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‘Culture’, innovation and interaction across southern Iran from the Neolithic to the Bronze Age (c.6500-3000 BC)

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Abstract

Southern Iran saw profound socio-economic and political transformations between 6500 and 3000 BC, which are marked by a series of innovations in ceramic production. This paper looks at the pace and nature of change in prehistoric ceramic technology and decorative style to investigate the relationships between processes of culture change, innovation and transmission. It is noted that the dynamics of culture change across the diverse cultural and physical geography of Southern Iran are marked by a complex pattern of rapidly dispersing major technological innovations followed by protracted periods where there is evidence for regionally distinctive stylistic elaboration of vessel decoration and form. The multifaceted and variable relationships between people, material culture, technology, style and landscapes have the potential to provide insight into the dynamics of culture change.

Keywords

Culture, technology, innovation, ceramics, Iran, prehistory

I. Introduction

Throughout prehistory, southern Iran was a key route for interaction, communication and the dispersal of innovation from west to east, and east to west (e.g. Lamberg-Karlovsky 1978, 1989; Renfrew 1996: Fig. 5.2; Sherratt 1997: Fig. 0.2; Weeks et al. 2006b: 24). This extensive region saw profound socio-economic and political transformations between 6500 and 3000 BC as the earliest village based societies progressively became more complex, and this culminated in the rise of the first cities in Iran. Amongst other things, these transformations are marked by a series of innovations in ceramic production technology, including approaches to vessel forming, decoration, and firing. Although constituting just one aspect of a larger cultural milieu, the major developments in ceramic technology and style are widely used to delineate individual chronological periods throughout southern Iran, and these in turn typically demarcate phases of culture change.

The approaches used to produce the earliest pottery in the ceramic Neolithic period (c.6500-5000 BC) of southern Iran were remarkably similar across a geographical area that stretched from the lowlands of Khuzestan in the west, through the various intermontane valleys of Fars, to the plains of Kerman to the east, and beyond (Figure 1). These vessels were hand formed most probably using a version of Sequential Slab Construction (SSC), and Vandiver (1995) has shown that this technology was actually used across a larger area stretching from the Central Western Zagros to Pakistani Baluchistan (also Petrie et al. in prep). The surface was then covered with a layer of finer clay, slipped, and/or decorated before being fired at a relatively low temperature. During the Chalcolithic period (c.5000-3000 BC) there were innovations in production technology that saw a similarly widespread distribution, including shifts in the types of raw materials used and marked increases in the firing temperatures that were achieved. In time the use of rotation in the forming process becomes more marked, and there was ultimately a shift to the use of fast wheels and the mass production of certain forms. Although these technologies were utilised contemporaneously in different regions over protracted periods, the ceramic vessels that were being made in each region during each phase typically display distinctive and idiosyncratic decorative motifs and painting styles.

This paper looks at the pace and nature of change in prehistoric ceramic technology and decorative style as a way of exploring the processes of culture change, innovation and transmission. The archaeological record of the regions that comprise southern Iran appears to be characterised by repeated cycles of technological innovation and conservatism in ceramic production that occur across a landscape marked by regionally distinct approaches to style. In the early-mid 20th century, archaeologists working in Iran assumed that the concordance of distinct decorative styles and specific geographic areas indicated the existence of regionally distinct archaeological "cultures". More recent approaches avoid such explicit associations, but many of the prevailing interpretations of culture change in southern Iran verge on adopting a culture-historical standpoint, and processes such as migration are often put forward as an explanation for change (e.g. Alden 1982; Alizadeh 1992, 2006, 2008). In fact, studies looking at territories, boundaries and cultures during the Neolithic period throughout the Near East are seeing a resurgence (e.g. Kozlowski and Aurenche 2005). Although it is not always explicitly articulated, the concept of the archaeological culture still holds currency, and throughout prehistory the material culture used in the different regions of southern Iran is distinctive (Voigt and Dyson 1992). It is likely that the geography of southern Iran has contributed to the formation of socio-economic and cultural boundaries and frontiers between the populations that occupied different regions (after Wolf 1982; Lightfoot and Martinez 1995). Nevertheless, by focussing on the stylistic differences between regions in spite of the similarities in the technological choices made by potters during the production process, archaeologists run the risk of overlooking important dynamics. Although it is quite clear that technology and style are interrelated (e.g. Lechtmann 1977; Conkey and Hasdorff 1990), in assessing cultural change, production technology and decorative style need not be given equal weight. The evidence for the pace of change in each in southern Iran suggests that connected yet distinct processes governed the

dispersal and/or transfer of innovation in production technology (forming) and the creation of regionally distinct innovations in decorative style and surface finish (post-forming).

The scale and importance of particular innovations and the pace at which they were adopted are critical factors for understanding the dynamics of culture change across the varied cultural and physical geography of Southern Iran. Caldwell (1968: 183) suggested that the prehistory of southern Iran was marked by periods of nuclear influence followed by periods of regionalism. Using an explicitly biological analogy, Beale and Lamberg-Karlovsky (1986: 264) subsequently suggested that the pace of change throughout the prehistoric sequence at the site of Tepe Yahya might better be understood by reference to the concept of "punctuated" evolution. This paper shows that a more nuanced variant of these concepts can be applied to all of southern Iran - a complex pattern where major technological innovations in ceramic production dispersed rapidly over short to medium distances, followed by protracted periods where regionally distinct stylistic elaboration appears to have operated across both time and space. The complex and variable relationships between people, material culture, technology, style and landscapes have the potential to tell us much about human behaviour and culture change.

II. Culture change and innovation

Explaining how and why cultural change occurs are perennial challenges for archaeologists, and the role that innovation plays in this process is not always self evident. In the introduction to the volume *What's New? A Closer Look at the Process of Innovation*, Torrence and Van der Leeuw (1989: 1; also McGlade and McGlade 1989: 282) emphasised that although the reasons how and why change occurs are fundamental aspects of human behaviour, these factors are often neglected, particularly the reasons why new behaviours are not accepted and change does not occur. In the same volume, Shennan (1989, 1996) noted that both processual and post-processual theoretical approaches have a tendency towards synchronic reconstruction, and as a result they have devoted little attention to questions of cultural transmission. He argued that by doing this they ultimately run the risk of "failing to get as far as the questions of long-term change which are supposed to be archaeology's privileged domain" (Shennan 1989, 1996: 283). Although we have seen increasing sophistication in approaches to archaeological thought in the intervening period, archaeologists still frequently neglect to explain how and why change take place, particularly in relation to large scale processes. Wolf (1982) has argued that cultural evolution operates on interconnected systems where societies are linked to each other by what he referred to as "social fields". This is but one model that has been used describe interconnections in prehistory, and joins concepts like "interaction spheres", "peer polity interaction" and "world systems" (see Kohl 2008: 496; Lamberg-Karlovsky 2009).

Philosophers, social theorists and archaeologists have long debated the nature and transmission of innovation (e.g. Plato, see D'Angour 2000; Aristotle [Politics Book V], see Pappin 2009; Marx 1867 [2004]); Durkheim 1912 [1995]; Childe 1937, 1942). Innovation is undoubtedly a complex topic that continues to be a subject of interest in a range of disciplines, including sociology, economics, business, design, and technology. Innovation can be seen as both an event and a process. It is often difficult to identify the actual event due to the nature of the archaeological record, but we can see the evidence of its having taken place. Torrence and van der Leeuw (1989: 7) have pointed out that most case studies of change that deal with the role of innovation focus on either detailed studies of change, or make general observations based on comparative studies, and "the conceptual framework, the techniques, and the knowledge needed to relate these two levels to one another seem to be lacking". Before the New Archaeology, culture change was typically seen as a result of diffusion, which was envisaged as either the replacement of populations (demic diffusion), or the spread of influences from outside (cultural diffusion) – the latter being a process incorporating elements of innovation, imitation and diffusion to varying degrees (Shennan 1989, 1996: 282). For example, Childe (1937) viewed diffusion as an essential component of both technological innovation and social evolution. Simplistic diffusion-based explanations have fallen

from favour, but as Sherratt (1993: 2) has pointed out, "the death of diffusion as a respectable explanation has left something of a vacuum in conceptualising . . . larger structures". The danger in attempting to characterise larger structures and processes is the tendency toward reductionism, where overly simplified explanations are put forward to explain nuanced dynamics and situations. More recent investigations of large scale processes continue to subsume the concept of diffusion in incorporating the terminology of 'spread', 'expansion', 'influence' and 'dependence'/'independence' as a means of explaining culture change (e.g. Sherratt 1993, 1997, 2004, 2007). The key to rationalising these diffusionistic tendencies when formulating broader models of cultural transmission has been the integration of explanations that take account of local conditions and contexts (e.g. Sherratt 1997; Shennan 1989, 1996; McGlade and McGlade 1989: 282), and also the role of individual agency, action and choice in the social process (e.g. Layton 1973, 1989; Lamberg-Karlovsky 2009).

Innovation is comprised of two key elements: invention or the original conception of a new idea, and adoption, or the actions involved in the acceptance and use of the invention (Torrence and van der Leeuw 1989: 3). Examples of major technological and social innovations in the archaeological record are legion, and the tendency for modern archaeologists to define a link between technological innovation and social change dates back to Thomsen (1837). However, although individual inventions might have played important roles in socio-economic development (e.g. Layton 1973, 1989), there is often no direct correlation between innovation and social change (e.g. Sørenson 1989). What is often lacking is a discussion of why innovations happen in the first place. In many ways, the key to understanding culture change and the role of innovation lies in our understanding of the process of transmission and transfer. Culture is a highly mutable concept, and archaeologists have typically envisaged it as being set of shared ideas, beliefs, attitudes, values, practices, and perhaps most visibly material things, which characterize a particular group and become distinct traditions as they are passed down through time - in essence it is something learned (e.g. Clarke 1968: 666; Torrence and van der Leeuw 1989: 5; DeMarrais 2004: 12; after Goodenough 2003: 6-7). Wolf (1984) has noted that culture is a useful starting point of inquiry. An evolutionary approach to culture suggests that individuals acquire patterns of behaviour from their parents (both 'literal' and 'cultural') and then intentionally/unintentionally or rationally/irrationally modify them in the light of their own experience, before passing them on to their own offspring (again, both 'literal' and 'cultural') (Boyd and Richerson 1985; Shennan 1989, 1996: 286; Lyman and O'Brien 2001). Although couched in a Darwinian framework, there are some similarities between this definition of transmission and the operation of Bourdieu's conception of *habitus*, which can be defined as a system of durable and transposable predispositions that develop in response to structures (class, family, education), and the external conditions that an individual encounters (Bourdieu 1977; Bourdieu and Wacquant 1992; also Dobres 2000: 136ff.).

Innovation is an inherently complex phenomenon whose comprehension requires attention to both the small scale processes relating to the incident of invention and its adoption and spread at a local scale, and also larger scale processes where entire populations are engaged (Shennan 1989, 1996: 289). Boyd and Richerson (1985; also Shennan 1989, 1996: 289) have suggested that once a cultural system has developed, there is a tendency not to innovate, and when innovations do occur, they are often resisted. They thus see cultural traditions operating as inheritance systems in which continuity is the norm, and modifications are combinations of accident, individual choice and cultural selection (Boyd and Richerson 1985: 291; also Shennan 1989, 1996: 289-291). Social structure can thus be seen to both facilitate and impede innovation (McGlade and McGlade 1989: 282), and when innovation occurs, it is at some level a conscious decision that was presumably made in response to a particular situation where people are either prepared or required to suspend their usual routines (Shennan 1989, 1996: 289). Scale is an important element, as the significance of an innovation is variable, and can vary between minor fashion changes to major technological developments (Shennan 1989, 1996: 289), which are not necessarily interdependent. The rates of

both invention and adoption are also variable, and responsive to social, economic and environmental conditions (Shennan 1989, 1996: 289).

There have been various attempts to model how, why, and at what rate new ideas and technology spread. Ideally, the adoption of innovation is progressive and conforms to a regular pattern whereby there is a group of pioneering adopters, who are followed by the majority, and are trailed by a group of laggards (McGlade and McGlade 1989: 283-284; citing Rogers 1962; Rogers and Shoemaker 1971). Such models are however inherently determinative, and lack a mechanism for taking account of variation in human behaviour, particularly factors such as the resistance to innovation, and the mutation/modification of innovation that might occur during the processes of transmission and tranfer. An alternative model proposed by McGlade and McGlade (1989: 288ff.) proposes that innovation is a dynamic evolutionary force and its transmission is dictated by constraining and facilitating processes such as diffusion, perception, attractivity, resistance, adaptation and adoption. The relative importance of each individual process is dependent upon local contexts and factors. Variants on this theme have also been proposed by Allen (1989) and van der Leeuw (1989).

For archaeologists, understanding the relationship between innovation and material culture is crucial, as the latter is usually the most abundant category of evidence encountered. Fortunately there are various ways in which material culture is approached that help to provide a means of understanding the socio-economic significance of innovation. It is now widely acknowledged that material culture plays an active role in the production and maintenance of cultural values and the operation of processes of social interaction at various scales (e.g. Bourdieu 1977; Hodder 1982, 1986; also Appadurai 1986 (ed.); Miller 1987). The investigation of how the crafts that produce material culture are organised, particularly the role of the crafts person, provides a means of understanding developments in technology, economy and society (see Dobres and Hoffman 1999 (eds); Costin 2001: 273ff). Also, the technologies and the technological choices that are made in the production of material culture are increasingly seen as being embedded within their cultural milieu: i.e. the choices of the potter are dependent on both functional criteria and contextual factors such as the social, economic, ideological and environmental setting that influence the agency and ideology of the individuals producing the material and the *chaîne opératoire* that they utilise (e.g. Ingold 1990; Lemonnier 1993; Dobres and Hoffman 1999; also Leroi-Gourhan 1964, 1965; Cresswell 1972; Tite 1999; Sillar and Tite 2000; Roux 2003). The interrelationship of technology and culture is further emphasised by ethnographic analyses, which have shown that social boundaries and identities can both be materialised through the execution of particular technical behaviours that are heterogeneous and dynamic (e.g. Gosselain 1999, 2000, this volume; Stark et al. 2000). These varying approaches each provide a means of understanding the social context of innovation and although many are typically used at a small scale, their inherent principles must be considered when trying to account for large scale dynamics.

Change in material culture is a critical factor, whether or not it is a result of innovation, and the desire to understand how and why change occur remain issues deserving attention. The prehistoric archaeology of Southern Iran provides a specific opportunity to take a "bottom up" approach in outlining the chronological and spatial dimensions of broad scale culture change, and to then hypothesise about the role of innovation and transmission in these processes.

III. The context and archaeology of the lowlands and highlands of southern Iran

The ranges of the Zagros Mountains are the dominant geographical feature of southern Iran and demarcate several distinctive geographical zones and regions (Figure 1). In the west the lowland plains of Khuzestan and its neighbours are linked to the alluvial plains of southern Mesopotamia. The areas of Fars and Kerman to the east of this are characterised by the intermontane valleys and plains of the highlands. Intensive sedentary settlement is limited to the plains and valleys that have both adequate water resources and sufficient areas of arable land (Carter 1994: 75; de Miroschedji

2003; Roustaei et al. 2006; Askari Chaverdi et al. 2008), and with relatively few exceptions these valleys and plains are scattered throughout southern Iran and are not continuous. They are however connected to each other by paths, tracks, roads and passes of various lengths, which traverse the Zagros and form a network of routes that link what are often far flung regions (Figure 1). This distinctive topography imposes specific constraints on human behaviour, particularly on the communication and interaction between the populations that live in the different valley systems, and the ancient inhabitants needed to be able to adapt their behaviour and subsistence practices to suit this variable landscape. In essence this is a varied landscape that fosters the creation of socio-economic and cultural boundaries and frontiers; it is an environment where in the words of Triandis and Suh (2002) "ecologies shape cultures". Some of the valleys and plains of southern Iran have been the focus of co-ordinated archaeological research, while others have seen little or no archaeological exploration. As a result, our knowledge of the prehistoric occupation of southern Iran is patchy and not consistently resolved. Nevertheless, broad patterns in the distribution of material culture and technological practices can be delineated, and it is possible to use those patterns to discuss the socio-economic context and the types of interaction that occurred between populations in different regions. For example, the archaeological evidence for the distribution of raw materials from specific locations makes it clear that there were connections between these regions from the earliest Neolithic.

There have been several major phases of archaeological research in southern Iran, beginning in the late 19th century and continuing up to the present. This research has incorporated excavation at sites of various sizes and types, extensive surveys of major routes and plains and full coverage surveys of specific areas (summarised in Voigt and Dyson 1992). At the culmination of the early phase of exploration and excavation, archaeologists typically referred to "cultures", which were defined on the basis of the discovery of distinctive types of material culture in excavations at a limited number of type-sites that were often separated by considerable distances and highly fractured landscapes. The prevailing approach to interpretation in the mid-20th century thus led to the delineation of cultural historical sequences that incorporated type-site names for individual periods, and typically used ceramic material as the key indice (e.g. McCown 1942; Vanden Berghe 1952, 1954). It is notable that these names continue to be employed by most scholars, primarily to differentiate chronological periods marked by distinctive changes in material culture, but also to refer to regionally distinct assemblages of material culture (e.g. Sumner 1972; Voigt and Dyson 1992; Alizadeh 2006; Potts et al. 2006; Weeks et al. in press). The 1960s and 70s saw a dramatic proliferation of archaeological research in most parts of Iran, particularly in the southwest and southeast. As a result of this major phase of work, several attempts were made to synthesise the archaeological evidence from these areas, particularly in terms of trying to establish the nature of cultural influence and communication between the populations living in different parts of Iran and also the surrounding regions (e.g. Caldwell 1968; Lamberg-Karlovsky 1978; Amiet 1979; Alden 1982). Much of this fieldwork halted with the Iranian Revolution. However, since 2000 there has been a dramatic increase in the publication of older excavations (e.g. Alizadeh 2003a, 2006, 2008; Potts 2001; Sumner 2003), and a considerable range of new work has also been commenced (e.g. Malek Shahmirzadeh 2002, 2003, 2004, 2006a, 2006b; Potts and Roustaei 2006; Fazeli 2007). The combination of new work and new publications of old excavations has seen a number of different chronological schemes put forward (e.g. Alizadeh 2006: 10-13; Alden et al. 2004: Fig. 2; Potts et al. 2006: Fig. 1.3; Weeks et al. 2006: Fig. 12). Although the sequences that are presented are all broadly similar, they differ in the details, so the chronology for the major regions of southern Iran that is presented in Table 1 is not universally agreed. Nonetheless, for purposes of clarity, an attempt has also been made to attribute individual chronological phases to broad periods (Ceramic Neolithic, Early Chalcolithic, Late Chalcolithic) familiar to those working in other regions.

INSERT TABLE 1 HERE

In the early 21st century, we are in a position where it is possible to reassess the cultural traditions of southern Iran and consider long-term developments in material culture and technology. There are however, several factors that constrain our understanding of culture change in these regions during prehistory. Many of these derive from the nature of the archaeological record and the intensity with which it has been investigated. Firstly, only a relatively small number of excavations have been undertaken in any one region of southern Iran, and at many sites, the exposures for which we have reliable stratigraphy are relatively limited in size. This means that regional chronological sequences have often been built up using data from individual sites, or by compiling data from several sites that have overlapping or interlocking chrono-stratigraphic sequences. For example, many of the sites that have been excavated in Khuzestan and Fars are low mound sites that were either occupied for a single cultural period, or were occupied, abandoned and then re-occupied in a subsequent cultural period when the inhabitants were using dramatically different material culture. In reality, smaller sites that were abandoned and reoccupied regularly often lack evidence for the transitions between cultural periods. Multi-period mound sites that are occupied for extended period often do have evidence for transitions, but none of the sites that have been excavated has a complete prehistoric sequence and all have evidence for abandonment during specific periods. These dynamics are exacerbated by the fact that the limited areas of large sites that are excavated might not present the entire sequence of occupation at that site. Unless there are comparable excavations at other sites it is difficult to extrapolate the results from one site to understand the dynamics operating within an entire region. Secondly, although there is considerable information available from archaeological surveys for many regions in southern Iran (Chase et al. 1967; Sumner 1972; Alden 1979; Prickett 1986; Alizadeh 1992; Kouchoukos 1998), the interpretation of survey results is constrained by our knowledge of excavated sequences. Thus while evidence for transitions might be present in surface assemblages, we lack precise evidence for the context in which they took place. There is also the additional problem of the impact of alluviation and modern agricultural practices on site visibility and preservation (e.g. Kouchoukos 1998; Kouchoukos and Hole 2003).

The nature of the archaeology of southern Iran is such that there appears to be a relationship between the adoption of innovation and culture change. It is not always clear where innovations originated, and as we often lack information about the transitions between specific chronologically distinct periods, the archaeological record often implies that innovations appeared suddenly. Thus rather than a nuanced process of invention, adoption and dispersal, we are often seeing things that appear fully formed. This means that there are inherent limitations to identifying the way in which innovations are dispersed and adopted, and it is easy to see why migration is put forward as an explanation for change. As will be shown, there are occasions where migration is the most likely explanation for the archaeological data, but it is also essential that other explanations are also considered. With these limitations in mind, it is possible to outline a number of broad trends and patterns in looking at the vast sweep of evidence for ceramic production in southern Iran that dates from the mid-late 7th to the late 4th millennium BC.

IV. Developing ceramic technologies in southern Iran from the 7th to the 4th millennia BC

The earliest evidence for the firing of clay to produce ceramic vessels in the Near East comes from the Central Western Zagros Mountains, which is a key region in the eastern arm of the Fertile Crescent (Mortensen 1992: 276; after Smith and Crepeau 1988; Meldgaard et al. 1963; also Mellart 1975: 70ff.; Hole 2005). The innovation of producing fired ceramic vessels began to spread throughout southern Iran during the 7th and subsequent millennia BC, further technological innovations in ceramic production developed, were dispersed and progressively adopted in different regions. Although the sequence in which technological innovations appear is broadly similar in different regions, these developments first appear in each at slightly different times. Although there is always the possibility that independent invention occurred, the chronological evidence suggests that in most cases, the major technological innovations typically took place once and were then adopted by populations in different areas, rather than taking place in several different regions.

Relatively few detailed analyses of ceramic technology in southern Iran have been carried out, and the exemplary study by Pamela Vandiver (1986, 1987) on the technology of the prehistoric ceramic sequence at Tepe Yahya is the only analysis that provides a detailed assessment of diachronic development. Detailed analyses of ceramics from certain phases in Fars have been conducted by James Blackman (1981, 1989).

The earliest ceramics found at sites throughout southern Iran belong to a very widely spread "soft-ware" tradition (Dyson 1965: 217, Voigt and Dyson 1992: 266; also Vandiver 1987; Beale 1992: 282; Weeks et al. 2006). Vessels are characteristically hand-made using chaff-tempered clay, have thick walls, are lightly fired, and are very crumbly. There appear to be local variations in the density of the fabric, the size and density of the chaff temper and the degree of surface finishing, but in essence this material belongs to one overarching potting tradition. This may indicate that with the arrival of new technological innovations, there was also scope for experimentation. In fact, Vandiver (1986, 1987, 1995) has shown that early ceramic vessels from the North and Central Western Zagros, Deh Luran, Kerman and into Pakistani Baluchistan were produced using Sequential Slab Construction (SSC). In Fars and Kerman it has been noted that baskets were often used in the forming process, and many vessels were subsequently covered with a coating of un-tempered clay, which was slipped and burnished to form a smooth surface that was often then decorated with monochrome, bi-chrome or polychrome pigments (Matson in Chase et al. 1967: 150; Vandiver 1986; Alden et al. 2004: 36-37; Weeks et al. 2006: 73-74; Alizadeh 2006: 8-10). The added layer of clay is often poorly preserved, and flakes away from the vegetal tempered core (e.g. Alden et al. 2004: Fig. 9.11-12). Some vessel types are only wet smoothed and burnished on the exterior and chaff impressions are still visible (Beale 1986: 42). The Late Neolithic (c.5500-5000 BC) in some regions sees a disappearance of painted surface decoration. The fired vessels are all generally soft, the fabric is fragile and the painted decoration frequently washes off. This suggests that the firing temperature was relatively low, most probably less than 700°C (after Blackman 1989: Table 2; Bernbeck 2004).

Given the long term conservatism in the production process, the low temperature firing and the varied decorative patterns produced, it might be assumed that these vessels were the product of small-scale and presumably part-time household production systems (following Costin 1991, 2001; see also Rice 1991). However, many of these are not "simple" vessels, and the careful use of a thin un-tempered layer of clay to produce a fine surface finish, the very high quality slipped and polished finish, and the wide range of often highly elaborate geometric motifs suggests that the potters possessed a high degree of skill in carrying out a relatively sophisticated *chaîne opératoire*. It is also likely that each vessel was both labour and time intensive to produce. So, although these potters might have been working at a small and possibly part-time scale, they should probably be considered specialists if only for the skill evident in the production and decorations of the vessels.

With the shift to the Early Chalcolithic in the 5th millennium BC, there were several technological innovations in the process of ceramic production, and these appear to have been adopted progressively in different areas. The first is the choice to use calcareous clays that do not require the addition of chaff-temper and which fire to a buff colour. These calcareous clays largely replace the use of vegetal tempered clay thereafter in most areas. Concurrent with this, there is also evidence for the use of basic turning devices and the application of distinctive black painted decoration, which replaces the bichrome and polychrome decoration applied to the Late Neolithic ceramics in some regions. These shifts are accompanied by sharp increases in the temperatures at which vessels are fired, to between 850-1000°C, which results in a notably harder ceramic (following Blackman 1989: Table 1). That this Early Chalcolithic firing technology was not completely controlled is attested by the evidence for significant numbers of over-fired vessels, particularly in the early 5th millennium BC, and this phenomenon is evident at sites in both Iran and Mesopotamia. It is however notable that by the end of the 5th millennium BC in Iran, potters were producing a wide

range of very refined ceramic vessel types that were typically decorated with very elaborate motifs and patterns (e.g. Langsdorff and McCown 1942: Plates 22-80; Beale 1986: Figs. 4.19-4.26; 1996: Plates 159-192; Alizadeh 2006: Figs. 23-52). This is quite different to the situation in Greater Mesopotamia which witnesses what Wengrow (2001) has described as an "evolution of simplicity", where decoration becomes progressively simplified during the 5th and 4th millennia BC.

We know little about the organisation of ceramic production during the Early Chalcolithic (c.5000-4000 BC) period in Iran, other than being able to note that there was considerable homogeneity in the technology generally, and in the motifs being used in specific regions. It is clear that potters were able to produce hand formed vessels of incredible fineness, which were often literally covered with decorative motifs of particular complexity. In talking about Khuzestan, Hole (1987: 91) has made the contrasting observations that this technological homogeneity is indicative of production taking place in only a few places and the material then being widely distributed, but also that the presence of wasters on many sites, suggests that production was more widespread. Sumner (1994: 59) has argued that during this period the advanced production technology, the high quality of the pottery produced, and the absence of evidence for ceramic production at the vast majority of sites in Fars, indicates that ceramic production was being increasingly centralised and was progressively becoming a more formal specialisation. The fact that the fast wheel was not being used suggests that a significant amount of time must have been expended to produce and paint these vessels. In Kerman, the Early Chalcolithic sees increasing sophistication in the organisation of production (Vandiver 1986), particularly with the introduction of potters marks on beakers. Beale and Lamberg-Karlovsky (1986: 254) have suggested that this might be related to the large-scale production of similar looking vessels and/or the necessity for groups of pots to be identifiable in communal kilns.

By the beginning of the 4th millennium BC, there are a range of further technological innovations in ceramic production, including clear evidence for a dramatic shift towards simplicity and efficiency in both the production process and the finished products. Significant differences in the timing and pattern of adoption of some of these innovations also become apparent. For example, in the lowlands, there is a last flourish of elaborate painted decoration during the late 4th millennium BC, focussed at Susa, which is followed by a wholesale change in the ceramic assemblage that comes to be characterised by mass produced vessel types including both wheel thrown and mould made forms (e.g. Voigt and Dyson 1992; also Delougaz and Kantor 1996; Potts 2001; Potts et al. 2006). These vessel types appear to have been introduced from Mesopotamia, and together with a range of other innovations play an important part in debates about the relationship between Mesopotamia and its neighbours during the later 4th millennium BC (Algaze 1993, 2001; Stein 1999; Potts 1999; Butterlin 2003). By the start of the 4th millennium BC in the highlands, much of the surface decoration disappears and it is replaced by treatments such as fine slips and burnishing, which continue to be used for many centuries before mass produced wheel thrown and mould made forms seen in the lowlands begin to appear (Petrie et al. 2006a, 2006b, 2007). The dynamics of these changes will be outlined below, but in general, throughout the 4th millennium BC, there is a progressive increase in the speed of turning until ultimately the fast wheel is adopted. It is also notable that in some areas, the pre-existing production technology was maintained for the production of certain vessel forms. From the mid-4th millennium BC, a number of what appear to be 'disposable' vessel forms are adopted, including the distinctive bevel rim bowl. These continue being used into the early 3rd millennium BC.

What we know about the organisation of Late Chalcolithic period (c.4000-3000 BC) ceramic production is variable. In Khuzestan, centralised ceramic production appears to have taken place in workshops from where vessels were then widely distributed (Johnson 1973). Kiln sites dating to the earlier 4th millennium BC have been discovered in the Kur River Basin in Fars, suggesting the production remained both specialised and centralised (Sumner 1988: 33). During the later 4th

millennium BC, there was a clear shift in approaches to organisation, with the simultaneous operation of distinct production systems to produce vessels from vegetal and grit-tempered clay fabrics (Alden 1979; Blackman 1981, 1989). It also appears that in the Kur River Basin specific vessel forms were being produced at specific sites, suggesting that production was centralised along product-specific lines (Alden 1979). However there is no consistent pattern, and in the later 4th millennium BC in Kerman, Vandiver (1986: 99) has shown that SSC continued to be used, in combination with the newly adopted technologies of wheel throwing, coiling and mould making. This emphasises that change is by no means uniform across southern Iran, and highlights the strength of the socio-cultural boundary between Fars and Kerman.

The vast sweep of evidence for technological innovations in ceramic production is summarised in Table 2. While there are widespread similarities in approach in different regions, it is important to emphasise that these technological innovations are not adopted everywhere simultaneously. The other critical factor is that there were also dramatic regional differences in approaches to decoration and style, which suggests that a range of cultural dynamics were in operation.

INSERT TABLE 2 HERE

V. Patterns of technological and stylistic innovation in ceramic production in southern Iran

At the broadest scale, it appears that there were variable cycles of innovation in operation in southern Iran throughout prehistory. In most instances, once they had become established in one area, major technological innovations or sets of innovations appear to have been transmitted to neighbouring populations and adopted relatively quickly. This was then followed by protracted periods that were technologically conservative, but which were marked by the elaboration of surface finishes and decorative schemes (i.e. post-forming processes; after Wright 2002), in what equates to changes of style and fashion. This was then followed by another cycle of technological innovation and subsequent stylistic elaboration, and so on. This is in some ways related to Caldwell's (1968: 183) observation that in southern Iran there were processes of nuclear influence followed by regionalism, which was in turn followed by nuclear influence, thus repeating the cycle. The patterns of this process can be most clearly seen by reviewing the sequences of the major regions in southern Iran, beginning with Khuzestan.

The first fired vegetal tempered soft-ware ceramic vessels are used in Khuzestan during the early 7th millennium BC, which is somewhat later than the earliest ceramics from sites in the Central Western Zagros (Voigt and Dyson 1992: I. 124, 129, II. Table 2; Alizadeh 2003a). No evidence for the independent invention of fired ceramics has yet been discovered, and we do not know precisely how the invention of firing ceramic vessels made its way to Khuzestan. The existence of obvious precursors in the Central Western Zagros and the fact that the earliest material that has been discovered already shows some sophistication in the technology and approaches to surface decoration suggests that it was not a local innovation. Once ceramics start being used in Khuzestan there is "an unbroken and evolutionary" sequence from the *Formative Susiana* to the *Archaic Susiana 3* phase (Alizadeh 2003a: 8, 2008: 62-66; see Table 1). Although there are elaborations, the primary technology essentially remains unchanged until the mid-6th millennium BC (*Formative Susiana – Archaic Susiana 3*). Nevertheless, during this very protracted period, we see potters create literally dozens of different approaches to surface finish and decoration (e.g. Delougaz and Kantor 1996: 211-247; Alizadeh 2003a: 47-48, 2008: 54-56), which were applied to vessels that show a gradual development and elaboration of form (Alizadeh 2008: Figs. 3a-3b). This period also sees the dispersal of both technological and stylistic approaches to other areas, including Fars (see below). In the early 6th millennium BC (*Archaic Susiana 3*), the appearance of distinctive decorative motifs indicate that long range contact was occurring, resulting in stylistic influence. It is not until the mid 6th millennium BC (*Early Susiana*; see Table 1), that grit temper begins to be used in combination with vegetal temper, and this change is also evident at sites in Deh Luran and

southern Mesopotamia (Voigt and Dyson 1992: 130; Alizadeh 2008: 9, 66). Although this technological change is widespread, the ceramics from each of these regions continue to exhibit local decorative characteristics (Alizadeh 2008: 9), suggesting that although the adoption of the technological choice was widespread, the need to maintain local approaches to decoration was socio-culturally important. In the *Middle Susiana* phase, we see the introduction of the range of technological innovations related to the production of harder fired buff wares that have grit and sand inclusions, and we also see early developments in the production of red-wares (Alizadeh 2008: 66-67; see Table 1). During the remainder of this phase we again see a protracted period marked by the progressive development and elaboration of vessel forms and approaches to surface finish and decoration (Alizadeh 2008: Figs. 3a-3b), and as with the *Archaic Susiana* phase, the *Middle Susiana* phase sees the dispersal of both technological and stylistic approaches to other areas (see below). The process of stylistic elaboration in the absence of major technological innovation continues into the *Late Susiana* phase, which shows some indications of stylistic influence from the highlands of Fars, primarily based on the use of dots in specific motifs, which are first evident in the *Early Bakun* ceramic assemblage and continued in use into the *Late Bakun* period (Alizadeh 1992: 25-26, 2008: 74-75; see Table 1). The production of red-wares also becomes more elaborate (Delougaz and Kantor 1996: 170, Pl. 162.I-AA). Alizadeh (2006: 23, 2009: 134-135) has suggested that the appearance of distinctive *Late Susiana I* pottery in the copper-rich Central Plateau may be linked with the exchange activities of south western mobile pastoralist tribes who were engaging in procuring copper, turquoise, and lapis, all of which began to appear regularly in Fars, lowland Susiana and Mesopotamia in the 5th millennium BC. The *Susa II*/*Uruk* phase in Khuzestan marks a period of dramatic cultural and technological influence from southern Mesopotamia, including the adoption of administrative technologies in the form of seals, sealings, and numerical tablets (see Table 1). The changes to the ceramic repertoire are dramatic, and include the addition of a large range of Mesopotamian vessel shapes, and the innovative technologies used to produce mould made bevel rim bowls and various wheel made vessel forms (Voigt and Dyson 1992: 130-131). The picture during the *Susa III*/Proto-Elamite period in the late 4th millennium BC in Khuzestan is complicated by the fact that we lack evidence for the transition from the *Susa II* period (Petrie in press). However, this phase is not characterised by any major technological innovations in ceramic production. There are however clear stylistic changes in vessel form, which have parallels in the highlands of Fars (Dittman 1984). This was also the period that saw the development of a fully fledged proto-literate text system commonly known as Proto-Elamite or Susa III, whose use appears to have spread quickly, but in several distinct phases across the Iranian Plateau (Dahl et al. in prep).

It is not yet clear when the earliest ceramics were produced in Fars, but all early ceramics were produced using a similar soft-ware production technology. Tantalising hints have come from the discovery on the surface of some sites of ceramics showing "swoosh-pattern" decoration akin to *Formative Susiana* types that date to the early 7th millennium BC (Alizadeh 2006: 7). We do however have more reliable evidence for the widespread adoption of technologically and stylistically similar pottery across a wide area during the late 7th and early 6th millennium BC (*Mushki* phase; see Table 1). This appears to represent an extensive adoption of innovations that took place elsewhere. It is also likely that this spread originated either in Khuzestan or further north in the Zagros at sites such as Qaleh Rostam (Weeks et al. 2006: 23). Whether or not we are looking at the dispersal of a migrant population or just the adoption of the innovation of pottery making by an existing and previously aceramic population is not yet clear. Subsequent to this, there is clear evidence for the rapid proliferation of regionally distinct decorative styles (*Jari* + other local Late Neolithic decorative styles; see Table 1; Sumner 1977; Alizadeh 2006: 9; Weeks et al. 2006: 13ff.), and little evidence for technological innovation over a protracted period. In the shift from the Neolithic to the *Bakun* period in Fars, we see almost a complete abandonment of the technologies used to produce soft-ware ceramics, and the adoption of the innovations related to the production of harder fired buff wares that have grit and sand inclusions. Alizadeh (2006: 11) has argued that the black-on-buff pottery that appears in highland Fars in the *Early Bakun* (*Middle Fars*) phase has no

known antecedent in Fars, and was most probably introduced from lowland Susiana through a migration of people and/or specialised potters. It is however notable that in Mamasani, several motifs have been isolated in the Late Neolithic repertoire at Tol-e Nurabad that have close parallels to motifs seen in the *Early Bakun* levels, suggesting that in the Mamasani region at least, there are some indications of continuity in approaches to motifs from the Late Neolithic (c.5500-5000 BC) (Weeks et al. 2006a, 2006b). The protracted *Middle* and *Late Bakun* periods (see Table 1) see little change in terms of the technology used to produce painted buff ware ceramics, but considerable elaboration in the approaches to surface decoration and vessel form. Although the decorative style used during the *Middle Bakun* period in Fars is distinct, there are several motif combinations that have a very wide ranging distribution in southern and western Iran, which suggests the operation of specific types of interaction between the populations living in different regions (Alizadeh 2006: 11). It is not clear whether this was the product of the movement of people or the movement of material. The *Late Bakun* period sees a culmination of the elaborate surface decoration in Fars, and there appears to be some highland influence on the decorative styles used in Khuzestan (Alizadeh 2006: 23, 2008: 74-75; see below). In the shift from the *Bakun* to the *Lapui* period, we see a complete shift in both the types of clays that were being exploited and the approaches to surface decoration to the point where figurative and geometric decoration are essentially abandoned at more or less the same time (Sumner 1988; Blackman 1989). This is all the more marked as it follows the extremely vivid combinations of geometric and figurative motifs used during the *Late Bakun* phase. The key technological shift in the *Lapui* period seems to be the increased use of rotation to produce particularly refined rim forms and quite regular circular vessel apertures, which were often lacking in the preceding period. At least in the Mamsani region, a shift from the production of red fine wares to the production of buff fine wares with a red slip takes place during the *Lapui* period (Petrie et al. 2006a, 2007, in press), but this is the only apparent stylistic innovation. With the shift to the *Early Banesh* period, the bevel-rim bowl appears for the first time in the highlands, but this form is one of the few indicators of contact with the lowlands at this time (Alden 1979, 1982, 2003). It is with the *Middle Banesh* phase (c. 3300-3000 BC) that we see an even more dramatic shift towards simplicity and efficiency over refinement, with the use of the fast wheel and moulds to mass produce vessels. This happens somewhat before the adoption of sophisticated administrative technologies and proto-literate texts (Alden 1979, 1982). Some degree of regional variety in approaches to fabric preparation and surface finishing suggests that these innovations did not completely supplant existing technologies as they had in previous periods (Petrie et al. 2006a, 2006b).

In Kerman, the innovation of fired ceramic vessels occurs in the mid-6th millennium BC (*Yahya VIID – Tepe Gaz Tavila*); many centuries after this process took place in Fars. The similarities in approach suggest that the technology has moved, but as in Fars, it is not yet clear whether we are looking at a dispersal of a migrant population or the adoption of the innovation of pottery making. In the early 5th millennium BC (*Yahya VI/Iblis 0/I*), we see the local production of a hard fine-ware with grit inclusions (*Soghun*/*Bard Sir Painted* ware) that has some stylistic parallels with *Early Bakun* wares from Fars. However, the technological innovations required to produce these wares may have developed independently in Kerman, as they were produced using SSC and clay from local sources (Beale and Lamberg-Karlovsky 1986: 256; Vandiver 1986). It is also interesting that the production of these fine wares seems to coincide with precocious metal working innovations that appear to have taken place at the site of Tal-i Iblis. Although the pyro-technologies required for each process are very different (Frame 2004), we are nonetheless seeing sophisticated control of high temperatures in both instances. Are we seeing craft practitioners in Kerman engaged in a broad range of innovative experimentation during this period? In the mid-5th millennium BC (*Yahya V/Iblis II*), there is clear evidence for the importation of black-on-buff ware vessels from Fars to Kerman (Beale 1986: 86-87), and the related production technologies appear to have been adopted and elaborated upon in the late 5th and early 4th millennia BC with the local potters first producing black-on-buff ware and then black-on-red ware (Beale 1986: 67-82, 257, Fig. 4.1). These wares

appear together with what are referred to as *Lapui-related* red-ware vessel forms, which are more characteristic of the early 4th millennium BC in Fars, suggesting that this ware type and its associated technological traditions and innovations appear earlier in Kerman than they do in Fars, and potentially originated in the east (Beale 1986: 87; Voigt and Dyson 1992: 145, 149). There appears to be further elaboration of the local ceramic assemblages during the early-mid 4th millennium BC with the production of the various *Aliabad* wares (Chase et al. 1967: 79, 184). It is however during this period that the use of the fast wheel and moulds to mass produce vessels like the bevelled rim bowls, shoulder spouts, and wheel-made vessels with string cut bases occurs (Caldwell 1968: 182). The re-occupation of Tepe Yahya (IVC) during the late 4th millennium BC appears to be a foreign initiative (Lamberg-Karlovsky 1978; Potts 2001: 198), and involves the consolidation of the technologies used to produce bevel-rim bowls, trays and conical cups, as well as the use of Proto-Elamite/Susa III tablets.

VI. Innovation and the dynamics of transmission, adoption and elaboration

Although technological innovations in ceramic production technology appear to have spread relatively quickly between neighbouring regions, the pattern appears to have been staggered and inconsistent. This very much conforms to McGlade and McGlade's (1989: 288ff.) suggestion that innovation is a dynamic yet evolutionary force, and the process of transmission/transfer being likely dictated by constraining and facilitating social processes. These constraints operate independently in each region, and are dependent upon local contexts and factors. Beale and Lamberg-Karlovsky (1986: 263-264) have noted that at Tepe Yahya, there appears to have been little change during *Yahya VII*, but during *VI-VC* and *VB-VA*, the rate of change accelerates (Beale and Lamberg-Karlovsky 1986: 263-264). They suggested that the apparent manifestation of long periods of conservatism punctuated by shorter periods of rapid change in cultural development at Tepe Yahya finds interesting parallels in the theory of "punctuated" evolution in biology (Beale and Lamberg-Karlovsky 1986: 264 citing Gould 1980: 184; see also Eldredge and Gould 1972; Gould 1977). This observation broadly conforms to the principles of macroevolution as outlined by Zeder (2009), where change is a punctuated process in which periods of rapid transition are followed by long periods of relative stasis. This paper proposes that a nuanced model that distinguishes intermittent punctuated innovation in technological processes taking place within the context of relatively continuous innovation in stylistic processes can be applied to the prehistoric archaeology of southern Iran as a whole.

There are two critical questions that ideally must be answered in order to understand this process, firstly why does innovation operate in this manner in southern Iran, and secondly, what transmission processes existed that facilitated the process. There is a lack of strong archaeological evidence for both, but these are nonetheless questions of archaeological interest, so it is worth offering some speculation drawing on the evidence at hand.

The process of transmission has been more clearly addressed in the southern Iranian context. The archaeological record is such that it appears as though technological innovation had the potential to disperse quickly once it had occurred and this implies that specific types of communication and interaction were taking place between the populations inhabiting the different parts of southern Iran. However, the fact that there are periods of technological conservatism and that there are different regional trajectories suggest that the mechanisms that facilitated (and also constrained) the dispersal of innovations, are unlikely to have remained static over time. The somewhat nebulous complex and variable mechanisms by which innovations were dispersed and/or transmitted that were mentioned in the introduction are perhaps the most difficult elements to characterise, as they are perhaps most likely to be dictated by local conditions and contexts (Sherratt 1997; Shennan 1989, 1996; McGlade and McGlade 1989: 282), and the role of individual action and choice (Layton 1973, 1989). There are two critical and interconnected factors that are significant in the context of southern Iran. The first is the geography of the Zagros, which constrains the way people can live and move through

this region, and it is likely that the landscape of southern Iran played a specific role in the formulation of ethnic identities throughout prehistory. The second is the likelihood that the regions of southern Iran were more or less continually linked by people moving through this landscape. In the diverse geographic context of southern Iran, mobility is potentially the key factor for explaining the transmission of innovation and the specific distributions of distinctive ceramic forms and motifs throughout prehistory. However, the way that mobility was manifested is very significant. In each period or phase, it is possible that we are dealing with the mobility of objects, and both innovation and material might have moved as a result of the trade and exchange of particular vessels and/or their contents. Such movement of material can also result in imitation and emulation. It is also possible that the distribution of certain forms and styles represents the mobility of people, ranging from entire populations to individuals, such as itinerant potters or marriage partners with technological knowledge and the vocabulary of distinctive decorative motifs who move as a result of exogamous marriage traditions. It is most likely that this would have been variable in both time and space, and in all of these instances, specific socio-cultural behaviours would have been involved, particularly the processes of acceptance and resistance.

In discussing the Neolithic period in Fars, Weeks et al. (2006: 20ff.) have emphasised the role of seasonal mobility, raw material exchange and other more social factors such as exogamous marriage as mechanisms for facilitating interaction and the spread of ceramic technology between communities during the *Mushki* phase. They have also suggested that the regionalisation in ceramic decoration might be a product of the growth in populations within individual valley systems, which reduced the need for mobility in order to maintain viable populations (Weeks et al. 2006: 22). This model sees mobility in the later Neolithic phase primarily in human terms, and does not account for the ongoing role of pastoralism. In an extensive body of research comprising both research papers and monographs, Abbas Alizadeh (1988, 1992, 2003a, 2003b, 2006, 2008, 2009) has advocated specific connections between mobility and processes of cultural change in southern Iran at various points throughout prehistory, and he sees change primarily being a result of the actions of mobile pastoralists. As noted above, he has argued that the black-on-buff pottery that appears in highland Fars in the *Early Bakun* (or what he calls the *Middle Fars*) phase has no known antecedent in Fars, and was most probably introduced from lowland Susiana through a migration of people and/or specialised potters (Alizadeh 2006: 11). The similarities between the distribution of 5th millennium BC black-on-buff pottery and the areas of the highlands used by the modern Qashqa'i have also been emphasised (e.g. Alizadeh 2006), although the validity of this correlation has been questioned (e.g. Potts 2008; Askari et al. 2008). Migration as an explanation for culture change is not straightforward however, and leads to questions like "where did the pre-existing population go?" and "how were the migrants dealt with by the incoming population?" Are we seeing processes of demic or cultural diffusion or a combination of the two? In the southern Iranian context, it is more than likely that a straightforward movement of a population from one region to another is too simple an explanation. Where there is evidence for the introduction of a range of innovations related to ceramic production, such as that witnessed in the *Early Bakun* period, then it is almost certain that complex socio-economic processes were in play, including the need to assimilate new technologies, and also potentially new populations. There is also some possibility that such obvious technological changes might reflect cultural responses to changing socio-economic requirements, such as increases in population that necessitated a means of producing ceramic vessels more efficiently.

When thinking about such a broad range of technological developments and the processes of innovation and transmission, it is important to keep several significant parameters in mind. Although ceramics would have been used by every family if not every person within a given community, the nature of the vessels being used in southern Iran is such that it is highly unlikely that every family in every town, village or even household were involved with their production, even in the earliest Neolithic. Most of any prehistoric population would have been involved in some

fashion with day-to-day activities such as subsistence farming and animal management, whereas ceramic production is likely to have always been some sort of specialised process, involving a particular knowledge base. This is specifically the case with the interconnected processes of the production of ceramic fabrics, decorative styles, and the control of firing temperatures. Although direct evidence is lacking, the specific skills involved and the quality of the material produced suggests that from as early as the ceramic Neolithic in southern Iran, there were relatively few potters in any one village, community, or region. This makes it likely that virtually all ceramic vessels at any one settlement were the products of a relatively small proportion of the population that then used those products. Innovations in ceramic production technology thus need only have been passed between relatively small numbers of people in any two regions. The likelihood that face-to-face contact was taking place between potters in individual regions is interesting when we consider the fact that many of these technologies are very widely distributed (e.g. Wright 2002: 410-414). This suggests that some mechanism must have existed that facilitated both contract and information transfer. As this was most likely occurring between populations living at specific sites and in particular regions, it might be best described as an interaction network. Developments like the introduction of increasingly faster rotation and ultimately the fast wheel, and the gradual minimisation of surface decoration represent changes to the way ceramic production was organised that are likely to have seen even fewer people involved in the production process through time. This would have further reduced the number of individuals involved in processes of transmission. Perhaps the key point is that while we are observing processes of culture change, in the case of ceramics, the innovations are actually in the hands of a small number of people, but have an impact on entire populations. If this reconstruction is correct, then it suggests that although the innovations in ceramic production were widespread and the products that resulted were widely used, the transmission and transfer of technical knowledge and innovation was restricted to practitioners and producers. This suggests that the dispersal and transference of those innovations between groups was taking place within an open system, but this system was restricted to certain people within groups, so in respect to the detailed knowledge being transferred, the system was closed. Nevertheless, for the innovations to be accepted they need to be recognised as being beneficial by consumers. It is therefore perhaps valid to think of it as both an open and a closed system, depending on where one is looking from. The question as to what mechanisms or interaction networks existed to facilitate this transfer between groups is at present unanswerable.

Cutting across the trend toward regional distributions of specific motifs and motif combinations, there are also instances when specific vessel forms and/or decorative styles are particularly widespread. For example, Alizadeh's (1992, 2006: 11) comparative analysis of the *Middle Bakun* pottery assemblages from Fars and those from contemporaneous sites in Susiana, Behbehan and the Central Zagros has showed that this period witnessed the widespread distribution of a number of shared decorative motifs that did not exist previously. It is possible that this reflects imitation of styles by potters living in different regions, but it could also be indicative of the existence of a reciprocal social system involving the trade and/or exchange of vessels and their contents as gifts to gain access to foreign lands (Alizadeh 2006: 23; following Earle 1994; Gregory 1982). Alizadeh (2008: 74) argues that "the similarity between the ceramic assemblages of the lowlands and the highlands may be attributed to a shared tradition among craftsmen and interregional marriages rather than to mere imitation", but the specific reason for this is not clearly stated. It is important to remember that vessels may also have social significance, and the widespread distribution of specific decorative motifs may also indicate a similar distribution of specific practices related to those vessels. Possibilities abound. One major unresolved factor in all of this is that it is not at all clear where the pottery was being made in most instances. Although it is theoretically possible to investigate this, it has not yet been attempted on a wide scale. There are clearly major differences between the simultaneous production of distinctive vessels and motifs in different areas and the production of these objects in one area and their subsequent distribution, and until such dynamics

can be characterised, elaborate discussion of the significance of the distribution of specific motifs is likely to be futile.

It is not entirely clear why the punctuated pattern of innovation occurred in southern Iran. The archaeological evidence from each region suggests that major technological innovations in ceramic production appeared in clusters and subsequent to this there was a tendency not to engage in technological innovation for protracted periods. These innovations would likely have had various social, cultural and economic effects, and the mechanism or mechanisms by which they were dispersed and/or transmitted must have been both complex and variable. Kohl (2008) has argued that the spread and adoption of innovation across broad areas reflects shared developments, which are facilitated by the existence of "shared social fields". In most cases, it is not clear whether technological changes were the cause or the result of broader socio-economic change, and while a concept of punctuated technological innovation might describe the patterns that are evident in southern Iran, it does little to explain why this takes place. McGlade and McGlade's (1989) range of constraining and facilitating parameters provide a useful explanatory framework in this respect. Shennan (1989, 1996: 289) has suggested that when innovation occurs, it is at some level a conscious decision made in response to a particular situation where people are either prepared or required to suspend their usual routines. If this is correct, then it should also hold true for the resistance of innovation. If people are neither prepared nor required to suspend their routines, the resistance of innovation is more likely, and presumably it will either not take place, or if it does occur it may not be adopted.

Caldwell's (1964: 143) concept of the "interaction sphere" posits a correlation between interaction and innovation such that when different cultural traditions meet, new approaches are introduced to each group, and what he describes as new arrangements of forms – innovations and inventions – can be built. This has been followed by Lamberg-Karlovsky (2009: 75, 82), in his emphasis on the importance of interaction as a facilitator and motivator for change, and the role of agents in the process of trade and exchange. He suggests that certain institutions and incentives existed to allow for innovation and economic growth (Lamberg-Karlovsky 2009: 75, 82). Roux (2003) has argued that technological innovation occurs when there is both demand and enabling conditions. Major innovations are thus most likely to appear AND be adopted when societies are predisposed to accept change and/or have a need that must be satisfied. Drawing on Classical sources, D'Angour (2000) has argued that for innovation to succeed, it must appeal to existing individual and social perceptions about what is valuable. If it fails to do this, it is liable to be resisted. In terms of ceramic production, it appears that throughout prehistory in southern Iran, major technological innovations spread quickly over short distances, and often across social boundaries. This suggests that at certain points in time, potters were open to innovation, and populations were ready to accept these new approaches. However, in general, there were phases of protracted technological conservatism, which indicates that there were long periods during which there was no imperative or requirement for change. All the while, however, there appears to have been a constant need to reaffirm the existence of socio-cultural boundaries through the generation of regionally distinct decorative styles. It is also important to remember that although ceramics are only were but one element in a much broader cultural milieu, the technological innovations related to ceramic production were taking place concurrent with innovations in metal production, approaches to subsistence, and administrative technologies in the form of seals, sealings, tablets and ultimately the development of a fully fledged proto-literate text system whose use spread across the entirety of the Iranian Plateau. These innovations also appear to follow a similar trajectory to the punctuated pattern seen for ceramic innovations, which is significant as they all contribute to the increases in socio-economic complexity that culminated in the appearance of the first urban cities in Iran (e.g. Tal-e Malyan). Lamberg-Karlovsky (2003) has argued that the innovation of literacy was rejected on the Iranian Plateau in the early 3rd millennium BC and the subsequent phase of socio-economic development during that millennium was essentially illiterate.

The *Lapui* phase ceramics that are used in Fars between c.4100-3500 BC are an interesting example of the role of cultural assemblages in the past, and patterns of innovation and adoption. The *Lapui* assemblage is comprised of two types of red-ware: a coarse-ware, which typically has an irregularly burnished surface; and a fine-ware, which either has a red or buff fabric and a polished red slip (Sumner 1988; Petrie 2006a, 2006b). Vessels in both wares appear to have been turned using a slow wheel or tournette (Blackman 1989; Petrie et al. 2006a, 2006b). During the preceding *Bakun* period in Fars (4800-4100 BC), the ceramic assemblages are completely dominated by painted buff-ware ceramics made from calcareous clay. The contemporaneous ceramic assemblages from Khuzestan (*Middle-Late Susiana* – 5100-3900 BC) are likewise dominated by painted buff-ware, although a small but significant part of the assemblage is made up of coarse burnished red wares in shapes that are akin to the *Lapui* vessels subsequently used in Fars. Similarly, in Kerman, the ceramic assemblages of the later 5th millennium BC are dominated by black-on-buff or black–on-red wares, but also include examples a burnished red-ware that has been referred to a *Lapui* or *Lapui-related* ware (Beale 1986: 87; Voigt and Dyson 1992: 145, 149). The absolute chronologies of these assemblages suggest that burnished red-wares were being used contemporaneously and were small but significant components of the ceramic assemblages in use in both Khuzestan and Kerman. Although Fars is situated in between these two regions, red-wares do not appear with any frequency until the very end of the 5th millennium BC, at which time they completely replace painted buff-wares. This does not happen in either Kerman or Khuzestan. This can be interpreted in several ways. In the first instance, there must have been some specific reasons as to why the innovation of producing coarse burnished red-ware and red slipped ware was resisted in Fars until the late 5th millennium BC. It is then perhaps all the more surprising that once these technological and stylistic innovations were adopted, they completely replaced the existing technologies and decorative styles. Blackman (1989: 104-105, 106) proposed that the observed changes are unlikely to have been the result of the introduction of new, previously unknown technology, through diffusion, innovation or migration, but rather are more likely to be the result of cultural responses to changing socio-economic requirements. Sumner's (1988) initial interpretation of the survey data from the Kur River Basin suggested that the *Lapui* period marked a drop in the regional population, whereas Alizadeh (2006: 26) has suggested that it actually saw a population increase. There is also evidence from the Mamasani region that *Lapui* fine and coarse wares were each being produced from distinct sources of raw materials and then distributed to multiple sites. The disappearance of painted decoration suggests that potters were choosing different approaches to decoration. That this material became so widespread suggests that this shift was accepted by a population that was either receptive to or demanding change. Until we know more about the role of the decorated *Late Bakun* vessels that were being replaced, it is difficult to comment on which option is the more likely. The dynamics in the mid-late 4th millennium BC are also interesting, as in most cases, the new material culture elements such as wheel and mould-made vessel forms are nested within the existing local material culture assemblages (see Potts 2001; Petrie 2006a, in press). This contrasts with the situation of the earlier 4th millennium BC, and shows that in some instances, technological innovations completely replace existing practices, while in others, they are added to those practices. Which of these options transpires in any circumstance is likely to be dictated by a range of variables including the nature of both the innovation and the local social context into which it is transmitted.

Many of the technological changes that we see in ceramic production are related to the minimisation of energy expenditure and the maximisation of the rate of production of individual vessels. While vessels continue to be decorated with elaborate schemes until the beginning of the 4th millennium BC across much of the region, it is conceivable that pressures from population growth resulted in a progressive need to produce ceramic vessels more simply in order to satisfy demand. Larger populations are also likely to have required different social behaviours, not least because of increased potential for social differentiations, and there is also the potential that ideological factors played a role (e.g. Zeder 2009). Given the clear changes towards the use of more efficient

production techniques through time, it seems likely that the role of ceramics themselves also underwent change between the early ceramic Neolithic and the Late Chalcolithic phases. This is most clearly evident in the disappearance of painted decoration during the 4th millennium BC in Khuzestan (*Susa II*) and Fars (*Lapui*), concurrent with the adoption of technologies that enable mass production of utilitarian vessels.

Each of the major regions discussed here appears to present a distinctive sequence of material culture characterised by idiosyncratic painting styles, decorative motifs, and vessel forms. Drawing on the ethnographic evidence of Gosselain (1999), Wright (2002: 413) has noted that potters are willing to incorporate new techniques in post-forming manufacturing processes and suggests that it is these that are most readily transmitted between potters. She also argues that the small scale transfer of technological approaches preceded more intensified interaction involving the transfer of raw and finished materials (Wright 2002: 414). It is interesting that in each phase of elaboration in the highland areas, regionally-distinctive material assemblages appear to recur in more or less the same areas after each cycle of technological innovation. This suggests that there were also repeated cycles of correlations between the geographically proscribed regions of southern Iran and assemblages of material culture that were used. Although this runs the risk of being deterministic, it is important to reiterate that the geography of southern Iran was almost certainly a critical constraint on the processes of interaction, communication, innovation and transmission during prehistory. The geographic distribution of the cultural material between c. 6500 and 3000 BC is quite specific, so the patterns of similarity and difference between regions, and the evidence for the spread of innovation is suggestive of a constantly developing and changing dynamic, where there is a close relationship between the landscape, mobility and interaction between peoples across that landscape, and the recurring patterns of stylistic distribution.

If we accept that material culture is a maker of culture (Hodder 1982, 1986), then it is relatively straightforward to understand the existence of relationships between material culture and the signalling of social boundaries (Wobst 1977; Jones 1997; David and Kramer 2001; Wright 2002). Gosselain (1999, 2000) and Stark et al. (2000) have discussed the relationship between ceramic technology and social boundaries, with Gosselain drawing specific attention to the relationship between specific *chaînes opératoire* and linguistic distribution. In the southern Iran context, we are faced with a significant degree of commonality in approaches to ceramic production technology over protracted periods of time, which is evident across a wide area. However, there is also evidence of a tendency towards increased regional elaboration of decorative motifs. It is entirely possible that there might be distinctive local variations in approaches to ceramic production and distinctive *chaînes opératoire* that have not yet been identified. Detailed studies focussing on identifying variation in the density of the fabric, the size and density of the chaff temper and the degree of surface finishing, etc might be enlightening, but until such analyses are completed, we can only confirm that this material belongs to overarching potting traditions. Nonetheless, the evidence that there were stylistic innovations that led to the production of regionally distinct decorative styles after the dispersal of the new technological innovations, affirms that in some situations, there were socio-cultural mechanisms in place that necessitated the creation of smaller scale stylistic innovations in order to produce regionally-distinct material culture. Taken together this indicates that although there may well have been various boundaries and frontiers at different times during prehistory, these had a degree of permeability. It is important to remember that these processes were in the hands of the potters, i.e. those who produced this material. At one level it seems clear that the populations of each region of southern Iran possessed a robust sense of cultural identity that was reflected in the material culture being produced by their potters. Although the potters of each region were susceptible to technological conservatism, they were at the same time capable of and open to innovation.

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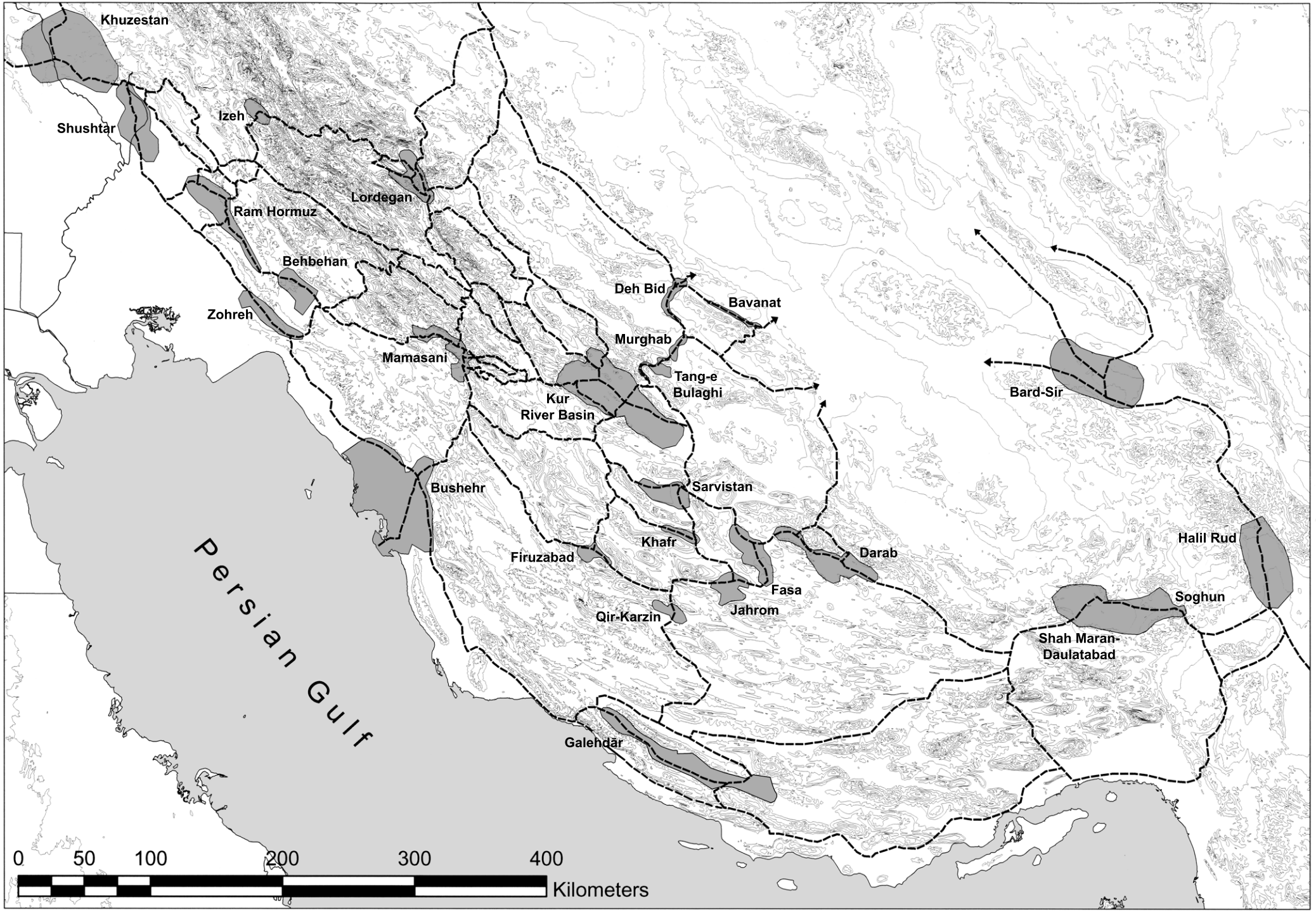
Table 1. Chronology for southern Iran

Year BC		*Susiana*	*Fars*	*Fasa/Darab*	*Daulatabad/ Soghun*	*Kerman*
	Ceramic Neolithic	Formative Susiana?				
7000						
		Archaic Susiana 0				
6500		Archaic Susiana 1				
		Archaic Susiana 2	Mushki			
6000			Mushki-Bashi	Jalyan		
		Archaic Susiana 3				
			Jari	Bizdan		
		Early Susiana			Early Yahya VII	
5500						
			Shamsabad	Late Neolithic		
					Yahya VII	
	Early Chalcolithic	Middle Susiana				Iblis 0/I?
5000						
			Early Bakun	Chalcolithic	Yahya VI	Iblis I
		Late Susiana/Susa I	Middle Bakun		Yahya VC	Early Iblis II
4500						
					Yahya VB	
			Late Bakun			
						Late Iblis II
					Yahya VA	
4000	*Late Chalcolithic*	Terminal Susiana	Lapui	Lapui/Vakilabad		
						Iblis III
		Susa II				
			Initial/Early Banesh	Unknown	GAP	
3500						
						Iblis IV
		Acropole 17–17X	E.Mid. Banesh	Unknown		
		Susa III	Late Middle Banesh	Unknown		
					Yahya IVC	
3000						

Table 2. Basic chronology for the southern Iranian sequence of technological development

Period	*Ware type*	*Method of manufacture*	*Hardness and firing temp.*
7th-6th mill. BC	Soft/coarse	Hand/SSC	Soft/Low-med (<700°C)
5th mill. BC	Buff-ware	Slow turned	Hard/med-high (850°C >1000°C)
E. 4th mill. BC	Burnished coarse	Slow turned	Hard/med-high (850°C >1000°C)
"	Slipped fine	Fast turned	Hard/med-high (850°C >1000°C)
L. 4th mill. BC	Coarse	Wheel	Hard/med-high (850°C >1000°C)
"	Vegetal tempered	Wheel/mould	Hard/med-high (850°C >1000°C)


Khuzestan
Shushtar
Izeh
Lordegan
Ram Hormuz
Behbehan
Zohreh
Deh Bid
Bavanat
Murghab
Mamasani
Tang-e
Bulaghi
Kur
River Basin
Bard-Sir
Bushehr
Sarvistan
Khafr
Firuzabad
Darab
Halil Rud
Fasa
Jahrom
Soghun
Qir-Karzin
Shah Maran-
Daulatabad
Persian Gulf
Galehdār
0
50
100
200
300
400
Kilometers