic) and then, after a short hiatus, the South Mound (Early Chalcolithic-Bronze Age) at Sialk, with few confirmed prehistoric settlements known from elsewhere. The exception is the Late Neolithic site of Ghabristan (pp. 373-4), but the absence of architecture at this site and the abundance of lithics, particularly obsidian pieces, imply that the site was probably a specialist camp used to manufacture lithics, and that it was not permanently occupied.

What is a common feature of all three plains is the short duration of the occupation of most settlements, with the majority only being occupied for one or two cultural periods, e.g. Ghabristan on the Kashan Plain; Zagheh, Ghabristan, Tepe Chahar Boneh, Ebrahim Abad and Cheshmeh Bolbol on the Qazvin Plain; and Parandak,

Poeinak, Kara Tepe; Mortezagerd, Maymonabad, Tepe Sialk, Tepe Surk Khub, Ismailabad, Barkin, Tepe Chakhmah and Fakhrabad on the Tehran Plain. The sites that were long lived are all associated with permanent water sources. Cheshmeh Ali lies next to the exit of a spring; evidence of palaeochannels has been found at both Sialk and Mafinabad; and at Tepe Pardis there is evidence, in the form of a human-made channel, of water manipulation and/or irrigation agriculture. Tentative evidence of water manipulation is also reported from Jeitun (Harris 2010b) and Sialk North (Kourampas et al. in press), but this awaits further confirmation. The implication, then, is that permanent settlement was not possible on the Central Plateau until the development of some form of water manipulation, although even with this technology, the braided channel systems of the Plateau meant that many sites were still only short-lived. For example, there is evidence that Mafinabad was abandoned as a result of the local water channel shifting (Gillmore et al. 2007: 299).

It has been suggested that irrigation technology spread to Iran from central eastern Mesopotamia (Hole 1977; Gillmore et al. 2011), where evidence of irrigation agriculture is found at the mid-sixth millennium site of Choga Mami (Oates 1969; Oates & Oates 1976; Helbaek in Oates & Oates 1976). However, to date, there is no tangible evidence for this link, and further investigation is needed before it can be substantiated. What is apparent is that even if the technology itself was spreading, whether it was for dry or irrigated agriculture, how it was adapted and used regionally varied, as the different settlement distribution patterns on the Qazvin, Kashan and Tehran Plains attests to.

In terms of the wider-reaching impact of this research, it indicates that the application of a wave of advance model to account for the spread of agriculture in Iran, and central and south Asia as a whole, is inappropriate. The distribution of Early Neolithic sites (ca. 8000-6500 BC) in Iran and neighbouring regions does not follow a clinal spread, with the oldest sites concentrated in central western Iran and the youngest sites occurring in eastern Iran. Rather, the pattern is much more dispersed with, for example the sites of Jeitun, Turkmenistan and Mehrgarh, Baluchistan being occupied long before settlement began on the Central Plateau. Recent research on the Central Plateau suggests that instead, early farmers were highly selective in the areas that they choose to settle, selecting only ‘optimal areas’ with high soil fertility

and moisture content (Sherratt 1980: 314). The spread of agriculture, then, was more like the children's game of 'leapfrog' rather than a wave (Fig. 2.14) with early farming settling only in the most suitable areas, and leaving large gaps in between (van Andel & Runnels 1995; Sherratt 1980; 2003). It was not until later developments, such as the technique of water management and manipulation, that farming groups were able to settle in more hostile regions, such as the Central Plateau, which they would originally have found difficult, if not impossible, to survive in. The application of 'one model fits all' to account for the spread of agriculture in both Europe and Central and South Asia as applied by Renfrew (1987), therefore clearly does not fit, and more work needs to be undertaken in order to establish where and how the founders of Mehrgarh came from.

References

Achilli, A., Olivieri, A., Pala, M., Metspalu, E., Fornariono, S. et al. 2007 Mitochondrial DNA variation of modern Tuscans supports the Near Eastern origins of Etruscans*, American Journal of Human Genetics* **80**, pp. 759-68.

Afary, J., Avery, P.W., & Mostofi, K. 2006. Iran. [online] Available at http://www.britannica.com/EBchecked/topic/293359/Iran. Accessed: 23/09/11/

Aitken, M. J., 1990. *Science-Based Dating in Archaeology.* London: Longman.

Alizadeh, A., 1997. Excavations at Chogha Bonut: the earliest village in Susiana. *The Oriental Institute News and Notes.* [online] Available at www.oi.uchicago.edu/research/pubs/nn/spr97_alizadeh.html. Accessed 23/09/11.

Alizadeh, A., 2003. *Excavations at the Prehistoric Mound of Chogha Bonut, Khuzestan, Iran.* Chicago: The Oriental Institute of the University of Chicago.

Alizadeh, A., ed., 2006. *The Origins of State Organization in Prehistoric Highland Fars, Southern Iran: Excavations at Tall-e Bakun.* Chicago: The Oriental Institute of the University of Chicago.

Alizadeh, A., 2009. Čogā Bonut. [online] Available at http://www.iranicaonline.org/articles/coga-bonut-archaeological-site Encyclopaedia Iranica. Accessed 23/09/11.

Alizadeh, A., Zeidi, M., Askari, A., Niakan, L. & Atabaki, A., 2005. Iranian Prehistoric Project: excavations at Tall-e Bakun A and B and Nushki: reconstruction of the prehistoric enviornment in Marvdasht, *Oriental Institute Annual Report 2003-2004.* [online] Available at oi.uchicago.edu/oi/AR/03-04/03-04_AR_TOC.html. Accessed 22/09/11.

Allaby, R.G., Fuller, D.Q. & Brown, T.A. 2008. The genetic expectations of a protracted model for the origins of domesticated crops, *Proc. of the Nat. Acad. of Sci. (USA)* **105**(37), pp. 13982-6.

Ammerman, A.J. & Cavalli-Sforza, L.L., 1971. Measuring the rate of spread of early farming in Europe, *Man* **6**, pp. 674-88.

Ammerman, A.J. & Cavalli-Sforza, L.L., 1973. A population model for the diffusion of early farming in Europe. In C. Renfrew (ed.), *The Explanation of Culture Change: Models in Prehistory*. London: Duckworth, pp. 335-58.

Ammerman, A.J. & Cavalli-Sforza, L.L., 1979. Model for the spread of agriculture in Europe. In C. Renfrew & K.L. Cooke (eds), *Transformations: Mathematical Approaches to Culture Change*. London: Academic Press, pp. 275-93.

Ammerman, A.J. & Cavalli-Sforza, L.L. 1984. *The Neolithic Transition and the Genetics of Population Growth in Europe.* Princeton: Princeton University Press.

Andel, van T.H. & Runnels, C.N., 1995. The earliest farmers in Europe, *Antiquity* **69**, pp. 481-50.

Anderson, A., 1991. The chronology of the colonization in New Zealand. *Antiquity* **65**, pp. 767-95.

Anderson, S.C., 1968. Zoogeographic analysis of the lizard fauna of Iran. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 305-71.

Anthony, D.W., 1990. Migrations in archaeology: the baby and the bathwater, *American Anthropologist* **92**(4), pp. 895-914.

Aoki, K., Shida, M. & Shigesada, N., 1996. Travelling wave solutions for the spread of farmers into a region occupied by hunter-gatherers, *Theoretical Population Biology* **50**(1), pp. 1-17.

Azamoush, M. & Helwing, B., 2005. Recent archaeological research in Iran – Prehistory to Iron Age, *Archaologische Mitteilungen aus Iran und Turan* **37**, pp. 189-246.

Arias, P., 2004. Comment in Rowley Conwy, *Current Anthropology* **45**(S4), pp. 99-100.

Badr, A., Müller, K., Schüfer-Pregl, R., El Rabey, H., Effgent, S. et al. 2000. On the origin and domestication history of barley (*Hordeum vulgare*), *Molecular Biology and Evolution* **17**(4), pp. 499-510.

Badripur, H., 2004. *Country Pasture/Forage Resource Profiles: Islamic Republic of Iran. Food and Agriculture Organization of the United Nations*. [online] Available at http://www.fao.org/ag/AGP/agpc/doc/Counprof/Iran/Iran.htm#broad. Accessed 25/10/11.

Baille, M.G.L., 1990. Checking back on an assemblage of published ^{14}C dates, *Radiocarbon* **32**(3), pp. 361-66.

Balaresque, P., Bowden, G.R., Adams, S.M. , Leung, H.-Y., King, T.E. et al., 2010. A predominantly Neolithic origin for European paternal lineages, *Public Library of Science Biology* **8**(1), pp. 1-10.

Ball, W., 1982. *Archaeological Gazetteer of Afghanistan*. Paris: Research Publications on Civilizations Sythesis No. 8. A.D.P.F.

Balter, M., 2007. Seeking agriculture's ancient roots, *Science* **316**, pp. 1830-5.

Bar-Yosef, O., 1998a. The Natuifan culture in the Levant, thresholds to the origins of agriculture, *Evolutionary Anthropology* **6**(5), pp. 159-77.

Bar-Yosef, O., 1998b. On the nature of transitions: the Middle to Upper Palaeolithic and the Neolithic Revolution, *Cambridge Archaeological Journal* **8**(2), pp. 141-63.

Bar-Yosef, O., 2000b. The context of animal domestication in southwestern Asia. In M. Mashkour, A.M. Choyke & H. Buitenhuis (eds), *Archaeozoology of the Near East IV*. Groningen: ARC-Publications, pp. 185-95.

Bar-Yosef, O. & Belfer-Cohen, A., 1991. From sedentary hunter-gatherers to territorial farmers in the Levant. In S. Gregg (ed.), *Between Bands and States*. Carbondale: Southern Illinois University, pp. 181-202.

Bar-Yosef, O. & Belfer-Cohen, A., 2002. Facing environmental crisis. Societal and cultural changes at the transition from the Younger Dryas to the Holocene in the Levant. In R.T.J. Cappers & S. Bottema (eds), *The Dawn of Farming in the Near East*. Berlin: Ex Oriente, pp. 55-66.

Bar-Yosef, O. & Meadow, R.H., 1995. The origins of agriculture and animal husbandry in the Near and Middle East. In T.D. Price & A.G. Gebauer (eds), *Last Hunters, First Farmers: New Perspectives on the Prehistoric Transition to Agriculture*. Santa Fe: SAR Press, pp. 39-94.

Barbujani, G. & Bertorelle, G., 2001. Genetics and the population history of Europe, *Proc. of the Nat. Acad. of Sci.(USA)* **98**, pp. 22-5.

Barbujani, G., Bertorelle, G. & Chikhi, L. 1998. Evidence for Paleolithic and Neolithic gene flow in Europe, *American Journal of Human Genetics* **62**, pp. 488-92.

Barbujani, G. & Chikhi, L. 2006. Population genetics: DNAs from the European Neolithic, *Heredity* **97**, pp. 84-5.

Barker, H., 1970. Critical assessment of radiocarbon dating, *Philosophical Transactions of the Royal Society of London Series A* **269**(1193), pp. 37-45.

Battaglia, V., Fornarno, S., Al-Zahery, N. Olivieri, A., Pala, M. et al., 2009. Y-chromosomal evidence of the culture diffusions of agriculture in southeastern Europe, *European Journal of Human Genetics* **17**, pp. 820-30.

Beaumont, P., 1972. Alluvial fans along the foothills of the Elburz Mountains, Iran, *Palaeogeography, Palaeoclimatology, Palaeoecology* **12**(4), pp. 251-73.

Beaumont, P., 1974. Water resource development in Iran, *The Geographical Journal* **140**, pp. 418-31.

Beaumont, P., 1989. *Drylands. Environmental Management and Development.* London & New York: Routledge.

Beale, T.W., 1973. Early trade in highland Iran: a view from a source area, *World Archaeology* **5**, pp. 133-48.

Belfer-Cohen, A. & Bar-Yosef, O., 2000. Early sedentism in the Near East: a bumpy road to village life. In K. Kujit, (ed.), *Life in Neolithic Farming Communities: Social Organization, Identifty and Differentiation*. New York: Plenum Publishers, pp. 19-37.

Bellwood, P., 2002. Farmers, foragers, languages, genes: the genesis of agricultural societies. In P. Bellwood & C. Renfrew (eds), *Examining the Farming/Language Dispersal Hypothesis*. Cambridge: McDonald Institute of Archaeological Research, pp. 17-30.

Bellwood, P., 2005. *First Farmers: The Origins of Agriculture.* Oxford: Blackwell Publishing.

Bellwood, P., 2009. The dispersals of established food-producing populations, *Current Anthropology* **50**(5), pp. 621-6.

Bellwood, P. & Renfrew, C. (eds), 2002. *Examining the Farming/Language Dispersal Hypothesis*. Cambridge: McDonald Institute of Archaeological Research.

Bender, B., 1978. Gatherer-hunter to farmer: a social perspective, *World Archaeology* **10**(2), pp. 204-22.

Bender, B., 1985. Emergent tribal formations in the American midcontinent, *American Antiquity* **50**(1), pp. 52-62.

Berger, R. & Protsch, R., 1973. The domestication of plants and animals in Europe and the Near East, *Orientalia* **42**, pp. 214-27.

Bernbeck, R., 2010a. Surface survey at Tol-e Bāsi. In Pollock, S., Bernbeck, R. & Abdi, K. (eds), 2010. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut, pp. 21-30.

Bernbeck, R., 2010b. The Neolithic pottery. In Pollock, S., Bernbeck, R. & Abdi, K. (eds), 2010. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut, pp. 65-151.

Bettinger, R., Richerson, P. & Boyd, R., 2009. Constraints on the development of agriculture, *Current Anthropology* **50**(5), pp. 627-32.

Binford, L.R., 1968. Post-Pleistocene adaptions. In S.R. Binford & L.R. Binford (eds), *New Perspectives in Archaeology*. Chicago: Aldine, pp. 313-41.

Binford, L.R., 2001. *Constructing Frames of References: An Analytical Method for Archaeological Theory Building Using Hunter-Gatherer and Environmental Data Sets.* Berkley (CA): University of California Press.

Bird, M.I., Hope, G. & Taylor, D., 2004. Populating PEP II: the dispersal of humans and agriculture through Austral-Asia and Oceania, *Quaternary International* **118**/**119**, pp. 145-63.

Blumer, M.A., 1992. Independent inventionism and recent genetic evidence on plant domestication, *Economic Botany* **46**, pp. 98-111.

Blumer, M.A., 1996. Ecology, evolutionary theory and agricultural origins. In D.R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism*. London: UCL Press, pp. 25-69.

Blumer, M.A. & Byrne, R., 1991. The ecological genetics of domestication and the origins of agriculture, *Current Anthropology* **32**(1), 23-54.

Bobek, H., 1968. Vegetation. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 280-93.

Bocquet-Appel, J.-P., 2011. The agricultural demographic transition during and after the agriculture inventions, *Current Anthropology* **52**(S4), pp. 497-510.

Bocquet-Appel, J.-P., Naji, S., Vander Linden, M. & Kozlowski, K., 2009. Detection of diffusion and contact zones of early farming in Europe from the space-time distribution of ^{14}C dates, *Journal of Archaeological Science* **36**, pp. 807-20.

Bogucki, P., 2007. Europe/Neolithic. In D.M. Pearsall (ed.), *Encyclopaedia of Archaeology*. Oxford: Elsevier.

Böhner, U. & Schyle, D., 2008. Radiocarbon CONTEXT database 2002-2006. [online] Available at http://context-database/uni-kolean.de/ [doi:10.1594/GFZ.CONTEXT.Ed.1] Accessed 20/09/11.

Bökönyi, S., 1969. *The animal remains from four sites in the Kermanshah valley, Iran: Asiab, Sarab, Dehsavar and Siahbid.* Oxford: Oxford University Press.

Bökönyi, S., 1977. *Animal Remains from the Kermanshah Valley, Iran.* Oxford: Oxford University Press.

Bökönyi, S., 1997. Zebus and Indian wild cattle, *Anthropozoologica* **25**/**26**, pp. 647-54.

Bökönyi, S., Braidwood R.J. & Reed, C.A., 1973. Early animal domestication dated? *Science* **182**(4117), p. 1161.

Boric, D., 2005. Deconstructing essentialisms: unsettling the frontiers of the Mesolithic-Neolithic Balkans. In D. Bailey & A. Whittle (eds), *Unsettling the Neolithic*. Oxford: Oxbow, pp. 16-32.

Boserup, E., 1965. *The Conditions of Agricultural Growth: The Economics of Agrian Change Under Population Pressure.* London: Ulwin.

Bowen-Jones, H., 1968. Agriculture. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 565-98.

Bowman, S., 1990. *Interpreting the Past: Radiocarbon Dating.* London: British Museum Publications.

Bowman, S. & Leese, M.N., 1995. Radiocarbon calibration: current issues, *American Journal of Archaeology* **99**(1), pp. 102-5.

Bradley, D.G. & Magee, D.A., 2006. Genetics and origins of domestic cattle. In Zeder, M.A., Emshwiller, E., Smith, B.D. & Bradley, D.G. (eds), *Documenting Domestication: New Genetic and Archaeological Paradigms.* Berkley: University of California Press, pp. 317-28.

Bradley, D.G., MacHugh, D.E., Loftus, R.T. Cunningham, P. Bradgley, D.G., 1994. Zebu- taurine variation in Y chromosome DNA: a sensitive assay for genetic introgression in west African trypanotolerant cattle populations, *Animal Genetics* **25**, pp. 7-12.

Bradley, D.G., MacHugh, D.E., Cunningham, P. & Loftus, R.T., 1996. Mitrochondrial diversity and the origins of African and European cattle, *Proc. of the Nat. Acad. Sci. (USA)* **76**, pp. 1967-71.

Bradley, R., 1984. *The Social Foundations of Prehistoric Britain.* New York: Longman.

Bramanti, B., Thomas, M.G., Haak, W., Unterlaender, M., Jones, P. et al., 2009. Genetic discontinuity between local hunter gatherers and central Europe's first farmers, *Science* **326**, pp. 137-40.

Braidwood, R.J., 1951. *Prehistoric Man.* Chicago: Chicago Natural History Museum.

Braidwood, R.J., 1960a. The agricultural revolution, *Scientific American* **203**(3), pp. 130-53.

Braidwood, R.J., 1960b. Seeking the world's first farmers in Persian Kurdistan: a full scale investigation of prehistoric sites near Kermanshah, *Illustrated London News* **237**, pp. 695-97.

Braidwood, R.J., 1960c. Preliminary investigations concerning the origins of food production in Iranian Kurdistan, *Advancement of Science* **17**, pp. 214-18.

Braidwood, R.J., 1961. The Iranian Prehistoric project 1959-1960, *Iranica Antiqua* **1**, pp. 3-7.

Braidwood, R.J., 1983. The site of Jarmo and its architectural remains. In L.S. Braidwood et al. (eds.), *Prehistoric Archaeology Along the Zagro Flanks*. Chicago: The University of Chicago, pp. 155-209.

Braidwood, R.J. & Braidwood, L.S., 1950. Jarmo: a village of early farmers in Iraq, *Antiquity* **24**, pp. 189-95.

Braidwood, R.J. & Howe, B., 1960. *Prehistoric Investigations in Iraqi Kurdistan.* Chicago: University of Chicago Press.

Braidwood, R.J. & Willey, G.R. (eds), 1962. *Courses Towards Urban Life: Archaeological Considerations of Some Cultural Alternates.* Chicago: Aldine.
Braidwood, R.J., Howe, B. & Reed, C.A., 1961. The Iranian Prehistoric project, *Science* **133**, pp. 2008-10.
Braidwood, L.S., Braidwood, R.J., Howe, B., Reed, C.A., Watson, P.J. (eds), 1983. *Prehistoric Archaeology along the Zagros Flanks.* Chicago: The University of Chicago, Oriental Institute Publications.
Bronk Ramsey, C., 2009. Bayesian analysis of radiocarbon dates, *Radiocarbon* **51**(2), pp. 337-60.
Brookes, I.A., 1982. Geomorphological evidence for climate change in Iran during the last 20,000 years. In J.L. Bintliff & W. van Zeist (eds), *Palaeoclimates, Palaeoenvironment and Human Communities in the Eastern Mediterranean Region in Later Prehistory*. Oxford: B.A.R. International Series 133 (i & ii), pp. 191-228.
Brookes, I.A., 1989. *The Physical Geography, Geomorphology and Late Quaternary Histry of the Mahidasht Project Area, Qara Su Basin, Central West Iran.* Ontario: Royal Ontario Museum.
Brookes, I.A., Levine, L.D. & Dennel, R.W. 1982. Alluvial sequences in Central West Iran and implications for archaeological survey, *Journal of Field Archaeology* **9**, pp. 285-99.
Brown, T.A., Jones, M.K., Powell, W. & Allaby, R.G., 2008. The complex origins of domesticated crops in the Fertile Crescent, *Trends in Ecology and Evolution* **24**(2), pp. 103-10.
Buck, C. E., Cavanagh, W.G. & Litton, C.D., 1996. *The Bayesian Approach to Interpreting Archaeological Data.* Chichester: Wiley.
Buck, C.E., Litton, C.D. & Scott, E.M., 1994. Making the most of radiocarbon dating: some statistical considerations, *Antiquity* **68**, pp. 252-63.
Budja, M., 2004. Comment in Rowley-Conwy, *Current Anthropology* **45**(S4), pp. 100-1.
Burney, C.A., 1961. Excavations at Yanik Tepe, north-west Iran, *Iraq* **23**, pp. 138-53.
Burney, C.A., 1962. Excavations at Yanik Tepe, north-west Iran, *Iraq* **24**, pp. 134-49.
Burney, C.A., 1964. The excavations at Yanik Tepe, Azerbaijan, 1961: Third preliminary report, *Iraq* **26**, pp. 54-61.
Burney, C.A. & Lang, D.M., 1972. *The Peoples of the Hills*. New York: Praeger.
Caldwell, J.D., 1967. Tall-i Iblis, *Iran* **5**, pp. 144-6.
Candolle de, A., 1884. *Origin of Cultivated Plants,* Hamburg: Deutsch Press.
Cauvin, J., 2000. *The Birth of the Gods and the Origins of Agriculture.* Cambridge: Cambridge University Press.
Cauvin, J., 2001. Ideology before economy, *Cambridge Archaeological Journal* **11**(1), pp. 106-7.
Cavalli-Sforza, L.L., 1997. Genetic and cultural diversity in Europe, *Journal of Anthropological Research* **53**(4), pp. 383-404.
Charles, M. & Bogaard, A., 2010. Charred plants and macro-remains from Jeitun: Implications for early cultivation and herding practises in western Central Asia.

In D.R. Harris (ed.), *Origins of Agriculture in Western Central Asia*. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology, pp. 150-65.
Chikhi, L., Destro-Bisol, G., Pascali, V. & Barbujani, G., 1998. Clines of nuclear DNA markers suggest a largely Neolithic ancestry of the European gene pool, *Proc. of the Nat. Acad. Sci.* **95**(15), pp. 9053-8.
Chikhi, L., Nicholas, R.A., Barbujani, G. & Beaumont, M.A., 2002. Y-genetic data support the Neolithic demic diffusion model, *Proc. of the Nat. Acad. Sci.* **99**(17), pp. 11008-13.
Childe, V.G., 1925. *The Dawn Of European Civilization.* London: Kegan, Trench, Trübner & Co.
Childe, V.G., 1934. *New Light on the Most Ancient Near East.* London: Kegan Paul.
Childe, V.G., 1942. *What Happened in History.* Harmondsworth: Penguin Books.
Childe, V.G., 1952. *New Light on the Most Ancient East,* London: Routlege & Kegan Paul.
Childe, V.G., 1968. *The Dawn of European Civilization.* London: Routledge & Kegan Paul.
Clark, J.G.D., 1965a. Radiocarbon dating and the expansion of farming culture from the Near East over Europe, *Proceedings of the Prehistoric Society* **31**, pp. 57-73.
Clark, J.G.D., 1965b. Radiocarbon dating and the spread of the farming economy, *Antiquity* **39**, pp. 45-8.
Cohen, M.N., 1977. *The Food Crisis in Prehistory: Overpopulation and the Origins of Agriculture.* New Haven: Yale University Press.
Cohen, M.N., 2009. Rethinking the origins of agriculture, *Current Anthropology* **50**(5), pp. 591-5.
Colledge, S., 1998. Identifying pre-domestication cultivation using multivariate analysis. In A. Damania. J. Valkoun, G. Willcox & C. Quallset (eds), *The Origins of Agriculture and Plant Domestication*. Syria: ICARDA, pp. 121-31.
Colledge, S., 2002. Identifying pre-domestication cultivation using multivariate analysis: presenting the case for quantification. In R.T.J. Cappers & S. Bottema (eds), *Studies in Early Near Eastern Production, Subsistence, and Environment.* Berlin: Ex Oriente, pp. 141-52.
Colledge, S., Conolly, J. & Shennan, S., 2004. Archaeobotanical evidence for the spread of farming in the eastern Mediterranean, *Current Anthropology* **45**(S), pp. 35-59.
Coningham, R.A.E., Fazeli, H., Young, R.L. & Donahue,R.E., 2004. Location, location, location: a pilot survey of the Tehran plain, *Iran* **42**, pp. 1-24.
Coningham, R.A.E., Fazeli, H., Young, R.L., Gillmore, G.K., Karimian, H. et al., 2006. Socioeconomic transformations: settlement survey in the Tehran plain and excavation at Tepe Pardis, *Iran* **44**, pp. 33-62.
Coningham, R.A.E., Manuel, M. & Fazeli, H., in press. Socio-economic transformations on the Dasht-e-Kashan: excavations at Ghabristan.
Conklin, H.C., 1957. *Hanunoo Agriculture.* Rome: United Nations FAO.

Constantini, L., 1984. The beginning of agriculture in the Kachi Plain: the evidence of Mehrgarh. In B. Allchin (ed.), *South Asian Archaeology 1981*. Cambridge: Cambridge University Press, pp. 29-34.

Constantini, L. & Lentini, A., 2000. Studies in the vegetation history of Central Baluchistan, Pakistan, Palynological investigation at Mehrgarh. In M. Taddei & G.D. Marco (eds), *South Asian Archaeology 1997*. Rome: Istituto Italiano per l'Africa e l'Oriente, pp. 133-59.

Coon, C.S., 1951. *Cave Explorations in Iran, 1949.* Philadelphia: University Museum, University of Pennsylvania.

Coon, C.S., 1952. Excavation in Hotu Cave, 1951. A preliminary report, *Proceedings of the American Philosophical Society* **96**, pp. 231-49.

Coon, C.S., 1957. *The Seven Caves: Archaeological Explorations in the Middle East.* New York: Knopf.

Coon, C.S. & Ralph, E.K., 1955. Radiocarbon dates from Kara Kamar, Afghanistan, *Science* **122**(3176), pp. 921-22.

Coppa, A., Bondioli, L., Cucina, A., Frayer, D.W., Jarrige, C. et al. 2006. Early Neolithic tradition of dentistry, *Nature* **440**, pp. 755-6.

Crawford, V.E., 1963. Beside the Kara Su, *Bulletin of the Metropolitan Museum of Art* (April), pp. 263-73.

Cressey, G.B., 1958. Qanats, karez and foggaras, *Geographical Review* **48**, pp. 27-44.

Cruciana, F., Frattam, La R., Santolamazza, P., Sellitto, D., Pascone, R. et al., 2004. Phylogeographic analysis of haplogroup E3b (E-M215) Y-chromosomes reveals multiple migratory events within and out of Africa, *Journal Human Genetics* **74**, pp. 1014-22.

Cruciani, F., Fratta, La R., Tromvetta, B., Santolamazza, P., D. Sellitto et al., 2007. Tracing past human male movements in northern/eastern Africa and western Eurasia: new clues from Y-chromosomal haplogroups E-M78 and J-M12, *Mol. Biol. Evol*. **24**, pp. 1300-11.

Cucina, A. & Petrone, P., 2005. The 1997-2000 field seasons at Mehrgarh: preliminary anthropological and taphonomic evidence. In C. Jarrige & V. Lefevre (eds), *South Asian Archaeology 2001*. Paris: Editions Recherche sur les Civilisations, pp. 79-84.

Currat, M. & Excoffier, L., 2005. The effect of the Neolithic expansion on European molecular diversity, *Proceedings: Biological Sciences* **272**(1564), pp. 679-88.

Danti, M.D., 2006. The Sialk Regional Archaeological Survey 2005: Sialk Reconsideration Project. In S. Malek Shahmirzadi (ed.), *The Fishermen of Sialk*. Tehran: Iranian Center for Archaeological Research, pp. 67-77.

Delougaz, P., 1967. Choga Mish, *Iran* **5**, pp. 147-9.

Delougaz, P. & Kantor, H.J., 1973. Chogha Mish, *Iran* **11**, pp. 189-91.

Delougaz, P. & Kantor, H.J., 1975. Chogha Mish, *Iran* **13**, pp. 176-7.

Delougaz, P., Alizadeh, A. & Kanotor, H.J., 1996. *Chogha Mish: The First Five Seasons of Excavations 1961-1971*. Chicago: Oriental Institute of the University of Chicago.

Dennell, R.W., 1985. The hunter-gatherer/agricultural frontier in prehistoric temperate Europe. In S.W. Green & S.M. Perlman (eds), *The Archaeology of Frontiers and Boundaries*. London: Academic Press, pp. 113-40.

Dennell, R.W., 1992. The origins of crop agriculture in Europe. In P.J. Watson (ed.), *The Origins of Agriculture: An International Perspective*. Washington: Smithsonian Institution Press, pp. 71-94.

Dewan, M.L. & Famouri, J., 1968. The soils of Iran. In W.B. Fisher (ed.), *The Land of Iran.* Cambridge: Cambridge University Press, pp. 250-63.

Diamond, J., 1997. Location, location, location: the first farmers, *Science* **278**, pp. 1243-4.

Diamond, J., 2002. Evolution, consequences the and future of plant and animal domestication, *Nature* **418**, pp. 700-7.

Djamali, M., Beaulieu, J.-L. de, Shah-Hosseini, M., Andrieu-Ponel, V. & Ponel, P., 2008. A late Pleistocene long pollen record from Lake Urmia, Iran, *Quaternary Research* **69**, pp. 413-20.

Djamali, M., Kürschner, H., Akhani, H., de Beaulieu, J.-L. & Amini, A., 2008. Palaeoecological significance of the spores of the liverwort *Riella* (Riellaceae) in a late Pleistocene long pollen record from the hypersaline Lake Urmia, NW Iran, *Review of Palaeobotany and Palynology* **152**(1/2), pp. 66-73.

Dobney, K. & Larson, G., 2006. Genetics and animal domestication: New windows on an elusive process, *Journal of Zoology* **269**(2), pp. 261-71.

Dolukhanov, P., 1993. Foraging and farming groups in north-eastern and north-western Europe: identity and interaction. In J. Chapman & P. Dolukhanov (ed.), *Cultural Transformation and Interactions in Eastern Europe*. Aldershot: Avesbury.

Dolukhanov, P., Shukurov, A., Gronenborn, D., Sokoloff, D., Timofeev, V. & Zaitseva, G., 2005. The chronology of Neolithic dispersal in Central and Eastern Europe, *Journal of Archaeological Science* **32**(10), pp. 1441-58.

Dow, G.K., Olewiler, N. & Reed, C., 2005. The transition to agriculture: climatic reversals, population density, and technical change. Simon Fraser University: Department of Economics Discussion Papers. [online] Available at www.econ.sfu.ca/research/discussion/dp05-1.pdf. Accessed 19/09/11.

Dupanloup, I., Bertorelle, G., Chikhi, I., Barbujani, G., 2004. Examining the impact of prehistoric admixture on the genome of Europeans, *Mol. Biol. Evol.* **21**, 1361-72.

Dupree, L., 1952. The Pleistocene artifacts of Hotu Cave, Iran, *Proceedings of the American Philosophical Society* **96**(3), pp. 250-7.

Dupree, L., 1980. *Afghanistan* (3rd ed.). Princeton (NJ): Princeton University Press.

Dupree, L. et al., 1972. Prehistoric research in Afghanistan (1959-1966), *Transactions of the American Philosophical Society* **62**(4), pp. 1-84.

Dyson, R.H., 1965. The relative stratigraphy and chronology of Iran. In R.W. Ehrich (ed.), *Chronology in Old World Archaeology*, 2nd edition. Chicago: University of Chicago Press, pp. 215-50.

Dyson, R.H., 1991. The Neolithic period through the Bronze Age in north-eastern and north-central Persia. [online] Available at

http://www.iranicaonline.org/articles/ceramics-i. Accessed 02/11/11. Last updated 11/10/11.
Dyson, R.H., Muscarella, O.W. & Voigt, M.V.,1969. Hasanlu Project 1968: Hajji Firuz, Dinkha Tepe, Se Girdan and Qalatgah. *Iran* **7**, pp. 179-81.
Egami, N. & Masuda, S., 1962. *Marv-Dasht I: The Excavations at Tall-i-Bakun.* Tokyo: Institute of Oriental Culture of the University of Tokyo.
Egami, N., Masuda, S. & Gotoh, T., 1977. Tal-i Jarri A: a preliminary report of the excavations in Marv Dasht, 1961 and 1971, *Orient* **13**, pp. 1-14.
Epstein, H., 1971. *The Origin of the Domestic Cattle of Africa*. New York: Africana.
Epstein, H. & Mason I.L., 1984. Cattle. In N I.L. Mason (ed.), *Evolution of Domesticated Animals*. London: Longman, pp. 6-27.
Ervynck, A., Dobney, K., Hongo, H. & Meadow, R., 2001. Born free? New evidence for the status of pigs from Çayönü Tepsi, eastern Anatolia, *Paleorient* **27**(2), pp. 47-73.
Fazeli, H., 2001. 'An investigation of craft specialisation and cultural complexity of the Late Neolithic and Chalcolithic periods on the Tehran Plain'. Ph.D Thesis, University of Bradford.
Fazeli, H. & Djamali, M., 2002. The process of specialised ceramic production at Zagheh prehistoric site based on the archaeological evidence and petrography result. In M. Azarnoush (ed.), *First Symposium of Archaeology in Iran: The Role of Science in Archaeology*. Tehran: Cultural Heritage Organisation Press.
Fazeli, H. & Abbasnejad, R., 2005. Social transformations and interregional interaction in the Qazvin plain during the 5th, 4th and 3rd millennia BC, *Archaologische Mitteilungen aus Iran und Turan* **37**, pp. 7-26.
Fazeli, H. & Abbasnejad, R., 2007. Prehistoric chronology of Tepe Ghabristan. In H. Fazeli (ed.), *The Archaeology of the Qazvin Plain.* Tehran: University of Tehran press, pp. 79-120.
Fazeli, H. & Ajourlu, B., 2007. Tepe Ismailabad. In H. Fazeli (ed.), *The Archaeology of the Qazvin Plain.* Tehran: University of Tehran Press, pp. 149-210.
Fazeli, H. & Young, R., 2008. Landlord villages of the Tehran plain: season 1, *Iran* **46**, pp. 347-60.
Fazeli, H., Coningham, R.A.E. & Pollard, A.M., 2001. Chemical characterization of the Late Neolithic and Chalcolithic pottery from the Tehran Plain, Iran, *Iran* **39**, pp. 55-71.
Fazeli, H., Donahue, R.E. & Coningham R.A.E., 2002. Stone tool production, distribution and use during the Late Neolithic and Chalcolithic on the Tehran Plain, Iran, *Iran* **40**, pp. 1-14.
Fazeli, H., Coningham, R.A.E. & Batt, C.M., 2004. Cheshmeh-Ali revisited: towards an absolute dating of the Late Neolithic and Chalcolithic of Iran's Tehran plain, *Iran* **42**, pp. 13-23.
Fazeli, H., Wong, E. & Potts, D.T., 2005. The Qazvin Plain revisited: a reappraisal of the chronology of the Northwestern Central Plateau, Iran, in the 6th to the 4th millennium BC, *Ancient Near Eastern Studies* **42**, 3-82.

Fazeli, H., Salimi, M. & Young, R., 2009. Landlord villages of the Tehran plain, and historical archaeology in Iran, *Iran* **47**, pp. 149-64.

Coningham, R., Fazeli, H., Young, R., Gillmore, G., Karimian, H., Maghsoudi, M., Donohue, R. & Batt, C. (2006). Socio-economic transformations: settlement survey in the Tehran Plain and excavations at Tepe Pardis. *Iran* XLIII: 33-62

Fazeli, H., Coningham, R.A.E., Young, R.L., Gillmore, G.K., Maghsoudi, M. & Raza, H. 2007. Socioeconomic transformations in the Tehran plain: final season of settlement survey and excavations at Tepe Paradis, *Iran* **45**, pp. 269-85.

Fazeli, Nashli, Hassan; Beshkani, A; Markosian, A; Ilkani, H; & Young, R 2009. The Neolithic to Chalcolithic transition in the Qazvin Plain, Iran: chronology and subsistence strategies, *Archaologische Mitteilungen aus Iran und Turan* **41**, pp. 1-21.

Fazeli, N.M., Vidale, M., Guida, G. & Coningham, R.A.E., 2010. The evolution of ceramic manufacturing technology during the Late Neolithic and Transitional Chalcolithic periods at Tepe Pardis, Iran, *Archaeologische Mitteilungen aus Iran und Turan* **42**, pp. 87-112.

Feynman, J. & Ruzmaikan, A., 2007. Climate stability and the development of agricultural societies, *Climatic Change* **84**(3/4), pp. 295-311.

Fisher, R.A., 1937. The wave of advance of advantageous genes, *Ann. Eugen* **7**, pp. 355-69.

Fisher, W.B. (ed.), 1968. *The Land of Iran.* Cambridge: Cambridge University Press.

Fix, A.G., 1996. Gene frequency clines in Europe: demic diffusion or natural selection, *Journal of the Royal Anthropological Institute* **2**, pp. 625-43.

Flannery, K., 1969. Origins and ecological effects of early domestication in Iran and the Near East. In P. Ucko & G. Dimbleby (eds), *The Domestication of Plants and Animals*. London: Aldine, pp. 73-100.

Flannery, K., 1973. The origins of agriculture, *Annual Review of Anthropology* **2**, pp. 271-310.

Flannery, K., 1983. Early pig domestication in the Fertile Crescent: a retrospective look. In T.C. Young, P.E.L. Smith & P. Mortensen (eds), *The Hilly Flanks: Essays on the Prehistory of Southwest Asia*. Chicago: Oriental Institute, University of Chicago, pp. 163-88.

Flores, C., Maca-Meer, N., Gonzalez, A.M., Oefner, P.J., Shen, P.D., Perez, J.A., Rojas, A., Larruha, J.M., Underhill, P.A., 2004. Reduced genetic structure of the Iberian peninsula revealed by Y-chromosome analysis: implications for population demography, *European Journal of Human Genetics* **12**, pp. 855-63.

Forenbaher, S. & Miracle, P., 2005. The spread of farming in the eastern Adriatic, *Antiquity* **79**, pp. 514-28.

Fukai, S., Horiuchi, K. & Matsutani, T., 1973. *Marv Dasht III: The Excavations at Tall-i-Mushki*. Tokyo: Institute of Oriental Culture of the University of Tokyo.

Fuller, D.Q., 2007. Contrasting patterns in crop domestication and domestication rates: recent archaeobotanical insights from the Old World, *Annals of Botany* **100**, pp. 903-24.

Fuller, D.Q., Allaby, R.G. & Stevens, C., 2010. Domestication as innovation: the entanglement of techniques, technology and chance in the domestication of cereal crops, *World Archaeology* **42**(1), pp. 13-28.

Gamble, C., Davies, W., Pettitt, P., Hazelwood, L. & Richards, M., 2005. The archaeological and genetic foundations of the European population during the Late Glacial: implications for agricultural thinking, *Cambridge Archaeological Journal* **15**(2), pp. 193-223.

Ganji, M.H., 1968. Climate. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 212-49.

Garrard, A., 1999. Charting the emergence of cereal and pulse domestication in south-west Asia, *Environmental Archaeology* **4**, pp. 67-86.

Gebauer, A.B. & Price, T.D. (eds), 1992. *Transition to Agriculture in Prehistory.* Wisconsin: Prehistory Press.

Ghayoumi, J., Ghermezcheshme, B., Feiznia, S. & Norouzi, A.A., 2005. Integrating GIS and DSS for identification of suitable areas for artificial recharge, case study Meimeh Basin, Isfahan, Iran, *Environmental Geology* **47**, pp. 493-500.

Ghirshman, R., 1954. *Iran From the Earliest Times to the Islamic Conquest.* Harmondsworth: Penguin.

Giacomo, Di F. et al., 2004. Y-chromosomal haplogroup J as a signature of the post-Neolithic colonization of Europe, *Human Genetics* **115**, pp. 357-71.

Gillmore, G.K., Coningham, R.A.E., Young, R., Fazeli, H., Rushworth, G., Donahue, R. & Batt, C, 2007. Holocene alluvial sediments of the Tehran plain: sedimentation and archaeological site visibility. In L. Wilson, P. Dickinson & J. Jeandeon (eds), *Reconstructing Human-Landscape Interactions*. Newcastle: Cambridge Scholars Publishing, pp. 37-67.

Gillmore, G.K., Coningham, R.A.E**.**, Fazeli, H., Young, R.L., Magshoudi, M., Batt, C.M. & Rushworth, 2009. Irrigation on the Tehran plain, Iran: Tepe Paradis - the site of a possible Neolithic irrigation feature?, *CATENA* **78**(3), pp. 285-300.

Gillmore, G.K., Stevens, T., Buylaert, J.P., Coningham, R.A.E., Batt,C., Fazeli, H., Young, R. & Maghsoudi, M., 2011. Geoarchaeology and the value of multidisciplinary palaeoenvironmental approaches: a case study from the Tehran Plain, Iran, *Geological Society London Special Publications* **352**, pp. 49-67.

Gkiasta, M., Russell, T., Shennan, S. & Steele, A.J., 2003. Neolithic transition in Europe: the radiocarbon record revisited, *Antiquity* **77**(1), pp. 45-62.

Goff Meade, C. & Pullar, J., 1970. Tepe Abdul Hosein, *Iran* **8**, pp. 199-200.

Goff Meade, C., Smith, P.E.L., Cuyler Young, Jr, T. et al., 1968. Survey of excavations in Iran during 1966-67, *Iran* **6**, pp. 157-71.

Goldsmith, E., 1984. The qanats of Iran. In E. Goldmsith & N. Hildyard (eds), *The Social and Environmental Effects of Large Dams: Volume 1. Overview*. [online] Available at www.edwardgoldsmith.org/1031/the-qanats-of-iran. Accessed 21/09/11.

Gopher, A., Abbo, S. & Lev-Yadum, S., 2002. The 'when', the 'where' and the 'why' of the Neolithic revolution in the Levant, *Doc. Praehist.* **28**, pp. 1-14.

Goring-Morris, N. & Belfer-Cohen, A., 1998. The articulation of cultural processes and Late Quaternary environmental change in Cisjordan, *Paleorient* **23**(2), pp. 71-93.

Goring-Morris, A.N. & Belfer-Cohen, A., 2011. Neolithization processes in the Levant: the outer envelope, *Current Anthropology* **52**(S4), pp. 195-208.

Griffiths, H.E., Schwalb, A. & Stevens, L.R., 2001. Environmental change in southwestern Iran: the Holocene ostracod fauna of Lake Mirabad, *The Holocene* **11**(6), pp. 757-64.

Gronenborn, D., 1999. A variation on a basic theme: the transition to farming in southern central Europe, *Journal of World Prehistory* **13**, pp. 123-210.

Gronenborn, D., 2004. Comment in reply to P. Rowley-Conwy, *Current Anthropology* **45**(S), p. 101.

Hamlin, C., 1974. Seh Gabi, 1973, *Archaeology* **27**, pp. 274-7.

Hamlin, C., 1975. Dalma Tepe, *Iran* **13**, pp. 111-28.

Harris, D.R., 2003. Paradigms and transitions: reflections on the study of the origins and spread of agriculture. In A.J. Ammerman & P. Biagi (eds), *The Widening Harvest: The Neolithic Transition in Europe: Looking Back, Looking Forward*. Boston (MA): Archaeological Institute of America, pp. 43-58.

Harris, D.R., 2010a. *Origins of Agriculture in Western Central Asia*. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology.

Harris, D.R., 2010b. 'Neolithic subsistence systems and the beginnings of agriculture in South Central Asia', paper presented at the 7ICANNE Conference, London 12-16th April 2010.

Harris, D.R. & Gosden, C.,1996. The beginnings of agriculture in western Central Asia. In D.R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*. London: UCL Press, pp. 370-89.

Harris, D.R., Gosden, C. & Charles, M.P., 1996. Jeitun: recent excavations at an Early Neolithic site in southern Turkmenistan, *Proceedings of the Prehistoric Society* **62**, pp. 423-42.

Harris, D. R., Masson, V.M., Berezkin, Y.E., Charles, M.P., Cosden, C. et al., 1993. Investigating early agriculture in Central Asia: new research at Jeitun, *Antiquity* **67**(255), pp. 324-38.

Harrison, J.V., 1968. Geology. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 111-87.

Hassan, F., 1975. Determinants of the size, density, and growth rates of hunting and gathering populations. In S. Polgar (ed.), *Populations, Ecology and Social Evolution*. The Hague (Paris): Mouton, pp. 27-53.

Hayden, B., 1990. Nimrods, piscators, pluckers and planters: the emergence of food production, *Journal of Anthropological Archaeology* **9**(1), pp. 31-69.

Hayden, B., 1996. Feasting in prehistoric and traditional societies. In P. Wiessner & W. Schiefenhovel (eds), *Food and the Status Quest: An Interdisciplinary Presepective*. Oxford: Berghahn Books, pp. 127-48.

Hayden, B., 2001. Fabulous feasts: a prolegomenom to the importance of feasting. In M. Dietler & B. Hayden (eds), *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics and Power.* London: Smithsonian Institution Press, pp. 23-64.

Hayden, B., 2003. Were luxury foods the first domesticates? Ethnoarchaeological persepectives from Southeast Asia, *World Archaeology* **34**, pp. 458-69.

Hayden, B., 2009. The proof is in the pudding: feasting and the origins of domestication, *Current Anthropology* **50**(5), pp. 597-602.

Hedges, R.E.M., Housley, R.A., Bronk-Ramsey, C.R. & Klinken, G.J, van, 1990. Radiocarbon dates from the Oxford AMS system: archaeometry datelist II, *Archaeometry* **32**(2), pp. 211-37.

Heiser, C.B., 1990. *Seed to Civilization: The Story of Food.* San Francisco: W.H. Freeman.

Helbaek, H., 1969. Plant collecting: dry-farming, and irrigation agriculture in prehistoric Deh Luran. In F. Hole, K.V. Flannery & Neely, J.A. (eds), *Prehistory and Human Ecolology of the Deh Luran Plain*. Ann Arbor (MI): Memoirs of the Museum of Anthropology University of Michigan, pp. 383-426.

Helbaek, H., 1972. Samarran irrigation agriculture at Chogha Mami in Iraq, *Iraq* **34**(1), pp. 35-48.

Helmer, D., Gourichon, L. Monchot, H., Peters, J., Sana Segui, M., 2005. Identifying early domestic cattle from Pre-Pottery Neolithic sites on the Middle Euphrates using sexual dimorphism. In J.-D. Vigne, J. Peters & D. Helmer (eds), *The First Steps of Animal Domestication: New Archaeological Approaches*. Oxford: Oxbow, pp. 86-95.

Helwing, B., 2005. Long distance relations of the Iranian highland sites during the late Chalcoltihic period: new evidence from the Joint Iranian-German excavations at Arisman. In U. Franke-Vogt & H.-J. Weisshaar (eds), *South Asian Archaeology 2003. Proceedings of the Seventeenth International Conference of the European Association of South Asian Archaeologists.* Aachen*:* Forschungen zur Archaologie ausser europaischer Kulturen, pp. 171-8.

Henrickson, E., 1985. An updated chronology of the Early and Middle Chalcoltihic of the Central Zagros highlands, western Iran, *Iran* **23**, pp. 63-108.

Heun, M., Schafter-Pregl, R., Klawan, D., Castagna, R., Accerbi, M., Borghi, B. & Salamini, F., 1997. Site of einkorn wheat domestication identifed by DNA fingerprinting, *Science* **278**, pp. 1312-14.

Heydari, S., 2010. A survey of rockshelters near Tol-e Băsi. In Pollock, S., Bernbeck, R. & Abdi, K. (eds), 2010. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut, pp. 265-8.

Hiendleder, S., Mainz, K., Plante, Y. & Lewalski, H., 1998. Analysis of mitrochondrial DNA indicates that domestic sheep are derived from two different maternal sources: no evidence for contributions from urial and argali sheep, *Journal of Heredity* **89**: pp. 113-20.

Hiendleder, S., Phua, S.H. & Hecht, W., 1999. A diagnostic assay discriminating between two major Ovis aries mitrochondrial DNA haplogroups, *Animal Genetics* **30**, pp. 211-13.

Hiendleder, S., Kaupe, S., Wassmuth, R. & Janke, A., 2002. Molecular analysis of wild and domestic sheep questions nomenclature and provides evidence for domestication from two different subspecies, *Proceedings of the Royal Society of London, Series B* **269**, pp. 893-904.

Higgs, E.S. & Jarmon, M.R., 1969. The origins of agriculture: a reconsideration, *Antiquity* **43**, pp. 31-41.

Higgs, E.S. & Jarmon, M.R., 1972. The origins of animal and plant husbandry. In E.S. Higgs (ed.), *Papers in Economic Prehistory*. Cambridge: Cambridge University Press, pp. 3-14.

Hill, E., Jobling, M.A. & Bradley, D.G., 2000. Y-chromosome variation and Irish origins, *Nature* **404**, pp. 351-52.

Hillman, G.C., 1978. On the origins of domestic rye *Secale cereale*: the finds from Aceramic Can Hassan III in Turkey, *Anatolian Studies* **28**, pp. 157-74.

Hillman, G.C., 2000. Abu Hureyra 1: The Epipalaeolithic. In A.M.T. Moore, G.C. Hillman & A.J. Legge (eds), *Village on the Euphrates. From Foraging to Farming at Abu Hureyra*. New York: Oxford University Press, pp. 327-98.

Hillman, G.C. & Davies, M.S., 1990. Measuring domestication rates in wild wheat and barley, *Journal of World Prehistory* **4**, pp. 157-222.

Hobbes, T., 1651 (reprinted 2008). *Leviathan*. Charleston (SC): Forgotten Books.

Hodder, I., 1990. *The Domestication of Europe.* London: Blackwell.

Hodder, I., 2001. Symbolism and the origins of agriculture in the Near East, *Cambridge Archaeological Journal* **11**(1), pp. 107-12.

Hole, F., 1968. Evidence of social organization from Western Iran, 8000-4000 BC. In S. Binford & L. Binford (eds), *New Perspectives in Archaeology*. Chicago: Aldine, pp. 245-65.

Hole, F., 1977. *Studies in the Archaeological History of the Deh Luran Plain: The Excavation of Chagha Sefid.* Ann Arbor (MI): Memoirs of the Museum of Anthropology University of Michigan.

Hole, F., 1983. The Jarmo chipped stone. In L.S. Braidwood, R.J. Braidwood, B. Howe, C.A. Reed & P.J. Watson (eds), *Prehistoric Archaeology Along the Zagros Flanks*. Chicago: University of Chicago, pp. 233-84.

Hole, F., 1987. *The Archaeology of Western Iran, Settlement and Society from Prehistory to the Islamic Conquest.* London: Smithsonian Institute Press.

Hole, F., 2000. New radiocarbon dates for Ali Kosh, Iran, *Neolithics* **1**, p. 13.

Hole , F., 2004. Neolithic Age in Iran. [online] Available at http://www.iranicaonline.org/articles/neolithic-age-in-iran. Accessed 23/09/11.

Hole, F., 2006. Agricultural sustainability in the semi-arid Near East, *Climate of the Past Discussions* **2**, pp. 485-518.

Hole, F. & Flannery, K.V., 1967. The prehistory of southwest Iran: a preliminary report, *Proceedings of the Prehistoric Society* **33**, pp. 147-206.

Hole, F., Flannery, K.V. & Neely, J.A., 1969. *Prehistory and Human Ecology of the Deh Luran Plain: An Early Villlage Sequence from Khuzistan, Iran.* Ann Arbor (MI): Memoirs of the Museum of Anthropology, University of Michigan.

Horwitz, L.K., 2003. Temporal and spatial variation in Neolithic caprine exploitation strategies, a case study of fauna from the site of Yiftah'el (Israel), *Paleorient* **29**, pp. 19-58.

Horwitz, L.K., Tchernov, E., Ducos, P., Becker, C., von den Driesch, A., Martin, A & Garrard, A., 1999. Animal domestication in the southern Levant, *Paleorient* **25**, pp. 63-80.

Housley, R.A., 2004. Eastern Mediterranean chronologies: the Oxford AMS contribution, *Radiocarbon* **36**, pp. 55-73.

Howe, B., 1983. Karim Shahir. In L.S. Braidwood, R.J. Braidwood, B. Howe, C.A., Reed, P.J. Watson (eds), *Prehistoric Archaeology along the Zagros Flanks*. Chicago: Oriental Institute of the University of Chicago, pp. 23-154

Hubbard, R.N.L.B., 1990. The carbonised seeds from Tepe Abdul Hosein: results of preliminary analysis. In J. Pullar (ed.), *Tepe Abdul Hosein: A Neolithic site in Western Iran Excavations 1978*. Oxford: B.A.R. International Series 563, pp. 217-23.

Hutchinson, G.F. & Cowgill, U.M., 1963. Chemical examination of a core from Lake Zeribar, Iran, *Science* **140**, pp. 67-9.

Ilkhani-Moghadam, H. Newton, C. & Robinson, M. (in press). Archaeobotanical analysis of the Neolithic and Chalcolithic contexts from Tepe Pardis.

Ingold, T., 1996. Growing plants and raising animals: an anthropological prospective on domestication. In D.R. Harris (ed.), *The Origins and Spread of Pastoralism in Eurasia*. London: UCL Press, pp. 12-25.

Jarrige, C., 2005. Human figurines from the Neolithic levels at Mehrgarh. In U. Franke-Vogt & H.-J. Weisshaar (eds), *South Asian Archaeology 2003*. Aachen: Deutsches Archaologisches Institut, pp. 27-38.

Jarrige, J.-F., 2000. Mehrgarh Neolithic: new excavations. In M. Taddei & G.D. Marco (eds), *South Asian Archaeology 1997*. Rome: Istituto Italiano per l'Africa e l'Oriente, pp. 260-83.

Jarrige, J.-F. & Lechevallier, M., 1980. Les fouilles de Mehrgarh, Pakistan: problemes chronologiques, *Paleorient* **6**, 253-8.

Jarrige, J.-F., Jarrige, C. & Quivron, G., 2005. Mehrgarh Neolithic: the updated sequence. In C. Jarrige & V. Lefevre (eds), *South Asian Archaeology 2001*. Paris: Editions Recherche sur les Civilisations, pp. 129-42.

Jarrige, C., Jarrige, J.-F., Meadow, R. & Quivron, G., 1995. *Mehrgarh Field Reports 1974-1985 From Neolithic Times to the Indus Civilization,* Sindh: The Department of Culture and Tourism, Government of Sindh, Pakistan.

Javeri, M., Abdi, K. & Bernbeck, R., 2010. Small finds. In S. Pollock, R. Bernbeck & K. Abdi (eds), 2010. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut, pp. 191-204.

Jones, A., 2004. Comment to Rowley Conwy, *Current Anthropology* **42**(S), pp. 101-2.

Jones, M. & Brown, T.A., 2000. Agricultural origins: the evidence of modern and ancient DNA, *Holocene* **10**, pp. 775-82.
Jones, M., Brown, K.T. & Allaby, R.G., 1996. Tracking early crops and early farmers: the potential of biomolecular archaeology. In D.R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*. London: Routledge, pp. 93-100.
Jordan, P. & Zvelebil, M.A. (eds), 2009. *Ceramics Before Farming: The Dispersal of Pottery Among Prehistoric Eurasian Hunter-Gatherers.* Walnut Creek (CA): Left Coast Press, Inc.
Kantor, H.J., 1978. Chogha Mish and Chogha Bonut, *Iran* **16**, pp. 189-91.
Kantor, H.J., 1979. Chogha Mish and Chogha Bonut, *Oriental Institute Annual Report* 1978-79, pp. 33-8.
Kantor, H.J., 1980. Chogha Mish and Chogha Bonut, *Oriental Institute Annual Report* 1979-80, pp. 14-18.
Kehl, M., 2009. Quaternary climate change in Iran – the state of knowledge, *Erdkunde* **63**(1), pp. 1-17.
Kelts, K. & Shahrabi, M., 1986. Holocene sedimentology of hypersaline Lake Urmia, northwestern Iran, *Palaeogeography, Palaeoclimatology, Palaeoecology* **54**, pp. 105-30.
Kendrew, W.G., 1961. *The Climates of the Continents.* London: Oxford University Press.
Kilian, B., Ozkan, H., Walther, A., Kohl, J., Dagan, T., Salamini, F. & Martin, W., 2007. Molecular diversity at 18 loci in 321 wild and 92 domesticate lines reveal no reduction of nucleotide diversity during Triticum monococcum (einkorn) domestiation: Implications for the origins of agriculture, *Molecular Biology and Evolution* **24**, pp. 2657-68.
King, R. & Underhill, P., 2002. Congruent distribution of Neolithic painted pottery and ceramic figurines with Y-chromosome lineages, *Antiquity* **76**, pp. 707-14.
King, R., Ozcan, S.S., Carter, T., Kalfaoglu, E., Atasoy, S. et al., 2008. Differential Y-chromosome Anatolian influences on the Greek and Cretan Neolithic*, Ann. Hum, Genet*. **72**, pp. 205-14.
Kislev, M.E., Hartmann, A. & Bar-Yosef, O., 2006. Early domesticated fig in the Jordon Valley, *Science* **312**, pp. 1372-74.
Kivisild, T., Rootsi, S., Metspalu, M., Metspalu, E, Parik, J. et al., 2003. The genetics of language and farming spread in India. In P. Bellwood & C. Renfrew (eds), *Examining the Farming/Language Dispersal Hypothesis*. Cambridge: McDonald Institute for Archaeological Research, pp. 215-23.
Kleiss, W. & Kiani, M.Y., 1995. *Iranian Caravansaries*. Tehran: Iranian Cultural Heritage Organization.
Kohl, P.L., 1984. *Central Asia: Paleolithic Beginnings to the Iron Age.* Paris: A.D.P.F.
Kourampas, N., Simpson, I.A., Nejad, M.G. et al., *in press.* Sediments, soils and livelihood in a Late Neolithic village on the Iranian Plateau: Tepe Sialk.
Kozlowski, S.K., 1994. Radiocarbon dates from aceramic Iraq. In O. Bar-Yosef & R.S. Kra (eds), *Late Quaternary Chronology and Paleoclimates of the Eastern*

Mediterranean. Tucson (MA): Radiocarbon, American School of Prehistoric Research, pp. 255-64.
Kozlowski, S.K. & Aurenche, 0. 2005. *Territories, Boundaries and Cultures in the Neolithic Near East*. Oxford: BAR International Series 1362.
Kudela, K. & Bobik, P., 2004. Long-term variations of geomagnetic rigidity cutoffs, *Solar Physics* 224, pp. 423-31.
Kuijt, I., 2009. What do we really know about food storage, surplus, and feasting in preagricultural communities? *Current Anthropology* **51**(5), pp. 641-4.
Ladizinsky, G., 1980. Origin and domestication of the southwest Asian grain legumes. In D.R. Harris & G.C. Hillman (eds), *Foraging and Farming: The Evolution of Plant Exploitation.* London: Unwin Hyman, pp. 374-89.
Lamberg-Karlovsky, C.C., 1968. Survey and excavations in the Kirman area, *Iran* **6**, pp. 167-8.
Lamberg-Karlovsky, C.C., 1969. Tepe Yahya, *Iran* **7**, pp. 184-6
Lamberg-Karlovsky, C.C., 1970. Tepe Yahya, *Iran* **8**, pp. 197-9.
Lamberg-Karlovsky, C.C., 1971. The Yahya Project: Tepe Yahya and Tepe Dasht-i Deh, *Iran* **9**, pp. 182-3.
Lamberg-Karlovsky, C.C., 1972. Tepe Yahya 1971: Mesopotamia and the Indo-Iranian Borderlands, *Iran* **10**, pp. 89-100.
Lamberg-Karlovsky, C.C., 1974. Tepe Yahya, *Iran* **12**, pp. 228-31.
Lamberg-Karlovsky, C.C., 1976. The Yahya Project, *Iran* **14**, p. 172.
Lambton, A.K.S, 1953. *Landlord and Peasant in Persia: A Study of Land Tenure and Land Revenue Administration*. London: Oxford University Press.
Langsdorf, A. & McCown, D.E., 1942. *Tall-i Bakun A: Season of 1932*. Chicago: Oriental Institute Publications 54.
Larkum, M., 2010. Phytolith analysis of samples from on- and off-site deposits at Jeitun. In D.R. Harris (ed.), *Origins of Agriculture in Western Central Asia*. Philadelphia: University of Pennsylvnia Museum of Archaeology and Anthropology, pp. 142-9.
Larson, G., 2011. Genetics and domestication: important questions for new answers, *Current Anthropology* **52**(S4), pp. 485-95.
Larson, G., Dobney, K., Albarella, U. G., Fang, M., Matisoo-Smith, E. et al. 2005. Worldwide phylogeography of wild boar reveals multiple centers of pig domestication, *Science* **307**(5717), pp. 1618-21.
Larson, G., Albarella, U., Dobney, K., Rowley-Conwy, P., Schibler, J. et al., 2007. Ancient DNA, pig domestication, and the spread of the Neolithic into Europe, *Proc. Natl Acad. Sci. (USA)* **104**(37), pp. 15276-81.
Lawler, A., 2003a. International collaboration: Iran reopens its past, *Science* **302**, pp. 970-3.
Lawler, A., 2003b. Bronze Age finds: looting savages new site, *Science* **302**, pp. 974-5.
Lawler, H., 2008. From the horse's mouth, *Humanities* **29** (5). www.neh/gov/news/humanities/2008-2009/HorsesMOuth.html. Accessed 10/01/12.

Lechevallier, M., 1984. The flint industry at Mehrgarh. In B. Allchin (ed.), *South Asian Archaeology 1981*. Cambridge: Cambridge University Press, pp. 41-51.
Lechevallier, M., 1995. Area MRS.3S. In C. Jarrige & et al. (eds), *Mehrgarh: Field Reports 1974-1985 From Neolithic Times to the Indus Civilization*. Sindh: Department of Culture and Tourism, Government of Sindh, Pakistan, pp. 278-81.
Lechevallier, M. & Quivron, G., 1981. The Neolithic in Baluchistan: New evidence from Mehrgarh. In H. Hartel (ed.), *South Asian Archaeology 1979*. Berlin: Dietrich Reimer Verlag, pp. 71-93.
Lechevallier, M., Meadow, R.H. & Quivron, G., 1982. Depots d'animaux dans les sepultures Neolithicques de Mehrgarh, Pakistan, *Paleorient* **8**(1), pp. 99-106.
Lee, R.B., 1968. What hunters do for a living, or, how to make out on scarce resources. In R.B. Lee & I. DeVore (eds), *Man the Hunter*. Chicago: Aldine, pp. 30-41.
Lee, R.B. & DeVore, I. (eds), 1968. *Man the Hunter.* Chicago: Aldine Publishing Company.
Legge, T., 1996. The beginning of caprine domestication in Southwest Asia. In D.R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*. London: UCL Press, pp. 238-62.
Lev-Yadum, S., Gopher, A. & Abbo, S., 2000. The cradle of agriculture, *Science* **288**, pp. 1602-3.
Libby, W.F., 1955. *Radiocarbon Dating*. Chicago: University of Chicago Press.
Libby, W.F., Anderson, E.C. & Arnold, J.R. 1949. Age determination by radiocarbon context: world-wide assay of natural radiocarbon, *Science* **109**(2827), pp. 227-8.
Loftus, R.T, MacHigh, D.E., Bradley, D.G., Sharp, P.M. & Cunningham, P., 1994. Evidence for two independent domestications of cattle, *Proc. Natl. Acad. Sci.* (USA) **91**, pp. 2757-61.
Lovell, J.L., 2004. *The Late Neolithic and Chalcolithic periods in the southern Levant: New data from the site of Teleilat Ghassul, Jordon*. Oxford: B.A.R. International Series 974.
Lowe, J.J. & Walker, M.J.C., 2000. Radiocarbon dating the last Glacial-Interglacial Transition (ca 14-9 ^{14}C ka BP) in terrestrial and marine records: the need for new quality assurance procedures, *Radiocarbon* **42**(1), pp. 53-68.
Lowe, J.J. & Hoek, W.Z., 2001. Inter-regional correlation of palaeoclimatic records for the Late Glacial-Interglacial Transition: a protocol for improved precision recommended by the INTIMATE project group, *Quaternary Science Reviews* **20**(11), pp. 1175-87.
Lowie, R.H., 1946. *An Introduction to Cultural Anthropology.* New York: Rinehart.
Lubbock, J., 1865. *Pre-historic Times.* London: Williams & Norgate.
Luikart, G., Fernandez, H., Mashkour, M. et al., 2006. Origins and diffusion of domestic goats inferred from DNA markers. In Zeder, M.A., Emshwiller, E., Smith, B.D. & Bradley, D.G., (eds), *Documenting Domestication: New Genetic*

and Archaeological Paradigms. Berkley: University of California Press, pp. 297-307.

Luikart, G., Gielly, L., Excoffier, L., Vigne, J.-D., Bouvet, J. & Taberlet, P., 2001. Multiple maternal origins and weak phylogeographic structures in domestic goats. *Proc. Natl Acad. Sci. (USA)* **98**(10), pp. 5927-32.

Luo, M.-C., Yang, Z.L., You, F.M., Kawahara, T., Waines, J.G. & Dvorak J., 2007. The structure of wild and domesticated emmer wheat populations, gene flow between them, and the site of emmer domestication, *Theoretical and Applied Genetics* **114**, pp. 947-59.

Majidzadeh, Y., 1976. 'The early prehistoric cultures of the Central Plateau of Iran: An archaeological history of its development during the fifth and fourth millennium B.C'. Thesis (Ph. D), University of Chicago.

Majidzadeh, Y., 1981. Sialk III and the pottery sequence at Tepe Ghabristan: the coherence of the cultures of the Iranian Central Plateau, *Iran* **19**, pp. 141-6.

Malek Shahmirzadi, S., 1977. 'Tepe Zagheh: A sixth millennium B.C. village in the Qazvin Plain of the Central Iranian Plateau'. Thesis (PhD), University of Pennsylvania.

Malek Shahmirzadi, S, 1988. 'Status' in the Neolithic villages as displayed in burial customs, with emphasis on Zagheh, *Iranian Journal of Archaeology and History* **2**, pp. 2-12.

Malek Shahmirzadi, S., 1995. The chronology of the Central Plateau of Iran, from the Neolithic to the beginning of urbanization, *Megalleh Bastansehnaci and Tarigh*, pp. 2-18.

Malek Shahmirzadi, S. (ed.), 2002. *The Ziggurat at Sialk*. Tehran: Iranian Cultural Heirtage Organization (ICHO), Deputy for Research, Archaeological Research Centre.

Malek Shahmirzadi, S. (ed.), 2003. *The Silversmiths of Sialk.* Tehran: Iranian Cultural Heirtage Organization (ICHO), Deputy for Research, Archaeological Research Centre.

Malek Shahmirzadi, S. (ed.), 2004. *The Potters of Sialk.* Tehran: Iranian Cultural Heirtage Organization (ICHO), Deputy for Research, Archaeological Research Centre.

Malek Shahmirzadi, S., (ed.), 2006a. *The Fishermen of Sialk*. Tehran: Iranian Cultural Heirtage Organization (ICHO), Deputy for Research, Archaeological Research Centre.

Malek Shahmirzadi, S., (ed.), 2006b. *The Oldest Fortified Village of Iran.* Tehran: Iranian Cultural Heirtage Organization (ICHO), Deputy for Research, Archaeological Research Centre.

Mashkour, M., 2004. Preliminary report of the archaeozoological studies of the third season of the Sialk Reconsideration Project. In S. Malek Shahmirzadi (ed.), *The Potters of Sialk*. Tehran: Iranian Centre for Archaeological Research, pp. 95-108. (In Persian.)

Mashkour, M., 2006. Faunal remains from Tol-e Nurabad and Tol-e Spid. In D. Potts & K. Roustaei (eds), *The Mamasani Archaeological Project Stage One*. Tehran: Iranian Centre for Archaeological Research, pp. 135-46.

Mashkour, M., Fontugne, M. & Hatté, C., 1999. Investigations on the evolution of subsistence economy in the Qazvin plain (Iran) from the Neolithic to the Iron Age, *Antiquity* **73**, pp. 65-76.

Mashkour, M., Mohaseb, A. & Debue, K., 2006. Towards a specialized subsistence economy in the Marv Dasht plain. Preliminary zooarchaeoloigcal analysis of the faunal assemblages from Tall-e Mushki , Tall-e Jari A and B and Tall-e Bakun A and B. In A. Alizadeh (ed.), *The Origins of State Organizations in Prehistoric Highland Fars, Southern Iran, Excavations at Tall-e Bakun*. Illinois: Oriental Institute Publications, pp. 101-5.

Masson, V., 1961. The first farmers in Turkmenia, *Antiquity* **35**, pp. 203-13.

Masuda, S., 1974. Tepe Sang-e Caxamaq, *Iran* **12**, pp. 222-3.

Matney, T., 1995. Re-excavating Cheshmeh Ali, *Expedition* **37**(2), pp. 26-38.

Matney, T., Pittman, H. & Fazeli, H., 2011. Cheshmeh Ali Publication Project. [online] Available at http://gozips.uakron.edu/~matney/Cheshmeh AliHome.htm. Accessed 21/09/11.

Matthews, R. & Fazeli, H. 2004. Copper and complexity: Iran and Mesopotamia in the fourth millennium BC, *Iran* **42**, pp. 61-75.

Matthews, R., Mohammadifar, Y., Matthews, W. & Motarjem, A., 2010. Investigating the Early Neolithic of western Iran: the Central Zagros Archaeological Project (CZAP), *Antiquity* **84**(323), http://antiquity.ac.uk/projgall/matthews323. Accessed 20/09/11.

Matthews, R., Mohammadifar, Y. & Matthews, W., 2010. 'The Central Zagros Archaeological project (CZAP): cult and sedentism in the Neolithisation of central west Iran', paper presented at the 7ICANNE Conference, London 12-16th April 2010.

McCoriston, J. & Hole, F., 1991. The ecology of seasonal stress and the origins of agriculture in the Near East, *American Anthropologist* **93**(1), pp. 46-69.

McCown, D.E., 1942a. The material culture of early Iran, *Journal of Near Eastern Studies* **1**(4), pp. 424-9.

McCown, D.E., 1942b. *The Comparative Stratigraphy of Early Iran*. Chicago: University of Chicago Press.

McCown, D.E., 1954. *The Comparative Stratigraphy of Early Iran*. Chicago: University of Chicago Press.

McDonald, M.M.A., 1979. 'An examination of Mid-Holocene settlement pattern in the central Zagros region of western Iran'. Thesis (PhD), University of Toronto.

Meadow, R.H., 1975. Mammal remains from Hajji Firuz: a study in methodology. In A.T. Clason (ed.), *Archaeozoological Studies*. Oxford: North-Holland Publishing Company, pp. 265-83.

Meadow, R.H., 1981. Early animal domestication in South Asia: a first report of the faunal remains from Mehrgarh, Baluchistan. In H. Härtel (ed.), *South Asian Archaeology 1979*. Berlin: Dietrich Reimer Verlag, pp. 143-81.

Meadow, R.H., 1983. The vertebrate faunal remains from Hassanlu Period X at Hajji Firuz Tepe. In M.M. Voigt (ed.), *Hajji Firuz Tepe, Iran: The Neolithic Settlement*. Philadelphia: The University Museum, University of Pennsylvania, pp. 369-422.

Meadow, R.H., 1984. Notes on the faunal remains from Mehrgarh, with a focus on cattle (*Bos*). In B. Allchin (ed.), *South Asian Archaeology 1981*. Cambridge: Cambridge University Press, pp. 34-40.

Meadow, R.H., 1989a. Prehistoric wild sheep and sheep domestication on the eastern margin of the Middle East. In P.J. Crabtree, D.V. Campana & K. Ryans (eds), *Early Animal Domestication and its Cultural Context*. Philadelphia: University Museum, University of Philadelphia, pp. 24-36.

Meadow, R. H., 1989b. Osteological evidence for the process of animal domestication. In J. Clutton-Brock (ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. London: Unwin Hyman, pp. 80-90.

Meadow, R.H., 1996. The origins and spread of agriculture and pastoralism in northwestern South Asia. In D.R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*. London: UCL Press, pp. 390-412.

Meadow, R.H. & Patel, A.K., 2002. From Mehrgarh to Harrappa and the Dholavila: prehistoric pastoralism in north-western South Asia through the Harrappan period. In S. Settar & R. Korisettar (eds), *Prehistory: Archaeology of the Harrappan Cilvilization VII*. New Delhi: Manohar, pp. 391-409.

Meldgaard, J., Mortensen, P. & Thrane, H., 1963. Excavations at Tepe Guran, Luristan, *Acta Archaeologica* **34**, pp. 97-113.

Mellaart, J., 1970. The earliest settlements in western Asia from the ninth to the end of the fifth millennium BC. In I.E.S. Edwards (ed.), *The Cambridge Ancient History: Part I Prolegomena and Prehistory.* Cambridge: Cambridge University Press, pp. 248-303.

Mellaart, J., 1975. *The Neolithic of the Near East.* London: Thames & Hudson.

Melville, C., 1984. Meteorological hazards and disasters in Iran: a preliminary survey to 1950, *Iran* **22**, pp. 113-50.

Millard, A.R., 2008. A critique of the chronometric evidence for homonid fossils: Africa and the Near East 500-50 ka, *Journal of Human Evolution* **54**(6), pp. 848-74.

Miller, N.F., 2003. Some plant remains from the 1996 excavation. In A. Alizadeh (ed.), *Excavations at the Prehistoric Mound of Chogha Bonut, Khuzestan, Iran*. Chicago: The Oriental Institute of the University of Chicago, pp. 123-8.

Miller, N.F. & Kimiaie, M., 2006. Some plant remains from the 2004 excavations of Tall-e Mushki, Tall-e Jari A and B, and Tall-e Bakun A and B. In A. Alizadeh (ed.), *The Origins of State Organization in Prehistoric Highland Fars, Iran: Excavations at Tall-e Bakun*. Illinois: The Oriental Institute of the University of Chicago, pp. 107-18.

Misonne, X. De, 1968. Mammals. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 294-304.

Molina-Cano, J.L., Russell, J.R., Moralejo, M.A. et al., 2005. Chloroplast DNA microsatellite analysis supports a polyphypetic origin for barley, *Theoretical and Applied Genetics* **110**(4), pp. 613-19.

Moore, A.M.T. & Hillman, G.C., 1992. The Pleistocene to Holocene transition and human ecology in southwest Asia: the impact of the Younger Dryas, *American Antiquity* **57**, pp. 482-94.

Morrell, P.L. & Clegg, M.T., 2007. Evidence for a second domestication of barley (Hordeum vulgare) east of the Fertile Crescent, *Proc. Natl Acad. Sci. (USA)* **104**(9), pp. 3289-94.

Mortensen, P., 1962. On the chronology of early village farming communities in northern Iraq, *Sumer* **18**, pp. 73-80.

Mortensen, P., 1964. Additional remarks on the chronology of early village-farming communities in the Zagros area, *Sumer* **20**, pp. 28-36.

Mortensen, P., 1974. A survey of prehistoric settlement in northern Luristan, *Acta Archaeologica* **45**, pp. 1-47.

Mortensen, P., 1975, The Hulailan survey, *Iran* **13**, pp. 190-1.

Moulherat, C., Tengberg, M., Haquet, J.F. & Mille, B., 2002. First evidence of copper at Neolithic Mehrgarh, Pakistan: analysis of mineralized fibres from a copper bead, *Journal of Archaeological Science* **29**(12), pp. 1393-401.

Mourant, A.E., Kopec, A.C. & Domaniewska-Sobczak, K., 1976. *The Distribution of the Human Blood Groups and Other Polymorphisms.* Oxford: Oxford University Press.

Munro, N.D., 2003. Small game, the Younger Dryas, and the transition to agriculture in the southern Levant, *Mitteilungen der Gesellschaft für Urgeschichte* **12**, pp. 47-71.

Neely, J.A. & Wright, H.T., 1994. *Early Settlement and Irrigation on the Deh Luran Plain: Village and Early State Societies in Southwestern Iran*. Ann Arbor (MI): University of Michigan, Museum of Anthropology.

Negahban, E.O., 1974. Sagzabad, *Iran* **12**, p. 216.

Negahban, E O., 1977. Preliminary report of Qazvin Expedition, *Malek* **2**, pp. 26-34.

Negahban, E O., 1979. A brief report on the painted building at Zagheh, *Paleorient* **5**, pp. 239-50.

Nagatati, N., 2004. In search of the Sialk miners: preliminary prospect of copper resources used by the Sialk artisans. In S. Malek Shahmirzadi (ed.), *The Potters of Sialk*. Tehran: Iranian Center of Archaeological Research, pp. 63-8.

Negahban, E.O., 1977. Preliminary report of Qazvin expedition: excavation of Zagheh, Qabristan, Sagzabad (1971-72), *Marlik* **2**, 26-44.

Nesbitt, M., 2002. When and where did domesticated cereals first occur in southwest Asia? In R. Cappers & S. Bottema (eds), *The Dawn of Farming in the Near East.* Berlin: Ex Oriente, pp. 113-32.

Nicholson, P.T., 1983. Hodder Westropp: nineteenth century archaeologist, *Antiquity* **57**, pp. 205-10.

Niklaus, T.R., Bonani, G., Suter, M. & Wolfli, W., 1994. Systematic investigations of uncertainties in radiocarbon dating due to fluctuations in the calibration curve, *Nuclear Instruments and Methods in Physics Research* **92**, pp. 194-200.

Niknami, K.A., 2000. *Methodological Aspects of Iranian Archaeology: Past and Present*. Oxford: B.A.R. International Series 852.

Nowak, M., 2001. The second phase of Neolithization in east-central Europe, *Antiquity* **75**, pp. 582-92.

Oates, D. & Oates, J.,1976. Early irrigation agriculture in Mesopotamia. In G. de G. Sieveking, I.H. Longworth & K.E. Wilson (eds), *Problems in Economic and Social Archaeology*. London: Duckworth, pp. 109-35.

Oates, J., 1969. Choga Mami, 1967-8. A preliminary report, *Iraq* **31**, pp. 115-52.

Oberlander, T. M., 1968. Hydrography. In W.B. Fisher (ed.), *The Land of Iran*. Cambridge: Cambridge University Press, pp. 264-79.

Oosterbaan, R.J., 1983. Modern interferences in traditional water resources in Baluchistan, *Water Research Journal* **139**, pp. 53-60.

Oosterbaan, R.J., 2000. Groundwater use, drainage and land reclamation in the alluvial fan of *Garmsar* Irrigation Project, Iran. Report of FAO consulatancy assignment. ILRI. Wageningen. [online] Available at www.waterlog.info/reports.htm. Accessed 21/09/11.

Ozkan, H., Brandolini, A., Schafer-Pregl, R. & Salamini, F., 2002. AFLP analysis of a collection of tetraploid wheats indicates the origin of emmer and hard wheat in southeast Turkey, *Molecular Biology and Evolution* **19**, pp. 1797-801.

Ozkan, H., Brandolini, A., Pozzi, C., Effgen, S., Wunder, J. & Salamini, F. 2005. A reconsideration of the domestication geography of tetraploid wheats, *Theoretical and Applied Genetics* **110**, pp. 1052-60.

Ozkan, H., Willcox, G., Graner, A., Salamini, F. & Kilian, B. 2010. Geographic distribution and domestication of wild emmer wheat (*Triticum dicoccoides*), *Genet. Resour. Crop. Evol.,* DOI 10.1007/s1-722-010-9581-5.

Passarino, G., Semino, O., Bernini, L.. & Santachiara-Benerecetti, A.S. 1996. Pre-Caucasoid and Caucasoid genetic features of the Indian population, *American Journal of Human Genetics* **59**, pp. 927-34.

Peasnall, B., 2002. Iranian Neolithic. In P.N. Peregrine & M. Ember (eds), *Encylopedia of Prehistory Volume 8: South and Southwest Asia*. New York (NY): Kluwer Academic/Plenum Publishers, pp. 215-35.

Pedrosa, S., Uzun, M., Arranz, J.J., Gutierrez-Gil, B., San Primitivoi, F. & Bayoni, Y., 2005. Evidence of three maternal lineages in Near Eastern sheep supporting multiple domestication events, *Proceedings of the Royal Society of London B* **272**, pp. 2211–7.

Perkins, D., Jr., 1969. The fauna from Çatal Höyük: evidence for early cattle domestication in Anatolia, *Science* **164**(3876), pp. 177-9.

Perles, C., 2001. *The Neolithic in Greece*. Cambridge: Cambridge University Press.

Perry, W., 1937. *The Growth of Civilization.* Harmondsworth: Penguin.

Peters, J., Helmer, D., Driesch, A., von den & Segui, S., 1999. Early animal husbandry in the northern Levant, *Paleorient* **25**(2), pp. 27-48

Peters, J., Driesch, A., von den & Helmer, D., 2005. The Upper Euphrates-Tigris Basin, cradle of agro-pastoralism? In J.-D. Vigne, J. Peters & D. Helmer (eds), *The First Steps of Animal Domestication.* Oxford: Oxbow Books, pp. 96-124.

Petrone, P.-P., 2000. Mehrgarh: new bio-cultural evidence from the Neolithic graveyard. In M. Taddei & G. de Marco (eds), *South Asian Archaeology 1997*. Rome: Istituto Italiano per l'Africa e l'Oriente, pp. 285-99.

Pettitt, P.B., Davies, W., Gamble, C.S. & Richards, M.B., 2003. Palaeolithic radiocarbon chronology: quantifying our confidence beyond two half-lives. *Journal of Archaeological Science,* **30**(12), pp. 1685-93.

Piazza, A., Rendine, S., Minch, E., Menozzi, P., Mountain, J. & Cavalli-Sforza, L.L., 1995. Genetics and the origin of European languages, *Proc. Natl. Acad. Sci. (USA)* **92**(13), pp. 5836-40.

Pinhasi, R., Fort, J. & Ammerman, A.J., 2005. Tracing the origin and spread of agriculture in Europe, *PLoS Biol.* **3**(12), pp. 2220-9.

Piperno, D.L., Weiss, E., Holst, I. & Nadel, D., 2004. Processing of wild cereal grains in the Upper Palaeolithic revealed by starch grain analysis, *Nature* **430**, pp. 670-3.

Planhol, X. De, 1968. Geography of settlement. In W.B Fisher (ed.), *The Land of Iran.* Cambridge: Cambridge University Press, pp. 294-305.

Plastino, W., Kaihola, L., Bartolomei, P. & Bella, F., 2001. Cosmic background reduction in the radiocarbon measurement by scintillation spectrometry at the underground laboratory of Gran Sasso, *Radiocarbon* **43**(2A), pp. 157-61.

Pluciennik, M. 1998. Deconstructing the 'Neolithic' in the Mesolithic-Neolithic transition. In M. Edmonds & C. Richards (eds.), *Understanding the Neolithic of North-Western Europe*. Glasgow: Cruithne Press, pp. 61-84.

Pollock, S., 2010a. Excavation and site stratigraphy. In Pollock, S., Bernbeck, R. & Abdi, K. (eds), 2010. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut, pp. 31-65.

Pollock, S., 2010b. Radiocarbon dates. In Pollock, S., Bernbeck. R. & Abdi, K. (eds), 2010. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut, pp. 262-4.

Pollock, S., Bernbeck, R, & Abdi, K. (eds), 2010a. *The 2003 Excavations at Tol-e Baši, Iran*. Berlin: Deutsches Archäologisches Institut.

Pollock, S., Bernbeck, R. & Abdi, K., 2010b. *The Excavations at Tol-e Mashi, Iran. Social Life of a Neolithic Village*. Mainz.

Potts, D.T., 2004. Yanik Tepe, *Encyclopaedia Iranica.* [online] Available at http://www.iranica.com/articles/tepe-yahya. Accessed 23/06/11.

Potts, D.T. & Roustaei, K. (eds), 2006. *Mamasani Archaeological Project Stage One.* Tehran: Iranian Centre for Archaeological Research.

Potts, D.T., Roustaei, K., Alamdari, K., Alizadeh, A., Asgari Chaverdi, A. et al., 2005. Eight thousand years of history in Fars Province, Iran, *Near Eastern Archaeology* **68**(3), pp. 84-92.

Potts, D.T., Roustaei, K., Weeks, L.R. & Petrie, C.A., 2006. The Archaeology of southwestern Iran. In D. Potts & Roustaei, K. (eds), *The Mamasani*

Archaeological Project Stage One. Tehran: Iranian Centre for Archaeological Research, pp. 1-17.
Price, T.D., 1995. Social inequality at the origins of agriculture. In T.D. Price & G.M. Feinman (eds), *Foundations of Social Inequality*. New York: Plenum, pp. 129-51.
Price, T.D., 2000. *Europe's First Farmers.* Cambridge: Cambridge University Press.
Price, T.D. & Bar-Yosef, O., 2011. New data, new ideas: an introduction to Supplement 4, *Current Anthropology* **52**(S4), 163-74.
Prickett, M., 1976. Tepe Yahya Project: Upper Rud-i Gushk Survey, *Iran* **14**, pp. 175-6.
Prickett, M., 1986. Settlements during the early periods. In C.C. Lamberg-Karlovsky (ed.), *Excavations at Tepe Yahya, Iran, 1967-75, the Early Periods*. Cambridge (MA): Harvard University Press, pp. 215-47.
Pullar, J., 1979. Tepe Abdul Hosein, *Iran,* **17**, pp. 153-5.
Pullar, J., 1981. Tepe Abdul Hosein, *Iran,* **19**, p. 179.
Pullar, J., 1990. *Tepe Abdul Hosein: A Neolithic Site in Western Iran. Excavated 1978.* Oxford: B.A.R. International Series 563.
Pumpelly, R., 1908. *Explorations in Turkestan: Expedition of 1904.* Washington: Carnegie Institution of Washington.
Purugganan, M.D. & Fuller, D.Q., 2009. The nature of selection during plant domestication, *Nature* **457**, pp. 843-8.
Quintana-Murci, L., Semino, O., Poloni, E.S., Liu, A., Van Gik, M. et al., 1999. Y-Chromosome specific YCAII, DYS19 and YAP polymorphisms in human populations: a comparative study, *Annals of Human Genetics* **63**, pp. 153-66.
Quintana-Murci, L., Krausz, C., Zerjal, T., Sayar, H., Hammer, M.F. et al., 2001. Y-chromosome lineages trace diffusion of people and languages in southwestern Asia, *American Journal of Human Genetics* **68,** pp. 537-42.
Quintana-Murci, L., Chaix, R., Wells, R.S., Behar, D.M>, Sayar, H. et al., 2004. Where west meets east: the complex mtDNA landscape of the southwest and central Asian corridor, *American Journal of Human Genetics* **74**(5), pp. 827-45.
Ralph, E.K., 1955. University of Pennsylvania Radiocarbon dates I, *Science* **121**, pp. 149-51.
Redding, R.W., 1988. A general explanation of subsistence change: from hunting and gathering to food production, *Journal of Anthropological Archaeology* **7**(1), pp. 56-97.
Redding, R.W., 2003. First report on the faunal remains. In A. Alizadeh (ed.), *Excavations at the Prehistoric Mound of Chogha Bonut, Khuzestan, Iran*. Chicago: University of Chicago, pp. 137-49.
Redding, R.W., 2005. Breaking the mold: a consideration of variation in the evolution of animal domestication. In J.-D. Vigne, J. Peters & D. Helmer (eds), *The First Steps of Animal Domestication: New Archaeological Approaches*. Oxford: Oxbow, pp. 41-8.

Redding, R.W. & Rosenburg, M., 1998. Ancestral pigs: a New (Guinea) model for pig domestication in the Near East. In S.M. Nelson (ed.), *Ancestors for the Pigs: Pigs in Prehistory*. Philadelphia: University of Pennsylvania Museum, pp. 65-76.

Redman, C.L., 1978. *The Rise of Civilization: From Early Farmers to Urban Society in the Ancient Near East.* San Francisco: W.H. Freeman & Company.

Reimer, P.J., Brown, T.A. & Reimer, R.W., 2004. Discussion: reporting and calibration of post-bomb ^{14}C data, *Radiocarbon* **46**(3), pp. 1299-304.

Reimer, P.J., Baille, M.G.L., Bard, E. et al., 2009. IntCal09 and Marine09 radiocarbon age calibration curves 0-50,000 years cal BP, *Radiocarbon* **51**(4), pp. 1111-50.

Renfrew, C., 1987. *Archaeology and Language: The Puzzle of Indo-European Origins.* London: Pimlico.

Renfrew, C., 1989. Models of change in language and archaeology, *Transactions of the Philological Society* **87**(2), pp. 103-55.

Renfrew, C., 1992. Archaeology, genetics and linguisitic diversity, *Man* **27**, pp. 445-78.

Renfrew, C., 2000. Concepts in molecular genetics. In C. Renfrew & K. Boyle (eds), *Archaeogenetics: DNA and the Population Prehistory of Europe*. Cambridge: McDonald Institute of Archaeological Research, pp. 3-12.

Renfrew, C., 2001. From molecular genetics to archaeogenetics, *Proc. Natl Acad Sci. (USA)* **98**(9), pp. 4830-2.

Renfrew, C., 2002. The emerging synthesis: the archaeogenetics of farming/language dispersals and other spread areas. In P. Bellwood & C. Renfrew (eds), *Examining the Farming/Language Dispersal Hypothesis*. Cambridge: McDonald Institute of Archaeological Research, pp. 1-16.

Renfrew, C., 2003. The linguistic transition in Europe: linguistic aspects. In A.J. Ammerman & P. Biagi (eds), *The Widening Harvest. The Neolithic Transition in Europe: Looking Back, Looking Forward.* Boston: Archaeological Institute of America, pp. 327-6.

Renfrew, C. & Bellwood, P. (eds), 2002. *Examining the Farmer/Language Dispersal Hypothesis.* Cambridge: McDonald Institute for Archaeological Research.

Richards, M., 2003a. The Neolithic transition in Europe: archaeological models and genetic evidence, *Documenta Praehistorica* **30**, pp. 159-67.

Richards, M., 2003b. The Neolithic invasion of Europe, *Annual Review of Anthropology* **32**, pp. 135-62.

Richerson, P.J., Boyd, R. & Bettinger, R.L., 2001. Was agriculture impossible during the Pleistocene but mandatory during the Holocene? A climate change hypothesis, *American Antiquity* **66**, pp. 387-411.

Richards, M., Macaulay, V., Bandelt, H.J. & Sykes, B.C., 1998. Phylogeography of mitochondrial DNA in western Europe, *Annals of Human Genetics* **62**(3), pp. 241-60.

Richards, M., Corte-Real, H., Foster, P. et al. 1996. Paleolithic and Neolithic lineages in the European mitochondrial gene pool, *American Journal of Human Genetics* **59**, pp. 185-203.

Richards, M., Macaulay, V., Sykes, B. et al., 1997. Reply to Cavalli-Sforza & Minch, *American Journal of Human Genetics* **61**, pp. 251-4.

Richards, M., Macaulay, V., Hickey, E. et al., 2000. Tracing European founder lineages in the Near Eastern mtDNA pool, *American Journal of Human Genetics* **67**, pp. 1251-76.

Rindos, D., 1980. Symbiosis, instability and the origins and spread of agriculture, *Current Anthropology* **21**, pp. 751-72.

Rindos, D., 1984. *The Origins of Agriculture: An Evolutionary Perspective.* London: Academic Press Inc.

Rindos, D., 1986. Darwinism and its role in the explanation of domestication. In D.R. Harris & G.C. Hillman (eds), *Foraging and Farming: The Evolution of Plant Exploitation*. London: Unwin Hyman, pp. 28-41.

Robb, J., 1991. Random causes with directed effects: the Indo-European language spread and the stochastic loss of lineages, *Antiquity* **65**(2), pp. 287-91.

Robb, J., 1993. A social prehistory of European languages, *Antiquity* **67**(4), pp. 747-60.

Robb, J. & Miracle, P., 2007. Beyond 'migration' versus 'acculturation': new models for the spread of agriculture, *Proceedings of the British Academy* **144**, pp. 99-115.

Roberts, N. & Wright, H.E., Jr, 1993. The Near East and southwest Asia. In H.E. Wright, Jr, Kutzbach, J.E., Webb, T., III et al. (eds), *Global Climates Since the Last Glacial Maximum*. Minneapolis: University of Minnesota Press, pp. 194-220.

Rollefson, G.O., 2001. 2001: An archaeological odyssey, *Cambridge Archaeological Journal* **11**(1), pp. 114-17.

Rossen, A. & Weiner, S., 1994. Identifying ancient irrigation: a new method using opaline phytoliths from emmer wheat, *Journal of Archaeological Science* **21**, pp. 125-32.

Rossenburg, M. & Redding, R.W., 2000.Hallan Cemi and early village organization in eastern Anatolia. In I. Kujit (ed.), *Life in Neolithic Farming Communities: Social Organization, Identity and Differentiation.* New York: Plenum, pp. 39-61.

Rossenburg, M., Nesbitt, M., Redding, R.W. & Peasnall, B.L., 1998. Hallan Çemi, pig husbandry, and post-Pleistocene adaptions along the Taurus-Zagros arc (Turkey), *Paleorient* 24(91), pp. 25-41.

Rosser, Z.H., Zerjal, T., Hurles, M.E. et al., 2000. Y-chromosomal diversity in Europe is clinal and influenced primarily by geography, rather than by languge. *American Journal of Human Genetics* **67**, pp. 1526-43.

Rothman, M.S., 2003. Ripples in the stream: Transcausian-Anatolian interaction in the Murat/Euphrates basin at the beginning of the third millennium BC. In Smith, A.T. & Rubinson S. (eds), *Archaeology in the Borderlands:*

Investigation in Caucasia and Beyond. Los Angeles: Cotsen Institute Monograph 47, pp. 95-110.
Rowley-Conwy, P., 2004. How the west was lost (and comments), *Current Anthropology* **45**(S4), pp. 83-113.
Russell, N., 1995. The bone tool industry at Mehrgarh and Sibri. In C. Jarrige et al. (eds), *Mehrgarh: Field Reports 1974-1985 From Neolithic Times to the Indus Civilization*. Sindh: Department of Culture and Tourism, Government of Sindh, Pakistan, pp. 583-614.
Russell, N., Martin, L. & Buitenhuis, H., 2005. Cattle domestication at Çatalhöyük revisited, *Current Anthropology* **46**(suppl. 5), pp. 101-8.
Sahlins, M., 1972. *Stone Age Economics.* Piscataway: Aldine Transaction.
Sahlins, M., 2005. The Original Affluent Society, http://www.primitivism.com/original-affluent.htm. Accessed 20/099/11.
Sahoo, S., Singu, A., Himabindu, G. et al., 2006. A Prehistory of Hindian Y chromosomes: Evaluating demic diffusion scenarios, *Proc. Natl Acad. Sci. (USA)* **103**(4), pp. 843-8.
Schmidt, A. & Fazeli, H., 2006. Tepe Ghabristan: a Chalcolithic tell buried in alluvium, *Archaeological Prospection* **14**(1), pp. 38-46.
Schmidt, A., Quigley, M., Fattahi, M. et al., 2011. Holocene settlement shifts and palaeoenvironments on the Central Iranian Plateau: investigating linked systems, *The Holocene* **21**(4), pp. 583-95.
Schmidt, E.F., 1935a. Excavation at Ray, *Bulletin of the University Museum* **5**(4), 25-7.
Schmidt, E.F., 1935b. The Persian Expedition, *Bulletin of the University Museum* **5**(5), 41-9.
Schmidt, E.F., 1936. Rayy research 1935, part 1, *Bulletin of the University Museum* **6**(3), pp. 79-87.
Schmidt, E.F., 1953. *Persepolis I: Structures, Reliefs, Inscriptions.* Chicago (IL): Chicago University Press.
Schmidt, E.F., 1957. *Persepolis II: Contents of the Treasury and Other Discoveries.* Chicago (IL): University of Chicago Press.
Schmidt, E.F., 1970. *Persepolis III: The Royal Tombs and Other Monuments.* Chicago (IL): Chicago University Press.
Scott, E.M., 2003. The Fourth International Radiocarbon Intercomparison (FIRI), *Radiocarbon* **45**, pp. 135-285.
Scott, E.M., Aitchison, T.C., Harkness, D.D. et al., 1989. An interim progress report on stages 1 and 2 of the international collaborative program, *Radiocarbon* **31**(3), pp. 414-21.
Sellier, P., 1995. Physical anthropology and funerary practises. In C. Jarrige et al. (eds), *Mehrgarh Field Reports 1974-1985 From Neolithic Times to the Indus Civilization.* Sindh: The Department of Culture and Tourism, Government of Sindh, Pakistan, pp. 404-8, 519-22.
Semino, O., Magri, C., Benuzzi, G. et al. 2004. Origin, diffusion and differentiation of Y-chromosome haplogroups E and J: inferences on the Neolithization of

Europe and later migratory events in the Mediterranean area, *American Journal of Human Genetics* **74**, pp. 1023-34.
Semino, O., Passarino, G., Brega, A. et al., 1996. A view of the Neolithic demic diffusion in Europe through two Y chromosome-specific markers, *American Journal of Human Genetics* **59**(4), pp. 964-8.
Semino, O., Passarino, G., Oefner, P.F. et al., 2000. The genetic legacy of Paleolithic *Homo sapiens sapiens* in extant Europeans: a Y chromosome perspective, *Science* **290**, pp. 1155-9.
Semino, O., Magri, C., Benuzzi, G., Lin, A.A., Al-Zahery, N. et al. 2004. Origin, diffusion and differentiation of Y-chromosome haplogroups E and J: Inferences on the Neolithization of Europe and later migratory events in the Mediterranean area*, Am. J. Hum Genet*. **74**, pp. 1023-34.
Sengupta, S., Zhivotovsky, L.A., King, R. et al., 2005. Polarity and temporality of high resolution Y-chromosome distributions in India identify both indigenous and exogenous expansions and reveal minor genetic influence of Central Asia Pastoralists, *American Journal of Human Genetics* **78**, pp. 202-21.
Shennan, S., 2009. Evolutionary demography and the population history of the European Early Neolithic, *Human Biology* **81**(2/3), pp. 339-55.
Sherratt, A., 1972. Socio-economic and demographic models for the Neolithic and Bronze Age of Europe. In D.L. Clark (ed.), *Models in Archaeology*. London: Metheun, pp. 477-542.
Sherratt, A., 1980. Water, soil and seasonality in early cereal cultivation, *World Archaeology* **11**(3), pp. 313-30.
Sherratt, A., 1997. Climatic cycles and behavioral revolutions: the emergence of modern humans and the beginning of farming, *Antiquity* **71**, pp. 271-87.
Sherratt, A., 2003. Fractal farmers: patterns of Neolithic origin and dispersal. In J. Cherry, C. Scarre, & S. Shennan (eds), *Explaining Social Change: Studies in Honour of Colin Renfrew*. Cambridge: McDonald Institute for Archaeological Research, pp. 53-65.
Sherratt, A., 2007. Diverse origins: regional contributions to the genesis of farming. In S. Colledge & J. Connally (eds),*The Origins and Spread of Domestic Plants in Southwest Asia and Europe*. London: Publications of the Institute of Archaeology, UCL, pp. 1-20.
Sherratt, A. & Sherratt, S., 1988. The archaeology of Indo-European: An alternative view, *Antiquity* **62**, pp. 584-95.
Simmons, A.H., 2007. *The Neolithic Revolution in the Near East.* Tucson: The University of Arizona Press.
Simpson, I.A. & Nejad, M.G., 2008. Field-based geoarchaeological investigations, Sialk, Plain of Kashan, Iran, unpub. report, Geoarchaeology Research Cluster, University of Sterling.
Skellam, J.G., 1951. Random dispersal in theoretical populations, *Biometrika* **38**, pp. 196-218.

Smith, B.D., 2001. The transition to food production. In G.M. Feinman & T.D. Price (eds), *Archaeology at the Millennium: A Source Book*. New York: Springer, pp. 199-230.
Smith, P.E.L., 1967. Ghar-i-Khar and Ganj-i Dareh, *Iran* **5**, pp. 138-9.
Smith, P.E.L., 1968. Ganj Dareh Tepe, *Iran* **9**, pp. 158-60.
Smith, P.E.L., 1972. Ganj Dareh Tepe, survey of excavation in Iran during 1970-71, *Iran* **10**, pp. 165-8.
Smith, P.E.L., 1974. Ganj Dareh Tepe, *Paleorient* **2**(1), pp. 207-9.
Smith, P.E.L., 1975. Ganj Dareh Tepe. Survey of excavation, 1973-4, *Iran* **13**, pp. 178-80.
Smith, P.E.L., 1978. An interim report on Ganj Dareh Tepe, Iran, *American Journal of Archaeology* **82**, pp. 538-40.
Smith, P.E.L., 1990. Architecture innovation and experimentation at Ganj Dareh, Iran, *World Archaeology* **21**(3), pp. 323-35.
Smith, P.E.L. & Young, T.C. Jr, 1972. The evolution of early agriculture and culture in Greater Mesopotamia: a trial model. In B.J. Spooner (ed.), *Population Growth: Anthropological Implications*. Cambridge (MA): Massachusetts Institute of Technology Press, pp. 1-59.
Smith, P.E.L. & Young, T.C. Jr, 1983. The force of numbers: population pressure in the central western Zagros. In T.C. Young, Jr, P.E.L. Smith & P. Mortensen (eds), *The Hilly Flanks and Beyond: Essays on the Prehistory of Southwestern Asia.* Chicago: Oriental Institute University of Chicago.
Snyder, J.A., Wasylik, K., Fritz, S.C. & Wright, H.E., Jr, 2001. Diaton-based conductivity reconstruction and palaeoclimatic interpretation of a 40-ka record from Lake Zeribar, Iran, *Holocene* **11**, pp. 737-46.
Sokal, R.R., Oden, N.L. & Thomson, B.A., 1999. A problem with synthetic maps, *Human Biology* **71**, pp. 1-13.
Sokal, R.R., Oden, N.L. & Wilson, C., 1991. Genetic evidence for the spread of agriculture in Europe by demic diffusion, *Nature* **351**(6322), pp. 143-5.
Sokal, R.R., Oden, N.L. & Wilson, C., 1992. Patterns of population spread, *Nature* **355**(6357), p. 214.
Solecki, R.S., 1969. Survey in western Azerbaijan. *Iran* **7**, 189-90.
Soares, P., Achilli, A., Semino, O., Davies, W., Macaulay, V., et al. 2010. The archaeogenetics of Europe, *Current Biology* **20**, pp. R174-83.
Spriggs, M., 1989. The dating of the Island Southeast Asian Neolithic: an attempt at chronometric hygiene and linguistic correlation, *Antiquity* **63**(3), pp. 587-613.
Spriggs, M. & Anderson, A., 1993. Late Colonization of East Polynesia, *Antiquity* **67**, pp. 200-19.
Srivastava, V.C., 2008. Origin and beginning of agriculture in Indian borderland: the case of Afghanistan. In L. Gopal & V.C. Srivastava (eds), *History of Agriculture in India (up to c.1200 AD).* New Delhi: PHISPC: Centre for Studies in Civilizations, pp. 100-6.
Stampfli, H.R., 1983. The fauna of Jarmo, with notes on animal bones from Matarrah, the ‘Amuq and Karim Shahir. In L.S. Braidwood et al. (eds),

Prehistoric Archaeology Along the Zagros Flanks. Chicago: Chicago University, pp. 431-84.
Steele, J., 2009. Human dispersals: mathematical models for the archaeological record, *Human Biology* 81(2/3), pp. 121-40.
Stein, A., 1940. *Old Routes of Western Iran*. New York: Greenwood Press.
Stevens, L.R., Wright, H.E., Jr, & Ito, E., 2001. Proposed changes in seasonality of climate during the Lateglacial and Holocene at Lake Zeribar, Iran, *Holocene* **11**, pp. 747-55.
Stevens, L.R., Ito, E., Schmalb, A. & Wright, H.E., Jr, 2006. Timing of atmospheric precipitation in the Zagros Mountains inferred from a multi-proxy record from Lake Mirabad, Iran, *Quaternary Research* **66**, pp. 494-500.
Straus, L., 2004. Response to Rowley-Conwy 2004, *Current Anthropology* **45**(S4), pp. 104-5.
Sudupak, M.A., Akkaya, M.S. & Kence, A., 2004. Genetic relationships among perennial and annual *Cicer* species growing in Turkey assessed by AFLP fingerprinting, *Theoretical and Applied Genetics* **108**(5), pp. 937-44.
Sumner, W.M., 1990. Full-coverage regional survey in the Near East: an example from Iran. In S.K. Fish & S.A. Kowalewski (eds), *The Archaeology of Regions: A Case for Full-Coverage Survey*. Washington (DC): Smithsonian Institution Press, pp. 87-115.
Sykes, B., 1999. The molecular genetics of European ancestry, *Philosophical Transactions of the Royal Society of London B* **345**, pp. 131-40.
Sykes, B., 2003. European ancestry: The mitrochondrial landscape. In A.J. Ammerman & P. Biagi Boston (eds), *The Widening Harvest the Neolithic Transition in Europe: Looking Back, Looking Forward*. Boston (MA): Archaeological Institute of America, pp. 315-27.
Tanno, K.I. & Willcox, G., 2006a. The origins of cultivation of *Cicer arietinum* L. and *Vicia faba* L.: early finds from Tell el-Kerkh, north-west Syria, late 10th millennium BP, *Vegetational History and Archaeobotany* **15**, pp. 197-204.
Tanno, K.I & Willcox, G., 2006b. How fast was wild wheat domesticated? *Science* **311**, p.1886.
Taylor, R.E., 1997. Radiocarbon dating. In R.E. Taylor & M.J. Aitken (eds), *Chronometric Dating in Archaeology*. New York: Plenum Press, pp. 65-96.
Tenberg, M., 2003. The archaeobotanical project at Tepe Sialk: a preliminary report. In S. Malek Shahmirzadi (ed.), *The Silversmiths of Sialk*. Tehran: Iranian Centre of Archaeolgoical Research, pp. 9-11.
Tenberg, M., 2004. Archaeobotanical analysis at Tepe Sialk: results from the 2003/4 season. In S. Malek Shahmirzadi (ed.), *The Potters of Sialk*. Tehran: Iranian Centre of Archaeological Research, pp. 25-32.
Thomas, J., 1998. Towards a regional geography of the Neolithic. In M. Edmonds & C. Richards (eds), *Understanding the Neolithic of North-Western Europe*. Glasgow: Cruithne Press, pp. 37-61.

Thornton, C., 2009. The emergence of complex metallurgy on the Iranian Plateau: escaping the Levantine Paradigm, *Journal of World Prehistory* **22**(3): pp. 301-27.

Thornton, C., 2010. Sang-e Chakhmaq, *Encylopaedia Iranica.* [online] Available at www.iranica.com/articules/sang-chakmaq. Accessed 24/4/11.

Tite, M.S., Bowman, S.G.E., Ambers, J.C. & Matthews, K.J., 1987. Preliminary statement on an error in Britism Museum radiocarbon dates (BM-1700 to BM-2315), *Antiquity* **61**, p. 168.

Torroni, A., Bandelt, H.-J., D'Urbano, L. et al., 1998. mtDNA analysis reveals a major late Paleolithic population expansion from southeastern to northeastern Europe, *The American Journal of Human Genetics* **62**, pp. 1137-52.

Torroni, A., Bandelt, H.-J., Macaulay, V. et al., 2001. A signal, from human mtDNA, of postglacial recolonization in Europe, *American Journal of Human Genetics* **69**, pp. 844-52.

Tringham, R., 2000. Southeastern Europe in the transition to agriculture in Europe: bridge, buffer or mosaic. In T.D. Price (ed.), *Europe's First Farmers*. Cambridge: Cambridge University Press, pp. 19-56.

Tsuneki, A, & Zeidi, M., 2008 (eds), *Tang-e Bolaghi: The Iran-Japan Archaeological Project for the Sivand Dam Salvage Area.* Ibaraki: University of Tsukuba, Studies for West Asian Archaeology.

Turnball, P.F. & Reed, C.A., 1974. The fauna from the Terminal Pleistocene of Palegawra Cave: a Zarzian occupation site in northeast Iraq, *Fieldiana Anthropology* **63**(3), pp. 81-146.

Turney, C.S.M., Coope, G.R., Harkness, D.D. et al., 2000. Implications for the dating of Wisconsinian (Weichselian) Lateglacial events of systematic radiocarbon age differences between terrestrial plant macrofossils from a site in SW Ireland, *Quaternary Research* **53**, pp. 114-21.

Uerpmann, H.-P., 1978. Metrical analysis of faunal remains from the Middle East. In R.H. Meadow & M.A. Zeder (eds), *Approaches to Faunal Analysis in the Middle East*. Cambridge (MA): Peabody Museum, pp. 41-5.

Underhill, P.A., 2003. Inference of Neolithic population histories using Y-chromosome haplotypes. In C. Renfrew & P. Bellwood (eds), *Examining the Farming/Language Dispersal Hypothesis*. Cambridge: McDonald Institute for Archaeological Research, pp. 65-78.

Underhill, P.A., 2004. Inferring human history: clues from Y-chromosome haplotypes, *Cold Harbor Symposia on Quantiative Biology* **68**, pp. 487-93.

Underhill, P.A., Passarion, G., Lin, A.A. et al., 2001. The phylogeography of Y-chromosome binary haplotypes and the origins of modern human populations, *Annals of Human Genetics* **65**, pp. 43-62.

Vanden Berghe, L., 1952. Archaeologische opzoekingen in de Marv Dasht vlakte (Iran), *Jaarbericht ex Oriente Lux* **12**, pp. 212-20.

Vanden Berghe, L., 1954. Archaeologische navorsingen in de omstreken van Persepolis, *Jaarbericht ex Oriente Lux* **13**, pp. 394-408.

Vanden Berghe, L. 1959. *Archéologie de l'Iran Ancien*. Leiden: Brill.

Veen, M. van der, 2010. Agricultural innovation: invention and adoption or change and adaptation, *World Archaeology* **42**(1), pp. 1-12.
Vandiver, P., 1995. The production technology of early pottery at Mehrgarh. In C. Jarrige et al. (eds), *Mehrgarh Field Reports 1974-1985*. Karachi: The Department of Culture and Tourism, Government of Sindh, pp. 648-61.
Vigne, J.-D., Carrere, I., Briois, F. & Guilaine, J., 2011. The early process of mammal domestication in the Near East: new evidence from the pre-Neolithic and pre-pottery Neolithic in Cyprus, *Current Anthropology* 54(S4), pp. 255-71.
Vita-Finzi, C., 1968. Late Quaternary alluvial chronology, *Geologische Rundschau* **58**(2), pp. 951-73.
Voigt, M.M., 1983. *Hajji Firuz Tepe, Iran: The Neolithic Settlement.* Pennsylvania: University of Pennsylvania.
Voigt, M.M. & Dyson, R.H., 1992. The chronology of Iran ca. 8000-2000 BC. In R.W. Ehrich (ed.), *Chronologies in Old World History*. Chicago: University of Chicago Press, pp. 122-78.
Walker, M.J.C., Coope, G.R., Harkness, D.D. & Lowe, J.J., 1999. Can AMS radiocarbon measurements provide a more reliable chronology than Beta counting for the Last Glacial-Interglacial transition? *Final Report on Natural Environment Research Council Grant*.
Waterbolk, H.T., 1960. The 1959 carbon-14 symposium at Groningen, *Antiquity* **34**(1), pp. 14-8.
Watkins, T., 1997. The Human Environment, *Paleorient* **23**(2), pp. 263-70.
Watkins, T., 2001. Response. *Cambridge Archaeological Journal* **11**(1), pp. 117-19.
Watson, P.J., 1983. A note on the Jarmo plant remains. In L.S. Braidwood et al. (eds), *Prehistoric Archaeology Along the Zagros Flanks*. Chicago: University of Chicago Press, pp. 501-5.
Wasylikowa, K., Witkowski, A., Walanus, A. et al., 2006: Palaeolimnology of Lake Zeribar, Iran, and its climatic implications, *Quaternary Research* **66**, pp. 477–93.
Weeks, L., Alizadeh, K.S., Niakan, L. et al., 2006. Excavations at Tol-e Nurabad. In D.T. Potts & K. Roustaei (eds), *The Mamasani Archaeological Project Stage One*. Tehran: Iranian Centre for Archaeological Research, pp. 31-88.
Weiss, E. & Zohary, D., 2011. The Neolithic Southwest Asian founder crops: their biology and archaeobotany, *Current Anthropology* **52**(suppl. 4), pp. 237-54.
Weiss, E., Kislev, M.E. & Hartmann, A., 2006. Autonomous cultivation before domestication, *Science* **312**, pp. 1608-10.
Wilkinson, T., 2003. *Archaeological Landscapes of the Near East*. Arizona: The University of Arizona Press.
Willcox, G., 1990. Charcoal remains from Tepe Abdul Husein. In J. Pullar (ed.), *Tepe Abdul Hosein: A Neolithic site in Western Iran Excavations 1978*. Oxford: B.A.R. International Series 563, pp. 223-9.
Willcox, G., 2005. The distribution, natural habitats and availabilty of wild cereals in relation to their domestication in the Near East: multiple events, multiple centers, *Vegetation History and Archaeobotany* **14**, pp. 534-41.

Willcox, G. & Tanno, K., 2006. Response to “How and when was wild wheat domesticated?”, *Science* **313**(5785), pp. 296-7.
Willcox, G., Buxo, R. & Herveux, L., 2009. Late Pleistocene and Early Holocene climate and the beginning of cultivation in northern Syria, *Holocene* **19**(1), pp. 151-8.
Willcox, G., Fornite, S. & Herveux, L., 2008. Early Holocene cultivation before domestication in northern Syria, *Vegetation History and Archaeobotany* **17**(3), pp. 313-25.
Wilson, J.F., Weiss, D.A., Richards, M., Thomas, M.G., Bradman, N. & Goldstein, D.B., 2001. Genetic evidence for different male and female roles during cultural transitions in the British Isles, *PNAS USA* **98**, pp. 5078-83.
Wong, E.H., Petrie, C.A. & Fazeli, H., 2010. Cheshmeh Ali ware: a petrographic and geochemical study of a Transitional Chalcolithc period ceramic industry on the northern central plateau of Iran, *Iran* **48**, pp. 11-26.
Wright, H.E., Jr, 1968. Natural environment of early food production north of Mesopotamia, *Science* **161**(3839), pp. 334-9.
Wright, H.E., Jr, 1969. Tepe Farukhabad, *Iran* **7**, pp. 172-3.
Wright, H.E., Jr, 1976. The environmental settings for plants domestication in the Near East, *Science* **194**(4263), pp. 385-9.
Wright, H.E., Jr., 1993. Environmental determinism in Near Eastern Prehistory, *Current Anthropology* **34**(4), pp. 458-71.
Wright, H.E., McAndrews, J.H & Zeist, W. van, 1967. Modern pollen rain in western Iran, and its relation to plant geography and Quaternary vegetational history, *Journal of Ecology* **55**, pp. 415-53.
Wright, H.T., 1981. *An Early Town on the Deh Luran Plain: Excavation at Tepe Farakhabad.* Ann Arbor (MI): Memoirs of the Museum of Anthropology University of Michigan Number 13.
Wulff, H.E., 1968. The *qanats* of Iran, *Scientific American* **219**(1), pp. 94-105.
Young, R. & Fazeli, H., 2008. Interpreting animal bones in Iran: considering new animal bone assemblages from three sites in the Qazvin Plain within a broader geographical and chronological perspective, *Paleorient* **34**(2), pp. 153-72.
Young, T.C., Jr, 1962. Taking the history of the Hassanlu area back another 5000 years, *Illustrated London News* **241**, pp. 707-9.
Young, T.C., Jr, 1966. Survey in western Iran, 1961, *Journal of Near Eastern Studies* **24**(5), pp. 228-39.
Young T.C., Jr & Weiss, H., 1974. The Godin Project, *Iran* **12**, pp. 207-11.
Zeder, M.A., 1999. Animal domestication in the Zagros: a review of past and current research, *Paleorient* **25**(2), 11-25.
Zeder, M.A., 2001a. ‘Feast or forage, the transition to agriculture in the Near East’. Paper presented at the Annual Meetings of the Society for American Archaeology, New Orleans.

Zeder, M.A., 2001b. A metrical analysis of a collection of modern goats (*Capra hircus aegargus* & *C. h. hircus*) from Iran and Iraq: implications for the study of caprine domestication, *Journal of Archaeological Science* **28**(1), pp. 61-79.
Zeder, M.A., 2006a. A critical examination of markers of initial domestication in goats (*Capra hircus*). In M.A. Zeder et al. (eds), *Documenting Domestication: New Genetic and Archaeological Paradigms*. Berkeley: University of California Press, pp. 108-208.
Zeder, M.A., 2006b. Central questions in the domestication of plants and animals, *Evolutionary Anthropology* **15**, pp. 105-17.
Zeder, M.A., 2008a. Animal domestication in the Zagros: an update and directions for future research. In E. Vila et al. (eds), *Archaeozoology of the Near East VIII*. Lyon: Travaux de la Maison de l'Orient et de la Mediterranean (TMO), pp. 243-78.
Zeder, M.A., 2008b. Domestication and early agriculture in the Mediterranean basin: origins, diffusion and impact, *Proc. Natl Acad. Sci. (USA)* **105**(33), pp. 11597-604.
Zeder, M.A., 2009. The Neolithic macro-(r) evolution: macroevolutionary theory and the study of culture change, *Journal of Archaeological Research* **17**(1), pp. 1-63.
Zeder, M.A., 2011. The origins of agriculture in the Near East, *Current Anthropology* **52**(S4), pp. 221-35.
Zeder, M.A. & Hesse, B., 2000. The initial domestication of goats (*Capra hircus*) in the Zagros Mountains 10,000 years ago, *Science* **287**(5461), pp. 2254-7.
Zeder, M.A. & Smith, B.D., 2009. A conversation on agricultural origins: talking past each other in a crowded room, *Current Anthropology* **50**(5), pp. 681-92.
Zeder, M.A., Emshwiller, E., Smith, B.D. & Bradley, D.G., 2006. Documenting domestication: the intersection of genetics and archaeology, *Trends in Genetics* **22**(3), pp. 139-55.
Zeist, W. van & Wright, H.E., Jr, 1963. Preliminary pollen studies at Lake Zeribar, Zagros Mountains, southwestern Iran, *Science* **140**(3562), pp. 65-7.
Zeist, W. van & Bottema, S., 1977. Palynological investigations in western Iran, *Palaeohistorica* **19**, pp. 19-85.
Zeist, W. van & Bottema, S., 1991. *Late Quaternary Vegetation of the Neat East.* Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A. Wiesbaden: Ludwig Reichery Verlag.
Zilhao, J., 1993. The spread of agro-pastoral economies across Mediterranean Europe: a view from the Far West, *Journal of Mediterranean Archaeology* **6**(1), pp. 5-63.
Zilhao, J., 2000. From the Mesolithic to the Neolithic in the Iberian Penninsula. In T.D. Price (ed.), *Europe's First Farmers*. Cambridge: Cambridge University Press, pp. 144-82.
Zohary, D., 1992. Domestication of the Neolithic Near Eastern crop assemblage. In P.C. Anderson (ed.), *Prehistoire de l'Agriculture Nouvelles approches*

experimentales et ethnographiques. Paris: Centre National de la Recherche Scientifique, pp. 81-6.

Zohary, D., 1996. The mode of domestication of the founder crops of southwest Asian agriculture. In D.R. Harris (ed.), *The Origins and Spread of Pastoralism in Eurasia*. London: UCL Press, pp. 149-59.

Zohary, D. & Harlan, J.R., 1966. Distribution of wild wheats and barley, *Science* **153**(3740), pp. 1074-80.

Zohary, D. & Hopf, M., 1988. *Domestication of Plants in the Old World, the Origin and Spread of Cultivated plants in West Asia, Europe and the Nile Valley.* Oxford: Clarendon Press.

Zvelebil, M. (ed.), 1986. *Hunters in Transition*. Cambridge: Cambridge University Press.

Zvelebil, M., 1993. Hunters of farmers? The Neolithic and Bronze Age societies of north-east Europe. In J. Chapman & P. Dolukhanov (eds), *Cultural Transformations and Interactions in Eastern Europe.* Aldershot: Avebury, pp. 146-62.

Zvelebil, M., 1998a. Agricultural frontiers, Neolithic origins and the transition to farming in the Baltic Basin. In M. Zvelebil, L. Domanska & R. Dunnel (eds), *Harvesting the Sea, Farming the Forest: the Emergence of Neolithic Societies in the Baltic Region*. Sheffield: Sheffield Academic Press, pp. 9-27.

Zvelebil, M., 1998b. Genetic and cultural diversity in Europe: a comment on Cavalli-Sforza, *Journal of Anthropological Research* **54**(3), pp. 411-17.

Zvelebil, M., 1998c. What's in a name: the Mesolithic, the Neolithic, and the social change at the Mesolithic-Neolithic transition. In M. Edmonds & C. Richards (eds)*, Understanding the Neolithic of North-Western Europe*. Glasgow: Cruithne, pp. 1-37.

Zvelebil, M., 2000a. Transitions to agriculture in Eastern Europe. In T.D. Price (ed.), *Europe's First Farmers*. Cambridge: Cambridge University Press, pp. 57-92.

Zvelebil, M., 2000b. The social context of the agricultural transition. In C. Renfrew & K. Boyle (eds), *Archaeogenetics: DNA and the Population Prehistory of Europe*. Cambridge: McDonald Institute for Archaeological Research, pp. 57-79.

Zvelebil, M., 2002. Demography and dispersal of early farming populations at the Mesolithic-Neolithic transition: linguistic and genetic implications. In P. Bellwood & C. Renfrew (eds), *Examining the Farming/Language Dispersal Hypothesis*. Cambridge: McDonald Institute for Archaeological Research, pp. 379-95.

Zvelebil, M. & Rowley-Conwy, P., 1984. Transition to farming in northern Europe: a hunter gatherer perspective, *Norwegian Archaeological Review* **17**(2), pp. 104-28.

Zvelebil, M. & Rowley-Conwy, P., 1986. Foragers and farmers in Atlantic Europe, in M. Zvelebil (ed.), *Hunters in Transition*. Cambridge: Cambridge University Press, pp. 67-93.

Zvelebil, M. & Zvelebil, K.V., 1988. Agricultural transition and Indo-European dispersals, *Antiquity* **62**, pp. 574-83.

Webpages

ECO Geoscience Database, http://www.ecogeodb.com/ECO_Detail.asp?P=Soil&CN=Iran&C=IRN. Accessed 10/05/2012.

http://www2.demis.nl/mapserver/mapper.asp. Accessed 10/05/2012.

Illegal constructions threaten Tepe Sialk, 2006. CAIS Archaeological & Cultural News of Iranian World, *The Circle of Ancient Iranian Studies* [online] Available at http://www.cais-soas.com/News/2006/July2006/25-07.htm. Accessed 22/09/11.

Iranian Centre for Archaeological Research (ICAR), 2008. History of archaeology in Iran. [online] Available at http://en.icar.ir/documents/document/0/11587/ICAR.aspx. Accessed 05/02/11.

The Central Zagros Archaeological Project: Investigating the Neolithic in Western Iran. [online] Available at http://www.czap.org/sheikh.php. Accessed 22/09/11.