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Pastoralism as Institutions: Modeling the Pastoral Landscape in Tibet in the Second and First Millennium BC

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by

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ABSTRACT OF THE DISSERTATION

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Professor Michael D. Frachetti, Chair

Previous archaeological research has made significant advances in our understanding of the chrono-spatial patterns of ancient human occupation of the Tibetan Plateau based on archaeobotanical, zooarchaeological, and material cultural analysis. The surge of archaeological data in prehistoric Tibet calls for further analysis of the potential social and environmental forces that shaped the prehistoric landscapes of Tibet. This dissertation presents a synthetic analysis of the role of pastoralism in shaping the economy, materiality, and mobility of Tibetan societies in the second and first millennium BC. Based on both previously published archaeological evidence and my own analysis of newly documented archaeological data, I argue that pastoralism can be seen as a social institution that is shaped and reproduced through participation, which fundamentally changes the ecological and cultural landscapes of Tibet in the second and first millennium BC.

This research tackles this theme using a multi-methodological approach that includes survey archaeology, excavation, geospatial modeling, and network analysis. I present early pastoralism in Tibet through the lens of emergent institutions that structured the geographic patterns of settlement, cultural interactions and patterns of landscape organizations under changing cultural conditions at both local and trans-regional scales. My research also combines traditional archaeological material culture analysis with landscape archaeology and geospatial analysis in Tibet. My exploratory archaeological survey is the first survey of pastoralist landscapes by identifying and interpreting the long-term ecological and social formation of pastoralist sites across eco-zones in the mountainous regions of Tibet. The research contributes to our understanding of emerging pastoralism in prehistoric Tibet, as well as its durability as a persistent and contemporary tradition on the Tibetan Plateau.

At a local scale, I analyzed the material remains of an agropastoral settlement in the first millennium BC, Bangga, suggesting that ancient people occupied Bangga and practiced settled pastoralism in a changing cultural context. In addition to the archaeology in Bangga, I also conducted an exploratory archaeological survey in the Shannan region based on the hypothesis that pastoral activities are continuous through time and space. The survey successfully identified two prehistoric pastoral corrals, Badong and Yukang. Both sites are repeatedly used in prehistoric, historic, and modern times. According to the results of material culture analysis, radiocarbon dating, excavations, ethnoarchaeological GIS analysis, and soil erosion models on those two sites, I further argue that the human-environmental feedback possibly facilities the reproduction of pastoralism on a local scale.

At a trans-regional scale, I developed two new geospatial models, coupled with a comprehensive material cultural analysis that interprets how Tibet's cultural landscape is

associated with pastoral mobility networks. The pastoral mobility network is constructed under the assumption that herds travel along the best vegetation; the cultural landscape is represented by a social network based on the similarity of ceramics. I discover that the settlement pattern of Tibet between 3600 and 2200 BP is significantly correlated with the pastoral networks. The pastoral network is broadly similar to the ceramic social network, especially in eastern Tibet. The trans-Himalayan participation explains the discrepancies between the pastoral mobility networks and the ceramic social networks and is again validated by a contextual analysis of the newly discovered bronze mirrors in Tibet.

Chapter 1: Introduction

The word “Tibet” has different meanings to different people and the narratives of its history and culture change through time and space and vary in different academic traditions. In the Westerners’ eyes, Tibet was long fantasized as an arcadia hidden in the far-away oriental lands, that became a historic site for knowledge seeking, particularly the knowledge of Buddhism (Bishop 1989; Shen 2015). To the ancient Chinese, the Tibetans were mostly “pastoral nomads” to the west, living in cities and tents (Liu 945/1975). According to ancient Chinese sources, the Tibetans' origin is possibly associated with the Qiang people dating back to at least the Han Dynasty (Chen and Gao 2003). To the ancient Tibetans themselves, the origin myth is also variable. The most widespread, orally transmitted story has it that the Tibetans descended from a monkey bodhisattva father and an ogress mother (Gyaltsen 1328/2002).

Archaeological data, however, present a vibrant social system that never ceased to embrace exotic cultures, leading to the openness and diversities of the Tibet Plateau. Nearly a hundred years of excavations and surveys revealed rich prehistoric archaeological remains across the Tibetan Plateau that are intimately connected to the cultures of its surrounding regions, including central China, the eastern Eurasian steppe and mountains, and South Asia (Figure 1.1).

1.1 Aim of the dissertation

In Tibetan archaeology, debates have never ceased concerning when, how and why ancient humans have adapted to and populated the Tibetan Plateau (e.g., Brantingham and Gao 2006; Aldenderfer 2011). Current archaeological and historical narratives of the shaping of Tibet’s cultural landscapes emphasize the role of agriculture in settling Tibet, initially from the northeastern Tibetan Plateau (Chen et al., 2015). However, other potential factors in settling

Tibet, such as how pastoralism may have shaped the Tibetan landscape, have not been scholarly addressed in a satisfactory detail. In this dissertation, I seek to answer two questions concerning the institutional role of pastoralism on shaping the Tibetan cultural landscapes and settlement pattern: 1). How has pastoralism emerged, developed, and been reproduced under dynamic socio-environmental settings at a local scale? 2). How has pastoralist participation contributed to the shaping of large-scale cultural and ecological landscapes in Tibet?

I answer the first question of the dissertation with local-scale, site-specific analysis of three archaeological sites and ethnographic data in central and southern Tibet. This part of the research consists of the excavations and material culture analysis of the Bangga site, an archaeological survey of corrals on the mountains, GIS analysis on the ethnographic pastoral sites, and soil erosion models of the corrals. Situated within a wider consideration of the earliest documented herding sites in central Tibet (e.g., Qugong), I argue that ancient pastoralists relied upon varied degrees of farming and herding to occupy both arable river valleys and highland pasturelands in the study area under changing cultural phases and seasonal mobility schemes from the first millennium BC. These pastoralist activities produce a recognizable spatial pattern that is reflected in modern ethnographic records. The long-term regularities of pastoral activities in the highland grasslands are possibly shaped by positive human-environment feedback loops, as demonstrated by my archaeological survey and soil erosion models of the pastoral corrals.

I approach the second question of the dissertation by studying the general settlement pattern and the similarities of the material culture dating to this period. I generate a network of pastoral mobility with a ceramic social network. The analysis presented in the dissertation offers a novel way of characterizing the ecological and cultural landscapes on the Tibetan Plateau after the introduction of pastoralism. By combing quantitative and material cultural methods, I argue that the pastoral networks, constructed based on vegetation quality, largely contribute to the participation across most of the Tibetan Plateau, which eventually leading to the formation of the cultural landscapes between the second millennium and the first millennium BC.

1.2 Structure of the dissertation

The introduction is a rough sketch of the dissertation that illustrates the research questions and intellectual background of the study. In Chapter 2, I turn to the theoretical and methodological approaches that underpin the dissertation. The theoretical basis of this research leverages concepts from landscape archaeology and theories of practice, institutions, and participation, inspired by the recent trend of conceptualizing pastoralism as a social institution shaped by human participation (Frachetti 2012; Rouse 2015; Lulewicz 2020). Chapter 2 also provides the methodological background by reviewing briefly the application of computer models in archaeology. Because simulation in archaeology contains a wide range of statistical and geospatial methods, I discuss the details of the methodology applied to the case studies presented in subsequent chapters. Finally, I provide a discussion of the terminological definitions used throughout the dissertation.

Chapter 3 offers a comprehensive review of the history and major debates in the prehistoric archaeology of Tibet. I illustrate a brief history of the significant archaeological discoveries in different parts of Tibet from the 1920s till now. I divide the prehistoric archaeological chronology of the entire Tibetan Plateau into three phases: the late Pleistocene to 4000 BC; 3500 BC to 1600 BC; 1600 BC to 200 BC. The narrative is organized based on the major debates of the three phases: 1). The initial peopling of the Tibetan Plateau; 2). The "Neolithization" process of the Tibetan Plateau; 3). The emergence and spread of pastoralism with surging trans-regional interactions.

Chapter 4 discusses the environmental settings of the study area, including the Tibetan Plateau and the Shannan area, where my archaeological fieldwork was conducted. The paleoenvironmental studies of Tibet suggest that the climate became similar to that of modern times after 4400 BP. This discussion justifies the use of contemporary satellite imagery in computer models in subsequent chapters.

Chapter 5 starts with a case study on the Bangga site in central Tibet in the first millennium BC. I argue that the architecture, material culture, zooarchaeological and archaeobotanical evidence from Bangga provide evidence for agropastoralist strategies in the first millennium BC, featuring both local barley farming and sheep/goat herding, a subsistence mode similar to the Qugong Culture sites. However, the Bangga material assemblage features a drastic decrease in surface-polished ceramics and the absence of microblades, indicating higher investment in herding (Zhang 2022). The results depict a more dynamic and diversified system of subsistence in the high-altitude regions, as the ancient people switched between different economic practices and combine them in an innovative way, suggesting that pastoralism at this time emerged not only as a subsistence strategy, but as a social-economic institution that structured wider social and economic domains. The discovery at Bangga encourages more research on pastoral land use in central Tibet.

Chapter 6 turns to a local scale analysis, focusing on the modern spatial patterns of pastoral land use. I present a GIS analysis of the ethnographic pastoralists in the Damxung region and the Yarlung River Valley. By extracting the environmental variables of the pastoral sites in ArcGIS, I compared the statistical differences of those variables among lowland the agropastoral corrals, corrals of highland herders and environmental background. Through this analysis, I discovered that the pastoral sites are distinguishable from the background environment, suggesting a clear locational pattern of pastoralists. The locational pattern is then used to interpret previously published archaeological sites in this region (e.g., the Jiaritang site).

Chapter 7 studies the archaeological continuity of new pastoral sites identified in the archaeological survey in the Yarlung Valley. I discovered two repeatedly used pastoral corrals, the earliest remains of which date to the first millennium BC. This is the earliest and first discovery of pastoral corrals and campsites to date in Tibet archaeology and provides evidence for both the archaeological chronology of this region and the long-term pastoral land use in specific places.

Chapter 8 explores the possible environmental mechanisms that shape the archaeological continuity of the pastoral sites. I investigate the soil retention capacity of the stone walls by modeling the soil erosion status of the sites. The stone walls function as traps that alter the local sediment dynamics, which may contribute to the formation of pastoral hotspots.

Chapter 9 presents a computer model that studies how the pastoral mobility network contributes to the settlement pattern between 3600 and 2200 BP. The pastoral mobility network is constructed based on the movements from the best vegetation to the croplands in Tibet. The model is compared with the distribution of archaeological sites in this period and the Tibetan monasteries. I find significant correlations between the pastoral network and the settlement pattern.

Chapter 10 investigates how the geographical model contributes to the interpretations of cultural landscapes. I generate a social network to compare with the pastoral network. The social network is constructed based on the similarity of ceramics. We find that the two networks are largely similar except for western Tibet. Based on qualitative analysis of the material remains, the trans-Himalayan movements may account for the discrepancies between the ceramic and pastoral networks.

Chapter 11 further provides evidence on the trans-Himalayan participation by presenting a detailed analysis of the newly discovered bronze mirrors in Tibet. I argue that bronze mirrors of local and Central-Asian types coexisted in Tibet, indicating a similar yet non-uniform way of using mirrors in the institutional domains of burial practices and religion across Tibet.

Chapter 12 summarizes the main conclusions and suggests possible work in the future.

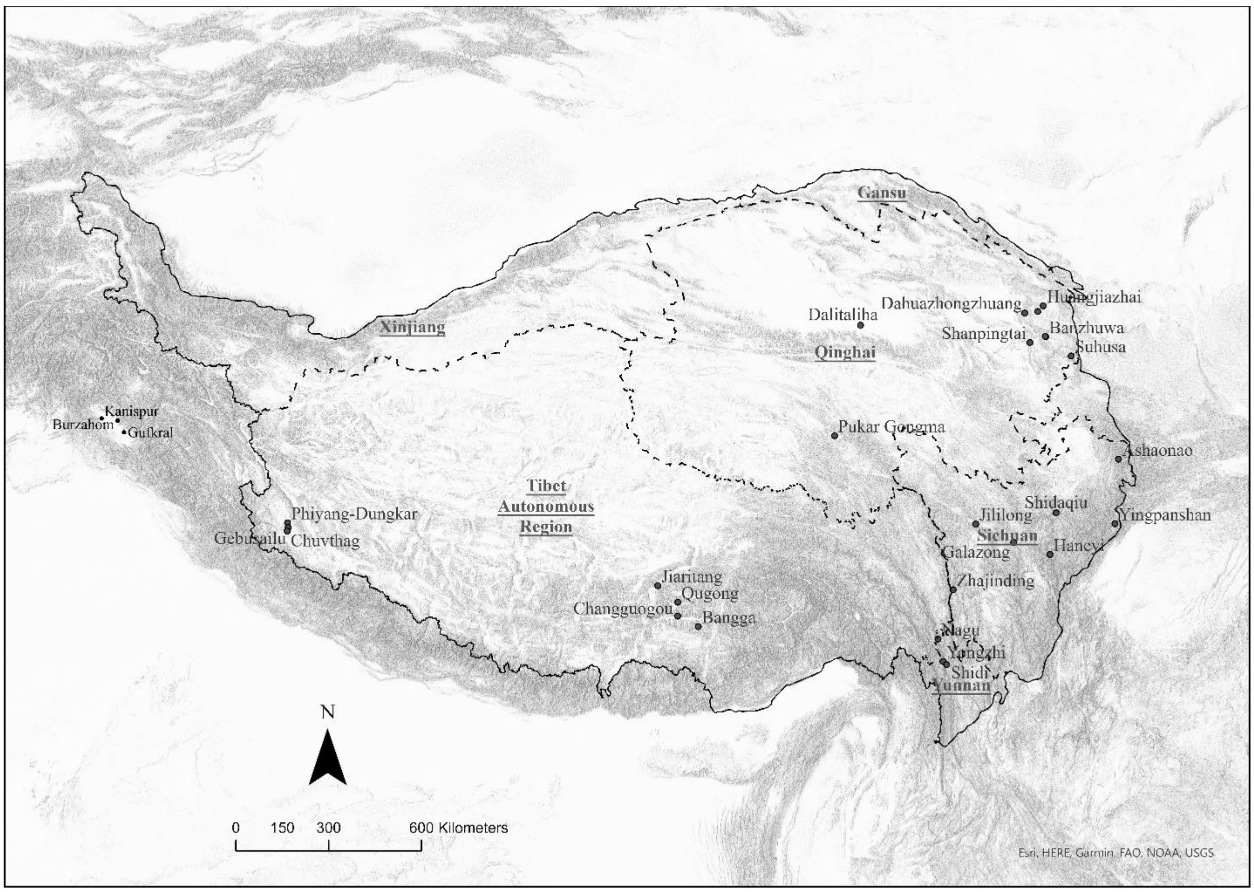


Figure 1.1: The extent of the Tibetan Plateau and the main sites discussed in the text dating from 3600 to 2200 BP

Chapter 2: The theoretical and methodological background

2.1 Landscape archaeology, participation, and institutions

Although landscape archaeology is a recent academic approach and first applied in archaeological research in the 1960s (David and Thomas 2016), the scholarly engagement with landscape first focused on the relationships among land, environment, and humans and has deep roots in art, humanities, and social science (e.g., geography, economics) in both the European-American and Chinese academic traditions. In art and social science, the concept of landscape originates in Dutch, meaning to make a land, region or environment (*landtscap*, Antrop 2018). The rise of landscape paintings in northern Italy and Flanders in the Renaissance era offers a novel way of understanding the role of people as observers and their relationship with the outside, physical world (Cosgrove 1998; Johnson 2006). From the nineteenth century onwards, this concept has become the core topic in cultural geography in European academia and Carl Saur introduced it to mainstream geography in America in the early 1920s (Sauer 1925/2008). By the mid-20th century, regional studies focused on the historical and geomorphological processes that shaped the contemporary observable palimpsest of social and physical geography (e.g., Hoskins 1970). The early studies of landscape were dominated by European scholars, based on the survey of the physical landscape and its historical evolution through methods such as cartography as they are associated with the practical need to correctly document exotic landscapes, especially during the Age of Discovery (Johnson 2006).

In China, the depiction of social landscapes also emerges as a long-term tradition that is deeply entangled with many academic pursuits throughout the history of Chinese academics, arts, and politics, even though this tradition has never been systematically theorized as an academic discipline. Based on the mural paintings in the imperial burial of Wang Chuzhi, Rawson (2002) suggests the origin of the Chinese mountain landscape painting to be a way in which the deceased is positioned in a political world under his control. In the case of the Wang Chuzhi burial, the landscape painting in the burial is tool for channeling the living world and the afterlife, which also symbolizes political power (Rawson 2002). In prehistoric archaeology, the tradition of studying the spatial relationships of remains appeared in China as early as the latter half of the 20th century. Early archaeological research focused on interpreting ancient settlement systems and kinship organizations under the Marxist paradigm. For example, as early as the 1960s, the excavators of the Banpo site, located in Northwestern China (Shaanxi Province), postulated that a matrilineal community occupied the site, which consisted of several blood clans (CASS and Shaanxi 1963). The argument was based on the spatial distributions of the houses, ditches, burials, and river channels in this large prehistoric settlement. The research on the geospatial aspects of archaeological remains continues to grow and the scope of research goes far beyond the kinship organizations of individual settlements (Banpo et al., 1988; Henan 1999; Peking 1983). In recent years, review papers on landscape archaeology encourage synthetic analyses integrating GIS and paleoenvironmental studies (e.g., Zhang 2010; He 2022). More research aims at a holistic understanding of landscape organizations, demonstrating that Chinese archaeological data have great potential in the interpretation of the geospatial, cultural, and social-political landscapes (e.g., Zhang et al., 2010; 2013; Qin et al., 2010).

The landscape approach to ancient pastoralism has been applied globally by archaeologists in the past few decades, mainly in studying the spatial relationships of pastoralist remains and surface features (e.g., Chang and Koster 1986; Frachetti 2009). With the advance of GIS and other spatial analytic techniques, this methodology has become widespread and has led to a florescence of research in Asia and elsewhere (Houle and Lee 2011; Wright et al., 2009;

Frachetti 2006; Capriles and Tripcevich 2016). For the archaeology of pastoralism, the landscape approach goes beyond the categorical identification of pastoralism/nomadism/semi-nomadism by emphasizing a variety of spatial relationships between human investments and ecology. Methodologically, landscape archaeology practitioners mainly employed large-scale surface surveys on the pastoral remains with direct core tests, a field approach that was anticipated by earlier scholars (Cribb 2004).

Anthropologists and geographers have discussed the idea of the landscape in a variety of conceptual frameworks in the past decades (e.g., Anschuetz et al., 2001; Cosgrove 1998; Tilley 1994; Ingold 1993). In geography, the landscape approach is cast as a mechanism for seeing both social and environmental contexts from a certain angle (Cosgrove 1989). It is an ambiguous and pervasive term for which a strict generalizable definition may not be required or invited (Godsen and Head 1994). Thus, it may be relatively easy to define what is not a landscape (Ingold 1993), yet what is a landscape remains a subjective and open discourse. For simplicity, I use a definition of landscape oriented specifically toward the study of pastoralist remains, proposed by Frachetti (2009):

A pastoralist landscape is defined as the socially and naturally (co-) created contexts that frame the perceived and physical extents of practices and experiences of pastoral societies. The perceived extent of a society's landscape is a product of the spatial and temporal patterns of that society's behavior, which is contiguous with the actual distribution of particular locations coupled with the historical memory and stochastic accumulation of socially meaningful locales in the collective cultural geography of interrelated agents and groups (Frachetti 2009: 22).

In his definition, the pastoral landscape is both human-constructed and experienced resulting in a physical form for materialistic study. The long-term accumulation of pastoralist behaviors, shaped by repeated and often-predictable exploitation of resources, will eventually result in an archaeological palimpsest (Bailey 2007). The archaeological records of pastoral behaviors are the incremental and overlapping products of social and ecological interactions through time. The phenomena of archaeological (or historical) continuity thus require synthetical analysis of environmental data, individual human behavior, and social institutions. In archaeology, the study of the spatial relationships of landscape features is often based on geospatial and paleoenvironmental analysis. Those analyses focus on a wide array of remains such as seasonal campsites, year-round dwellings, animal pens, trails, hydrological facilities, burials, rock arts, etc. From the perspective of field archaeology, the landscape approach requires the surveys and data sampling strategies to transcend site-specific focus and switch the research paradigm to inter-locality analysis and human-environment co-evolution. Recent research in Central Asia and other regions has managed to identify variable pastoral landscape features. Significant advances are made to reconstruct the palimpsest pastoral landscape regarding altitudinal adaptations, resource extraction, site tethering, seasonal mobility, and political complexity through time (e.g., Brosseder 2015; Caspari et al., 2017; Hammer 2012; Houle 2010; Honeychurch and Amartuvshin 2007; Frachetti 2012).

I situate my research broadly under the theoretical umbrella of landscape archaeology, and in doing so introduce and apply two concepts in my research: Institution and Participation. These concepts are discussed by previous scholars from multiple disciplines including anthropological archaeology, political science, and economics, but require specific explanation as I apply them to the archaeological study of prehistoric pastoralists.

Institution:

Several academic endeavors have been made to transcend the concept of "culture" in anthropology and archaeology. In archaeology, the concept of institution is almost synonymous with "social regularities" (Frachetti 2009; 2012; Rouse 2015; North 1991). Different definitions of the term institution, or other similar terms such as "social field" (Wolf 1982; 1984), "cultural institution" (Wallance 1966) are proposed by several archaeologists and anthropologists and used to explain larger political and economic "world systems" (Wallerstein 1974), Lulewicz (2020) recently borrowed the term "institutions" in his theory of studying relations in archaeology, narrowing the research scope of the institution to the study of organizations of people with common objectives, which is similar to North's definition of "organization" in his New Institutional Economy (North 1990).

The concept of institution used in my research is directly borrowed from North's work. He defines institution concisely as:

"humanly devised constraints that structure political, economic and social interactions" (North 1991:1)

North emphasizes the function of social institutions because he interprets the evolution of institutions as a fundamental driver of economic performance. In archaeology, institutions can be divided into several social domains, representing the norms or regularities shared within a particular region (Frachetti 2012). In this dissertation, I seek to study the formation and change of social institutions shaped by repeated instantiations of human behaviors (e.g., pastoral movement, trade, material conveyance, and idea exchange) which rely upon human-environmental interactions to take shape at the most basic level. In this way, potential relationships between the long-term reuse of pastoral locales serves to co-generate ecological realities and social institutions (Marshall et al., 2018). Although human-environmental interactions are not necessarily “institutions” in the sense applied here, ecologically pragmatic and socially responsive practices carried out through time contribute to shaping social institutions that are both environmental and ideological in nature. For example, the economic aspect of institutions can be approached by investigation human subsistence strategies, where repeated practical behaviors to meet biological needs are conditioned by both social and environmental feedback, a process of which is referred to as the reproduction of institutions in this research (e.g., pastoral hotspots, Marshall et al., 2018 and seasonal pastoral movements, Frachetti et al., 2017).

Participation:

The concept of participation is currently undertheorized in archaeological literature, yet it has already been applied in numerous case studies (e.g., Doumani 2014; Frachetti et al., 2017; Rouse 2015; a recent case in Chinese archaeology, see Jaang 2015). According to this school of thought, participation is *the social engagement of people that shape and reproduce institutions* (Frachetti et al. forthcoming). Participation, in this definition, is distinct from interaction (generally) since it demands alignment of institutional understanding of norms, codes, and appropriate actions. Interaction alone can exist without such clear alignments.

Within the framework of this developing discourse I use the concept of participation alongside the term “*hudong* 互动”, which is frequently used in Chinese archaeology literature and generally translates as “interaction”. Similar to participation, the meaning of *hudong* emphasizes the inter-relationships of cultural entities that align practically to shape the society. We notice that there is a difference in the usage of terms in the Chinese and European-North

American anthropological traditions for illustrating interaction among social agents at different levels, which can be traced back to the divergence of national research traditions in the twentieth century (Chen 1997). The terms *hudong* and participation may find their common roots in the thoughts of Karl Marx (Bottomore et al., 1992), who interprets social evolution by the changing interplays between agents, which further shape the modes of relations and forces of production (Patterson 2003; Bottomore et al., 1992). This line of thought is inherited by several prolific thinkers in social science (e.g., Childe 1950; North 1990; Wolf 1982).

In Chinese archaeology, *hudong* is mostly used to describe the relationships between archaeological cultures, which is further interpreted as the contacts of ethnic groups (theoretical concerns on the concept of *hudong* and its usage see Chang 1986; Jiao 2021; Li 2008). For example, Li Boqian (2008) states:

"Archeological cultures do not exist in isolation and they have interactions (hudong) among each other…… Particular archaeological cultures are usually associated with social or ethnic groups." (Li 2008:16; translated by author)

"考古学文化不是孤立存在的，考古学文化之间的关系是互动的关系…… 特定的考古学文化常常与特定的人们共同体或曰族团相对应。"(Li 2008: 16)

But in this sense, *hudong* itself does not fully capture the essence of participation described above; this would require that "archaeological cultures" inherently reflect shared institutional norms, which is not necessarily the case on the basis of material similarity alone. As such, *hudong* is most commonly used to describe large-scale or broad material synergies among social groups or cultures, without delving deeply into the way these materials signify or demand participation on the part of individuals or groups. In contrast the focus on participation often entails examining practical alignments that are evident on a local and granular scale, including daily practices or individual actions, where agents conform their modes of practice in explicit or implicit ways (Rouse 2015).

Using the concepts of institution and participation in landscape archaeology, I aim to illustrate how repeated environmental and practical aspects of pastoral activity may have shaped several relevant institutional domains of the prehistoric landscape in Tibet on both a trans-regional scale (the participation among social groups) and a local scale (the human environmental interactions).

2.2 Institutionalizing pastoralism in archaeology

Pastoralism in Eurasia has been a much-debated topic in archaeology and anthropology in the past few decades (e.g., Khazanov 1994; Harris 1996; Frachetti 2009; Spengler 2015). The discussions span from the origin of pastoralism to state formation, and pastoralists' relationship with agricultural societies in the context of the exchange networks in Eurasia (e.g., Barfield 1993; Honeychurch 2014; Di Cosmo 2002). Little is known about when and how pastoralism emerged as a specialized socio-economic strategy in Tibet (Miehe et al., 2009). The nascent state of archaeology of Tibetan pastoralism today encourages a review of the study of pastoralism in adjacent regions, such as the eastern and central Eurasian steppe. In most areas of Eurasia, a persistent academic tradition focuses on the variabilities and social institutions of pastoral nomadism.

Anthropology of pastoralism in the last century has focused on generating a conceptual typology rooted in the polarized relationship between "nomadism" and "sedentarism". Anatoly Khazanov makes distinctions based on economic typology and he divided pastoralism into four basic forms: pastoral nomadism, semi-nomadic pastoralism, semi-sedentary nomadism, and herdsman husbandry/ distant pastures husbandry (Khazanov 1994). Modern ethnographic studies distinguish different types of highland adaptations based on mobility patterns in highland Asia. Kreuzman (2012) concludes with five types of modern mobility patterns: combined mountain agriculture, detached mountain pastoralism, classical mountain pastoralism, resettlement project in high pastures, and agropastoral resettlement schemes in lowland regions. Most scholars commonly agree that pastoralism is a flexible and variable strategy, often vacillating between sedentism and nomadism, pastoralism, and agriculture (Salzman 2018). Abundant research in recent decades has stepped away from the use of typological categories, criticizing them for positioning the research focus on subjectively constructed ideal types to order fragmentary data (Dyson-Hudson 1972). Salzman (1972) documented in detail the mobility patterns and subsistence activities of two pastoral tribes in Iranian Baluchistan: Yarahmadzai and Gamshadzai. The tribes have a tripartite economy of pastoralism, plant cultivation, and raiding labor. This economy is termed as “multi-resource pastoralism”, which is also prevalent in other parts of the world (Spengler et al., 2014). Frachetti (2008) has summarized ethnographic research to demonstrate the changing strategies of pastoralists within relatively short time scales. He emphasizes variability in managing social and ecological demands through time as a key characteristic of nomadic flexibility and resilience. These different conceptualizations *per contra* pastoral typology have been applied in interpreting archaeological data accordingly (Spengler et al., 2014; Rosen 2003).

Viewing pastoralism as an institutional system functioning to condition broader social systems, rather than as a type of society, or an element of “culture” characterized by the reliance on herds, has been a recent debate in anthropology (Rouse et al., 2022). This theoretical trend is mostly seen in the archaeological interpretations of the social and economic roles of ancient pastoralism in the Eurasian steppe. Pioneering research by Owen Lattimore (1940/1962) acutely points out that horses, as an essential herd animal for large-scale pastoral mobility, may contribute to the military advantages of the people on China's frontiers, while sheep and goats are earlier and more important herds in the economic institutions. The institutional change derived from using herd animals keeps being a central topic in the scholarly debates on the eastern Eurasian continent. Interestingly, it is Lattimore's "horse hypothesis" that has a greater impact on the historical and archaeological research in Eurasia (e.g., Gimbutas 1956). For example, Anthony (2010) reconstructs the history of the Indo-European people through multiple lines of evidence, including linguistics, material culture, and zooarchaeology. He argues that horse riding is the fundamental driving force for the spread of cultural elements in the vast regions from the Danube River to the Indus Valley. Honeychurch (2014) systematically studies the rise of the north Asian complex societies based on state-of-art archaeological data. In a similar vein to Anthony, he also interprets the introduction of horse riding as a mechanism that resulted in the rearrangement of social relations through increasing human mobility. The "horse riding hypothesis" was recently challenged by Frachetti and Benecke (2009) based on the zooarchaeology in Begash, suggesting that the sheep/goat and cattle, rather than horses, may serve to shape alternative economic institutions that underpinned social relationships in Central Asia. The role of pastoral mobility as a mechanism that facliates trans-regional participation is again tested with computer simulations across the sites of Silk Road (Frachetti et al., 2017). This research broadly resonates with the recent calls to dispel the long-held myth of "nomadism" in archaeology (e.g., Rouse et al., 2022), as new evidence of multi-resourced pastoralism in ancient eastern Eurasia grows rapidly (e.g., Matuzeviciute et al., 2020; Yatoo et al., 2020; Doumani et al., 2021).

With new research quickly updating our understanding of the institutional nature of pastoralism, the ethnographic studies and comprehensive surveys in pastoral regions switch to the investigation of pastoralists' variable choices of social, political, and ecological strategies (e.g., Grillo 2012; Honeychurch 2007). A practical and theoretical problem still looms large in archaeology that whether the comprehensive archaeological survey of features and remains related to pastoralism is realistic (Chang and Koster 1982). Early scholars postulated the material remains and strategies of "pastoralist societies" to be ephemeral and thus difficult to trace archaeologically (Cribb 2004). In the long-term debate about whether archaeological remains of nomads can be detected over decades, some argue that nomads are not traceable because their material culture is relatively poor and decomposes over time, hence the emergence of pastoral societies in the Near East can only be demonstrated by gaps in the occupational chronology (Finkelstein and Perevolotsky 1990). Cribb (2004) conducted a pioneering ethnoarchaeological study on the pastoralists in Turkey and Iran. To distinguish the pastoral campsite from other surface features, he documented the categories of everyday objects and their spatial relationship within several pastoral campsites in southern Turkey. Still, he claimed it is hard to distinguish pastoral campsites from ground surface remains unless direct test excavation is performed (Cribb 2004). Today, pastoralist archaeology is increasingly facilitated by the use of inter-disciplinary methods including geoarchaeology, zooarchaeology, biomolecular studies, and GIS to identify campsites as well as variability concerning diet, subsistence activity, health, and mobility (e.g., Shahack- Gross et al., 2003; Caracotche 2001; Hammer 2014; Hermes et al. 2018; Wilkin et al., 2021).

2.3 The methodological background

The increasing use of scientific methods in recent years in Tibetan archaeology leads to a better understating of the archaeological chronology, subsistence economy, and trans-regional cultural participation. Beyond the traditional typological, stylistic, and contextual analysis of several newly discovered archaeological remains, I also use computer models to simulate the ecological landscapes and social institutions, which may be a result of the changing facets of human participation on a trans-regional scale and regional scale.

Although Geographical Information System (GIS) is no longer a novel method for Chinese archaeologists, the application of computer simulation and modeling in archaeological research in China is relatively scarce. The scope of computer models in Chinese archaeology is limited, most of which are deductive geospatial case studies on least-cost path analysis, site catchment area analysis, predictive modeling, and hydrological modeling (Liu 2008; Zhang 2014). Most geospatial applications based on Chinese archaeological data are primarily used to look for correlations between environmental variables and broad-scale cultural transformational or site distribution patterns. The past and current trends in the global archaeological practice of incorporating complex computer models and GIS analysis using high-resolution environmental and archaeological data provide a robust body of literature on which my research is based (e.g., Gillings et al., 2020).

Computer simulation research in archaeology is characterized as "an abstracted representation of the real-world process" (Doran and Hodson 1975). The computer simulation method, usually in the form of geospatial analysis, became an important interpretive tool that accommodates New Archaeology's optimistic ambition from the 1970s of reconstructing the "laws" of ancient societies (Lake 2014). Positivist hypothesis testing using deductive predictions of sites' spatial locations, and catchment analyses played a dominant role in early geospatial case studies (Clark 1972; Hodder and Orton 1976). This fluorescence of formal geospatial models and mathematical abstractions of archaeological data (e.g., social network analysis) met with much criticism by the post-processualists since the 1980s, who laid criticism on the very foundational aspect of most geospatial models: the concept of space (early critics of" lawful" archaeology see Flannery 1973; post-processual critics of landscape archaeology see Flemming 2006). For example, Tilley emphasizes that the human perception of the landscape is beyond the capacity of computer geospatial models and maps based on a Cartesian coordinate system (Shanks and Tilley 1987; Tilley 1994). The assumption that the physical landscape acts as a measurable "backcloth" of human activity is no longer warranted, and the formal mathematical analysis of archaeological data quickly entered a period of hiatus and decline.

However, with the advancement of GIS techniques and the rapid increase of processing powers of personal computers in recent years, the use of computer models is re-emerging as an important cross-disciplinary inquiry (Gillings et al., 2020). The iterative nature of computer models enables archaeologists to trace changes within a particular process and the process of changes. The recent development of the agent-based model also adds factors such as uncertainty and human experience. The complexity of models in modern archaeology facilitates more nuanced interpretations of social, economic, and ecological processes.

As the well-known aphorism from the statistician George Box stated, "all models are wrong" (Box 1976), the computer models in archaeology in most cases do not generate new data or provide precise reconstructions of ancient society. However, archaeologists benefit from computer models in their capacity to create a laboratory environment for hypothesis testing, where the input data and parameters of the models can be manipulated freely depending on the research questions. Following the recent trend of combining different computer simulation methods, my research presented in Chapters 8, 9 and 10 rely on three formal geospatial modeling methods (flow accumulation, network analysis, and soil erosion model), in an effort of combining quantitative analytical methods with the results from excavations, surveys and material cultural analysis. The methodological details for each case study will be addressed in the corresponding chapters below.

2.4 Terminology

It is important to explain my use of terms in this dissertation, before probing deeper into the archaeological data. In most cases, I use the term "pastoralist" as a general term to refer to groups whose way of life relies heavily on herding of domesticated animals, which serve as the mainstay of a their cultural, political, and economic identity. From a strictly economic (productive) perspective, pastoralism globally is well documented as exhibiting a diverse suite of strategies, often with a variable combination of engagements in farming, mobility, and trade. For this study, I sometime add emphasis on agropastoralists in order to highlight the practical strategies commonly seen in Tibet, which often entail a greater focus on farming with limited, seasonal mobility around year-round villages. In those contexts where ecological restrictions of high elevation prevent more intensive farming, Tibetan pastoralists may also practice opportunistic agriculture for harvesting fodder. Given the variation observed across the range of practices, I avoid using terms such as "transhumance", "nomadism", or" nomadic pastoralists" to refer to populations with a relatively high degree of residential mobility, unless they are from cited work (for discussion see Ingold 1985).

I also choose to directly refer to the absolute dates of the sites and materials as much as possible instead of using the terms such as "Neolithic Age", "Bronze Age" and so on. Those terms are only used when they are drawn from cited works or from regions where the archaeological periodization has already reached a common agreement among most scholars (e.g., the northeastern Tibetan Plateau). The periodization is controversial owing to the scarcity of archaeological data in most parts of the Tibetan Plateau. Archaeologists only reached a consensus on the loosely defined "Early Metal Age" of Tibet (Tong 1985). The chronology and periodization in the northeastern rim of the Tibetan Plateau are relatively well understood. The Neolithic cultures first appeared in northeastern Tibet including middle and late Miaodigou remains (4000-3500 BC), Zongri (3600-2000BC), Majiayao (3300-2000BC). The Bronze Age and early Iron Age cultures include Qijia (2200-1600BC), Kayue (1600-200BC), Xindian (1600-600BC), Siwa (1300-500BC), Nuomuhong (1400-400BC), and some sporadic findings bearing some Han culture elements dating to the Eastern Zhou period.

In other parts of the Tibetan Plateau, the chronology is far less precise. The encounters between communities with food-production techniques and local hunter gatherers possibly led to the co-existence of ceramics with microlithic remains, which is first documented in eastern Tibet (Hou et al., 2015; Zhang et al., 2020). The introduction of agropastoralism seems abrupt as evidenced by the archaeological records to date in most areas of Tibet. For example, the earliest "Neolithic" site, Qugong, in central Tibet, seems to have a certain form of agropastoralism and metal objects (a bronze arrow, CASS 1999). Similarly, the sites with the earliest ceramic tradition in western Tibet generally postdate 2000 BC. One exception is the site of Mabu Co in Xigatse, which is described as an early hunting-gathering "culture" with sophisticated ceramic technology (National Bureau of Cultural Relics 2022). In Tong Enzheng's first comprehensive review of Tibet archaeology, he defines the "Early Metal Age" to be a period following the "Stone Age" of Tibet and featuring the use of metal objects in the archaeological records. In

Tong's article, the term Tibet mainly refers to the Tibet Autonomous Region (Tong 1985). The "Early Metal Age" is roughly dated from 1000 BC to the 6th century AD. In general, the periodization of the archaeological record on the Tibetan Plateau requires further validation. The non-uniform relationships among residential mobility, bronze manufacture, trade, food production, and lithic and ceramic traditions are possibly essential characteristics of the prehistoric people in Tibet. The second and first millennium BC, where I situate my research, is a period when bronze and iron artifacts were already used, yet their social significance and provenances remain debated.

Chapter 3: A review of the prehistoric archaeology in Tibet

3.1 A brief history of archaeology in Tibet

The Tibetan Plateau has long been a vital node connecting eastern China, the South Asian subcontinent, and Central Asia (Huo 2017). However, the archaeology of Tibet has just stepped into its golden age in recent years (d'Alpoim Guedes and Aldenderfer 2019). The rapid surge of archaeological discoveries and research largely changed our understanding of high-elevational adaptations, the cultural-historical framework, and trans-regional communications in prehistoric Tibet. Here I organize my narrative on the rich research history in Tibet selectively, with a particular focus on the remains from the first and second millennium BC, such as the remains of Qugong, Karuo, Kayue, Xindian, Siwa, and the stone-cist grave "cultures", etc. Previous research has laid a critical foundation for further material culture analysis and computer modeling of the pastoral landscape and cultural interactions.

Archaeological and geological research in Tibet in the first half of the 20th century was predominately conducted by western expeditioners when archaeology has not yet become an academic discipline in Tibet. The mysterious nature of Tibet's culture and people, and the Kashag's (Tibet's administrative council since 1751) gesture of isolation in international politics aroused the curiosity of numerous expeditioners, pilgrims, politicians, and scholars across the world (e.g., Harrer 1953/2009; Kawaguchi 1909/2020). The documentation and art historical analysis of architecture, antiques, and paintings, among various other types of artworks, were among the mainstream academic pursuits for scholars working in Tibet for a long time (e.g., Tucci 1974). This research tradition persists today (e.g., Belleza 2014; 2020). Sporadic surface surveys and excavations were carried out, among which the work by Johan Gunnar Andersson, Nicholas Roerich, and Peter Aufshnaiter is the most relevant to this dissertation.

Johan Gunnar Andersson (1874-1960) was a Swedish geologist and archaeologist, and the founding father of China's modern archaeology (Chen 1997). He conducted the first archaeological surveys and excavations on the northeastern rim of the Tibetan Plateau between 1923 and 1924. The earliest archaeology in Tibet is primarily influenced by prehistoric archaeological research in the central plains, driven by Andersson's intention to trace the origin of the Yangshao painted pottery (Chen 1991). Along with his local assistants, Andersson discovered several Neolithic and Bronze age sites, which later became widely known, including Majiayao, Machang, Qijaiping, Zhujiazhai, Luohantang, Xindian, etc. In the autumn of 1923, he discovered and excavated the Bronze Age Kayao (Kayue) site, a few kilometers away from Xining city (Andersson 1925/2011). His placement of the relative dates of the sites was largely wrong, as he took a simple cultural evolutionary perspective and deemed the layers with the most elaborate painted pottery to be the latest in date. Despite that, Andersson's work paved the way for later archaeological research. Majiayao, Machang, Qijia, Xindian, and Kayue cultures were all named after his foundational works on the Tibetan Plateau and surrounding areas.

Nicolas Roerich (1874-1947) was a Russian scholar specializing in a wide range of humanitarian disciplines including linguistics, history, art, archaeology, and ethnography. His most famous work is a complete English translation of one of the most important Tibetan historical documents, the Blue Annals by Go Lotsawa (1392-1481), with the help of the great Tibetan scholar, Gedun Chhompel (Roerich 1976). Roerich is also the first scholar to investigate the nomadic remains archaeologically in Tibet. Between 1925 and 1928, he led the Central Asiatic Expedition in Xinjiang, Altai, western Mongolia, and Tibet, aiming to trace the distribution of the "animal style". He discovered some stone-cist burials and standing stones and collected a few artifacts, including bronze arrows, swords, and metal plates in the northern Tibet steppe. Based on the findings, he concludes that the northern Tibetan nomads were once actively connected with the Xiongnu and the Indo-Scythians (the survey results were published by his son, see Roerich 1930)

The Australian expeditioner, Peter Aufshnaiter (1899-1973), was the first person who conducted an "archaeological" excavation in the heartland of Tibet (Lhasa and its surrounding regions). His companion in Tibet, Heinrich Harrer, is possibly more famous to the public for his book, Seven Years in Tibet (Harrer 1953/2009). Along with Harrer, Aufshnaiter joined the German expedition in Nanga Parbat in 1939, supported by the leader of the Schutzstaffel, Heinrich Himmler. The British army arrested them in India following the start of the Second World War. However, they managed to escape from the captivity camp, crossed the Indian border, and stayed in Tibet until the war was over. During their stay in Lhasa, Aufshnaiter conducted the "excavation" at Shindo Rizur in 1950 (Aufschnaiter 1956), now near the Xianduo hydroelectric plant in Lhasa. According to his descriptions, some slab/stone-cist burials and human remains were found. Although he was not aware that he discovered some prehistoric burials, the artifacts were collected and documented in sufficient detail, including some iron artifacts and ceramic pots with spouts. Now we can tentatively date his findings to the "Early Metal Age" in Tibet, possibly between the first millennium BC and the first century AD. Although Aufshnaiter and Roerich are not archaeologists and their records were fragmentary, the record they are still worthy of academic considerations and have been analyzed by a few scholars (Huo 1995; Lu 2015).

After the People's Republic of China's abolishment of Kashag in Tibet (1959), archaeological excavations and research were mostly done by Chinese and local Tibetan archaeologists. Archaeological research and discoveries on the eastern and northeastern rim of the Tibetan Plateau are the most abundant, compared to other regions. The discovery of Karuo (eastern Tibet) and Qugong (central Tibet) are the most critical findings in Tibet to date. The Karuo site was discovered in 1977 and excavated by the Cultural Relics Management Committee of the Tibet Autonomous Region and Sichuan University in 1978 and 1979 (Xizang and Sichuan 1985). With an excavation area of approximately 1800 m^2, the excavators revealed several stone houses, roads, and pits. The unique material tradition was named the "Karuo Culture (3350 - 2100 BC)", bearing considerable regional characteristics and certain similarities with the Majiayao Culture in the upper Yellow River region. Similar remains were also found in the nearby Xiaoenda site (Zhang et al., 2019). Recent research on the human occupational history in Karuo suggested a hiatus period after 2100 BC (Song et al., 2021). The archaeological discoveries in eastern Tibet and western Sichuan were dominated by the stone-cist grave "cultures" in the late second millennium BC and the first millennium BC, which is relatively well-studied in Chinese archaeology (Luo 2012; Chen 2012). The stone-cist graves in the Hengduan mountains of eastern Tibet are intimately connected to the second and first-millennium BC cultures in the northeastern rim of the Tibetan Plateau, namely, the Kayue, Xindian, Nuomuhong, and Siwa cultures. After Andersson's foundational archaeological research in this region in the 1920s, Chinese archaeologists conducted intensive surveys and excavations in northeastern Tibet, especially in the valleys of the Huangshui River around the city of Xining, and established a widely-accepted archaeological chronology (Yu 1983; Xie 2002; Xu 2006; Shui 2001).

In central and southern Tibet, three years of excavations in Qugong in the 1980s, led by the Chinese Academy of Social Science revealed a prehistoric site in the middle branch of the Yarlung Tsangpo river region (CASS 1999). The excavators collected thousands of ceramics and stone artifacts from the burials and settlements associated with the early phase of this site. Based on those findings and the subsequent excavations in a similar site, Changguogou, on the northern bank of the Yarlung Tsangpo river, scholars named the Qugong culture. Several small-scale salvage excavations also revealed the stone-cist graves distributed in central and southern Tibet, suggesting the similarity of burial traditions across western and northern China (Huo 1995; Zhang 1988). Chronologically succeeding the early phase of the Qugong and Changguogou sites, the early phase of the Bangga site features a major material tradition in this region in the first millennium BC. Sichuan University led large-scale excavations in the Bangga site from 2015 to 2018. I will analyze the material remains of Bangga in detail as a case study in Chapter 5.

Western Tibet is another region with relatively systematic prehistoric archaeological data, especially those dating to the first millennium BC. Previous archaeological surveys and excavations were conducted mainly by local Tibetan archaeologists and archaeologists from Sichuan University. The major discovery in western Tibet to date is the massive archaeological site complex of Phiyang-Dungkar in Zanda County. The Phiyang-Dungkar site complex consists of numerous Buddhist grottoes, a few prehistoric settlements, and several large-scale burial sites spanning from the first millennium BC to the historic period (Sichuan et al. 2008).

In recent years, several ongoing large-scale excavations and surveys are quickly updating our understanding of the prehistoric human occupations in Tibet, such as the groundbreaking discoveries on the paleolithic remains in the Xardai Co, Chusang, and Nwya Devu sites (Meyer et al., 2017; Zhang et al., 2021; Zhang et al., 2018; H. Lu, personal communication). The intensive survey and excavations are ongoing by several archaeological institutions and universities in western Tibet (e.g., the Mabu Co site, National Bureau of Cultural Relics 2022), and the multi-disciplinary survey led by the Chinese Academy of Science (Yang et al., 2022).

However, most excavation reports have not been published in detail so far. We only see fragmentary information about the sites from some recently published papers focusing on the scientific analyses of the remains (e.g., Li et al., 2022; Tang et al., 2022; Yang et al., 2022).

3.2 Archaeological chronology and current debates

The cultural-historical approach has been a prevailing paradigm since the infancy of Tibet archaeology, contributing to the understanding of regional typo-chronology and cultural interactions. By determining the cultural affiliations of material assemblages through morphological comparisons, archaeologists achieved significant insights into the broad pattern of ecological and sociopolitical changes, which the final chapter of this dissertation will return to.

Without denying the fundamental importance of Paleolithic hunter-gatherers and early Majiayao-related populations in the process of occupying the Tibetan Plateau, this review focuses on the second and first millennium BC, speculating that the increasing exchanges of materials and ideas since the second millennium BC across the Eurasian continent may have played an important role for the shaping of social institutions and human-ecological interactions of the pastoral communities the Tibetan Plateau. I here illustrate a rough framework of three chronological phases on the Tibetan Plateau. Each phase features the introduction of new technologies, goods, and ideas to varying degrees. Of note, this periodization of cultural and social-political changes is only tentative without making any precise cuts, as the archaeological data in Tibet do not suffic for such generalizations.

The First Phase (late Pleistocene to approximately 4000 BC) is characterized by the initial peopling of the Tibetan Plateau and the later introduction of microblade technology (e.g., Brantingham and Gao 2006; Brantingham et al., 2007). This phase may seem trivial in the overall arrangement of this dissertation, as this research does not discuss any archaeological records from the paleolithic period. However, the legacies of the hunters and gatherers are presented in the archaeological records from much later periods on the Tibetan Plateau, even after agriculture and pastoralism were already adopted on the Tibetan Plateau (e.g., Lu 2014; 2022).

Among the technological and cultural traditions before the advent of food production, microblade technology is the most studied technological tradition on the Plateau. Most of the archaeological discoveries of early hunter-gatherers on the Tibetan Plateau are from surface collections. Early research postulated that the Tibetan Plateau was not inhabitable for hunter-gatherers based on environmental data and computer models (Chen 2006). Scholars speculated that this technology first appeared in the northeast margin of the Plateau, possibly as a result of the technological diffusion from northern China (e.g., An 1982; Zhang 2018). Sites around the Qinghai Lake region provide some of the earliest evidence to date for hunter-gatherers bearing microlithic technology, mostly dated before 3500 BC (Han et al., 2020; Tang 2011). Based on the location of those sites in the margins of the Plateau, several scholars have proposed a seasonal migration scheme between highland Tibet and surrounding lowlands, supported by possible evidence of long-distance material conveyance (Hou et al., 2020; Perreault et al., 2016). Recent studies in some earliest sites on the Plateau, including Chusang and Tshem gzhung kha thog, challenge this view of the seasonal settlement of the earliest humans (Han et al., 2020; Meyer et al., 2017). Although the number of Paleolithic sites with reliable dates increased dramatically in recent years, most of them are distributed along the eastern, western and southern periphery of the Tibetan Plateau, with a possible exception of the Siling Co site (e.g., Luo 2021). The long-distance seasonal migration scheme of hunter-gathers remains a critical and open debate in the prehistoric archaeology of Tibet.

Fine-grained and multi-disciplinary geospatial analysis have great potential to contribute to this question.

The Second Phase (3500-1600 BC) is characterized by the dispersal and development of the Majiayao-type remains and their spread and admixture with local cultural traditions. This phase can be understood as a gradual, selective, and regionally specific "Neolithization" process of the Tibetan Plateau, with increasing evidence of various forms of food production. Under the impact of the populations in the lowlands to the east of the Tibetan Plateau, several domains of institutions, such as ceramic production and food production, have undergone different changes among the Neolithic populations on the Tibetan Plateau, the process of which are not chronologically and spatially aligned. The Paleolithic site, Jiangxigou, also provides the earliest evidence of the ceramics on the Tibetan Plateau to date, but the cultural affiliation of the ceramics cannot be determined yet (Hou et al., 2015). From the third millennium BC onwards, The Majiayao "Culture"[1] assemblages dominate the cultural landscapes of the eastern Tibetan Plateau. The Majiayao Culture is characterized by its painted ceramics with sophisticated decorations, including a variety of spirals, circles, bands, etc. (for detailed analysis of the Majiayao ceramics see Hung 2011; Wei and Chang 2020). The most noteworthy phenomenon are the increasing discoveries of Majiayao's local variants across the eastern rim of the Tibetan Plateau. He (2015) posits that black burnished ceramics, notched rims, and protrusions on the body presented in the Neolithic remains at Haxiu are local elements. By contrast, the typical Majiayao painted ceramics in Haxiu are not

[1] Majiayao Culture has several local variants across the eastern Tibetan Plateau, leading to a vague and controversial definition of Majiayao as an "archaeological culture". Some scholars prefer to name those variants "cultures" (e.g., Zongri Culture, Yingpanshan Culture, Jiangweicheng Culture etc.). For simplicity, I use "Majiayao" to broadly refer to all the remains with Majiayao characteristics to varying degrees, including the sites of the Banshan and Machang phases in northeastern Tibet and the upper Yellow River region, Haxiu, Jiangweicheng, Yingpanshan, Liujiazhai in Western Sichuan, and the Zongri remains in the Gonghe basin of Qinghai.

dominant. Similar remains are also seen at the Jiangweicheng and Yingpanshan sites (e.g., Sichuan et al., 2006; Chengdu 2018). At the Zongri site in the Gonghe basin, the admixture of local ceramics with Majiayao culture is more evident. Cui (2015) suggests that the grey-white coarse wares in Zongri belong to the local Zongri people because of the exotic Majiayao impact through time. In the high elevation Karuo site in Chamdo, the similarity between the painted vessels of Karuo and Majiayao are vaguer (Chen 2012). Lu (2022) describes this pattern of cultural mosaic during the third millennium BC as differentiated patterns of interactions between local hunters and Majiayao farmers.

The subsistence economy of the Majiayao, Zongri, and Qijia cultures on the Tibetan Plateau is diversified. The existence of millet agriculture on the Neolithic Tibetan Plateau is debated (d'Alpoim Guedes 2018; Ren et al., 2021; Song et al., 2021; Chen et al., 2015; Jia 2012). At the Majiayao and Qijia sites, wild animals usually outnumber domesticated animals in most archaeological sites (Zongri sites see Ren 2017; An and Chen 2010; Majiayao sites see Ren 2017), except for the Changning site (Qijia culture, Li 2012). Of note, here we only refer to the Majiayao and Qijia sites within the Tibetan Plateau, as several scholars have demonstrated that a variety of domesticated animals are present already at the Qijia Culture sites outside of the Tibetan Plateau in Gansu, with increasing reliance on cattle and caprine through time (Brunson et al., 2020). Herds, including sheep and cattle, are already present during this period, especially on the periphery of the Tibetan Plateau and its surrounding regions. At the Qinweijia, Dahezhuang and Shizhaocun sites, cattle and goats are reported in the Qijia cultural layers. Caprine skeletons (possibly sheep) occur as burial goods in Majiayao cemeteries in Shizhaocun and Hetaozhuang sites (Flad et al., 2009). Recent studies in eastern Tibet at the Haxiu, Xiaoenda, and Karuo sites suggest that the reliance on wild animal resources is also predominant (He 2015; Zhang et al., 2019; Song et al., 2021). In general, herd animals and food production may already exist in the Majiayao period, but their significance in the human subsistence economy in the high-elevation environment remains debated. A recent surge of discussions on the transitions of material culture, subsistence strategy and social organizations have contributed greatly to our understanding of the social process during this period (e.g., Womack et al., 2021; Jaffe et al., 2022), However, it remains a problem to properly interpret the nature of the observed lowland-highland interactions. More in-depth analysis concerning the variability of the subsistence strategy and the material exchange may contribute to this inquiry (e.g., Zhang et al., 2019; Cui et al., 2015).

Phase Three (approximately 1600 BC to 200 BC) is the period that my research focuses on. Following the collapse of previous cultural traditions in northeastern and eastern Tibet, this period features the establishment of new cultural traditions showing extensive evidence of agropastoralism and the trans-regional exchange of ceramics, crops, and prestige goods. Drawing on multiple lines of evidence, several scholars argue that agriculture in the late Qijia period was in decline and the size of the settlements shrank (Dong et al., 2013; Li et al., 2021; Cui et al., 2018). This trend on the Tibetan Plateau features the final replacement of the Qijia culture by smaller settlements of the Kayue, Xindian and Nuomuhong, and Siwa cultures in the northeastern Tibetan Plateau. This Phase is also characterized by the emergence of the stone-cist grave “cultures”, the decline of the Neolithic sites on the eastern Tibetan Plateau (e.g., the Karuo and Majiayao Culture) and the surging discoveries of agropastoral settlements across the Tibetan Plateau. Increasing evidence of pastoralism, possibly in its full-fledged form, emerges with those cultural changes. For example, Xu (2006) argues that the Kayue remains demonstrated significant reliance on pastoral animals. He classifies the Kayue subsistence into the category of “semi-nomadism”, based on the evidence of sheep and cattle motifs on painted ceramics and the animal sacrifices including sheep, goats, and horses in burials. Shui (2001) attributes the decline of Qijia and the rise of pastoralism to the cooling climate regimes on the Tibetan Plateau. The agropastoral settlements and stone-cist burials grew rapidly in western and central Tibet in the second and first millennium BC. The increasing trans-regional interactions, communication networks and the formation of early complex polities in this period along the purported Highland Silk Road (Huo 2017) is the central theme of scholarly debates. In the following chapters I present several case studies and geospatial models in central Tibet to illustrate the material culture, the dynamics of subsistence and trans-regional participation during this period.

Chapter 4: Natural environment of the study areas

This dissertation consists of studies on different scales: regional and trans-regional. The case studies of material culture analysis, archaeological excavations, and geospatial models in Chapters 5-8 are regional-scale research of pastoral sites in central Tibet in the Qonggyai and Yarlung Valleys, Shannan. The trans-regional geospatial and material culture analysis in Chapters 9-11 are the metadata analyses of the entire Tibetan Plateau. The natural environmental settings, paleoenvironmental research, and their relationship with archaeological data are crucial considerations in the geospatial modeling.

The geography of the Tibetan Plateau has been frequently recorded by monks and expeditioners in early and late imperial China (e.g., Faxian, Xuanzang). Their records focus on the Pamir Mountain ranges since it is the crossroad channeling the Hexi corridor to the northern India subcontinent (Chen et al., 2022). The Austria-Hungary geologist, Ludwig von Loczy (1849-1920), first scientifically documented the extent of the Tibetan Plateau. He joined Béla Széchenyi's expedition to East Asia and provided a rich account of the geography of the mountain chains on the Tibetan Plateau (Chen et al., 2022). The geographical extent of the Tibetan Plateau defined in this research includes the area between 26°00′12″N - 39°46′50″N, and 73°18′52″E - 104°46′59″E, as defined by Zhang and colleagues (Figure 1.1; Zhang et al., 2002). This geographical extent borders India, Nepal, and Bhutan on the southern rim of the Himalayan mountains. It connects the Tarim basin and Hexi corridor to the north and includes the Pamir and Kala Kunlun mountainous regions in Kyrgyzstan, Tajikistan, Afghanistan, and Pakistan. The Hengduan mountains in western Sichuan mark its eastern boundary.

The Tibetan Plateau is a landmass with an average elevation of around 3500 to 5000 meters above sea level. Most of the areas in Tibet are dominated by high-elevation and flat plateaus, except for the deep-cut valleys of south-eastern Tibet. The modern environment on the Tibetan Plateau is characterized by intense solar radiation and low oxygen. The high solar radiation on the Plateau leads to a prolonged annual insolation duration and a considerable temperature drop at night. The westerlies cause a dry climate during the winter and the summer rainfalls are mainly brought by the Indian Summer Monsoon. Annual rainfall generally decreases from the southeast to the northwestern Plateau. The relatively high rainfall pattern in the southeastern corner of the Tibetan Plateau creates a landscape of subalpine coniferous forest, while most of the Plateau is characterized by steppe, desert, or semi-desert, which is occupied by pastoralists. The Tibetan Plateau is further divided into five subregions with different nature climates and geomorphology: the western Sichuan subregion; the eastern Tibet subregion; the Ngari subregion; the northern Tibet subregion and the southern Tibet valleys subregion (Ren 1999).

4.1 Natural environment of Shannan

I have conducted several archaeological surveys and excavations in the Qongyyai and Yarlung Valleys of northern Shannan since 2015. Shannan is a prefecture-level city in the Tibet Autonomous Region in the People's Republic of China, covering an area of 79254 square kilometers. Shannan is one of the most agriculturally productive regions on the Tibetan Plateau because it covers the fertile valleys of the middle branch of the Yalung Tsangpo river. The drainage area of the Yalung Tsangpo river and its tributaries in the northern part of Shannan is dotted with broad valleys (Chinese Academy of Science 1983). In this area, Naidong, Jiacha and Qusong county, located in the middle Yarlung Tsangpo river valleys, has the lowest elevation, around 3500 meters. Those valleys have been densely occupied. Most of the alluvial fans caused by incisions of rivers are used as agricultural fields. The geomorphology of Comai, Cuona, Luozha, Longzi and the southern part of Langkazi County in the southern part of Shannan predominantly features lake basins (Chinese Academy of Science 1983). The lake basins are generally depressions in the north rim of the Himalayas that collected water and became lakes during the early Miocene and Pleistocene. As the Tibetan Plateau rose, the climate turned arid, leading to the shrinking of the lakes. This geological process resulted in a lakeshore Plateau landscape with terraces. These lakeshore Plateaus are vast, and flat with ample sources of water that are suitable for pastoralism. This area is generally sparsely populated by highland pastoralists, yet agriculture can still be practiced in some low-elevation alluvial fans.

4.2 Paleoenvironmental considerations

The large-scale human movements and cultural subsistence changes on the Tibetan Plateau are often associated with climate changes (e.g., Chen et al., 2015; Dong et al., 2020). Although the uplift of the Tibetan Plateau may begin as early as 20 million years ago (Harrison et al., 1992), the uplift during the Quaternary period may have had a drastic impact on the environment and the spread of stone-knapping techniques to east Asia (Wang 2003). Chen and colleagues (2016) argue that the major human movements onto the Tibetan Plateau are caused by the warm and humid climate after the Last Deglacial period (18-11.6 ka BP), based on the reconstruction of the East Asian Monsoon (Chen et al., 2015) and Indian Summer Monsoon (Dykoski et al., 2005). The emergence of agropastoralism is associated with the cooling climate after the second millennium BC (Chen et al., 2016).

In this research I use high and medium-resolution modern satellite imageries and digital elevation models (DEM) to model the transregional participation across the Tibetan Plateau, focusing on the archaeological records after the second millennium BC. Large-scale reconstructions of the precipitation (Hou et al., 2012) and temperature (Li et al., 2015) on the Tibetan Plateau indicate that the climate remains stable and resembles the modern climate after the end of the Holocene Maximum (4400 BP). Although climate change may act as a driver for cultural change, human agency and resilience are also fundamental considerations when matching paleoenvironmental records with ancient human activities.

Therefore, I consider that it is acceptable to model large-scale human activities using modern environmental proxies based on three reasons: 1.) the spatial and chronological resolution of ancient climate change reconstruction is too coarse to simulate small-scale human activities through time; 2.) previous research suggests that the climate after the mid-late Holocene does not change in such a great magnitude that drastically influences the pattern of human activities; 3.) social, and political factors and human agency in high-elevational environments still need to be further addressed in archaeology. Their relationship with climate change through time is better to be discussed case by case qualitatively instead of being incorporated in the quantitative models in this research.

Chapter 5: Bangga: agropastoralism and cultural change in central Tibet

Research in the last two decades has yielded significant insights into when and how hunter-gatherers may have successfully settled on the Tibetan plateau (Brantingham and Gao 2006; Meyer et al., 2017; Zhang et al., 2018). Tibetan pastoralism, as one of the most important subsistence strategies in the high-altitude environment, was also getting increasing attention in recent years (Rhoades and Thompson 1975; Goldstein and Beall 1990; Bauer 2004; Chen et al., 2015; d'Alpoim Guedes and Hein 2018). Recent attention has been given to archaeological sites from various parts of the Tibetan plateau (e.g., Chen et al., 2015; d'Alpoim Guedes et al., 2014; d'Alpoim Guedes et al., 2015; d'Alpoim Guedes and Hein 2018; Dong et al., 2012; Dong et al., 2016; Zhang et al., 2019). Compared to the other regions, archaeological research in the central part of the Tibetan plateau is relatively limited, with only a small number of sites have been systematically excavated (d'Alpoim Guedes and Aldenderfer 2019, Figure 5.1), limiting our understanding the cultural development as well as the ancient subsistence pattern.

Compared to other regions of the Tibetan plateau, material culture and archaeological chronology on the northeastern Tibetan Plateau are relatively well understood (Xie 2002; Luo 2011; Chen 2015). The prevailing Neolithic cultures are Majiayao Culture (3980-2050 BC) and Qijia Culture (2183-1635 BC). Qijia Culture declined and split into small-scale cultures after the mid-second millennium BC (Xie 2002). Recent studies suggested that by the first millennium BC, people on the northeastern and eastern plateau practiced diverse forms of subsistence, including pastoralism, wild-animal hunting and agriculture (Chen et al., 2015; Dong et al., 2016;

d'Alpoim Guedes et al., 2015; He 2015; d'Alpoim Guedes et al., 2014; d'Alpoim Guedes 2018; Zhang et al., 2019).

Though the archaeology of the eastern Tibetan plateau is relatively rich, contemporary archaeological research is far from reaching a firm conclusion concerning cultural developments and the origin and development of agropastoralism in this region (Meyer et al., 2017). The state of this inquiry, however, is even poorer for the central and western parts of the Tibetan Plateau, even though the earliest evidence of human occupation at the Chusang site in central Tibet dates back to early Holocene (Figure 5.1; Meyer et al., 2017). There are only two occupational sites that have undergone archaeobotanical or zooarchaeological analyses on the central plateau: Qugong and Changguogou, both excavated in the late 1990s and early 2000s. Those two sites were considered to be the earliest Neolithic sites in this area, representing a regional material tradition in the second millennium BC (He 1994; CASS and Xizang 1999; CASS 1999). Animal remains from the early phase of Qugong site have suggested the possible existence of domesticated yak and sheep in the second millennium BC, implying that pastoralism was already practiced at Qugong (CASS 1999). At Changguogou, domesticated wheat (*Triticum sp.*), barley (*Hordeum vulgare*) and foxtail millet (*Setaria italica*) have been reported (Fu 2001; Liu et al., 2016; Lu 2016). In the western and northern regions of the Tibetan Plateau, sacrificial burials of sheep and horses from sites such as Butaxiongqu, Chuvthag, and Gurugyam cemeteries provide clear evidence of herd animal use by the late first millennium BC (Zhang et al., 2015; CASS et al., 2015).

5.1 The Bangga site

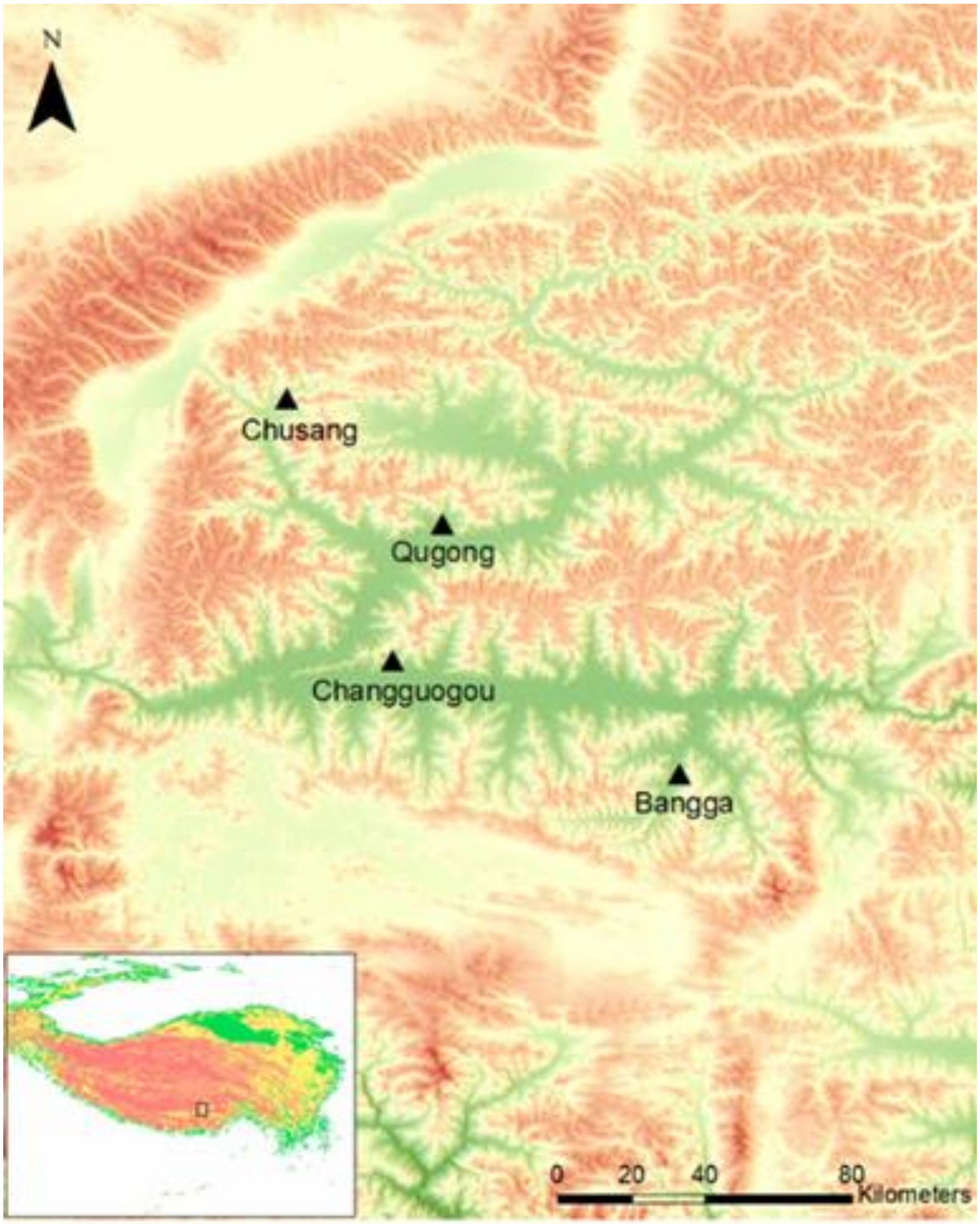


Figure 5.1: The prehistoric sites mentioned in this case study

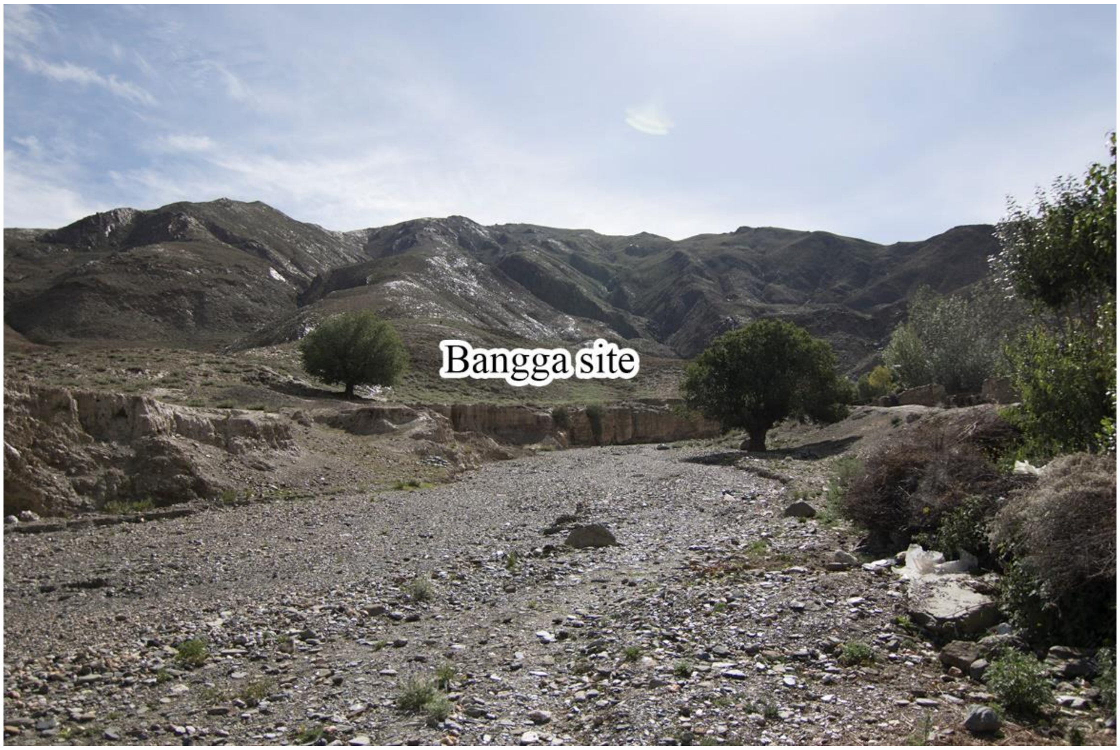


Figure 5.2: View of the Bangga site on an alluvial terrace, facing north-east, photograph by Zhengwei Zhang.

Bangga (29°05′13.66″ N, 91°43′15.36″ E, Figure 5.2) is a settlement consisting of multiple, large, stone enclosures. The ancient settlement lies adjacent to the modern agropastoral village of Bangga in the Yarlung Valley, approximately 10km northeast of Qonggyai County in the Tibetan Autonomous Region of China. At an elevation of approximately 3750 masl, Bangga is situated on an alluvial terrace, delimited to the south by a 10m-wide gully, and by a low mountain ridge to the north (Figure 5.2). Directly across this mountain ridge lies the summer pastureland used by residents of Bangga village today.

The first excavations of the Bangga site took place in 1985, led by the Tibet Autonomous Region Cultural Relics Management Committee (Wangdue and Kang 1986). Subsequent fieldwork led excavators to postulate that Bangga was occupied by agropastoralists, due to the similarities between the site's prehistoric stone architecture and analogous occupations of modern pastoralists in the region (Wangdue and Kang 1986; Li 2001; Wangdue 2001). From 2015–2018, a joint archaeological team of Sichuan University and Tibetan Autonomous Region Cultural Relic and Conservation Institute excavated a total area of 360m^2 at Bangga (Figure 5.3). A robust program of radiocarbon dating and detailed stratigraphic excavation (Figure 5.4) illustrate two phases of occupation within the 19 archaeological layers exposed in the 2015-2018 excavations. The late phase is represented by archaeological layers 1–12, which date from c. 400 BC to the modern era (Figure 5.6). Despite displaying some variation in colors, the late phase layers (1–12) are relatively homogenous, with a sandy texture (Figure 5.4). Few artifacts, faunal and botanical remains, were recovered or features (e.g., hearths) identified from these layers, suggesting relatively low-intensity occupation.

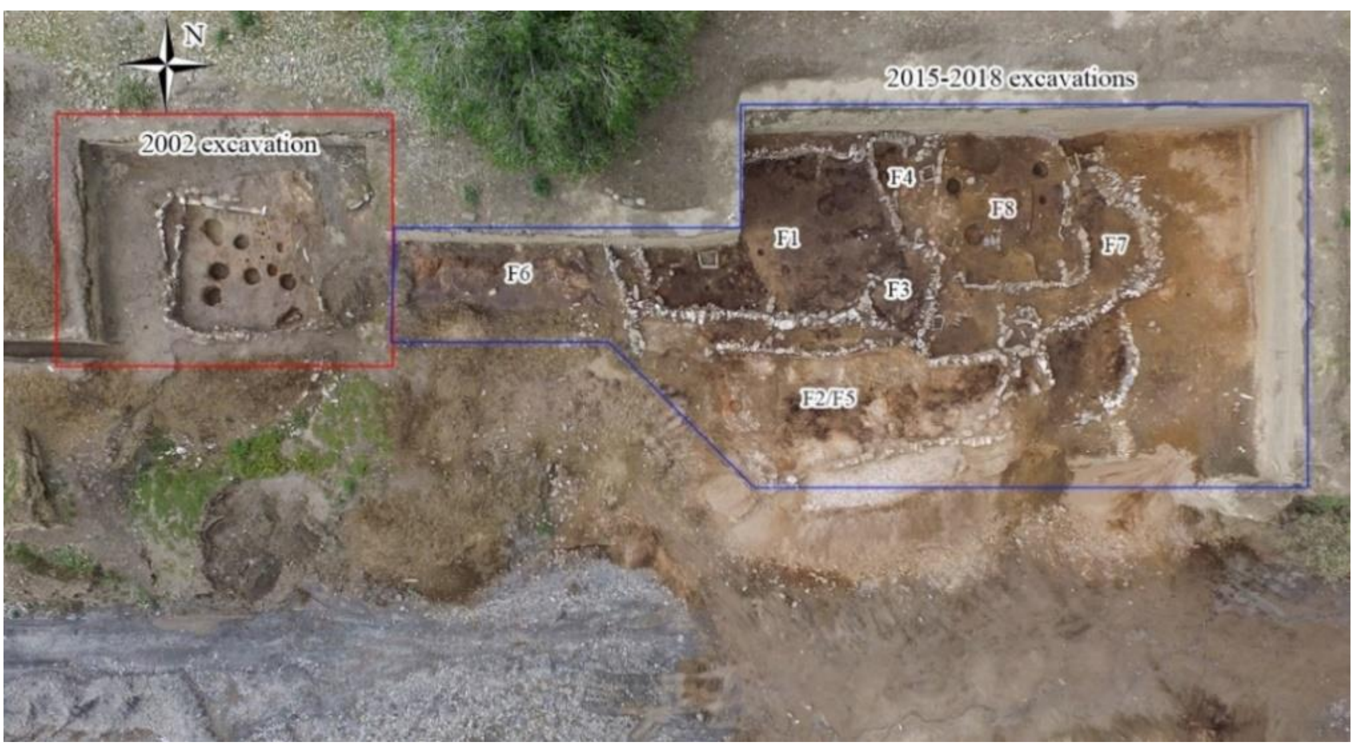


Figure 5.3: Plan of the Bangga site. Features within the stone enclosures were not drawn. F = household; F2 overlays F5; F8 overlays F7, photograph by Hailun Xu.

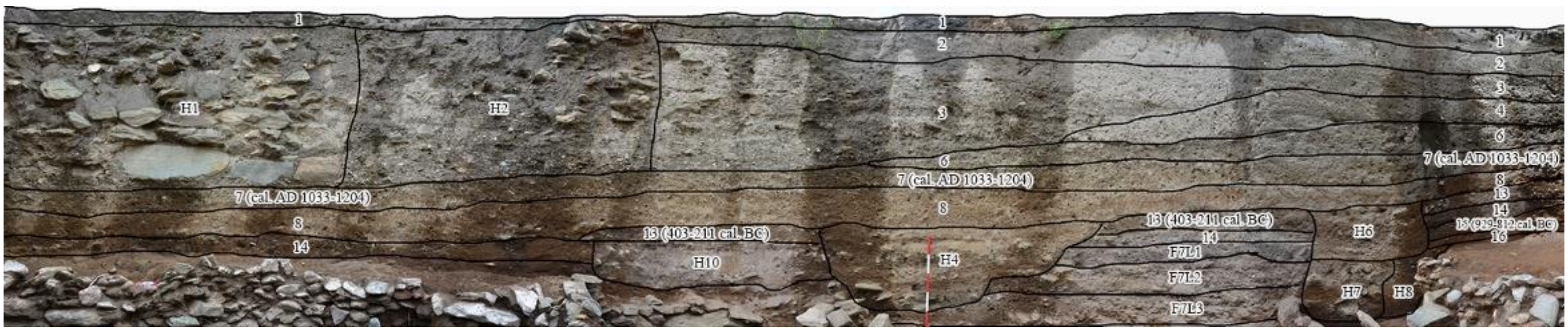


Figure 5.4: Stratigraphy of the Bangga site, north wall: L = layer; F = stone enclosure; H = pit. Calibrated radiocarbon dates (at 95.4% confidence) are presented with the layers; photograph by Hailun Xu; dates calibrated using the IntCal13 calibration curve in OxCal 4.3.2; Bronk Ramsey 2009; Reimer et al. 2013.

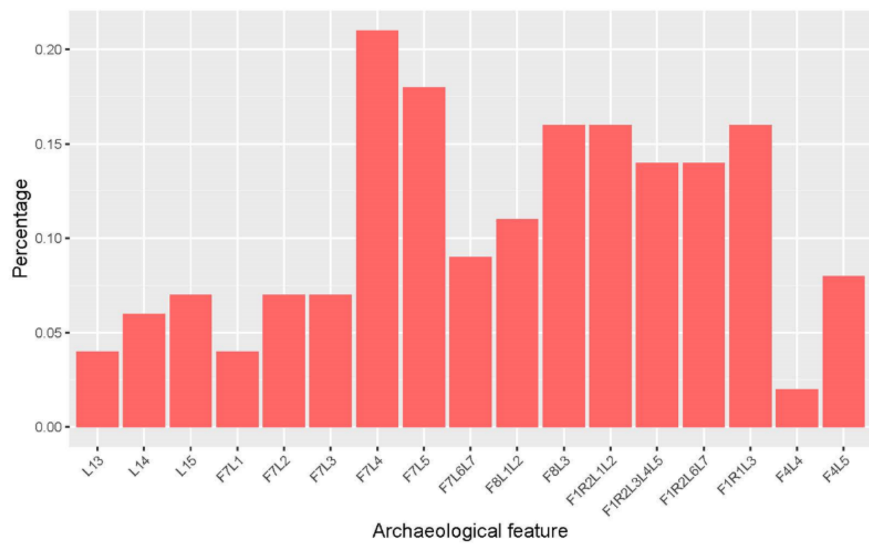


Figure 5.5: The percentage of polished ceramics at Bangga

Most of the stone enclosures are concentrated in the northern part of the site, with two large, rectangular enclosures (Figure 5.4; F2 and F5) dominating the southern portion. The walls, variable in height between 0.10 and 0.80m, were built out of stone slabs, possibly brought in from the immediate vicinity of the site, as similar materials are visible and abundant outside the excavation area. Multiple depositional layers were identified within the stone enclosures. This, in combination with evidence of refurbishment, such as wall removal and reconstruction, along with radiocarbon dates, provides further evidence that the site was repeatedly used and modified.

The most informative and abundant findings came from the earlier phase of the site's occupation (Figure 5.4). Over 400 features of various construction phases were recorded within the stone enclosures, including hearths, pits and postholes. These will be reported separately and in more detail in a monograph currently being prepared by Sichuan University. All eight of the early-phase enclosures were sealed by layer 14. Layers 15–19 were only present in the eastern part of the site, on the exterior of, but contemporaneous with, the stone enclosures. While these external layers are probably associated with activities that took place outside of the stone enclosures, they yielded very few artifacts.

5.2 Material remains of Bangga

We analyzed 7963 ceramic fragments from the 2015-2018 excavations. Pottery from the site is highly fragmented, with only one complete vessel. The upper levels (Layers 1–12) yielded dozens of thick, red sherds (Figure 5.7: a). This contrasts with a large quantity of relatively thin, brown sherds recovered from the lower levels and from within the stone enclosures (Layers 13–19 and F1–F8), the majority of which are hand-formed coarse ware. The early-phase ceramics demonstrate a decline in the surface-polishing techniques associated with ceramics from the preceding Qugong Culture and documented in the early phases of occupation at Qugong and

Changguogou (Figure 5.7: d–f). Notably, only 4 percent of ceramics from Bangga's lower levels are surface-polished (Figure 5.5). The surface decorations are generally dominated by zigzag and triangular curving lines that are mostly located on the vessels' shoulders and upper bodies. Although there is a dearth of bases, the pottery from early-phase Bangga primarily comprises round-based vessels. Handles are prevalent in the ceramic assemblage in the early phase, and typically include a lug attached to the middle of the vessel, a feature that is absent in the precedent Qugong Culture. At Bangga, we distinguished two ceramic forms: jars and bowls (Figure 5.7: b–c), among which the open-mouthed jar predominates.

Twenty-four stone tools were recovered and analyzed from the 2015 excavation at Bangga. These include stone weights, stone cores, flakes, grinding stones and millstones (Figure 5.8). Some of the stone weights and millstones were painted red.

We collected more than 10,000 faunal remains from Bangga from 2015 to 2018, and zooarchaeological analysis is conducted by Zhengwei Zhang (2022). Specimens that can be attributed to large-sized Bovinae, Equidae and various wild-living mammals, including musk deer, antelope and hare. The wild animals, however, comprise a small proportion of the assemblage. The presence of large Bovinae specimens indicates the presence of cattle or yak demonstrating similarities with the Qugong faunal assemblage (CASS 1999).

Relatively intact barley rachises were recovered in 2018, indicating the practice of barley-dominant agriculture at Bangga (Tang et al., 2020). The majority of wheat and barley remains from Bangga were retrieved from stone enclosure F1 in the north of the site, suggesting that F1 may be a domestic structure.

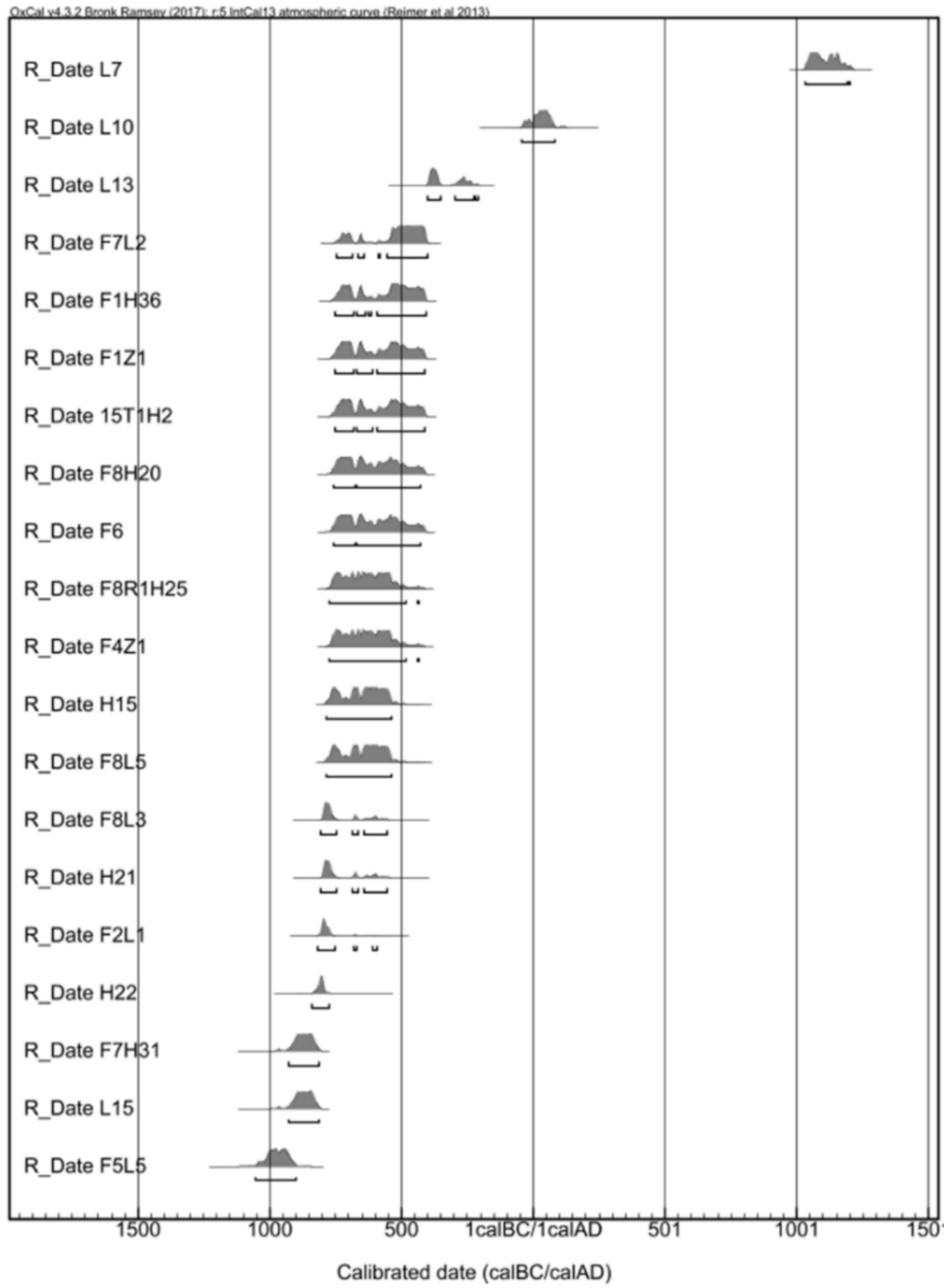


Figure 5.6: Calibrated radiocarbon dates for Bangga (using OxCal 4.3.2 and IntCal13 calibration curve; Bronk Ramsey 2009; Reimer et al. 2013); F = stone enclosure; H = pit; L = layer; R = room; T = trench; Z = hearth

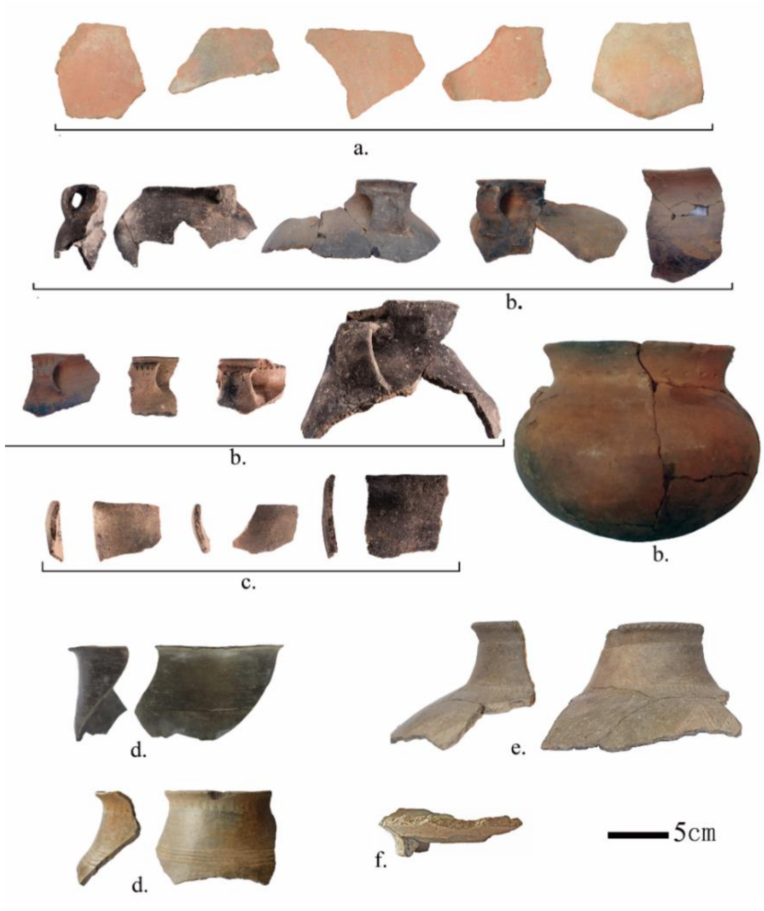


Figure 5.7: Ceramics at Bangga (a–c), compared with Qugong Culture ceramics from the Changguogou site (d–f): a) late phase red ceramics from Bangga; b) early phase open-mouthed jar from Bangga; c) early phase bowl from Bangga; d) surface-polished, open-mouthed jar collected from Changguogou; e) rim sherd of a surface-polished, ring-based jar collected at Changguogou; f) ring base collected at Changguogou, photographs by Xinzhou Chen, Zhenrong Li and Xiaowen Zhang.

5.3 Discussion: agropastoralism and cultural change

The excavation results illustrate an integrated subsistence economy wherein both farming and pastoralism were used at Bangga throughout the two occupation phases. The multi-resource nature of subsistence at Bangga is also reflected in the site layout and artifact distribution. Across the site, domestic structures are associated both with storage facilities and animal enclosures. In the northern part of the site, large stone enclosures, such as F1, F7 and F8, are interpreted as domestic spaces due to their various internal features, including hearths, pits and postholes. The majority of macro-botanical remains were recovered from this area, and the main enclosures connect, via, doorways to smaller enclosures. These also contain numerous pits, and were probably used as storage facilities. By contrast, domestic evidence is lacking in the southern part of the site. Here, the abundance of animal dung within structures F2 and F5 suggests they were probably used as animal enclosures.

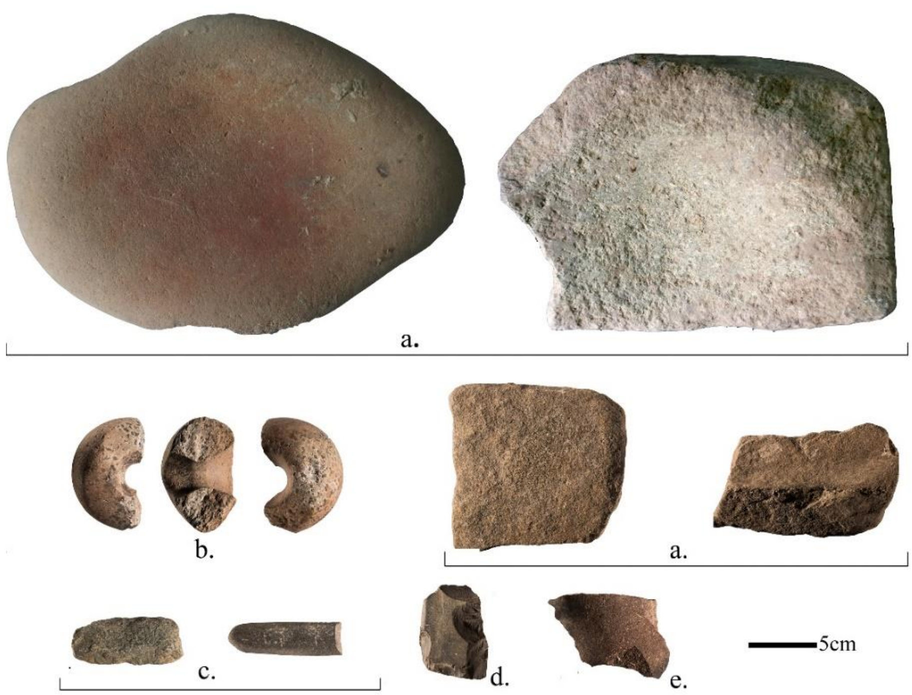


Figure 5.8: Early phase stone tools from Bangga: a. millstones; b. stone weight; c. grinding stone; d. chipped stone; e. flake, photographs by Xinzhou Chen, Yushi Zhi and Zhenrong Li.

My findings suggest that Bangga was divided into two functional zones, with domestic, residential areas in the north and animal corrals in the south. This resembles the layout of agropastoralist houses in modern Bangga village, where each house is also divided into two functional areas with a domestic area connected with a semi-detached animal enclosure. Such layouts are prevailing in modern pastoral settlements across the Tibetan Plateau, and resonate with Bronze Age pastoral settlements documented archaeologically from the Inner Asian Mountain Corridor (Frachetti and Mar'yashev 2007; Jia et al., 2017).

The faunal assemblage from Bangga comprises primarily domestic herd animals, mainly sheep and goats. Although zooarchaeological research is still ongoing, preliminary results show the presence of large Bovinae taxa—probably cattle or yak. The mountain pastures to the immediate north of the site are still used today by sheep and goat herders from modern Bangga village. It is likely that the same strategy would have been used by ancient herders.

Bangga's prehistoric economy was also characterized by local barley farming, as supported by the recovery of barley rachises, the by-products of crop processing. It is also notable that two cereal crops that originated in North China, broomcorn and foxtail millet, are absent at Bangga. Thus, the Bangga assemblage differs from those studied at Qugong cultural sites on the central Tibetan Plateau, such as Changguogou (1513–842 BC), where wheat and barley (south-western Asian crops), as well as the foxtail millet, were identified (Fu 2001). The presence in Central Tibet of both eastern and western Asian crops during the second and the first millennium BC should be understood in the wider context of the trans-Eurasian exchange of cereal crops (Frachetti 2012; Liu et al., 2019). Nevertheless, the distinction in cropping systems between Bangga and Changguogou should be considered in the context of the assemblage formation process, which biases towards routine food preparation of staple grains (Tang et al.

2020). It could also be driven by a variety of social, economic and ecological factors, including issues related to crop cold-tolerance, flexibility in crop flowering times, and the possibility of long-distance exchanges of grains (d'Alpoim Guedes et al., 2015; d'Alpoim Guedes 2018; Liu et al., 2017; Song et al., 2021), but also the culinary choice, a potential driver that has been discussed elsewhere (Liu et al., 2016).

I also document differences between the material cultural assemblages from second-millennium BC Qugong cultural sites (i.e., Qugong and Changguogou) and first-millennium BC Bangga. Indeed, the ceramic and lithic assemblages from Bangga exhibit aspects of both continuity of, and divergence from, the precedent Qugong Culture. At Qugong, the excavators divided the occupation into three: the early, late, and 'stone-cist burial' phases (CASS 1999). Early-phase Qugong material culture is characterized by its distinctive black fabric and finely polished surfaces, which comprised approximately 22 percent of the Qugong ceramic assemblage (CASS 1999). Ceramics at Bangga, however, appear to belong to a different pottery tradition, with the near absence of surface-polished sherds (only four percent). This resonates with the final occupational phase at Qugong, in the first millennium BC. In addition, the ring-based vessels with hollowed-out triangle decorations that are common at Qugong are completely absent in Bangga. Although these distinctions indicate changing material traditions between the second and the first millennia BC in Central Tibet, we also observe aspects of continuity between Qugong and Bangga, such as in the diamond-shaped, curving-line decorations found at both sites. A new style of lug decoration on the handles, however, characterizes pots at Bangga. Given the lack of evidence to suggest that these material changes resulted from external contact, we attribute them to local communities of practice, specifically within the context of ceramic production (Doumani 2014).

Ethnoarchaeological research across the globe has linked residential mobility to ceramic manufacturing time, and hence the overall investment of labor (Simms et al., 1997; Eerkens 2003). Eerkens (2003), for example, argues that the quantity of ceramics with unpolished surfaces, which increases the heat efficiency of the ceramics and reduces the manufacturing time, is usually positively correlated with residential mobility and vice versa (Schiffer 1990; Eerkens 2003). From this perspective, the decrease of labor input in association with the lack of surface-polished ceramics at Bangga, potentially signals higher residential mobility associated with increasing investment in pastoralism. This interpretation is consistent with the zooarchaeological evidence showing herding animals predominating the faunal assemblage (Zhang 2022).

Although stone tools are scarce at Bangga, three elements stand out when compared to the Qugong Culture. First, the absence of microblades at Bangga is notable and may indicate a final stage in the decline of microlithic traditions in this region (CASS 1999). Microblades are present at both the Qugong and Changguogou sites, although in small numbers (He 1994; CASS 1999). Microblade technologies first appeared in East Asia around 27000 BP and represent a very long and homogeneous technological tradition in the region until the mid-Holocene (e.g., Yi et al., 2013). Comparatively, microblade technology is often viewed in terms of its economic advantages, particularly for the hunting and processing of large- and medium-sized game animals (Elston and Kuhn 2002). One possible explanation for the discrepancy in the presence of microblades between Qugong and Bangga is that hunting was the focus of animal-based subsistence at Qugong, whereas the inhabitants of Bangga engaged more intensively in short-distance herding. Despite this economic difference, however, there are also similarities between the Bangga and Qugong lithic assemblages.

First, red-painted stone stools are documented at both sites. Approximately 20 percent of the Quagong stone tools were painted red, compared to 13 percent at Bangga. That no red-painted stone tools have been found at contemporaneous sites in other parts of the Tibetan Plateau may indicate continuity in stone tool decoration traditions between Qugong and Bangga. Second, grinding stones were recovered from Bangga and from the early phase at Qugong and Changguogou. Such stones can be used in multiple food-production contexts, although a primary function is for making flour, typically from cereals originating from southwestern Asia, such as wheat and barley (Fuller and Rowlands 2011). By contrast, East Asian cereals, such as millet and rice, were most often cooked by boiling and steaming. This deeply rooted distinction between East and West Asian culinary practices has been explored by various scholars, particularly in the context of early food globalization (e.g., Fuller and Rowlands 2011; Liu et al., 2016).

The presence of grinding stones and the absence of pottery vessels for boiling or steaming at Bangga hints at a flour-based culinary tradition. Such a cooking preference could have consequences for the selection of grain quality, with high gluten content being the priority as they extend better in grinding. This is consistent with archaeobotanical evidence showing barley to have been the main crop at Bangga, which resonates with the recent discussion on the culinary driver of the eastern dispersal of the Fertile Crescent crops (Liu and Reid 2020).

While current archaeological data are insufficient to illustrate comprehensively the changes in subsistence and material cultural traditions in central Tibet and across the Tibetan Plateau, my excavations at Bangga provide evidence for important differences (and similarities) between this site and the Qugong Cultural sites in central Tibet. Bangga yielded distinct botanical and faunal assemblages that show diversity in subsistence strategies, variations in labor-input in ceramic manufacturing that indicate differences in residential mobility, and evidence for culinary practices focused on the preparation of flour-based food. The absence of microblade technology indicates less reliance on hunting and game animals. How, then, can we explain these differences from a wider regional perspective?

The climate of this part of the Plateau has changed significantly during the Holocene and has been explored in the context of variations in Asian summer monsoon patterns (e.g., Wang et al., 2005). We do not, however, consider the environment to have been a primary driver of the material changes at Bangga, as there was no drastic climatic shift in Central Tibet around 1000 BC (e.g., Duan et al., 2012). Furthermore, Chen et al. (2015) have demonstrated that the environment was only one factor, among several, that induced shifts in prehistoric subsistence and farming technology elsewhere on the Tibetan Plateau. Rather, we have framed the differences between Qugong and Bangga in the context of shifting cultural paradigms between the second and the first millennium BC, particularly in relation to subsistence and material craft traditions. I argue that the differences were primarily driven by regional diversities, as populations move readily between distinct modes of subsistence, combining those different modes in a variety of innovative ways, as illustrated in other parts of Tibet and across China (e.g., Zhang et al., 2019; Liu and Reid 2020).

5.4 Summary

The results from my excavations at Bangga illuminate the emergence and development of agropastoralism on the Tibetan Plateau, especially in Central Tibet. The architecture, material culture, zooarchaeological and archaeobotanical evidence from Bangga offer a detailed case study of settled pastoralism in the first millennium BC and illustrate innovations and continuities from earlier sites. The Bangga material assemblage features a drastic decrease in surface-polished ceramics and the absence of microblades, indicating higher investment in a mixed economic strategy; the Bangga's prehistoric economy features local barley farming and sheep/goat herding, a subsistence mode similar to the Qugong Culture sites. The results at Bangga depict a more dynamic and diversified system of subsistence in the high-altitude regions, as the ancient people switched between different economic practices and combine them in an innovative way to shape the broader institutional structure.

Further questions remain regarding the seasonal regimes of pastoral mobility in central Tibet. When and how did the ancient pastoralists occupy the lowland valleys and the highland grasslands of Tibet? What strategy should we employ to discover the remains of the seasonal settlements of pastoralists in the mountainous regions? To investigate the wider landscape of Tibetan pastoralism and document its geographic continuity through time, I conducted ethnographical and archaeological surveys, test excavations, and GIS analysis focusing on the highland corrals in the Yarlung River Valley.

Chapter 6: The pastoral landscapes in central Tibet and an ethnoarchaeological GIS analysis

Studying the material remains of pastoralist and hunting communities is challenging in archaeology, especially in complex and diverse social-ecological landscapes such as the Andes, Africa, Central Asia, and Xinjiang (e.g., Frachetti and Ma'yashev 2007; Aldenderfer 2002). Most previous research focuses on discovering and distinguishing ephemeral remains, distributed unevenly throughout rugged terrain. Early ethnoarchaeological research draws on empirical comparisons between historic and modern campsites of mobile pastoral groups and the archaeological records, arguing that the combination of the spatial arrangement of artifacts (mainly ceramics), typology of settlements, and location choice have the potential to contribute to the identification of pastoralist remains in archaeology (Cribb 1992; Hole 1979; Western and Dunne 1979). The increasing use of geospatial techniques and remote sensing imagery in the past few decades offers new approaches to this classic question in archaeology.

Archaeological research in the Andes indicate that the settlement pattern of herders is distinguishable from that of hunter-gatherers, which encourages extensive surveys of pastoral remains in archaeology (Aldenderfer 2002). Surveys on the stone structures and campsites in the upland pastoral regions of the Italian Alps demonstrate that archaeological remains can be classified into different functional groups, based on quantifiable environmental variables and intra-site comparisons of material discard patterns (Carrer 2012; 2013; 2017). Archaeological surveys and GIS analysis indicate that pastoral sites are in areas with distinctive vegetation patterns (Frachetti and Maksudov 2014; Thabeng et al., 2019). Infrastructure of the ancient and modern pastoralists suggests considerable investments that improved the accessibility of water and pasture (Hammer 2014).

In Tibet, interpreting early pastoral remains is further complicated by the lack of comparable ethnographic and archaeological data and the potential non-uniform interactions between local hunting-farming groups and farming and pastoral groups from outside of the Tibetan Plateau (e.g., He 2015; Ren et al., 2020; Zhang et al., 2019). The drastic elevational differences between the river valleys, the mountainous areas, and the steppes in Tibet enable innovative and flexible utilization of the physical landscapes. The ancient people thus have a wide range of choices to switch between different social-ecological niches to utilize the nearby resources.

To investigate the potential locational preferences of pastoral campsites with different degrees of mobility and subsistence economy, I compare the geospatial characteristics of the locations between two groups of ethnographical pastoral sites in central Tibet using GIS. The ethnoarchaeological results are then used to interpret an archaeological dataset in this region dated to the first millennium BC.

6.1 Archaeological and ethnographical datasets

To compare the potential range in locations for seasonal corrals and short-term habitations, I documented and studied ethnographic seasonal corrals in two areas of central Tibet, the Yarlung Valley and the southern Damxung region. The Yarlung River Valley is in the agropastoral zone of Naidong County in northern Shannan. Despite the fact that lowland agriculture is practiced with an average elevation of approximately 3500-4200 masl in the Yarlung Valley, the dry and cold climate of this high elevation river valley makes it a challenging location for agriculture. The agropastoralists in the Yarlung Valley practice site-tethered pastoralism on the common pastures in the nearby mountains. The southern Damxung region is located to the north of Lhasa city, it is a transitional zone between the northern Tibetan steppes and the valleys of the milled branch of the Yarlung Tsangpo River region, which is mostly occupied by seasonal herders with larger herds (Chinese Academy of Science 1964).

Through visual inspection of Google Earth imagery, I generated a dataset consisting of 157 contemporary/ethnographic herding corrals in Yarlung Valley and 41 corrals in southern Damxung. To compare the archaeological dataset with the modern ethnographical data, I use a published dataset from the archaeological survey of the Qinghai-Tibet Railway, including 14 archaeological sites within the southern Damxung region. The sites are mainly in the Yangpachen Valley with one site (Jiaritang) dating to around 1000 BC (Xizang et al., 2005). The rest of the sites are not dated. During our archaeological survey from 2015-2016 around the Bangga site, we also published a dataset of 34 rock arts in the Qonggyai Valley (Yang et al., 2019; Figure 6.2).

The resulting aggregate database contained georeferenced locations of effectively all the ethnographic sites visible on the surface and known archaeological sites within the study zone, which was arbitrarily defined to cover a broad homogenous physical environment between 3500 and 4600 meters above sea level. A small number of the ethnographic pastoral sites were ground tested through my field surveys in 2018-2019 in the Yarlung Valley (see Chapter 7).

6.2 Analytical Method

To quantitatively examine environmental variables that may be associated with the locational preferences associated with different pastoralist practices, I selected five variables to compare the locational choices reflected in modern pastoral corrals in different elevational zones: elevation; topographical wetness index (TWI); summer NDVI; slope in degrees; total area of the viewshed within 5 kilometers of the site. The description of the variables and their potential relationships with different modes of human mobility and subsistence economy are presented below (Figure 6.1):

Elevation: elevation is the most used variable in the different locational choices of the pastoral sites (Carrer 2013). The landscape in the river valleys of Tibet typically consists of low-elevation valley bottoms for agriculture and high-elevation mountains for pastoralism, while the campsites are usually on high-elevation Plateaus (Yamaguchi 2011). I download DEMs from Shuttle Radar Topography Mission (SRTM) to analyze the elevations of the corrals. The DEM dataset has a spatial resolution of 30 meters.

NDVI: Previous research on Central Asian pastoralists suggests that the NDVI is broadly correlated with both pastoral mobility patterns and local-scale seasonal transhumance schemes (Caspari et al., 2017; Jia et al., 2020; Hammer 2014). The healthiness of the vegetation in a patch largely determines herd size (Frachetti 2009). I calculated the NDVI using multispectral images from Landsat 8 OLI/TIRS C1 Level 1 products, available from the database of the United States Geological Survey. I choose multispectral images with minimal cloud cover and use the multispectral images from two different dates in summer (August 12th and 22nd in 2022).

Topographical wetness index (TWI): TWI is a measurement of the saturation of the soil based on a function of watershed catchment area and slope (Sørensen et al., 2006). Because the herd animals get water mostly from plants rather than underground water or surface runoff, I consider the distance to streams as a trivial and confounding variable in modeling the settlement pattern of pastoralists. Instead, I use TWI as a measurement of the soil water retention capacity of each cell, which is shown to be related to the herbivore density in other pastoral areas (Bhola et al., 2012). I calculate the TWI using the GitHub Python package developed by Jeffrey Wolf and Andrew Fricker (Wolf and Fricker 2013).

Slope: slope is also a variable that is widely used for predictive modeling of human settlement in archaeology (Gillings et al., 2020). Areas with low slope values are usually geomorphologically stable and facilitate the long-term occupations of campsites and pastoral structures. I calculate the slope values in degrees using the “slope” function in ArcGIS.

Viewshed: viewshed is commonly used in archaeology as a proxy for human perception of landscapes. Pastoralists may prefer locations with a relatively small viewshed because of the predation risk (Western and Dunne 1979; Carrer 2013; Bhola et al., 2012), while hunters may choose their camps with better viewshed (e.g., Dooley 2014). In ArcGIS, the viewshed is calculated as a function of the terrain's undulations and the observer's height. This workflow results in a raster dataset surrounding the observer (the person in the pastoral sites, in our case), which is unsuitable for cross-comparison between different sites. I developed a Python tool using ArcPy (Appendix 1), which converts the viewshed raster into a vector. The area of the 5-kilometer circular buffer of the site determines the geometry of the vector. I use the 5-kilometer buffer because this is approximately the maximal human sight area with naked eyes from a given point. The area of the vector thus represents how well a person can see from the location of the pastoral corral.

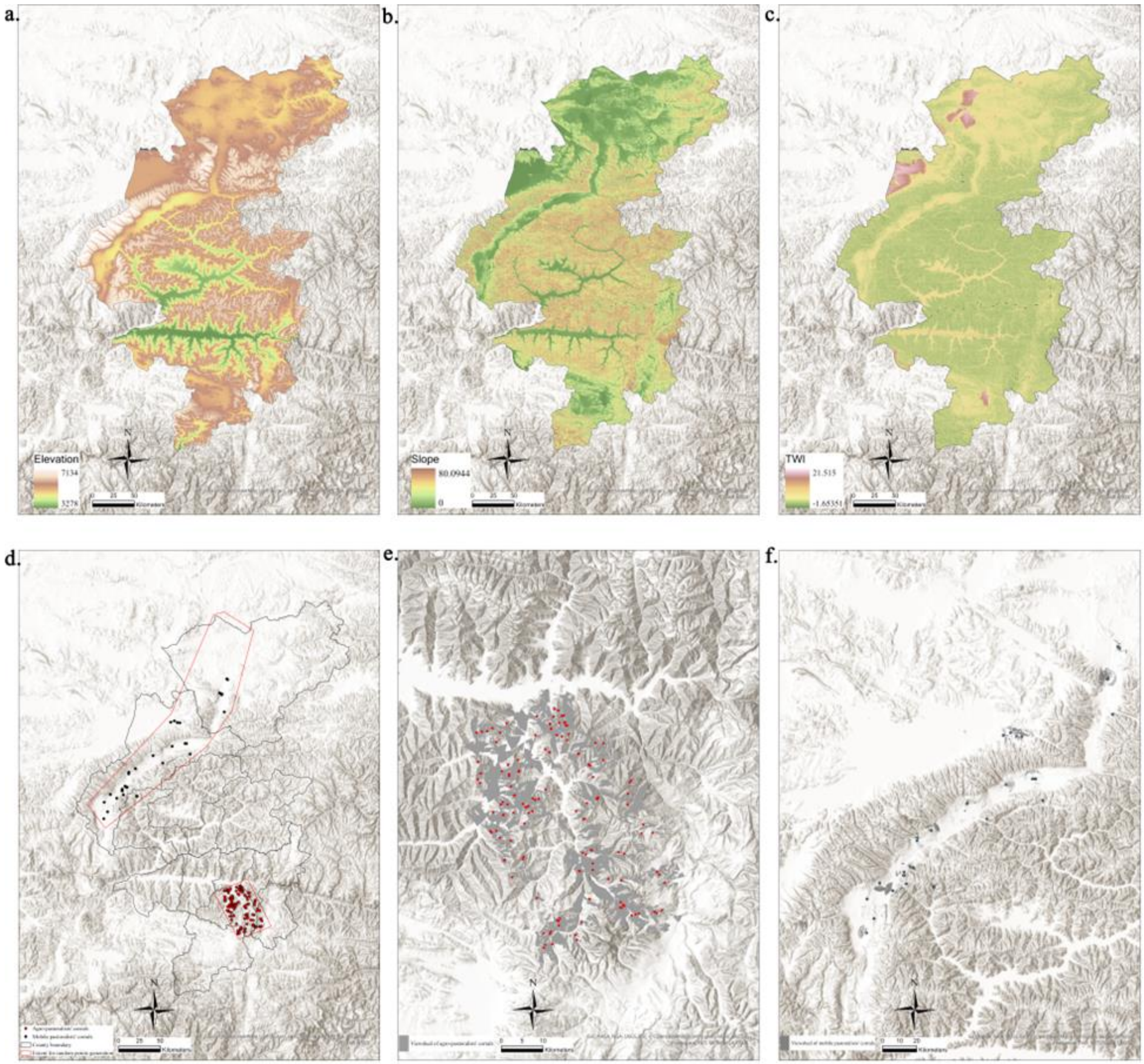


Figure 6.1: The environmental variables and the locations of ethnographic sites: a. elevation; b. slope; c. Topographic Wetness Index; d. the ethnographic corrals in Damxung and the Yarlung Valley; e. viewshed of the corrals in the Yarlung Valley; f. viewshed of the corrals in the Damxung region.

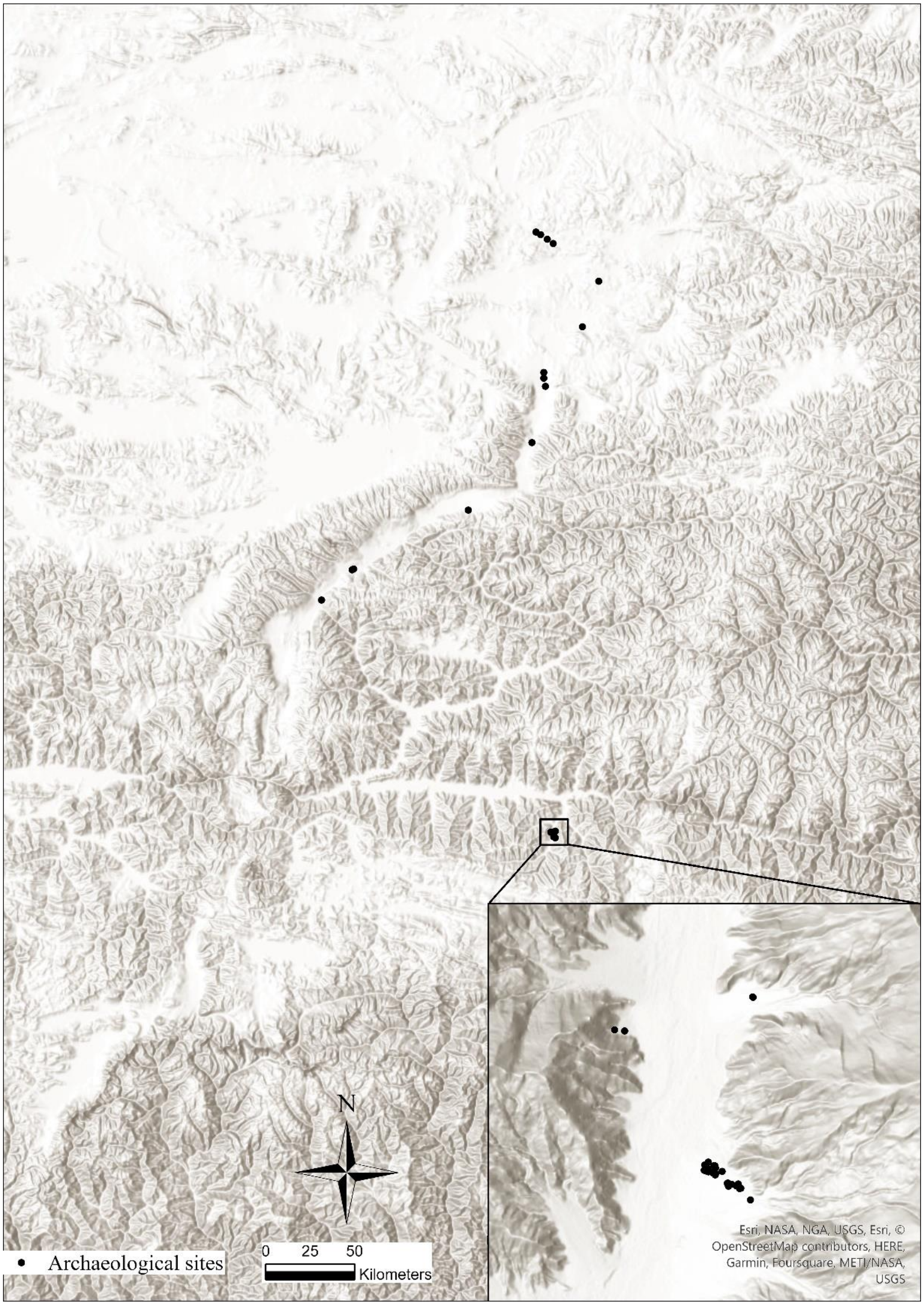


Figure 6.2: The location of archaeological sites in the study area (After Xizang et al. 2005; Yang et al. 2019).

6.3 Results and discussion

I extract the values of the slope, visibility, NDVI, elevation, and TWI from the modern corrals and compare them with the values from 20 cohorts of random points, iteratively generated in the study areas. The values of random points estimate the "background" environmental setting of the corrals. Five box plots compare the differences among five classes of points (Figure 6.5): the modern agropastoralist corrals in the Yarlung Valley (AC); random points in the Yarlung Valley (YR); the modern highland herding corrals in the southern Damxung region (MC); random points in the southern Damxung region (SDR); the archaeological sites discovered in the southern Damxung region from the 2005 survey in Qinghai-Tibet Railway construction (SDA); the rock arts discovered by our survey from 2015-2016 in the Yarlung Valley (RA).

Corrals are the central places for pastoral activities and human and animal movements. Construction of a corral usually indicates considerable and persistent investments in a particular spot, aiming at utilizing the nearby resources seasonally. The locations of modern corrals demonstrate a distinguishable pattern that is different with the environmental background. Both the agropastoral corrals and the highland herders' corrals (AC and MC) are in flat places where the slope values are significantly lower than the random points (Figure 6.5). The visibility scores of the highland herders' corrals (MC) are slightly lower than random points and that of the agropastoral corrals (AC) are much lower than random points. This is possibly due to the need for both the protection of herds from predation and shelter from wind. The NDVI values for both types of modern corrals (AC and MC) are higher than the background values, indicating that the corrals are usually constructed within patches with relatively good pastures. This pattern corresponds well with my ethnographic observations that richer grasses grow in the corrals soon after their abandonment, making the corrals easily distinguishable from the surrounding vegetation (Figure 6.3). Since the points of corrals in this analysis are in the center of the corrals as seen on the satellite imageries, the high NDVI values of the corrals may also be a result of the manuring effects of the animal dung. The TWI values suggest that the corrals are usually in areas with higher soil moisture. The statistical comparisons, however, demonstrate that it is difficult to distinguish highland herder corrals (MC) from agropastoral corrals (AC) since they both follow similar rules of locational choices. The NDVI, visibility, and slope values of highland herder corrals (MC) are lower, and the TWI and elevation values are higher, than those of the agropastoral corrals (AC). This pattern is due to the difference in the natural environments because the random points in the Yarlung Valley and the southern Damxung region (SDR and YR) demonstrate a similar pattern as well. In general, pastoral corrals, regardless of the subsistence economy and degree of mobility, suggest a clear locational pattern that is distinguishable from the natural environments. This locational pattern is possibly a long-term, collective result of both intentional locational choice and human-environmental feedbacks.

The 14 archaeological sites in the southern Damxung region (SDA) and the 34 rock arts in the Yarlung Valley (RA) show intriguing locational patterns that require further analysis by analyzing contextual archaeological information. The archaeological sites are located on flat terrains with a much higher visibility value but a lower NDVI value, suggesting a different locational choice from the modern agropastoral and highland herder corrals.

Figure 6.3: The aerial photograph of a recently abandoned summer corral to the north of the Bangga site. Note the difference in the vegetation within and outside the corral, photograph by Li Tang.

Microliths and flakes dominate the material assemblage in the 14 archaeological sites. Lithics include flakes, scrapers, projectile points, microlithic blades, and wedge-shaped, semi-conical cores. A notable feature of the archaeological sites in this region is the co-existence of lithics and pottery. Ceramics are present in nine sites, most of which are red or reddish-brown coarse ceramics with no decorations. The Zhongzhong site yielded 15 red ceramics with a coarse temper and triangular and parallel incisions. The archaeological sites are not radiocarbon dated since most of the sites located on the terraces in Tibet usually do not have cultural layers or other types of deposits. I notice that the co-existence of microlithic tools with pottery frequently occurs in many sites across the Tibetan Plateau before the first millennium BC, including the Majiayao culture sites, Jiangxigou, Karuo, Qugong, Dingzhonghuzhuzi (Qiere) sites (Zhang 2018; CASS 1999; Unpublished data from Sichuan University, Xu, H. personal communication). The surveyors date all the sites to the "Neolithic period" based on the characteristics of the lithic industry. The co-existence of pottery and ceramics indicates those sites can be roughly dated at least after 4000 BC, yet the possibly of multi-period occupation of those sites can be excluded.

Among the site with lithic tools, Jiaritang is the only excavated and radiocarbon-dated site. The site is located on the terrace in the Damxung-Yangpachen basin. It is excavated three times in 2003 and 2004 with a total area of 527 m^2. Microlithic cores and blades are predominant in the lithic assemblage in Jiaritang, with a small number of polished stone tools including grinding stones and weighing stones. The ceramic tradition in Jiaritang features grey and brown coarse wares with black and red slips. A small number of sherds are polished black ceramics. The decorations are abundant, including cord patterns, matted patterns, knobs, impressions, and assemblages and the abundance of decorations suggest that the material tradition of the Jiaritang site is different from any known material traditions in central Tibet (Xizang et al., 2005). Two stone piles, a stone hearth, and an ash pit were discovered. The excavator interprets the Jairitang site as a "pastoral nomadic "campsite, based on the scarcity of residential structures and the observation that the Damxung-Yangpachen basin is used by modern highland herders (Figure 6.4).

However, the lack of evidence for herding facilities (e.g., corral enclosures, dairying facilities, etc.) and animal bones in Jiaritang and the results of my GIS analysis do not seem to agree with this argument. The prevalence of microlithic assemblage and the high visibility of the sites make the Jiaritang site more similar to hunting camps rather than modern pastoral sites. The low NDVI value on the site indicates that it is possibly not for the exploitation of grassland resources, as the average NDVI value is almost the same as the values from the background environment. Beyond a different locational choice with modern pastoral corrals, the weighting stones and perforated stone balls discovered in Jiaritang are also postulated to be used as hunting tools (Xizang et al., 2005). The discoveries at Jiaritang possibly indicate the co-existence of hunting groups and pastoralists outside of the Lhasa Valley, in the context of pastoralism entering the Tibetan Plateau while the hunting practices still exists on many parts of the Tibetan Plateau after the second millennium BC (Zhang 2018).

The GIS analysis is only indirect evidence for interpreting the function of the archaeological sites. The discrepancy between Jiaritang and modern pastoral corrals does not provide adequate evidence for the absence of pastoral activities in this region in the second millennium BC. Recent excavations at the Jiaritang site and geoarchaeological research for identifying the dung layers may contribute to this question in the future (S. Chen. personal communication).

The 34 rock arts in the Yarlung Valley also demonstrate a different locational pattern. The spatial extent of the rock art is relatively restricted on the valley bottom, with the highest visibility and the lowest elevation. Rock arts in Eurasia are usually associated with pastoral activities based on iconographic and least-cost path analysis. However, the rock arts in the Yarlung Valley are broadly dated to the Tubo period, according to the presence of Buddhist treasure vase and g-Yung-Drung (a religious symbol in Tibet's local Bon religion, Yang et al., 2019). The religious purpose of the rock arts thus may contribute to the locational differences between the rock arts and the modern pastoral corrals.

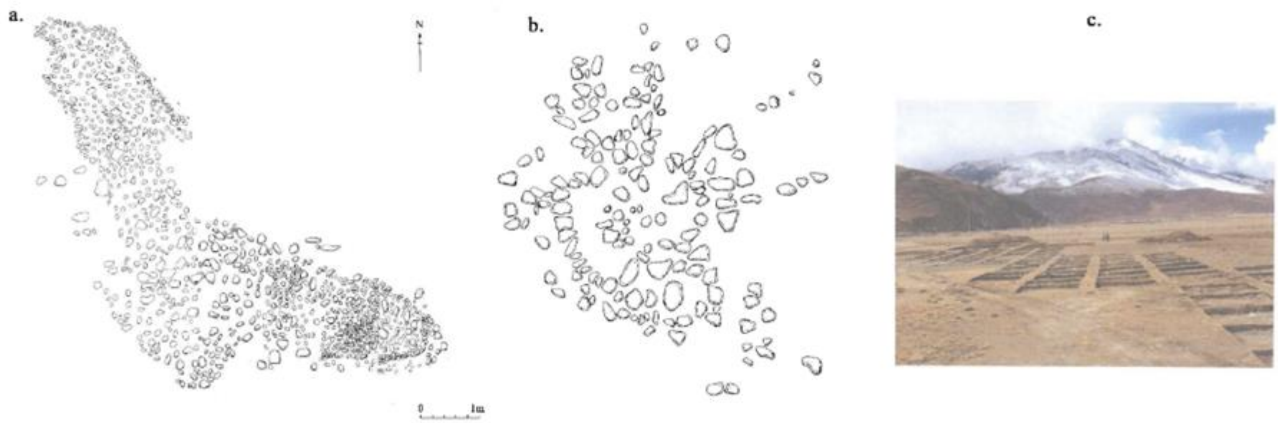


Figure 6.4: The Jiaritang site (after Xizang et al., 2005): a-b. the stone structures; c. the landscape of the Jiaritang site

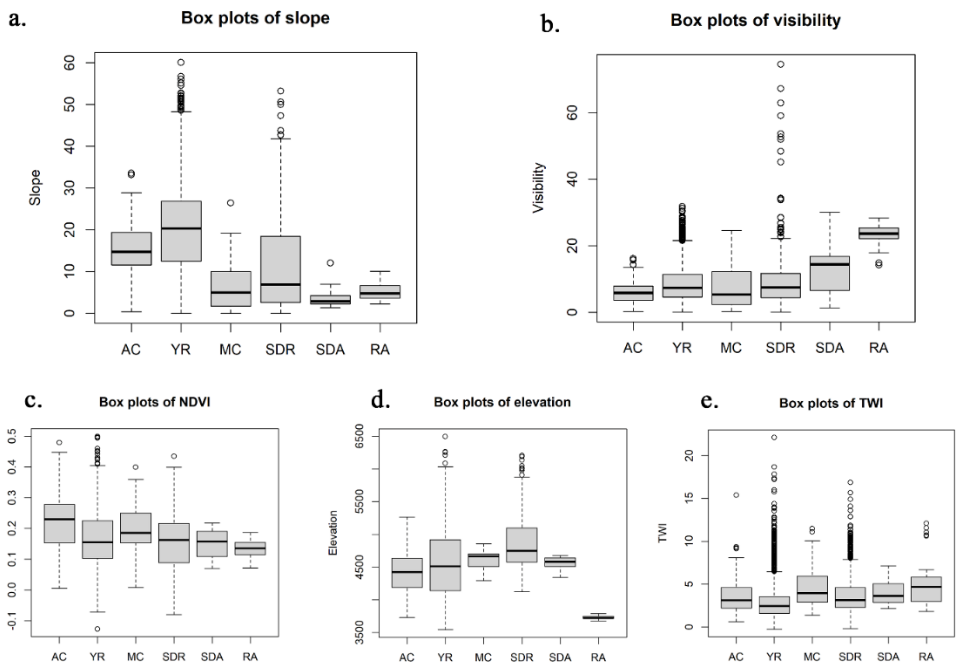


Figure 6.5: Comparisons of the variables between different classes of sites and random points in the southern Damxung and Yarlung Valley: AC- modern agropastoral corrals in the Yarlung Valley; YR- random points generated in the Yarlung Valley; MC- modern highland herder pastoral corrals in the southern Damxung region; SDR- random points generated in the southern Damxung region; SDA- archaeological sites discovered in the southern Damxung region (Xizang et al., 2006); RA- rock arts discovered in the Yarlung River Valley (Yang et al., 2019).

6.4 Summary

Although the comparisons here are based on five environmental variables that have behavioral significance to subsistence strategies, this ethnoarchaeological GIS analysis does not amount to a predictive model of archaeological pastoral corrals. The anthropological and archaeological influence of the variables needs to be further justified with empirical archaeological records before using them as independent variables. I consider that the locational choices of corrals are not suitable to be predicted using traditional predictive models in archaeology (e.g., logistic regression or maximum entropy; Wachtel et al., 2018) because the number of corrals used by the pastoralists is limited under a specific population density. There are always areas suitable for corral building, but pastoralists may not need to build more corrals. This is a significant problem in constructing predictive models of corrals that will result in false positives.

Through these geospatial analyses, I detect differences among ethnographic agropastoral campsites, highland herder campsites, archaeological sites, and the surrounding environments. The results indicate that different types of modern pastoral sites have a similar spatial pattern, which is distinguishable from the surrounding environment. The corrals are usually located in areas with low slopes, high biomass, high soil saturation, and low visibility. This pattern contributes to the understanding of several previously published archaeological sites in this region. The differences between the microlithic sites in the Damxung region and the modern corrals may be interpreted as the microlithic sites are mainly used for hunting game animals rather than pastoralism. The ethnoarchaeological analysis of the locational rules of pastoral corrals further suggests that the pastoral sites are bounded by both social and environmental constraints.

How do environmentally conditioned locational choices of pastoralists and human-environmental interactions shape the long-term usage of pastoral behaviors? I seek to understand the historical continuity of pastoral land use in the following chapters through an archaeological survey and geospatial modeling in the Yarlung Valley.

Chapter 7: The pastoral palimpsest and an exploratory survey on pastoral corrals

The mixed economy of farming and herding in Shannan illustrated in the archaeological research and ethnographic records enable a different way of conducting archaeological surveys. Previous ethnoarchaeological studies proposed that a complete survey of archaeological features relating to pastoral practices, including but not limited to, corrals, grasslands, water ditches, and huts, will yield a much richer dataset that can be used in a variety of innovative research (e.g., Chang and Koster 1982; Hammer 2012; 2014). Recent studies on pastoralism in Europe, Africa, and the Eurasian steppe have emphasized that pastoralists' repeated usage of the specific locations may trigger a wide variety of environmental and social consequences, including elevated nutrient hotspots and the formation of large-scale communication networks (Frachetti et al., 2017; Marshall et al., 2018). Following this line of academic pursuit, I surveyed the mountains of northern Shannan in the Remuna and Bangga villages using direct shovel test pits and small-scale test excavations in modern corrals to understand the continuity of the pastoral landscapes.

7.1 The ethnographical settings of the modern pastoral practices in Shannan

A general understanding of the modern subsistence practices in the Remuna village and the Yarlung Valley contributes to the contextualization of archaeological data. The information presented below is based on conversations with my local guide and general observations during the archaeological survey.

Compared to pastoralism, agriculture has an important role in the daily life of lowland village in northern Shannan today. The most common crop species in these locations include barley, wheat, rapeseed, potato, and peas. The villagers also purchase alfalfa seeds in their fields for fodder during the non-harvesting seasons. In Remuna, barley, rapeseed, pea, and potato are rotationally planted. In the first year, barley and potato are planted in February and harvested in July and August. The next year the villagers grow wheat and rapeseed in the same fields to maintain soil fertility and increase crop yield. Barley, peas, and wheat can only produce one crop a year, but alfalfa can produce two crops every year. The river valley residents keep a diverse array of animals. Sheep, goats, cows, yaks, pigs, and chickens are the dominant herd animals. Villagers also keep a small number of horses, donkeys, and mules. The exact number may vary, and different villages have different degrees of reliance on sheep/goats or cattle and yaks. Remuna villagers primarily herd cattle and yaks while the numbers of sheep and goats are much higher in villages in northern Shannan, such as Bangga. In Bangga, each household has about 30 sheep/goats but only two or three heads of cattle. The number of sheep/goats per family also varies based on the size of the household's agricultural field.

Yak used to be an important herd animal in most villages. However, some villages stopped herding yak in recent years in this region. This change is owing to yaks' high pasture demand, which makes yak pastoralism unprofitable. Horses were only owned by noble landlords and served as their transportation before 1950. Villagers became financially capable of owning horses and donkeys after the ancient serfdom system was abolished by the Chinese government. In Remuna, each household used to own one horse and donkey and used them as farm animals. However, with the increasing use of farm machinery, the villagers sold their horses and donkeys or gave them away as gifts in recent years. The agropastoralists travel only a relatively short distance, typically within 10 kilometers for everyday pastoralism. Pastoral mobility is restricted within the nearby mountains.

Local pastoralists herd their cattle in the vicinity of their villages. There is a clear distinction between summer and winter pasture for herd animals. In a few cases, they will take the cattle up to the mountains. During the winter, cattle are all kept in corrals because of the extreme climate, but yaks are kept in nearby mountains away from the village. Remuna villagers take turns herding their yaks in the summer and hire professional herders for milking, shearing, and collecting yak dung. Those professional herders live in the summer pasture site or camp near the animal corral. During the winter, herders are paid to take care of the animals when yaks remain in the corrals relatively far from the villages. Within a one-year pastoral circle, nine locations are visited. Sheep/goats are herded in an equal way as yaks. In Remuna, sheep/goats are herded in the mountains, yet they return to the corrals in the village for supplementary fodder every night. All the sheep and goats return to the Remuna lowland village during August and September and are fed with straw and chaff after agricultural fields are harvested. In late winter (January to March), lambs are taken back to the corrals in the lowland village and are fed with alfalfa[2].

[2] Informed by local herders.

7.2 An exploratory survey of the pastoral corrals in Shannan, 2018-2021

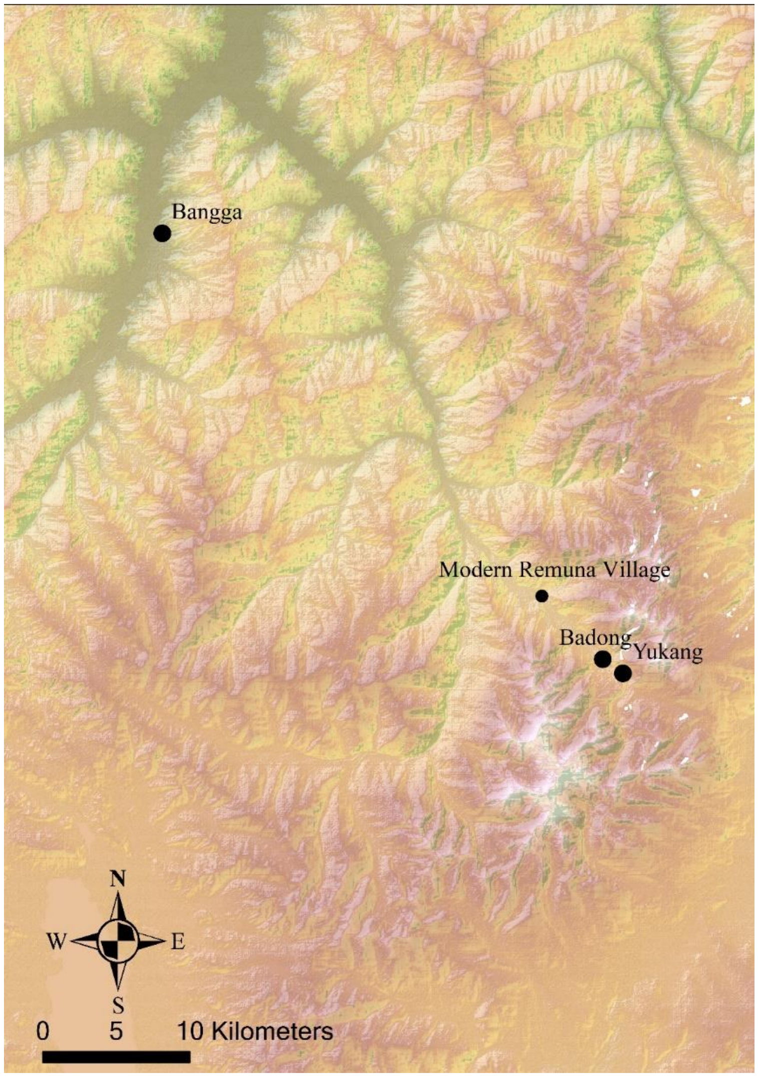


Figure 7.1: The location of the Badong and Yukang sites in the Yarlung Valley

Based on the hypothesis of pastoral hotspots (Marshall et al., 2018) and the simple assumption that pastoralists may repeatedly use the same location, I conducted a small-scale archaeological survey in the agropastoral Shannan region with colleagues from Washington University in St. Louis and Sichuan University. The survey was conducted in an unsystematic manner, focusing on the mountainous regions in two villages: Bangga and Remuna village. All modern corrals in those two villages were tested, using direct shovel test pits and small-scale excavations.

Of the 21 tested corrals, three of them were found to have cultural layers. One of the sites, Jiezhong, was dated to the 1970s. Yukang and Badong sites have ancient cultural layers, artifacts, and features dated to the first millennium BC (Figure 7.1). The results of the survey are reported below:

Figure 7.2: The Badong site, facing west, photograph by Xinzhou Chen.

The Badong site was discovered in 2018 during a shove test pit when a polished black ceramic sherd was unearthed (Figure 7.2). An ancient stone circle, with a height of around 10-30 cm, stands to the south of the modern stone pastoral corral. The northern part of the site is possibly destroyed due to the modern pastoral corral construction. Yet, the perimeter of the pastoral corral is still relatively intact, covering an area of around 480 m^2. Because modern pastoralists currently use Badong during the summer, we did not conduct any shovel test pits within the modern corral.

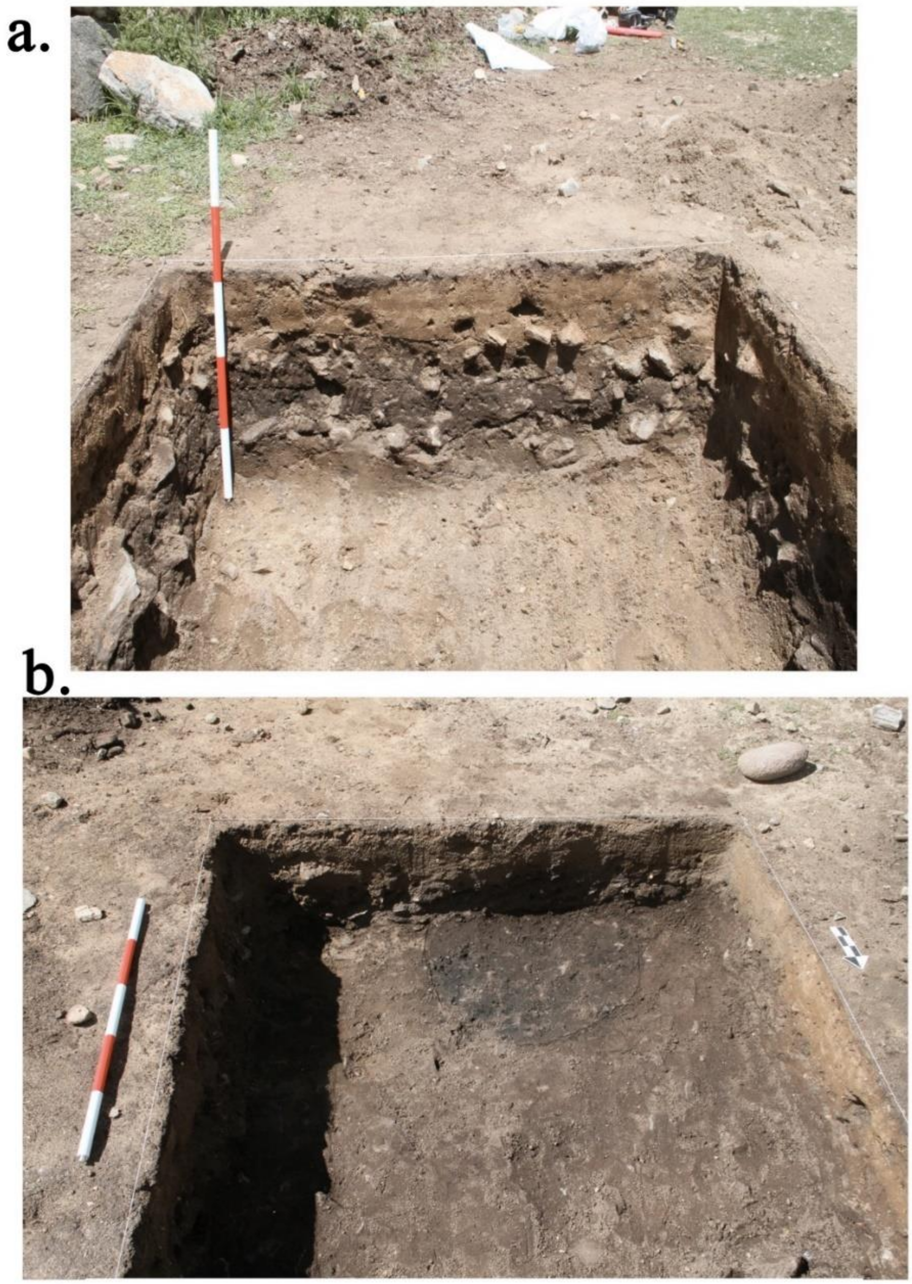


Figure 7.3: Archaeological features in Badong: a. east wall of the site; b. the ash pit H3 under L3, photographs by Xinzhou Chen.

I excavated a 1x1 meter unit in 2019 and a 2x2 meter unit in the center of the ancient corral in 2021. The stratigraphy is simple can be divided into three layers. The first layer L1 is the modern layer, covered by spare grass and a thin layer (about 1cm) of black dung deposition, left by the modern usage of pastoralists in the nearby Badong village. Under this thin layer of dung, there is a thick layer of yellow sand with the sporadic occurrence of small pebbles, possibly related to excessive water-induced erosion. A few red coarse ceramics are found within this layer (L2). The third layer L3 is characterized by grey-black sand with charcoals, poorly sorted large rocks, and small pebbles. A few ceramics with curving lines and burnished surfaces are found within this layer. This layer is possibly also related to the ancient dung deposit (Figure 7.3: a). Under the L3 we also discover a small round ash pit with many charcoals (Figure 7.3: b). However, no cultural artifacts are found within the ash pit. I took all the samples from the pit for floatation and the archaeobotanical identification is in progress in the archaeobotanical lab at Sichuan University. Preliminary results suggest no domesticated grains. Only wild grass species are present at Badong (X. Guo, personal communication).

Another site, Yukang, is directly situated under an abandoned pastoral corral (Figure 7.4). The Remuna pastoralists kept using the site until approximately ten years ago for summer yak herding. We do not see modern residential structures on this site. With an elevation of approximately 4600 masl, the site is located on a terrace to the north of the Yarlung River and is only 5 kilometers away from the sacred Yarlha Shampo mountain. No ancient structures can be seen on the ground surface. Therefore, its exact geographical extent is unknown. The modern pastoral site consists of two parts: a large rectangular stone corral and a circular stone enclosure to the south of the corral. The circular enclosure has a hearth within it and was used as a modern residential campsite for pastoralists. We conducted a shovel test under the circular enclosure but did not find ancient cultural layers.

I excavated a 2x2 meter trench in 2021 within the modern corral. The stratigraphy is similar to that of Badong. We see repeated occurrences of yellow sand and dark grey-black sandy layers, possibly suggesting that ancient people revisited the site several times and each visit was followed by a period of hiatus (Figure 7.5: b). Although the area of the test excavation is very small, we discovered an ancient stone structure (F1) underneath the modern structure (Figure 7.5: a). To validate the shape of the stone structure, I further opened a 1x1 meter grid extending to the west of the first trench. The stone structure is constructed of long slabs with a thickness of around 5-10 centimeters. There is an opening in the southern wall of F1, possibly serving as a doorway leading to another corral compound. All the cultural layers cover F1, indicating that F1 is a corral structure used for a long time. All the layers except for L6 yield orange/red coarse ceramics from historic periods. A thin, dark black layer (F1L3B) with a thickness of around 3 centimeters on the very bottom of the site, at the same depth as the bottom of the stone structure, contains sporadic black burnished ceramics with geometric incisions. Layer F1L3B indicates the initial occupation of the site. However, I cannot distinguish the boundaries between F1L3B and the layers above it. The Badong site was continuously used for a long time and the dark layers were likely formed by dung accumulations. Modern stone enclosures possibly replaced the ancient structure in recent years.

Figure 7.4: The aerial photo of the Yukang site, photograph by Hailun Xu.

Figure 7.5: The test excavation in Yukang in 2021: a. the stone structure. Arrow on the ground pointing to north; b. the east wall of the site, photographs by Xinzhou Chen and Hailun Xu

7.3 Discussion

7.3.1 The chronology and the material culture in the first millennium BC

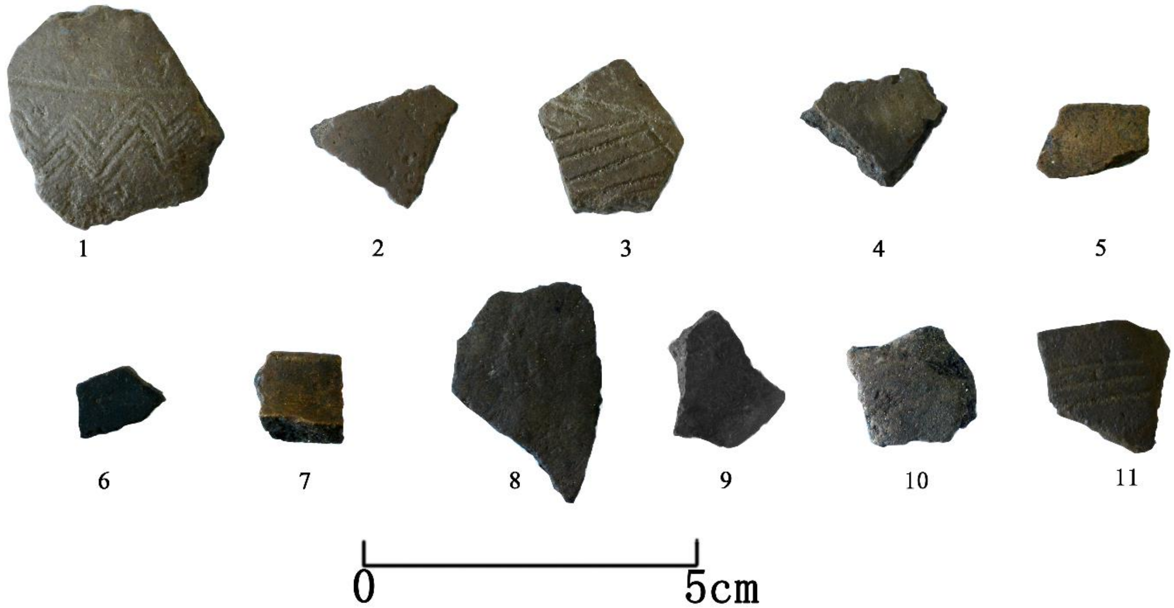


Figure 7.6: Ceramics from the earliest phase of the Badong (L3B) and Yukang (F1-2B) sites in the test excavations in 2021. 1-9. Badong (RBL3B) 10-11. Yukang(F1-2B), photographs by Xinzhou Chen.

Although the two test excavations are preliminary, they provide new information on the archaeological chronology, the agropastoral land use, and ancient human subsistence strategy when considering the available information in the surrounding regions. In Chapter 6, I argue that one significant cultural change happened around the end of the second millennium BC and the beginning of the first millennium BC, as demonstrated in the material culture analysis in Bangga, Changguogou, and Qugong. This change features the disappearance of microblade technology, and the decline in polished, ring-based ceramics (see Chapter 6). Combing data from the two sites and other lines of evidence from recently published data, we can see another tentative change in the ceramic tradition after the end of the first millennium BC in this region.

I collected 11 ceramics sherds from the earliest phase of the two sites (L3B in Badong, F1L3B in Yukang; Figure 7.6). During the test excavations, I found that the stylistic characteristics of the ceramics in the earliest layer/feature (L3 in Badong and F1L3 in Yukang) are not uniform. There is an apparent change in the texture of the ceramics in those units and only the ceramics from the bottom of those layers are the earliest. Only those 11 ceramic sherds from the bottom of those layers/features can be confidently dated to the middle first millennium BC based on their texture and decorations and the comparison with ceramics in other first millennium BC sites in central Tibet. The early ceramics are mostly grey and black coarse ceramics and surface treatment methods include coating and burnishing. Three sherds have decorations of geometric incisions. The incisions bear considerable similarities with the ceramics in the early phase of Bangga.

Although with only one radiocarbon date, I roughly date Layer 2 and Layer 3 in Badong and F1L3 in Yukang between the late first millennium BC to 8th century AD, where a small number of grey, orange, and red coarse wares were discovered in those units (Figure 7.7). Comparable archaeological ceramics from this period are very rare in central Tibet. The data, however, in recent discoveries at Jiesa and Bangga already provides us with some clues about another stylistic change in ceramics. The first millennium BC ceramic tradition as seen in Bangga and the late stone-cist burials in Qugong appears to be in decline at the end of the first millennium BC. Ceramics from Bangga Layer 12 (not dated, later than 400 BC) are gradually placed by sherds with a reddish color, coarse temper, and nearly no decorative patterns. The ceramics from layers before Tubo period demonstrate some similarities with those from Bangga

Layer 12, with a reddish color and coarse temper (Figure 7.7). Due to the limited number of the ceramics yielded in both sites, the observed pattern is only tentative and empirical. Recent discoveries in Jiesa also yield complete pottery wares that may belong to this period (Xizang et al., 2022).

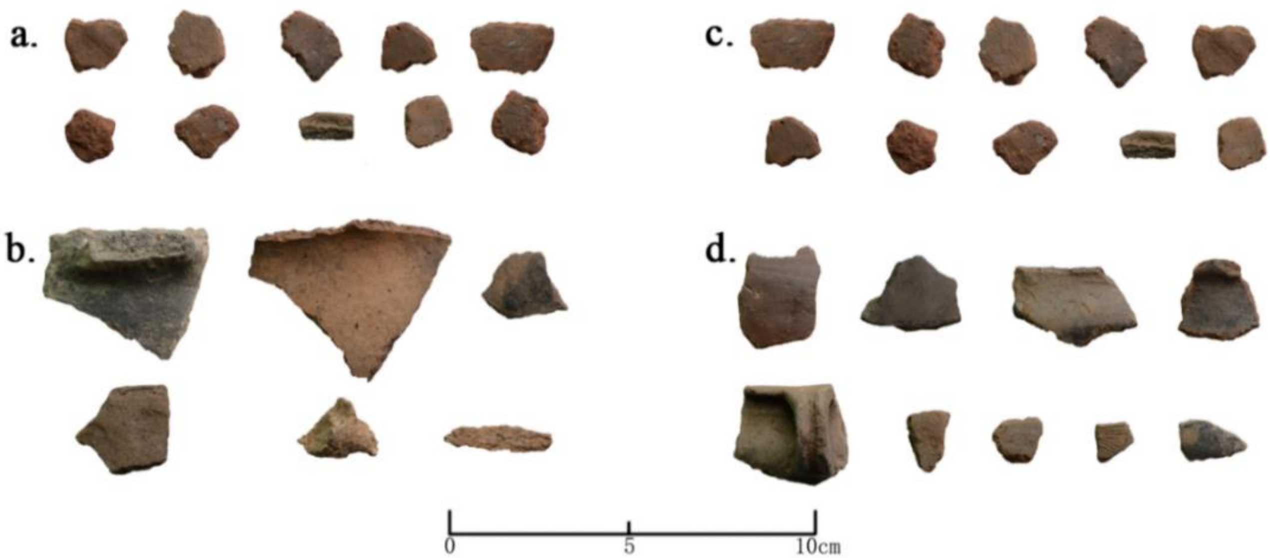


Figure 7.7: The ceramics and bones from the late phase of the Badong and Yukang sites. a. ceramics from Layer 1 in Badong; b. ceramics and bones from Layer 3 in Badong; c. ceramics from Layer 4 in Yukang d. ceramics from F1 in Yukang, photographs by Xinzhou Chen

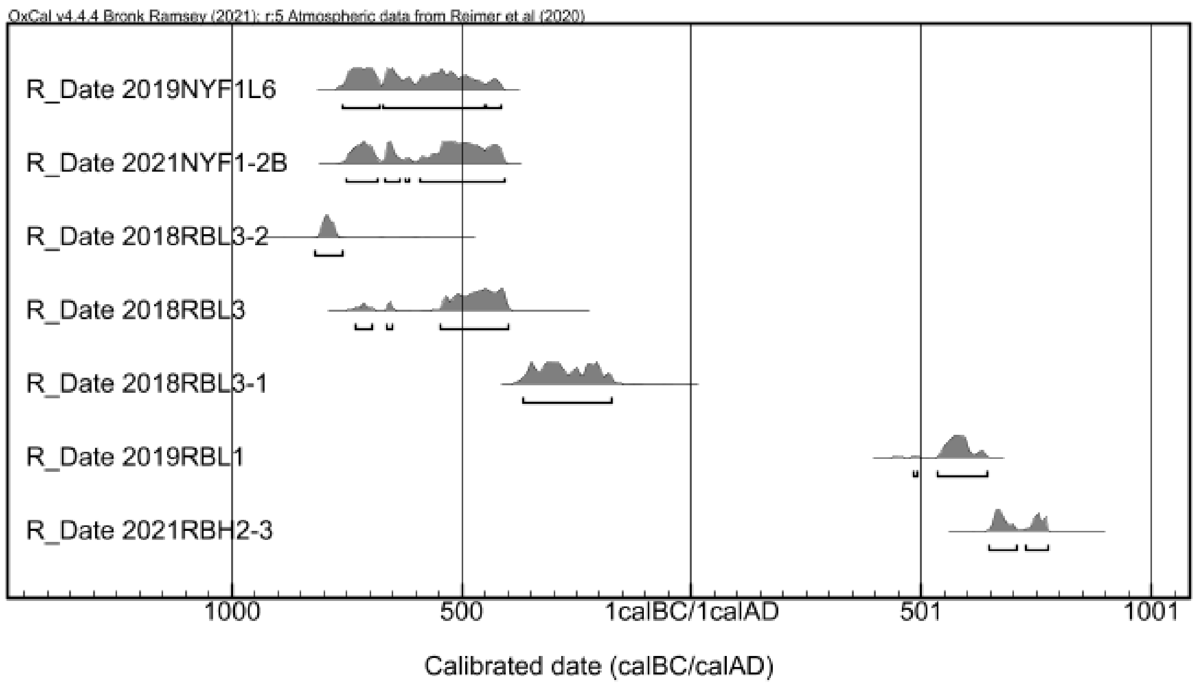


Figure 7.8: The calibrated dates of Badong and Yukang sites; Calibrated using Oxcal v.4.4.4, Ramsey (2021); Reimer et al., (2020)

Table 7.1: The radiocarbon dates from Badong (2019RB, 2018RB and 2021RB) and Yukang (2019 and 2021NY)

Site	**Sample Context**	**Lab no.**	**Sample type**	**Depth**	**Calibrated age (95.4%)**
Badong	2019RBL2	Beta-535500	Charcoal	Around 25 cm on the interface of L1 and L2 (2019 trench)	AD 484 – 644
Badong	2019RBL3	Beta-539961	Animal bone	Around 40 cm (2019 trench)	733 – 497 BC
Badong	2018RBL3-1	Beta-497838	Animal bone	L3 floatation	368 – 173 BC
Badong	2018RBL3-2	Beta-49783	Charred seed	L3 floatation	818 – 760 BC
Badong	2021RBH2-3	Beta-618015	Charred seed	Around 32 cm in an ash pile (2021 trench)	AD 649 – 775
Yukang	2019NYL6	Beta - 535501	Charcoal	50 cm (2019 trench)	758 – 416 BC
Yukang	2021NYF1-2B	Beta - 618015	Charcoal	45 cm (2021 trench)	751 – 408 BC

Dating open-air archaeological sites in Tibet is usually challenging. However, the presence of cultural layers enables direct dating and the estimation of the use span of the Badong and Yukang sites (Figure 7.8; Table 7.1). According to the radiocarbon dates and the material analysis presented above, the Badong site can be at least divided into two phases: the first phase is represented by RBL3, which is dated to the first millennium BC; the second phase is represented by L2, which is dated to the 5th century to the 8th century, around the pre-Tibetan Empire and Tibetan Empire period. The Yukang site can also be divided into at least two phases according to the ceramics. However, I only obtained radiocarbon dates from the earliest features and layers. Before the 2021 test excavation in Yukang, I did not realize the existence of stone enclosures due to the limited excavation area. Therefore, the site was divided into six layers in the 2019 field season. 2019RYL6 is the earliest layer, the same layer as 2021RYF1-2B according to the stratigraphy and the depth of the radiocarbon-dated sample. The earliest features and layers in Yukang are thus also dated to the middle first millennium BC, which is contemporary with the first phase of Badong. Both sites are dated to the same period of the early phase of the Bangga site in the Qonggyai Valley. The dating results indicate repeated usage of both corrals at least during three periods: the first millennium BC, the historic Tibetan Empire period, and modern era.

7.3.2 The residential mobility of the people in the Yarlung River Valley

Few archaeological records are found in high-elevational mountainous regions in Tibet. One exception is the recently discovered highland cave burial located at an elevation of approximately 5000 masl, indicating the existence of ritual practices in high-altitude environments (Lu et al., 2022). Modern stone structures in the mountains typically include small-scale water irrigation channels constructed by small slabs, Buddhist temples, Mani stones for rotatory worship, and a variety of pastoral facilities attached to the pastoral corral (e.g., diary or residential campsites). The sites discovered in this survey are morphologically identical to the modern corrals in Tibet.

Although the archaeological data in those sites do not permit direct analysis of residential mobility, analysis on nearby sites provides additional evidence for this inquiry. Recently zooarchaeological research based on the isotopic signatures of the animal teeth suggests that the animals in the nearby first millennium BC site, Bangga, may have a limited degree of pastoral mobility. Based on the sequential oxygen isotope analysis on sheep and goats tooth enamel, Zhang (2022) observes that the amplitude of the intra-tooth $\delta^{18}O$ variations is much narrower than that in the modern reference samples collected in the modern Bangga village. This pattern is interpreted as a more intensive human management strategy for sheep and goats in the first millennium BC. This management strategy is possibly the overnight corralling of animals as seen in the ethnographic records in this region. The sheep and goats possibly mostly consume underground water from wells or snow-melted water, which does not show the seasonal variation in the oxygen isotope ratios (Zhang 2022). The water source is less likely to result from long-distance, seasonal transhumance as seen in the modern northern Tibetan steppes and southern Shannan. Otherwise, we would expect a more dramatic variance in the isotopic data of the animal tooth enamel. The discovery of the Badong and Yukang sites in high-elevation mountains resonates with this research, suggesting that the ancient pastoralists may have used a small resource catchment area in the river valleys.

Analysis of modern corrals yields insights for postulating the residential mobility of the people using Yukang and Badong. Through the ethnographical GIS analysis in Chapter 6, I observe that the environmental variables including slope, NDVI, TWI, visibility, and elevation may not contribute to the locational differences between agropastoral corrals and highland herder corrals. However, the comparison between the size of the pastoral corrals provides clues on identifying different types of corrals. Ethnographic evidence suggests that the corral size usually correlates with the size of the herds and the labor input of the pastoral sector (Chang and Koster 1982). Based on the Google Earth satellite imageries, I selected corrals with measurable areas discussed in Chapter 6 and compare corrals of the highland herders in the Damxung region (n = 27) and the agropastoral corrals (n = 110) in the river valley of northern Shannan (Figure 7.9). I observe a clear distinction between the two types of corrals. The size of Yukang and Badong is 100m^2 and 480 m^2, both much smaller than the average size of the highland herder corrals. This indicates that the size of the herds owned by the ancient people in Yukang and Badong is possibly similar to that of the modern pastoralists with limited mobility. Ethnographic evidence from the agropastoral groups in the Yarlung and Qiangyai valley suggests that the corrals are usually used for herds of less than a hundred (yaks or sheep/goats). Pastoralists in the southern grassland of Shannan and northern Tibetan steppes, where the elevations of their lowland settlements generally exceed 4200 masl, usually own a greater number of herds[3].

A site catchment area analysis suggests the most possible location of lowland settlements. I assume a maximum of 5-hour pedestrian roundtrip travel of daily pastoral circle, according to my modern ethnographic observations that the sheep and goats will be tended in the corrals and brought back to lowland settlements every day. Based on this assumption, I generate a site catchment isochrone map using Tobler's hiking function and an SRTM DEM (Tobler 1993; White 2015; Figure 7.10). The Bangga site and southern Shannan grasslands are both located

[3] Informed by local herders.

outside of the 5-hour roundtrip catchment area. The Qiuduojiang grassland to the east of the Yarlung Valley is within the margins of the site catchment area. However, the elevation in the Qiuduojiang grassland is too high (above 4400 masl) for any agriculture practices. The lowland settlements of the pastoralists in Yukang and Badong are mostly likely in the Yarlung River Valley, which is populated by several modern villages.

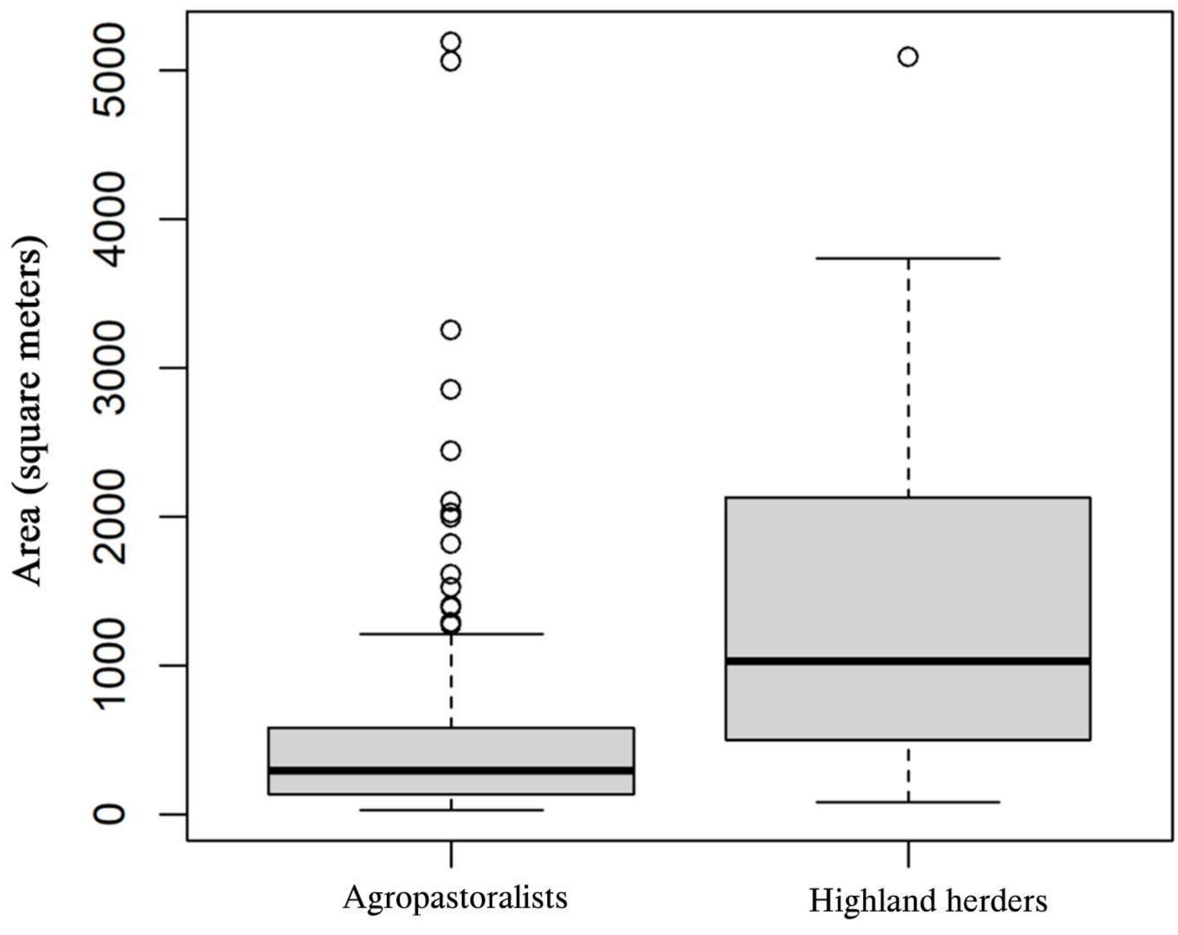


Figure 7.9: Comparison of site sizes between agropastoral corrals and highland herder corrals

7.3.3 The survey strategy in mountainous regions

As discussed in previous chapters, the prehistoric archaeological research on the Tibetan Plateau has long suffered from a dearth of data, especially in the Tibet Autonomous Region and the southern Qinghai province, as most of the data were from salvage excavations in the past few decades (Aldenderfer and Zhang 2003). Scholars seeking to understand the geospatial arrangement of the sites on the Tibetan Plateau exclusively rely on the records in the Cultural Relic Atlas of the Tibet Autonomous Region and Qinghai province (e.g., Chen et al., 2015; Dong et al., 2013). A recent review paper questions the over-reliance on the Atlas, arguing that the Atlas may represent a biased settlement pattern. They argue that the survey method of Chinese archaeologists, especially during the early years of Chinses archaeology, is flawed as they mostly focused on burials and settlements in the river valleys and alluvial fans. Therefore, archaeologists in China should employ a systematic survey method when possible (Jaffe et al., 2021).

The standard regional settlement pattern survey methodologies in contemporary Chinese archaeology were mostly developed in regions that are geomorphologically different from the Tibetan mountainous landscape. For example, The China-US Shandong regional survey in 1995, dubbed the earliest international systematic survey in China, employed a systematic survey approach successfully in the alluvial plains in the Shandong Peninsula. Low-elevation mountains and river basins dominate the survey area of the Shandong survey. The surveyors, usually in groups of 4-5 people, walk in several V-shaped lines and collect the ceramics on the ground (Fang 2002). By contrast, the high deposition rate and low archaeological visibility in the valley bottom will most likely result in a low-efficient survey in the mountainous regions of Tibet, demonstrated by a previous survey report using pedestrian survey and profile-sampling in central Tibet (Yang et al., 2019).

The archaeological survey in central Tibet faced a similar problem of surface artifact visibility, especially in the Lhasa and Shannan River Valley regions. Historical documents have emphasized the cultural importance of this region, referring to it as "the ancient cradle of the Tubo Empire" (Chen and Gao 2003). Intense archaeological surveys were conducted several times in this region. However, the ancient settlements in this region are usually buried deep by at least 2-5 meters from the surface, due to the high deposition rate of the alluvial fans (e.g., Qugong and Bangga, CASS 1999; Lu et al., 2021). The low density of farming practices further results in nearly zero percent surface visibility of artifacts (except for the Changguogou site, CASS et al., 1999), and subsequent surveys in those regions became difficult. Previous archaeological surveys emphasized the examination of alluvial fans and profiles (e.g., the Qiongjie River Valley survey, Yang et al., 2019). Discoveries of several mounded burials, stone-cist burials, and petroglyphs are reported using this traditional method (early discoveries see Xizang et al., 2005). However, the discoveries of prehistoric settlements and cemeteries are still rare. The archaeological surveys in this region almost exclusively rely on modern infrastructure constructions that reveal profiles (e.g., the Bangtangbu site in Yarlung River Valley, the archaeobotanical analysis of this site see Tang et al., 2021).

Although the scale of this preliminary survey is limited to the mountainous regions near two villages: Remuna and Bangga, the result of direct coring under modern corrals proves that the archaeological corrals are the most accessible archaeological features in the river valleys of Tibet when labor and time are limited. The archaeological findings resonate with the early calls for systematic surveys of the pastoral features (Chang and Koster 1982) and the suggestions for developing survey methods beyond systematic regional surveys in the mountainous regions by Chinese scholars (e.g., Shuo 2010). A variety of archaeological features, including but not limited to, water reservoirs and channels, small check dams, and dairying facilities, are potential targets for the surveys in the mountains in the future (successful surveys of similar features in Xinjiang see Li et al., 2017; Jia et al., 2017).

7.4 Summary

In this chapter, I provide evidence for long-term pastoralism in the high-elevational mountains in the Yarlung River Valley in the first millennium BC. The Badong and Yukang sites are the first and the earliest archaeological corrals discovered to date in Tibet, indicating that direct shovel tests and test excavations under modern pastoral facilities are useful archaeological survey strategies in mountainous regions. The archaeological remains in the sites, including the ash pits and stone enclosures, demonstrate significant investments in the same locations. The ceramics and radiocarbon dates provide further evidence of the material culture traditions and archaeological chronology in central Tibet in the first millennium BC. Coupled with previous zooarchaeological research, ethnographic evidence, and GIS site catchment analysis, I postulate that those sites serve as the pastoral corrals of the ancient lowland residents in the Yarlung Valley with limited residential mobility.

The test excavations are limited partly because pastoralists currently use the sites for summer yak herding during our field seasons, thus further excavations are not possible. A large-scale excavation with long trenches in both sites will undoubtedly yield more information on the structure of the site, especially in terms of the exact location of the ancient pastoralists' residential areas. Ongoing archaeobotanical research will provide additional evidence for the seasonality of the sites.

The discovery of pastoral sites in the Yarlung River Valley raise the question as to what socio-environmental institutions may have driven the long-term human occupation. I discuss the human-environmental interactions and the path dependency of pastoralists location choices in the GIS-based case study in Chapter 8.

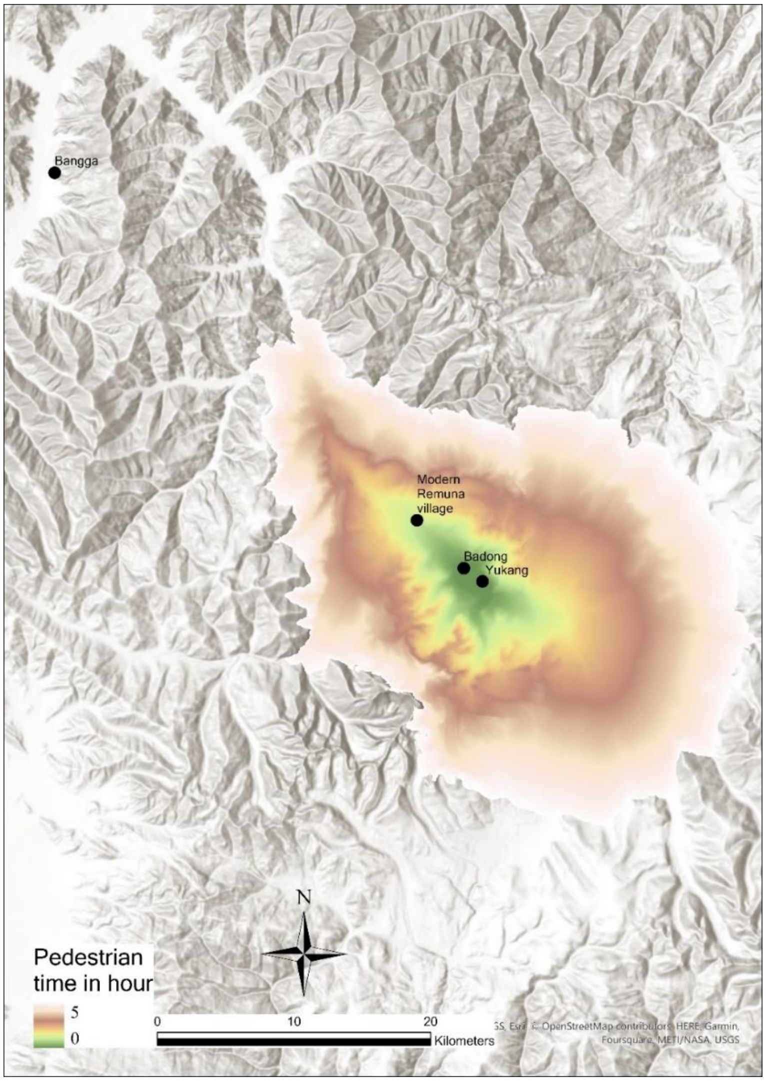


Figure 7.10: The isochrone map of the Badong and Yukang sites indicating the area of 5-hour pedestrian travel.

Chapter 8: A soil erosion model and the long-term pastoral hotspots in Tibet

Pastoralists' interaction with the environment is an ongoing academic pursuit across the globe. Ethnographical, ecological, and archaeological research demonstrates that pastoralists are active agents in shaping the local ecological niche and creating a resilient anthropogenic landscape that enables positive feedback loops between humans, wild animals, and the natural environments. The repeated pastoral land use pattern acted as a strong social institution that further shaped the communications on the Silk Road (Frachetti et al., 2017). Recent research in Europe and Africa indicates the repeated usage of historical pastoral corrals shapes long-term grass glades with distinguishable spectral reflectance (Thabeng et al., 2019). The anthropogenic pastoral hotspots leave long-term legacy effects on the landscape including the elevation of multiple soil fertility indexes, such as soil phosphorus, total nitrogen, nitrogen isotope, N^2O emission, plant species richness, and species diversity (e.g., Storozum et al., 2021; Saatkamp et al., 2021; Eguez et al., 2022). Micromorphological analyses of the sediments in and outside of the corrals provide additional evidence that the manuring effects of the animal dung may contribute to the persistence of the nutrient hotspots (Shahack-Gross et al., 2003; Marshall et al., 2018). Ethnoarchaeological research in the last few decades also demonstrates the unique locational choice of pastoral practices may be effective in maintaining the human-land relationship, resulting in a predictable pastoral land use pattern in the archaeological and ethnographical records.

In Tibet, the legacy effects of the repeated usage of archaeological pastoral corrals have never been tested. My fieldwork in Shannan, discussed in the previous chapter, indicates that the ancient and long-term usage of pastoral corrals is archaeologically visible. The "archaeological palimpsest", triggered by the exploitation of mountain resources, may result in similar ecological consequences as demonstrated in other parts of the world. The radiocarbon dates and the stratigraphic evidence in the corrals suggested periodic revisits by the pastoralists to the same location. The locations of the modern pastoral corrals in Tibet are mostly in geomorphologically stable areas, as seen in the Badong site, which is on a small alluvial fan on a relatively flat hillslope. This locational preference for pastoral corrals may also have long-term effects as well on the landscape evolution. By using the soil erosion model as an experimental archaeology method, I investigate the impact of ancient corral building activities on the local sediment dynamic process.

8.1 Soil erosion models

The increasing use of GIS software enables large-scale, quantitative characterization of the soil erosion process. The soil erosion model facilitates decision-making in several disciplines including environmental conservation, natural hazard assessment, and agricultural management, among various others. In archaeology, erosion models simulating landscape evolution and erosion risks have yielded significant insights into heritage management strategies, surface archaeological surveys, and human-environment interactions. Early archaeological case studies usually discuss the relationship between the location of archaeological sites and soil erosion based on geomorphological observations with the naked eyes (e.g., James et al., 1994)

USLE/RUSLE (Universal Soil-Loss Equation/ Revised Universal Soil-Loss Equation) is a frequently used and universally applicable method to quantify soil erosion (Wischmeier and Smith 1965; Reynard 1997). Large scale GIS analysis based on USLE/RUSLE reveals how the soil erosion dynamics impact the surface artifact visibility and the locations of archaeological sites (Howland et al., 2018; Ames et al., 2020). Unit Stream Power Erosion and Deposition (USPED) is another erosion model that is recently applied in archaeology (Mitasova 1996; Mitasova et al., 2013). This model is the backbone of a comprehensive, archaeological agent-based model project in the Mediterranean region, jointly developed by Barton and colleagues (2010; 2015). Based on the USPED model, paleoenvironmental reconstructions, and ethnographic data, researchers simulate the landscape evolution and use a complex agent-based model to assess the anthropogenic impacts of agriculture and pastoral behaviors on landscape formations in various regions in Central Asia and the Near East (Barton et al., 2010; 2012; Ullah 2011; Ullah et al., 2019)

To investigate the mechanism that possibly drives the formation of pastoral hotspots, I here use the USPED model in this research and modify the drone DEMs to create a quasi-laboratory environment to quantify the change in soil erosion and deposition under real and hypothetical landscapes surrounding the pastoral corrals.

8.2 Material and methods

The USPED model is a 2D, modified model of RUSLE. The USPED model replaces the LS factor in the RUSLE model by combining the upslope contributing area per unit width and the slope angle. It is a relatively simple model and is capable of modeling both the deposition and erosion values on each cell. According to Mitasova (1996), the net erosion/deposition can be calculated as:

$$T = R * K * C * P * A^{m}(\sin\beta)^{n}$$

where T is the net erosion and deposition in t/ha/year; R[(MJ·mm)/(ha·hr·yr)] is the rainfall intensity factor; K[(ton·ha·hr)/(ha·MJ·mm)] is the soil erosion resistance factor; C is the vegetation erosion protection factor (unitless). A is the upslope contributing area per unit width and β is the slope in degrees. The above factors are the same as the ones used in the USLE/RUSLE model. P is the conservation factor that is empirically derived from human activities. M and N are also empirically determined constants, where lower values are used for prevailing sheet erosion and higher values for rill erosion. The net erosion and deposition are estimated as:

$$ED = d(T*\cos\alpha)/dx + d(T*\sin\alpha)/dy$$

where ED is the net erosion and deposition value (tons/hectare/year). α is the aspect in degrees of the terrain and the dx and dy are the resolutions of the grid. A negative ED value represents erosion, and a positive value represents deposition. The model is run using the ArcPy code in Appendix 2.

8.2.1 Estimation of the variables in USPED

Calculated from data collected from 132 meteorological stations across America, Renard and Freimund (1994) proposed the function to calculate the R-factor (MJ mm /ha*year) for areas with annual total precipitation less than 850mm:

$$R = 0.0483P^{1.610}$$

where P is the annual precipitation of the research area. Based on this function, the R factor is estimated to be 701 (MJ*mm)/(ha*hr*yr).

The K factor measures how erodible the soil is and is scaled from 0 to 1 (unitless). The higher the K factor, the more erodible the soil is. I estimate the K factor based on the percent of sand, slit clay, and organic matter of the topsoil collected in the Badong site, using the function proposed by Sharpley and Williams (1990):

$$K = 0.1317*(0.2+0.3*e^{[-0.0256*SAN*(1-SIL/100)]}*(SIL/(CLA+SIL)^{0.3})*[1-(0.25*TOC)/TOC+e^{3.72-2.95*TOC}]*[1-(0.7*SN_1)/(SN_1+e^{(22.9*SN1-5.51)})]$$

where K is the soil erodibility factor; SAN is the weight percentage of sand; SIL is the weight percentage of silt; CLA is the weight percentage of clay; TOC is the weight content of the soil organic carbon; SN_1 = 1-SAN/100. According to this function, the soil erodibility in Badong is 0.052.

Research suggests that the C factor can be predicted by using satellite images of NDVI. The spatial resolution of the current open-source NDVI images is coarse (usually 30 meters or more). Therefore, using open-source multispectral images in the model is not acceptable as the drone DEM in this research greatly exceeds the resolution of the NDVI raster. Because the area of interest in the erosion model is relatively small, I supply a constant of 0.15 (alpine meadow), based on the research of Wang and Jiao (1996).

There are no human conservation activities in the research area, so the P factor is set to 1 (no conservation). I also supply the exponent of m and n to be 1, representing prevailing sheet erosion in the research area.

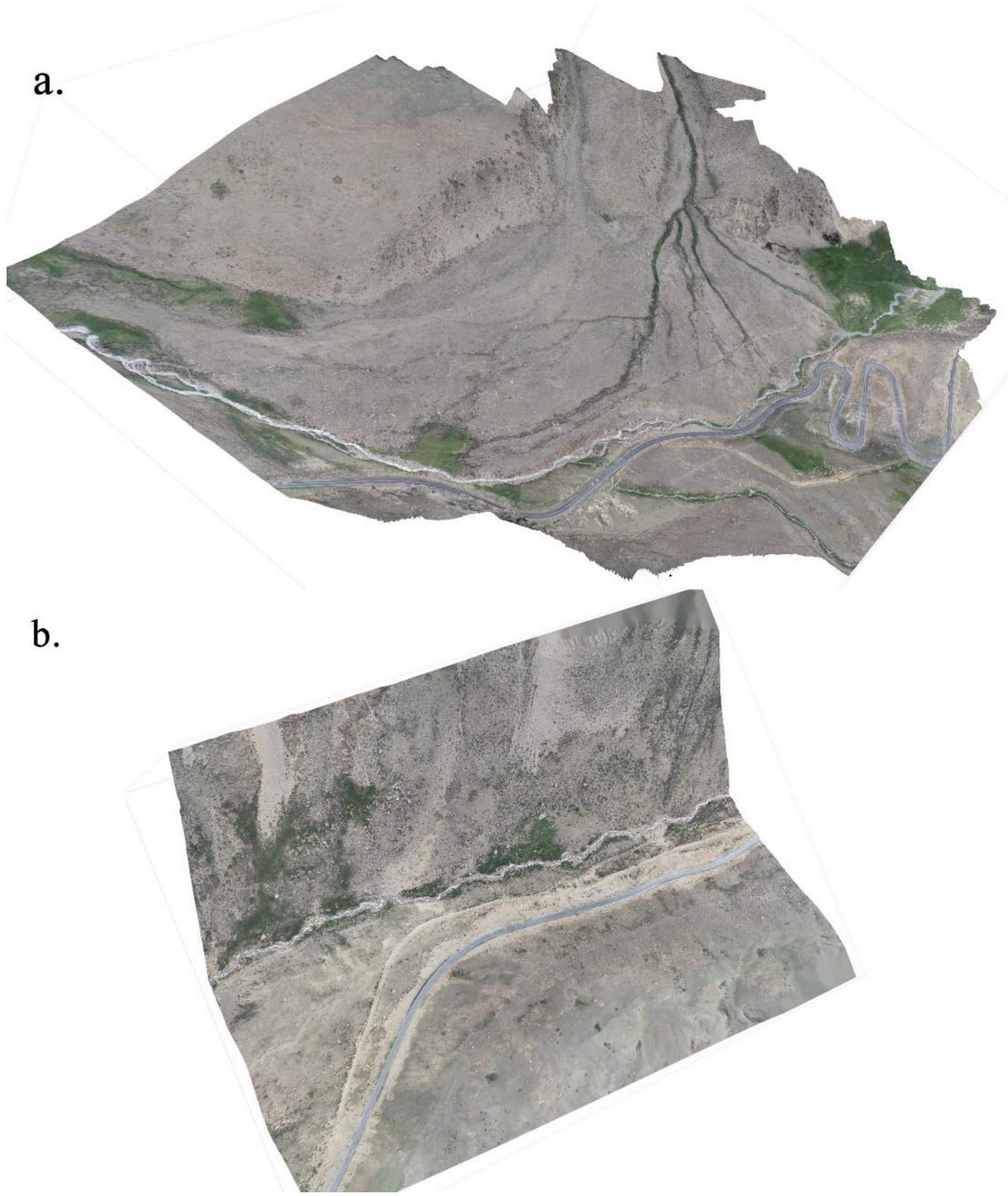


Figure 8.1: Three-dimensional models of the archaeological corrals and the surrounding environments. a. the Badong site; b. the Yukang site

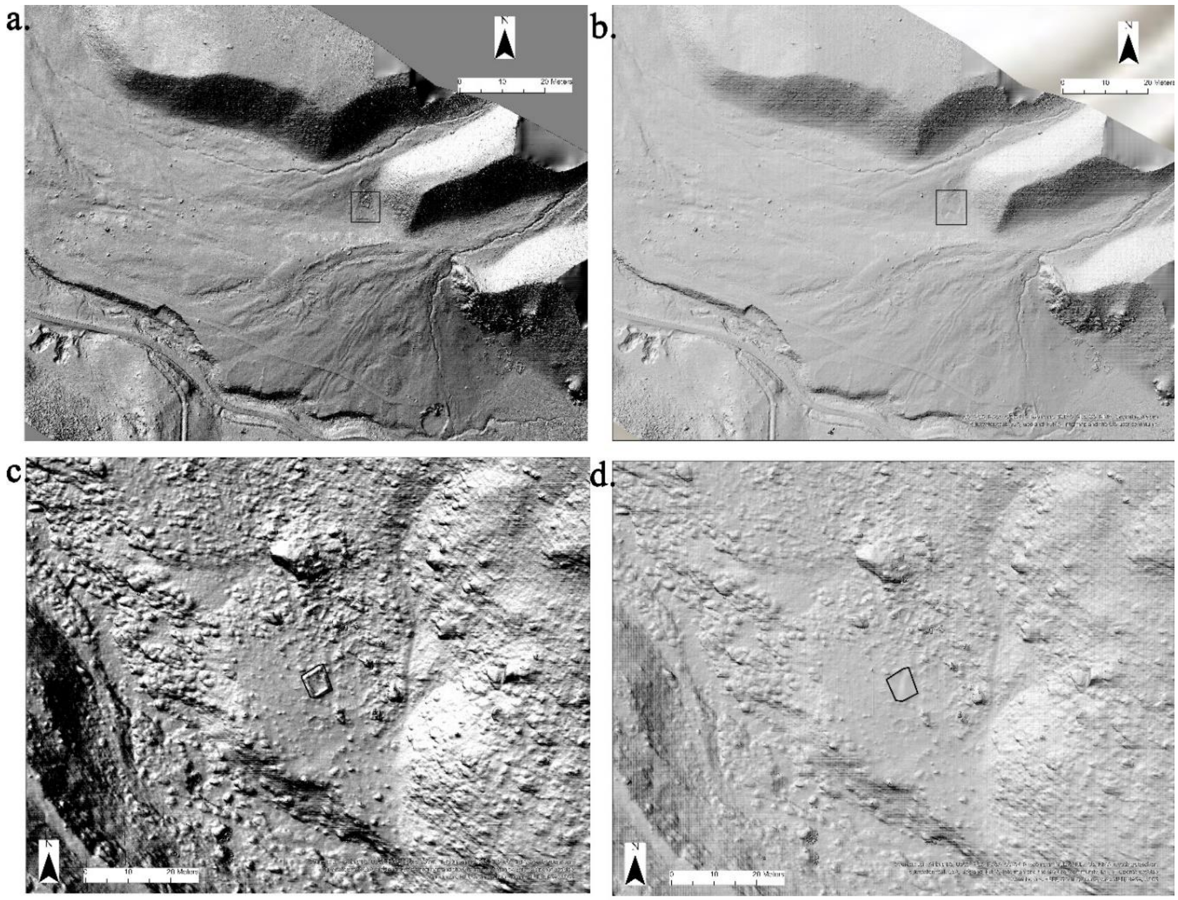


Figure 8.2: Hillshaded DEMs used as input in the erosion model a. the original DEM of the Badong site; b. the modified DEM where Badong is removed using the IDW interpolation; c. the original DEM of the Yukang site; the modified DEM where Yukang is removed using the IDW interpolation

8.2.2 Low-altitude photogrammetry using Unmanned Aerial Vehicle (UAV)

The area of interest in this model is relatively small, and the archaeological sites only cover a small area: 100m^2 (the known extent of the Yukang site), 480m^2 (the known extent of the Badong site), and 1000 m^2 (the extent of the modern pastoral site and the archaeological site of Badong). Therefore, the spatial resolution of commonly used open-source DEMs (e.g., ALOS, SRTM) does not suffice the need to model the sediment dynamics at a local scale. I conducted low-altitude photogrammetry based on a UAV (DJI Mavic 2) survey and produced 3D models of the sites and their surrounding landscapes (Figure 8.1). Hailun Xu from Sichuan University conducted the UAV survey. I create high-resolution DEMs based on the 3D models of the landscape. The DEMs have a cell size of 10 centimeters and are used as the input data for the soil erosion model.

8.2.3 Raster math of the DEM

To examine the mutual relationship between human activity and landscape evolution, the erosion model is run under two scenarios: one scenario is that the pastoral corral is used by the contemporary herders and will be used in the future, given that the stone structure will be functional for a considerable period; the other scenario is that the stone enclosure has never existed in this location. The second scenario is hypothetical that requires removing the corral from the DEM. DEM is a raster that contains information on the undulations of the ground surface. Each pixel on the DEM is coded with a floating-point value that represents the elevation of the location. Therefore, the removal of the corral from the DEM results in null values. To model the surface morphology without a corral, I use the inversed distance weighted interpolation (IDW), in ArcGIS, to fill the null value after using the “Clip Raster” tool in ArcGIS to remove the corral architecture. IDW is a regression method that predicts the value of a cell based on existing values within a specific search radius. This method, among various other regression algorithms, is often used to predict the spatial distributions of certain environmental proxies or artifacts (e.g., Conolly 2020). Based on this method, I create a new DEM where the corral is removed from the raster and replaced by predicted values, serving as an estimate of the "natural" elevations of the surface. The two DEMs are then used as inputs in the soil erosion model for further comparisons (Figure 8.2).

8.3 Results and discussion

The USPED model characterizes the areas around the archaeological sites that are subject to different degrees of water-induced erosion or deposition, assuming that the Badong and Yukang site is under a steady rate of excessive overland flow every year. The main erosion originates from the western part of the sites. After the removal of the archaeological sites, the erosion and deposition of the corral are completely changed, especially within the areas surrounded by the stone enclosures (Figure 8.3). I extract and compare the net erosion and deposition values from the polygons of archaeological sites (Figure 8.4). Those two sites are in areas with relatively stable erosive patterns compared to their surroundings. The average deposition of sediments after the removal of the corral structure in Badong changes slightly from 1.93 t/ha/yr to 1.28 t/ha/yr. The soil erosion for the Yukang site is more drastic, with the value of average net sediment erosion increasing from -0.62 t/ha/yr to -2.81 t/ha/yr (Figure 8.3; 8.4). The corral walls also change the direction of the surface water flows around the sites (Figure 8.5). The net erosion and deposition values here only serve as rough estimates of the soil retention capacities of the corral walls. Although the amplitude of the erosion pattern is different in those two sites, a common pattern is that the archaeological sites tend to have more intensive erosion without the walls. The DEM also demonstrates that the downslope moving sediments accumulate around the walls.

The differences of two sites in the soil retention capacity is due to the preservation of the walls. The ancient corral walls in the Badong site only have a height of 10-20 cm; the walls of the Yukang site are buried underneath the modern structures and the modern walls have a height of roughly 80-100 cm.

Although the stone walls are not intended for preventing hilly soil erosion and may only use as corralling facilities, the effectiveness of walls is widely documented as a supporting practice that mitigates erosion or improves the quality of vegetation, especially as features of ancient and modern agriculture terraces (e.g., Hammer 2012). Based on a large geospatial database of ground observations of landscape features in Europe, Panagos and colleagues (2015) argue that the stone walls are more important landscape features in reducing soil erosion risks in hilly regions like the Iberia Peninsula and Italy than the rest of Europe. In an ethnographic survey in Sikkim Himalaya, the researchers note that constructing stone barriers is a traditional soil retention practice that serves as sediment traps (Mishra and Rai 2013). Stone structures have been found in highland Peru to increase the quality of pasture by directing the water to the surrounding areas of the stream channel (Lane et al., 2022). The pastoral corral walls, in a similar vein, may have also facilitated soil retention, which has contributed to the long-term usage of a particular location.

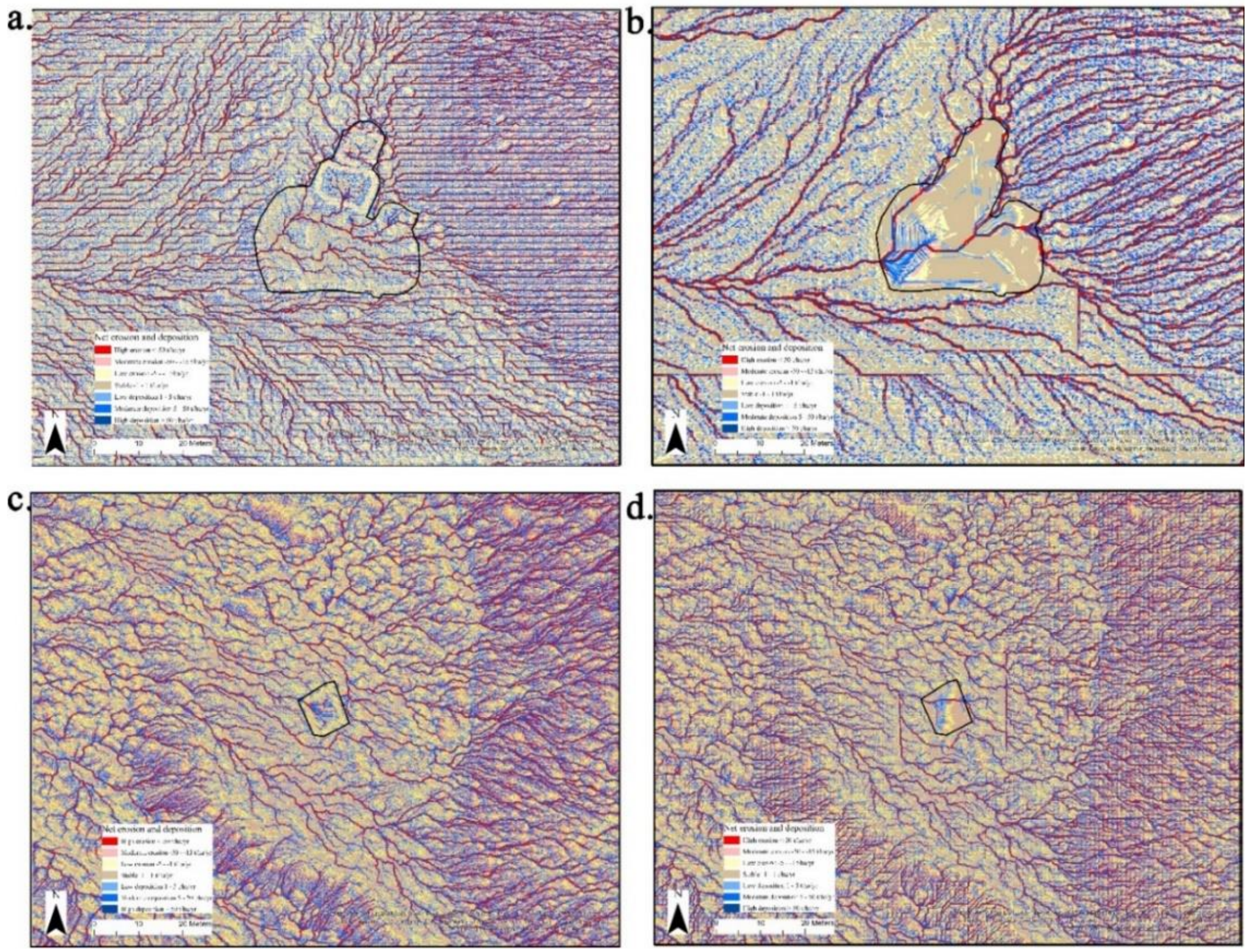
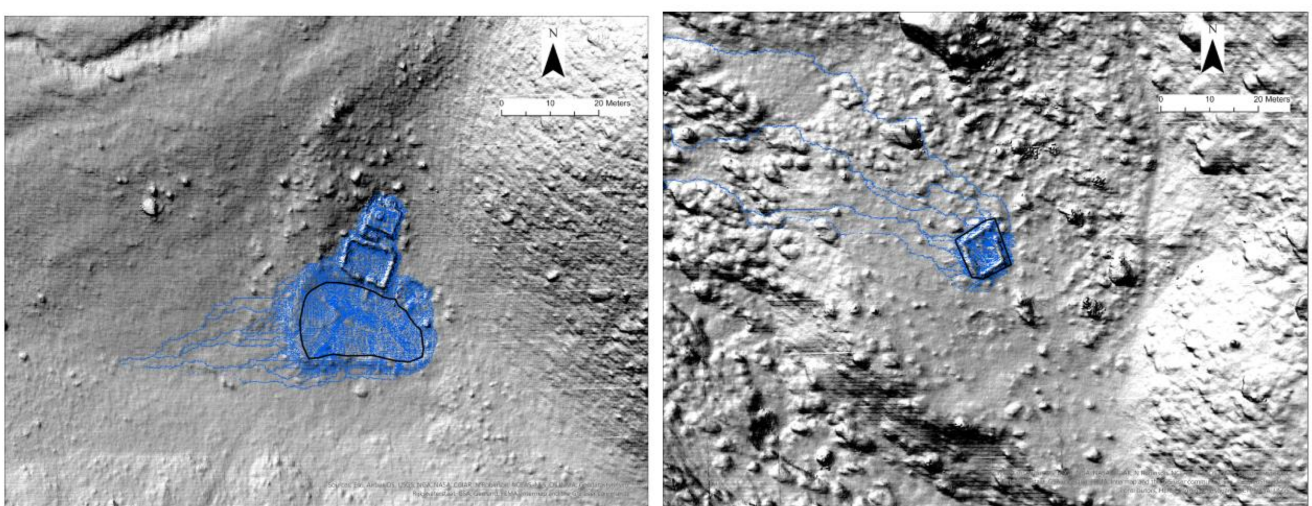


Figure 8.3: The net deposition and erosion of Badong and Yukang sites. a. the Badong site (mean: 1.93 t/ha/year); b. the Badong site with the corral architecture removed (mean: 1.28 t/ha/year); c. the Yukang site (-0.62 t/ha/year); d. the Yukang site with the corral architecture removed (mean: -2.81 t/ha/year)

Figure 8.4: Comparisons of the net deposition and erosion (t/ha/year) change in the Yukang and Badong sites. Negative values indicate deposition. Positive values indicate erosion.



a. b.

Figure 8.5: Comparisons of the net deposition in the archaeological sites. Blue areas indicate larger deposition values with a corral architecture. a. Badong b. Yukang

8.4 Summary

The erosion model demonstrates that the corral walls serve as a soil retention facility, which may contribute to the long durée landscape stability of a particular location. In this model, I assume that the modern stone enclosures represent the extent of the archaeological sites. Due to the limited scale of the archaeological survey, the extent of archaeological corrals may be significantly larger than the visible stone enclosures. The USPED model only accounts for the annual sediment transportation (Barton et al., 2010), and the accumulative change in the soil erosion pattern around the corrals may create micro-niches distinctive from their surrounding environment through time. The accumulative change in the erosion process around the micro-environmental niche may have a profound impact on the local vegetation due to the repeated human occupation, as the aerial photographs of the two archaeological sites reveal distinctive vegetation patches that are much larger than the known extent of the corrals.

Although the phenomenon of site reuse may seem trivial, the path-dependency of human activity is a debated anthropological issue, which also provides explanations for the long-term human settlement in somewhat unfavorable environments (Haas and Kuhn 2019). Pastoralism and its material remain may serve as *landscape anchors* both on local and trans-regional scales, encouraging repeated human occupation through time (Hammer 2014). The archaeological research of corrals serves as a pertinent case study for this academic inquiry. It remains a question of how and when other landscape features, such as water division channels, silt reservoirs, wells, and stone walls for the terrace fields, may have been used and participated in the shaping of the pastoral landscapes in the mountains of Tibet.

In Chapters 5-8, I present results of archaeological surveys, excavations, material cultural analysis and GIS case studies on several newly discovered pastoral sites in the northern Shannan region in central Tibet. The research illustrates how the vibrant cultural traditions and settlement patterns have altered and continued through time, in the context of pastoralism developed and was reproduced under changing socio-environmental conditions on a local scale. How did pastoralism may have further shaped a broad cultural-ecological landscape by institutionally reproducing itself through time and space? I approach this question through geospatial models and material cultural analysis across the Tibetan Plateau and its surrounding regions in subsequent chapters.

Chapter 9: Modeling the pastoral networks in Tibet, 3600-2200 BP

Situated at the heart of the Eurasian continent, the Tibetan Plateau hosts the world's largest high-altitude ecosystems and has been home to a diversity of cultures in the past and present. With over 70% of the landmass covered by grassland, pastoralism is the dominant human subsistence strategies on the Tibetan Plateau. Archaeological research on the human-environment interactions on this marginal landmass offers significant insights into how human adaptation to the extreme environment may have emerged and evolved. The lowland river valleys on the Plateau delineated the contemporary geographical extent of most of the long-term, year-round agropastoral settlements. The rest of the Tibetan high-altitude grasslands are sparely exploited by those pastoralists with relatively long seasonal pastoral mobility. The diversified cultural and ecological mosaic is possibly a long-lasting phenomenon to be traced back to at least the second millennium BC, as discussed in previous chapters. Tibet's participation in the massive long-distance exchange network across the Eurasian steppe, facilitated by the introduction of herd animals, may have laid the foundation for this cultural-ecological network.

Current scholarly debates in Tibet mainly focus on the timing and mechanisms of the initial peopling onto the Plateau and the subsequent emergence of permanent agricultural settlements. The Majiayao hunter-farmers in the Neolithic period occupied the northeastern margin of the Tibetan Plateau, in the foothill areas of central and eastern Qinghai and western Gansu from the fourth millennium BC. Their cultural influence quickly spread to the eastern Tibetan Plateau, penetrating the Hengduan Mountains and the Mekong River region. Recent studies indicate that subsequent major colonization of the Tibetan Plateau after 3600 BP was facilitated by the increasing reliance on frost-tolerant domesticates such as barley and wheat, and the use of herd animals, such as yak, horse, goat, and sheep (Chen et al., 2015; Dong et al., 2016).

Although increasing research pictures the change in cultural diversity and human subsistence in much greater detail, the mechanism of this major cultural and subsistence transition has not been analyzed in detail. It remains unclear to what degree pastoral mobility may contribute to the overarching network of large-scale exchange of goods, ideas, and information on the Tibetan Plateau. I seek to understand how the vegetation ecology of pastoralism may have shaped the settlement pattern and trans-regional participation through two computer models, using geographical network and social network analysis in Chapters 9 and 10.

9.1 The basics of least-cost path analysis

The model that I construct is rooted in the application of least-cost path and geographical networks. Least cost path analysis (LCP) is a method connecting several locations by generating a path with the least accumulative, user-defined cost (Figure 9.1). In archaeology, this method is normally based on Dijkstra's algorithm and can be easily performed in most of the current geospatial analysis software (e.g., GRASS, ArcGIS, QGIS, etc.). A standard least-cost path analysis requires three elements: origin, cost, and destination. Cost surface generation is probably the most important step to ensure a reliable and interpretable result. In archaeology, since the particular social and environmental factors are usually uncertain and speculative, the most frequently used cost functions are generated based on human physiological characteristics. The slope-based cost function proposed by Tobler (Tobler's hiking function, Tobler 1993), is the most used cost function when generating a pedestrian travel model. Tobler measures the correlation between walking speed and changes in slope. His function usually performs better than calculating LCPs using direct slope values, because Tobler's function considers that the increase of human energy expenditure is unilinear when traversing upslope. Other widely applied cost functions include Bell and Lock's function (Bell and Lock 2000), Pandolf's cost function (Pandolf et al., 1977), and Langmuir's cost function (Ullah and Bergin 2012), among many other variants of existing functions. Besides the various usage of different hiking functions, the cost can also be any variable that the user deems crucial for the model. Proximity to water, vegetation, wind velocity, and subsistence resource availability, among various others, are also used in different archaeological case studies (Herzog 2014; Verhagen et al., 2019).

Beyond the cost surfaces, human perception of the landscape is another crucial factor that needs to be incorporated into recent LCP analysis. Traditional least-cost path analysis treats people as all-knowing of their surrounding environments. The outputs of LCP analysis are usually the lines on a raster map. The underlying assumption behind the lines is usually that the ancient travel routes are planned well before the trip starts. Several recent studies have challenged this underlying assumption and added complexities and randomness to the path-finding process. For example, Lewis (2021) introduces the probability LCP analysis, by using Monte Carlo simulation to compensate for the vertical error of the digital elevation models. Crabtree and colleagues (2021) combine the agent-based model with the LCP analysis to simulate human migration to Australia, by iteratively modeling the path-finding behavior of a single agent. Field and colleagues (2007) map human mobility in prehistoric South Asia by defining a search radius (a 60-kilometer buffer) in each least-cost pathfinding process. The agent chooses the least-cost pathways within the radius iteratively until it reaches a pre-defined patch within a threshold value of environmental suitability. Those case studies illustrate the potential of the LCP analysis to model the uncertainties and randomness of past human activities.

9.2 Least-cost focal networks

Despite the advantages of LCP analysis, this method should not be used uncritically. One of the drawbacks of LCP analysis in archaeology lies in that it often requires a known destination or origin. Most of the built-in functions in contemporary geospatial analysis software do not permit the generation of pathways without either origin or destination, which are usually unknown when simulating past movements. Several attempts have been made to solve this problem. One workaround is producing multiple pathways connecting multiple origins and/or destinations (e.g., Howley 2007). Another solution is conflating several pathways by tracking the frequency of the traversed cells (e.g., Bell et al., 2002). In those case studies, the final outputs are usually the least-cost networks. White and Barber (2012) attempt to overcome the one-to-one pathways by introducing the "From Everywhere to Everywhere" (FETE, Figure 9.1: d) approach. This method calculates the LCPs between every point and its neighbors iteratively, resulting in the generation of least-cost corridors without assuming either destination or origins. However, the FETE method is very computation-intensive and time-consuming, especially when using a high-resolution cost raster of a large area (Crabtree et al., 2021). A less computation-intensive way of generating focal networks is based on hydrological analysis toolkits (Fabrega-Alvarez 2006; Frachetti 2006; Figure 9.1: e). For example, Frachetti (2017) simulates the movement of pastoralists by calculating the mobility networks of pastoralists moving from low elevation to high elevation in Central Asia, based on the assumption that pastoralists travel along the best grass.

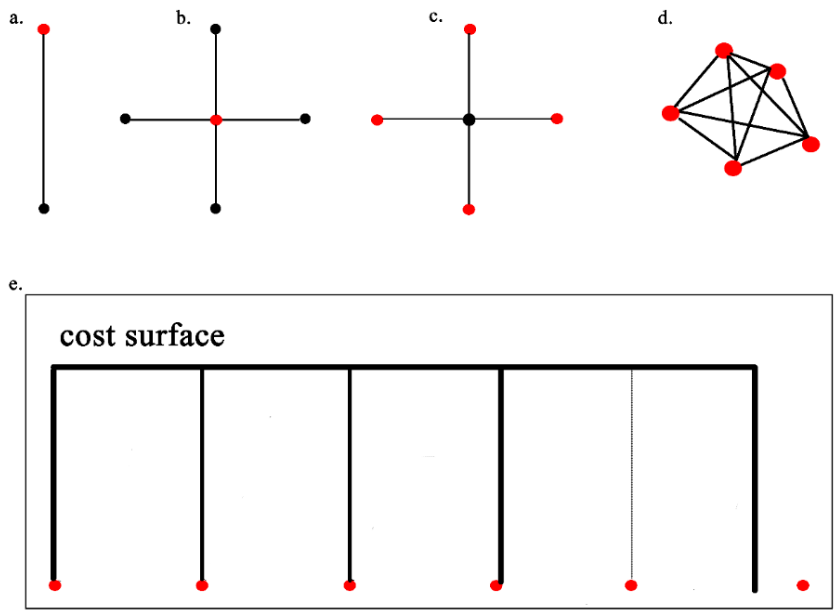


Figure 9.1: a. one-to-one LCP; b. many-to-one LCP; c. one-to-many LCP; d. many-to-many LCP; e. flow accumulation model as a least-cost network. The thickness of lines indicates the weighted frequency of travel; red dot: destination; black dots: origin; diagrams a-c is adapted from White and Barber (2012)

9.3 Material and method

In the flow accumulation model, the pathways are generated by calculating all the possible least cost paths towards given origins, which renders a focal network. The workflow is similar to that of modeling the flow of water across a surface (Figure 9.1: e; Maidment 1993). Inspired by White and Barber's FETE method (2012) and the flow accumulation method (Frachetti et al., 2017), I generate a model simulating the vegetation-to-cropland movements on the entire Tibetan Plateau, based on the assumption that pastoralists move through the best vegetation to the agricultural settlements.

Although ethnographic records indicate occasional trans-Himalayan trade and subsistence movements, which is entirely possible in prehistoric times (e.g., the Limi people, see Goldstein and Messerschmidt 1980), I here decide to keep the research area within the Tibetan Plateau for simplicity. The extent of the Tibetan Plateau used in this research is defined by Zhang and colleagues (2002). The shape file used in the model is downloaded from the database of the National Tibetan Plateau and Third Pole Environmental Data Center.

Increasing archaeological research in recent decades provides evidence of the prevalence of herd animals (mainly sheep, goats, and cattle, in some cases horses and yak), coupled with the presence of barley and wheat after the second millennium BC across the Tibetan Plateau (Dong et al., 2016; Chen 2015; Ren 2017; Jia 2012; Lu et al., 2021; Tang et al., 2020; 2022; He 2014; Zhang 2015; CASS 1999; Jaffe et al., 2021). Although the range of ancient residential mobility cannot be accurately determined on a case-by-case basis, the pastoral subsistence and the increasing use of herd animals are commonly considered to have facilitated a novel form of residential mobility and regional interactions (Lu et al., 2021; d'Alpoim Guedes and Hein 2018). The driving force of this large-scale cultural and subsistence transition is possibly the everyday pastoral circle and long-distance trade exchange facilitated by pack animals. The herds, pastoralists and caravan traders will rely on a common resource to sustain their trips: vegetation productivity.

Therefore, I consider vegetation quality to be the best indicator of herd-related mobility in the second millennium and first millennium BC. This research then simulates the best routes of pastoralist/herds movements, by calculating the pathways from all the arable land to the rest of the areas on the Plateau, along the trails of the best vegetation.

I download the modern land cover data compiled by the Food and Agriculture Organization of the United Nations (Global Land Cover-Share). The cropland pixels are vectorized to points and used as the origin points for the least path modeling. The vectorized points represent a rough estimate of the arable lands on the Tibetan Plateau. I use the Normalized Difference Vegetation Index (NDVI) values as the cost surface in the movement model. NDVI is an index indicating the healthiness of the vegetation which, in our case, is mainly the grasslands. NDVI is calculated from the multispectral satellite images based on the formula below:

$$. NDVI = (NIR - RED)/ (NIR + RED)$$

where RED and NIR stand for the spectral reflectance measurements acquired in the red and near-infrared regions, respectively. The NDVI raster is downloaded from the United States Geological Survey Data Archive, in the EROS Moderate Resolution Imaging Spectroradiometer (eMODIS) dataset. The NDVI raster in my model represents the vegetation of the Tibetan Plateau in August 2020, which serves as a rough estimate of the vegetation in ancient times (Figure 9.2). I choose to use the NDVI raster in August since it is a season when pastoral activities and vegetation productivity are both at their prime in Tibet. The cell size of the NDVI raster is 250 meters, meaning that the width of a cell on the map is 250 meters and vegetation variations below that threshold are not recognizable. NDVI is a value ranging from -1 to 1, where values approaching -1 indicate water body, rocks, and barren land. Because Dijkstra's algorithm cannot handle the pathfinding process with negative values, the original NDVI is scaled from 0 to 1.

Over each iteration, I run the hydrological flow accumulation of a single cropland point (Figure 9.3; Appendix 3), producing a raster map representing all the possible pathways from this agricultural settlement to the vegetation within the Tibetan Plateau. After n times of iterations (n= the total number of vectorized croplands), I sum all the raster and produce a pastoral movement network where the most frequently traveled "mobility highways" are highlighted with extremely high raster values. Although the flow accumulation networks are displayed using an arbitrary cutoff value of a standard derivation above the mean, the statistical analysis presented below uses the actual floating-point values in the resultant raster.

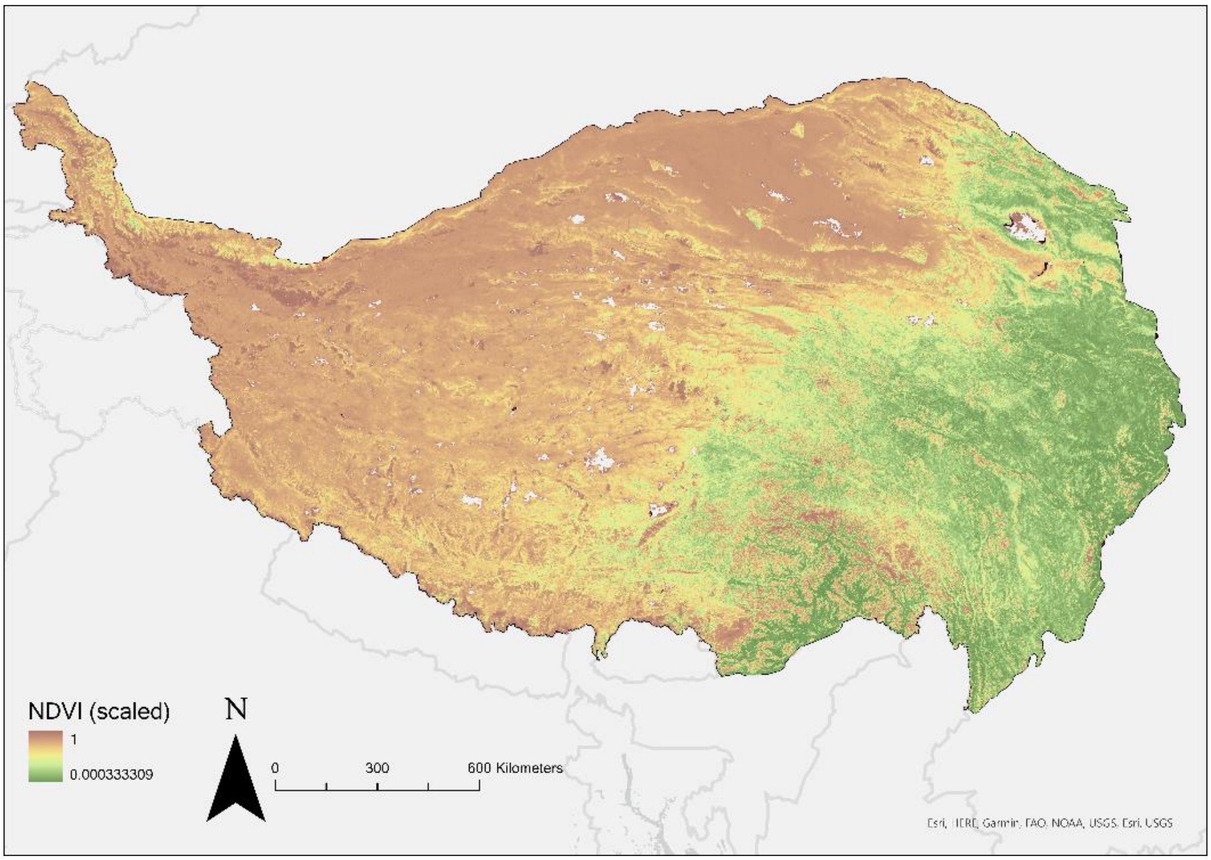


Figure 9.2: The scaled NDVI on the Tibetan Plateau (source: United States Geological Survey)

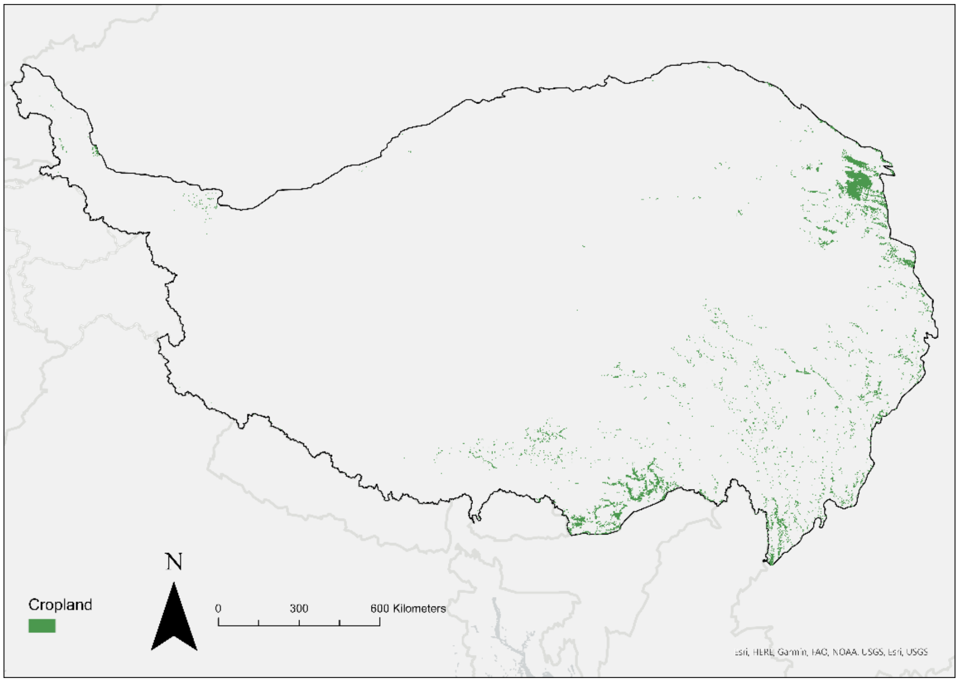


Figure 9.3: The extent of the Tibetan Plateau and the location of modern croplands. The croplands are used as the origin points in the flow accumulation model (source: The Food and Agriculture Organization)

9.4 Results and model validation

A single iteration of the flow model generates a focal network towards one patch of low-elevation cropland. The final output flow accumulation map contains the aggregate pathways to all the croplands. The simulated routes may contribute to the geographical settlement pattern over a vast territory (Figure 9.5).

To validate the flow accumulation model, I compiled a dataset including 1434 archaeological sites dated between 3600 BP and 2200 BP (Figure 9.5). Most of the sites in this dataset come from the legacy archaeological surveys in the past few decades and are mapped in the Cultural Relic Atlas of China. Although the Cultural Relic Atlas of China provides names, dates, and locations for all the archaeological sites discovered to the date of publication, it does not provide the accurate geographical coordinates of these sites. I manually georeferenced, county by county, the cultural relic maps in Tibet to get the exact location of the sites. Compared to the sites with actual coordinates, the error of the dataset is around 0-500 meters, which is equivalent to the length of 2 pixels on the eMODIS NDVI raster. Of note, although most of the sites are not directly radiocarbon dated, archaeologists determined the relative dates to cultures/phases (e.g., Shang, Zhou, Kayue, Xindian, etc.) by examining the typology of ceramics. Some sites may have a multi-period occupational history different from the records on the Atlas, as demonstrated by recent archaeological surveys and excavations (Lu et al., 2021; Jia 2019). The chronological control of the dataset is thus relatively poor. However, this is still acceptable for the validation of this model, as I consider the sites between 3600 and 2200 BP to be roughly contemporary and represent the general picture of settlement patterns and trans-regional participation after the adoption of pastoralism on the Tibetan Plateau. For a complete list of the archaeological sites see Appendix 4.

I validate the flow accumulation model with 1434 archaeological sites of this period, geolocated from published research articles, archaeological reports, and the Atlas of Cultural Relics of China (Figure 9.4). I generate 500 cohorts of 1434 random points and compare their flow values and distance to the simulated “highways” with the actual archaeological sites between 3600 and 2200 BP. The results suggest that the mean flow value of archaeological sites is about three times larger than the random points with a Z-score of 2.9, indicating that the mean flow value is larger than that of the random points by approximately three standard derivations. The mean distances to the simulated pathways of archaeological sites and random points are 8.8 km and 21.4 km, respectively, with a Z-score of 20.7. The validation of flow accumulation indicates that the archaeological sites have higher traffic volume and are geographically closer to the simulated pathways than random points, and the results are statistically significant (Figure 9.4).

Therefore, the simulated mobility between farmers and herders correlates with the location of archaeological sites in this period. Ancient people would have lived on or close to the "highways" to facilitate and benefit from the massive network of information flows across the Tibetan Plateau. The degree of participation of a particular site with other sites in the model, however, is varied and largely determined by its geographical proximity to the "highways"

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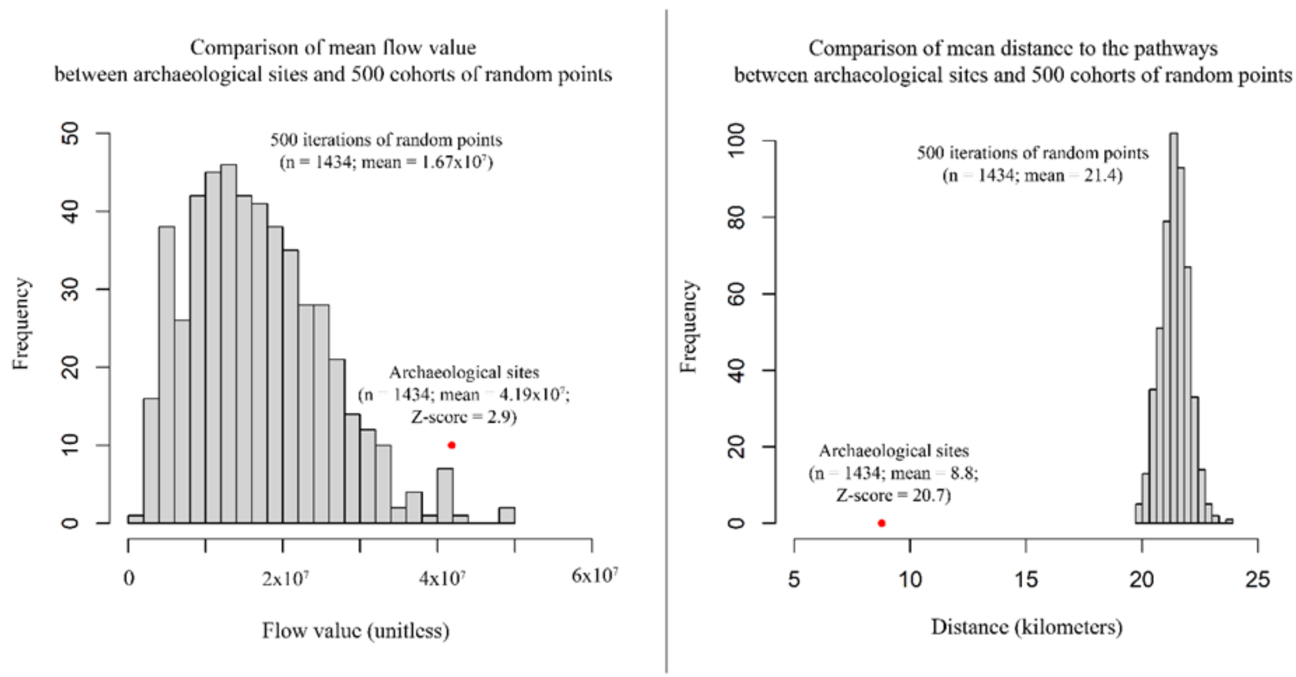

Figure 9.4: The statistical comparison of the flow value and the Euclidean distance to simulated pathways between the mean value of 500 iterations of random points and the 1434 archaeological sites (3600-2200 BP; red dots)

9.5 Summary

Supported by the archaeological database on the Tibetan Plateau, several geospatial meta-analyses on the archaeological settlement pattern seek to map the cultural communication routes between Tibet and the outside world, coupled with detailed analyses of bioarcheological data (Chen et al., 2015; Dong et al., 2016; Lancuo et al., 2019). Most previous GIS research is drawn on the assumption that human movement follows the "ease of travel" principle and generates the least-cost pathways that cross the river valleys with low slope values. Those models are illuminating in that they fit best with historically documented routes, such as the Tang-Tubo Road and the purported Tibetan Plateau Silk Road (Hou 2017; Lancuo et al., 2021).

The flow accumulation model generates several "mobility highways" along the best vegetation. This hidden network structure of human movements likely channeled the entire Tibetan Plateau by connecting most known archaeological sites that are otherwise geographically distant from each other. Most of the pathways are located within the grasslands. One exception is the southeast corner of the Tibetan Plateau, which is dominated by deep-cut valleys with forests (e.g., the Medog county in Nyingchi and the southern corner of the Tibetan Plateau). Although grasslands are not abundant in those regions, pastoralism still plays a role in the subsistence strategies of the local people as recorded by the modern census and ethnographical records. The scale of daily pastoral activities and herd-facilitated long-distance movements in the southeastern Tibetan Plateau is trivial, compared to the rest of the Tibetan Plateau. However, the number of archaeological sites dating to this period is also very limited. Thus the validation of the model is not biased.

The extensive and dynamic routes onto the Tibetan Plateau are already vaguely visible through the distribution of archaeological sites of different periods. Archaeological research in recent years suggests that ancient people may start occupying the Tibetan Plateau since the middle Pleistocene, as recent uranium series dating results from the human hand and footprints found on the travertine in Chusang date the earliest human presence on the Tibetan Plateau between 169 and 226 ka BP (Zhang et al., 2021). Although the new dates seem not to agree with previous dates at the same site (Meyer et al., 2017), more discoveries of the late Pleistocene and early Holocene (e.g., Zhang et al., 2018) clearly suggest people settled on the Tibetan Plateau at least since the late Pleistocene. More archaeological sites appear and concentrate on the northeastern rim of the Tibetan Plateau after the introduction of millet, barley, and wheat agriculture and pastoralism (Chen et al., 2015). Although this spatial pattern is certainly biased due to the unbalanced nature of current archaeological surveys and excavations, the number of human settlements increased drastically, the geographical extent of which extended into agriculturally marginal areas through time.

Based on the flow accumulation model, we can conclude from the model that the vegetation ecology largely contributed to the settlement pattern documented archaeologically in Tibet, and this movement network is likely to be associated with pastoral activities and herd-related long-distance movements surging after the second millennium BC. This spatial pattern of human settlements can be more reliably validated after a refined chronology of archaeological sites becomes available in the future.

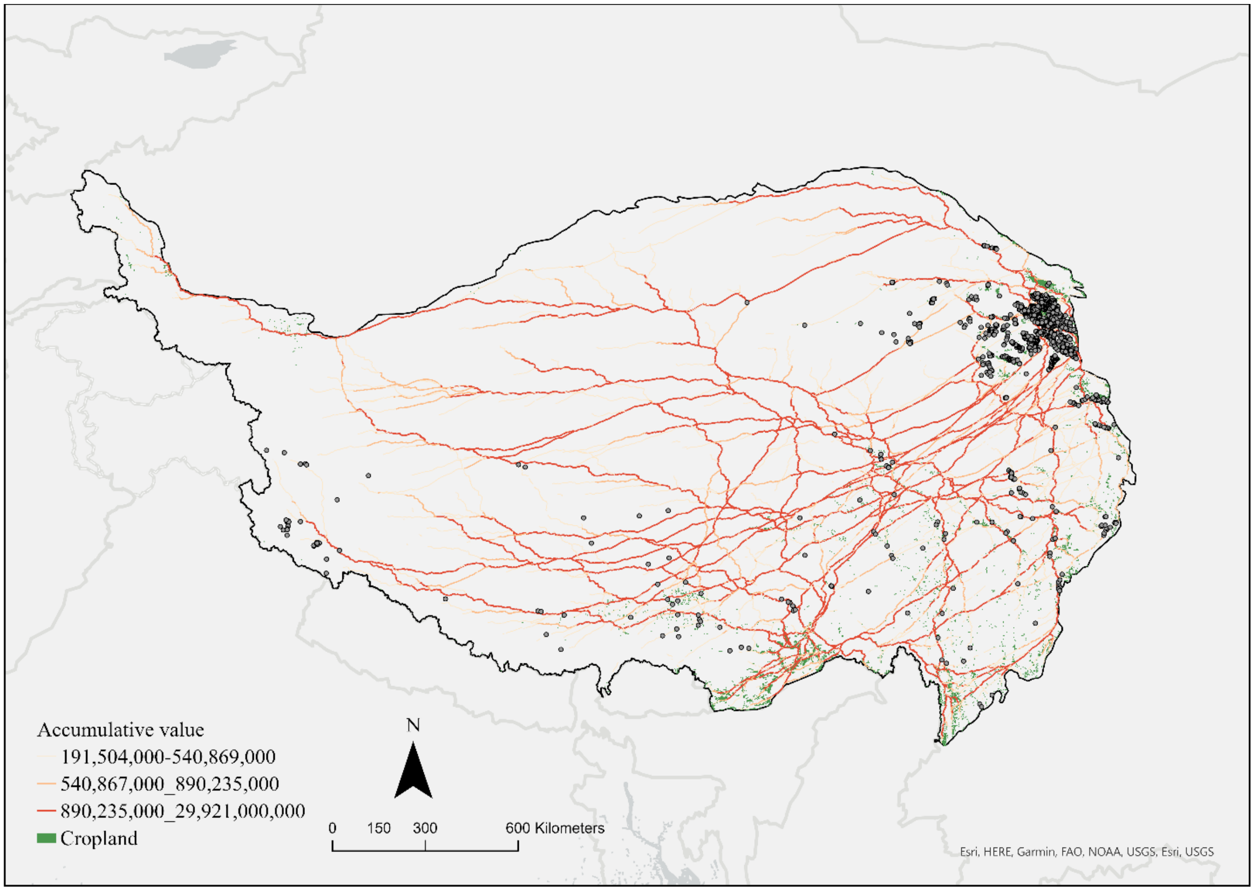

Figure 9.5: The simulated pathways along the best vegetation and the location of archaeological sites between 3600 and 2200 BP

Chapter 10: Shaping of the cultural landscape on the Tibetan Plateau: model comparisons

The resurgence of social network analysis in archaeology in recent years calls for attempts to couple network analysis with GIS models (e.g., Knappett 2013; Mills 2017; Peeples 2019). Social network analysis, derived from an array of disciplines outside of archaeology, is a formal way of analyzing social ties among actors. The ties, in archaeology, are often characterized by the similarities of material remains including ceramics, bronzes, various types of ornaments, or the types of animals or plants used by ancient people. Network analyses based on geographical or social ties yield significant insights into the geospatial arrangement of settlements (Apolinaire and Bastourre 2016; Paliou and Bevan 2016), the evolution of social complexity and the emergence of regional political centers (Lulewicz and Coker 2018; Lulewicz 2019), the configuration of food webs (Crabtree et al., 2017; 2021) and social inequalities (Bently et al., 2005; Schortman 2014), among various other scholarly inquiries. The integrated usage of GIS and social network analysis has illustrated that networks constructed using archaeological material evidence can be effectively compared with geographical networks to gain insights into the mechanisms that drive trans-regional participation, based on a variety of ties (e.g., Bikoulis 2012; Mills et al., 2013). The most used geographical ties include the least cost corridors based on terrain or a function of Euclidean distance. Mills and colleagues (2013) compare terrain-based spatial connectivity with the ceramic-based social network in southeast America. The spatial connectivity demonstrated varying patterns of social cohesion for sites in different regions. Coward (2010) generates social networks of the material remains for 591 archaeological sites from the Near East dated to the Epipaleolithic period (PPNA) and Early Neolithic period (PPNB). She calculates the similarity based on the common objects shared by the sites and concludes that the density of the social networks from the PPNA to PPNB increases. Based on this social network constructed with material evidence, Coward and Knappett (2013) further compare the social networks with two geospatial networks: one network is constructed using straight-line distances, and the other uses the GIS-derived pedestrian travel cost. Similar to Mills et al. (2013), they also discover that geographical proximity may not adequately explain the configuration of social networks. Hart (2012) also observes the same pattern when analyzing the network structure of the material remains of the Iroquois. Those studies suggest that the famous “isolation by distance” hypothesis (Wright 1943) may not contribute significantly to the variability of cultural landscapes. The networks among human groups are configured and manipulated under changing social institutions. Therefore, networks based on material similarities are most likely socially sensitive constructs, which alter quickly and easily under changing social institutions (Lulewicz 2020). By contrast, geographical networks are usually expensive, long-term human constructs. Once a geographical network is shaped, it is less prone to change under stable social-political and environmental conditions (Mills 2016).

Therefore, the interpretation of social networks calls for more sophisticated and fine-grained geospatial models, catering to the study area's specific social, political, and ecological characteristics. The methodological challenge for comparing social networks with geographical networks is that most GIS analytical platforms cannot easily convert the geospatial information into pairwise data for network analysis. To investigate how pastoral movements may have shaped the cultural landscapes on the Tibetan Plateau, I present a social network in this chapter based on the similarity of ceramics and quantitatively compare it with the flow accumulation model (the geographical model) generated in Chapter 9. I further draw upon the contextual, qualitative information from archaeological literature to account for the properties of the two networks.

10.1 Material and method

To examine the roles of nodes and the interconnectivity of archaeological sites within this network, I developed a Python program, which can compute the least accumulative cost between any pairs of points and convert the pairwise data into a matrix for formal network analysis (Appendix 6). The nodes in this matrix are 26 archaeological sites that are relatively well-excavated or intensively surveyed. Those sites are all dated between 3600 BP to 2200 BP.

The edges between the nodes are weighted by the “Pastoral Connectivity Index (PCI)”, defined by the accumulative least cost (unitless) of traveling from one node to another. In this network, the closer the site is to the simulated “pastoral mobility highways” of the flow accumulation model, the higher the PCI. The PCI is re-scaled from 0 to 1 (Appendix 7).

The PCI network is then compared with a ceramic social network, constructed using the same dataset of 26 archaeological sites (Figure 10.1). Ceramics is the most abundant material in archaeological sites and is often used as a proxy for the shared community of practices and social signaling (Mills et al., 2013; Lulewicz 2019). The similarity among ceramics from archaeological sites is also usually used as an indicator of cultural affinity (e.g., Groot 2019). The social network is based on a similarity index (the Jaccard index, Shennan 1997) of archaeological ceramics and serves as a null model of cultural interaction to compare with the PCI network. The selected archaeological sites include Qugong (曲贡; CASS 1999), Changguogou (昌果沟; CASS et al., 1999), Bangga (邦嘎; this research), Jiarirtang (加日唐; Xizang et al., 2005), Huangjiazhai (黄家寨; Qinghai and Jilin 1994), Shangbanzhuwa (上半主

洼; Qinghai 1998), Banzhuwa (半主洼; Qinghai et al., 1996), Suhusa (苏呼撒; Qinghai 1994a), Shanpingtai (山坪台; Qinghai and Hainan 1987), Dalitaliha (搭里塔里哈; Qinghai and CASS 1963), Dahuazhongzhuang (大华中庄; Huangyuan et al., 1985), Panjialiang (潘家梁; Qinghai 1994b), Pukar Gongma (普卡贡玛; Qinghai et al. 2017), Shidaqiu (石达秋; Aba et al., 2015), Ashaonao (阿梢垴; Sichuan et al. 2017), Zhajinding (扎金顶, Ganzi 1981), Jililong (吉里龙; Sichuan and Ganzi 1986), Galazong (呷拉宗; Sichuan et al., 2012), Yingpanshan (营盘山; Chengdu et al., 2013), Haneyi (罕额依; Sichuan and Ganzi 1998), Chuvthag (曲踏 CASS et al., 2015), Gebusailu (格布赛鲁; Sichuan et al., 2001), Phiyang-Dungkar (皮央东嘎; Sichuan et al., 2008), Shidi (石底; Yunnan 1983a), Yongzhi (永芝; Yunnan 1975), Nagu (纳古; Yunnan 1983b).

I broadly quantify the similarity among the archaeological sites based on 61 descriptive attributes of ceramics, including different types of surface treatment, paint, motif, shape, color, and temper. When a shared attribute is present in the ceramic assemblage, I code with the value 1, indicating that there is a correlation between the sites; otherwise, I give a value of 0 between the sites, suggesting no correlation. The Jaccard similarity between sites is calculated using the formula below:

$$\text{Jaccard} = a / (a + b + c)$$

where (a) is the number of attributes of ceramics shared in both sites; (b) is the number of attributes presented only in the first ceramic assemblage; (c) is the number of attributes presented only in the second ceramic assemblage. The Jaccard index is a value ranging from 0 to 1. The higher the Jaccard index, the higher the similarity (Shennan 1997; Appendix 6)[4].

Those two networks have different archaeological implications. The PCI network, derived from the previous simulation of the flow accumulation model, represents the possibility of the inter-regional exchange of material, goods, and ideas. Those exchanges can readily happen during trade, everyday pastoral activities, wars, gifting, or other types of connections. The ceramic social network, derived from the empirical characterization of ceramic typology, represents the cultural interactions observed and quantified archaeologically between different sites. Thus, the Jaccard index measures the degree to which the available geographical ties in Tibet are used to facilitate trans-regional interactions.

I use three centrality measurements available in UCINET to compare each node's cultural and geographical closeness between the two networks. The roles of nodes in each network are evaluated based on three centrality measurements: the degree centrality, eigenvector centrality, and betweenness centrality. Drawing on a large body of network analysis literature in social science (e.g., Mizoguchi 2009; Borgatti et al., 2002), I present a brief explanation of the centrality measurements below:

Degree centrality: degree centrality is the most used centrality measurement in archaeological networks. Degree centrality is the total of existing ties divided by the total of possible ties. In a weighted network, the degree of centrality is the average of its valued ties.

[4] The master table of the ceramic attributes used to calculate the Jaccard Index is too lengthy to be included in this document. The master table can be accessed in the Supplementary Files.

Betweenness centrality: higher values of betweenness centrality mean more nodes depend on this given node to reach other nodes. Nodes with high betweenness centrality thus indicate this node owns more social capital for acting as a broker in the network.

Eigenvector centrality: eigenvector centrality is a measure of centrality in which a node's centrality is its summed connections to others, weighted by those nodes' centralities. Therefore, if a node has only limited connections connected to other well-connected nodes, this given node will have a low degree centrality but a high eigenvector centrality.

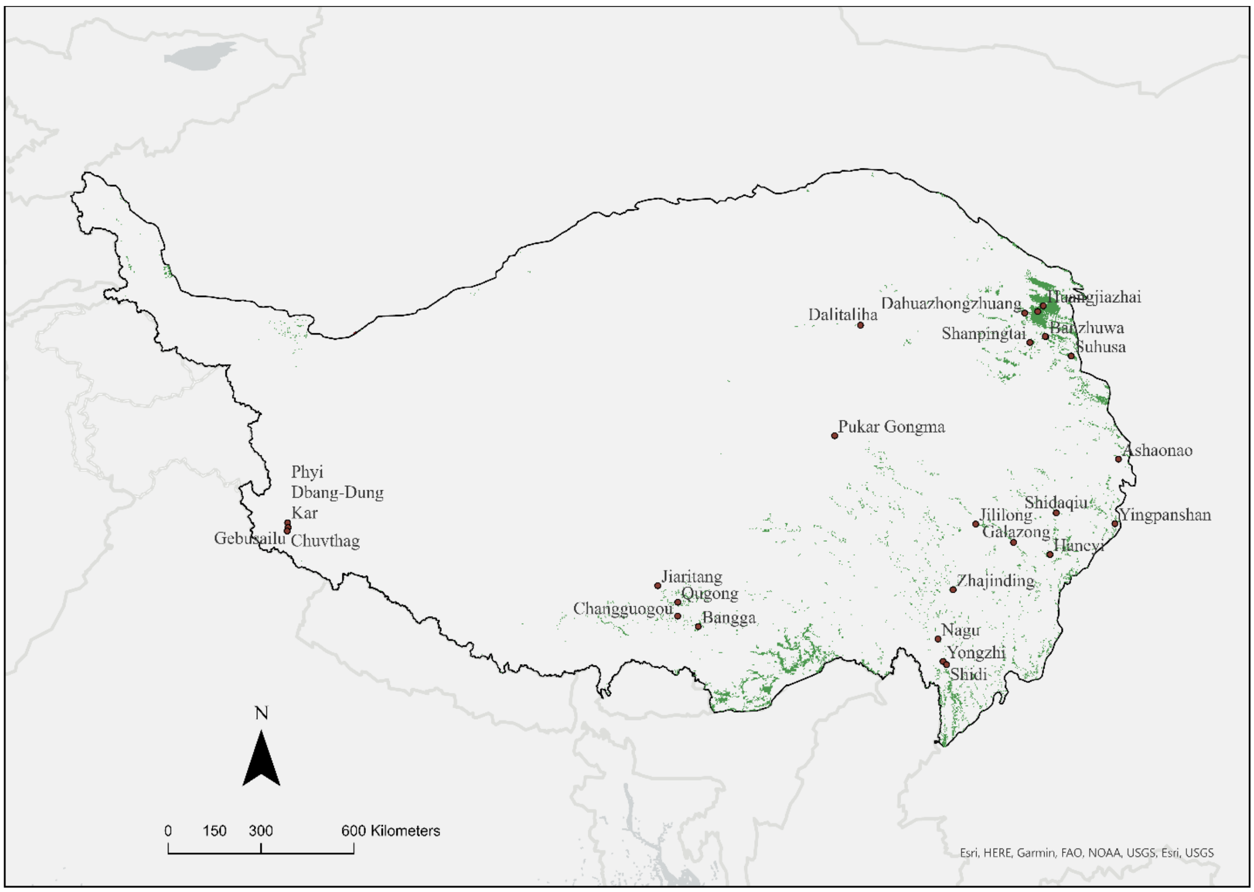

Figure 10.1: The 26 archaeological sites in the ceramic social network

10.2 Results and discussion

I visualize the results of the two network analyses using arbitrary cutoff values (Figure 10.2; 10.3). The cutoff value for the PCI network is 0.68 (248 ties), and for the ceramic network it is 0.65 (240 ties). Edges with weights lower than the cutoff values are hidden on the maps for visualization. In a network constructed by the Jaccard index of ceramics, all sites are connected. This non-binarized network does not permit the use of many centrality measurements (Peeples and Roberts 2013). Therefore, the cutoff values are chosen to remove the weak ties among the sites so that clusters of the linkages remain and both networks have a similar number of ties (Athenstädt et al., 2018). The network measurements of individual sites are shown in Appendix 7. The centrality measurements are summarized based on their locations to examine the geographical pattern of the social ties (Table 10.1; 10.2).

The PCI network measures the interconnectivity of the selected archaeological sites, facilitated by the idealized pastoral mobility along the best vegetation (Table 10.2; Figure 10.2). The sites in central Tibet, northeastern Tibet, and eastern Tibet are closely related to each other by the simulated pathways. Unsurprisingly, the most substantial ties are present among the geographically closest sites. However, some intriguing geographical patterns emerge in the PCI network. Two predominant corridors emerged as the original flow accumulation model and the PCI network. The corridors are connected to the northeastern rim of the Tibetan Plateau either through the Hengduan mountains and northwestern Sichuan grasslands or through the vast grasslands located in northern Tibet and southern Qinghai. The northwestern Yunnan sites are loosely connected to the most significant cluster to their north, channeled by the pathways through the mountain corridors in the Hengduan mountains. However, the magnitude of this Yunnan-Sichuan connection is much smaller. The western Tibet sites are relatively isolated, and they lack strong ties to reach central or northeastern Tibet to participate in the dense geographical and social networks in the east.

The ceramic network, constructed by empirical archaeological data, demonstrated a more nuanced geographical pattern (Table 10.1; Figure 10.3). The sites in eastern Tibet are still active agents in channeling interregional movements and probably serve as social brokers in the long-distance exchange of ideas, goods, and information. The eastern Tibet sites have the highest betweenness centrality, meaning that the eastern Tibet sites lie on numerous pairwise shortest paths across the Tibetan Plateau, facilitating cultural exchange. The corridors as seen in the Pukar Gongma site in the PCI network remain in the ceramic network, suggesting the grassland in southern Qinghai is a vital pathway linking central Tibet, northeastern Tibet and eastern Tibet. The Qinghai grassland may be intensively used during this period. Western Tibet sites participate in the ceramic network through their links with central Tibet sites and have the highest degree centrality and the second highest eigenvector centrality. The role of western Tibet in the network is the major difference between the ceramic network and the PCI network. The rest of the social network properties remain largely similar.

The network structure demonstrated through the computer simulation and quantitative network analysis bears striking parallels with cultural landscapes concluded from the existing archaeological material culture analyses, especially for the dense networks in the eastern Tibetan Plateau. However, the PCI network underestimates the cultural importance of western Tibet (and its connectivity with central Tibet). I address this issue in the next section by drawing a more detailed qualitative analysis based on a variety of archaeological artifacts.

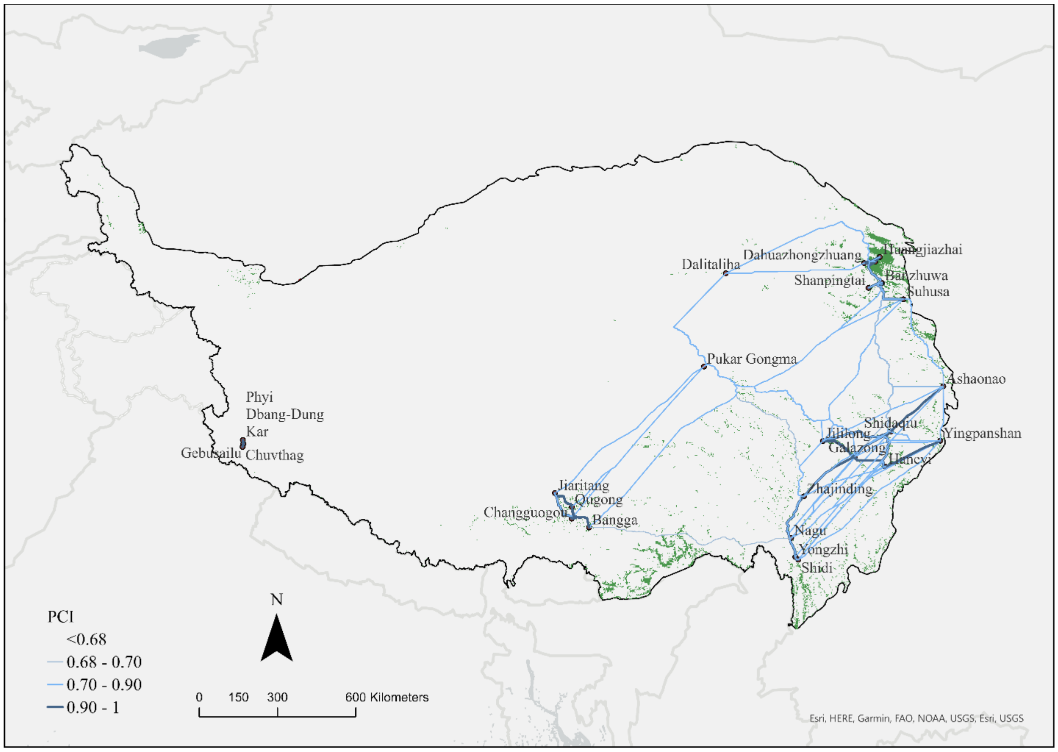

Figure 10.2: The PCI network using a cutoff value of 0.68

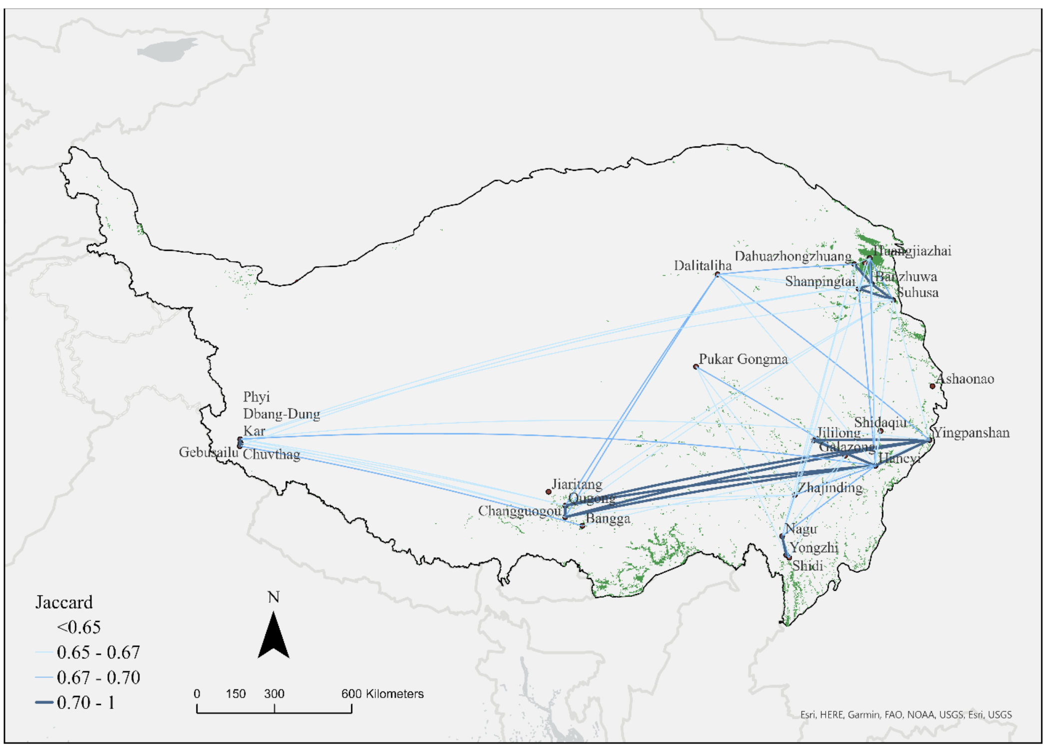

Figure 10.3: The ceramic social network using a cutoff value of 0.65

Table 10.1: Summary table of the centrality measurements in the ceramic social network

Region	Number of sites	Average degree centrality	Average eigenvector centrality	Average betweenness centrality
Northeastern Tibet	9	6.63	0.20	9.29
Central Tibet	4	6.27	0.19	8.44
Eastern Tibet	7	6.03	0.16	15.33
Western Tibet	3	6.62	0.19	6.83
Northwestern Yunnan	3	4.35	0.08	11.6

Table 10.2: Summary table of the centrality measurements in the PCI network

Region	Number of sites	Average degree centrality	Average eigenvector centrality	Average betweenness centrality
Northeastern Tibet	9	9.54	0.26	8.31
Central Tibet	4	3.72	0.03	1.47
Eastern Tibet	7	10.38	2.56	9.23
Western Tibet	3	2.67	0	0
Northwestern Yunnan	3	7.80	0.17	3.22

10.3 Qualitative assessment of the models based on material cultural analysis

Network analysis in archaeology is usually used as a provocative representation of relationships between subjects, based on archaeological assemblage similarity. Both the benefit and shortcomings of this approach are due to its quantitative nature. The properties of networks are further complicated by the way in which the observed similarity is interpreted archaeologically. Discrepancies usually exist among the comparisons of quantitative similarity, the subjective observation of the similarity, and the archaeological interpretation of the similarity (e.g., Athenstädt et al., 2018). Although often appearing in the archaeological literature in a qualitative manner, the typological analyses of ceramics, stone, and bronze artifacts in the past few decades in Tibet provide a pertinent source for the assessment of the networks.

10.3.1 The cultural connections between northeastern and eastern Tibet

As early as the 1980s, several scholars have noted the importance of the eastern Tibetan Plateau as a cultural crossroad connecting the mountainous regions in western and northern China (Figure 10.4). Tong (1986) noted the similarities between the stone-cist burials and the cultures from the northeastern Plateau. Based on the observation drawn from relatively limited archaeological data, he named this pattern the “crescent-shaped cultural communication belt.” This notion later became influential in Chinese archaeology. Scholars working in western Sichuan further elaborate on this argument by pinpointing the morphological similarities of the double-handled jars in the Xindian Culture, Tangwang remains, Kayue Culture, and stone-cist graves. Those jars share a similar morphology of exaggerated handles connecting the rim and the body, the whirlpool motifs, and zigzag motifs. Chen (1989) further argues that the stone-cist graves indicate direct human migration from the northeastern Plateau to western Sichuan. Other scholars argue that there are alternative routes to enter the eastern Tibetan Plateau, such as the grassland pathways of southern Qinghai (Li 2011; Shi 2006). The long-distance connections may be rooted in the local Neolithic Cultures, as the Majiayao-related painted ceramics are already present in a few Neolithic sites in western Sichuan and the eastern Tibet Autonomous Region (Li 2011; Luo 2012; Chen 2012). Besides the ceramics, bronze weapons (Yang et al., 2016; Chen 2011), ornaments, and burial customs (Li 2011) are all indicators of the large-scale latitudinal exchange on the eastern periphery of the Tibetan Plateau.

Archaeological discoveries in the Neolithic Liujiazhai site and Ruoergai grasslands (Sichuan et al., 2021; Unpublished data in Sichuan University, Xu, H. personal communication) in recent years suggest active exchange of material and ideas during the Majiayao period across the grassland corridors in northwestern Sichuan. This argument is reinforced by the geochemical evidence for possible direct conveyance of the Majiayao painted pottery (Hung 2011). The latitudinal exchange was much more intensive and geographically extensive during the second millennium and first millennium BC, followed by the emergence of the stone-cist graves in this region (Luo 2012). The flow accumulation model, the PCI network, and the ceramic social network all correctly indicate this interconnectivity between the northeastern Plateau and the eastern Tibetan Plateau.

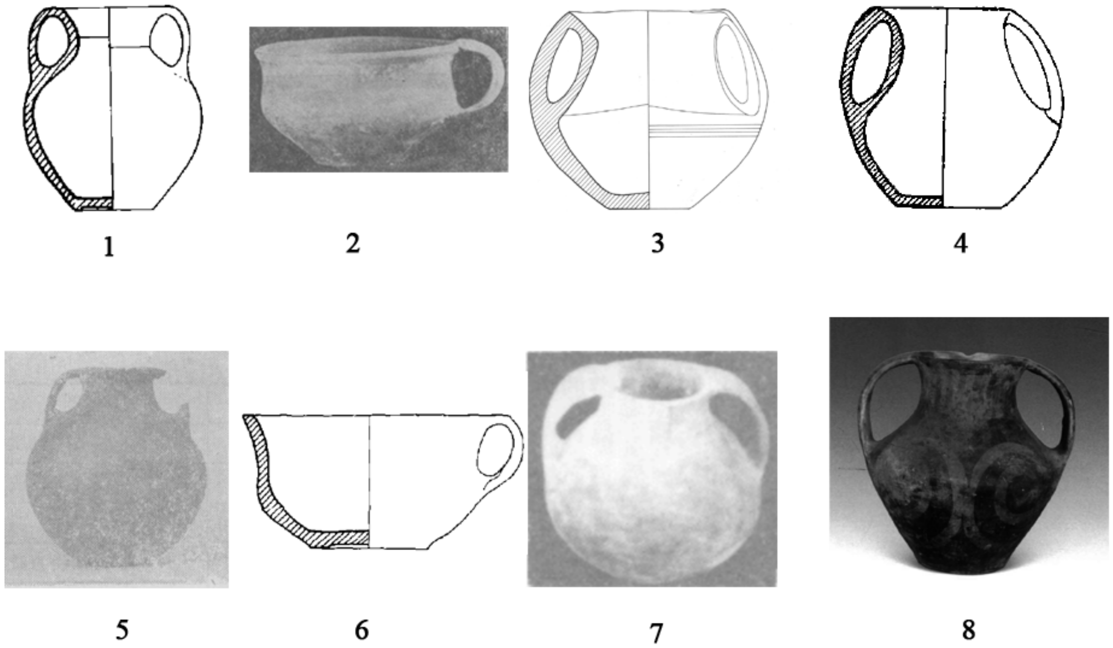

Figure 10.4: Comparisons between the ceramics from eastern Tibet and northeastern Tibet. 1. Double-handled jar in Shangbanzhuwa (northeastern Tibet) 2. Single-handled jar in Shangbanzhuwa (northeastern Tibet) 3. Double-handled jar in Pukar Gongma (northeastern Tibet) 4. Double-handled jar in Dalitaliha (northeastern Tibet) 5. Double-handled jar in Zhajinding (eastern Tibet) 6. Single-handled jar in Yingpanshan (eastern Tibet) 7. Double-handled jar in Xiangbei (eastern Tibet) 8. Double-handled jar in Yingpanshan (eastern Tibet)

10.3.2 The cultural connections between eastern, western, and central Tibet

The sporadic findings in central Tibet and northeastern Tibet provide evidence that eastern Tibet acts as a broker in the trans-regional exchange. Burial goods in the Xiangbei cemetery demonstrate strong similarities with the artifacts in western Sichuan (Xizang 1986). Stone-cist burials are also prevalent in central and western Tibet. However, the diagnostic ceramics and cord patterns in Karuo and the Neolithic sites from western Sichuan disappear in the central Tibetan sites. However, the eastern cultural influences are weak when the cultural traits travel further west from eastern Tibet. The relatively independent nature of the Qugong Culture in the second millennium BC is inherited by the remains in Bangga, dated between 3000-2200 BP. The material assemblage at Bangga leads archaeologists to conclude that the Qugong/Changguogou to Bangga change is an endogenous cultural change (see Chapter 5). The connections between the central Tibet and eastern Tibet are evidenced by the shared tradition of polished surface treatment in ceramics, decorations of ceramics, stone-cist burials, and millet agriculture (Wang 2008; Shi 2012; Lu 2015). We also see the weak ties between eastern Tibet and central Tibet from typological analyses of the bronze mirrors, where eastern Tibetan /Central Asian style mirrors, and local style mirrors may have coexisted (see Chapter 11).

The ceramics and stone tools in central Tibet also bear weak ties with those from Xinjiang in the first millennium BC, yet the routes of this cultural exchange are not certain. Early excavations in the Shindo Rizur site in Lhasa provide evidence that the single-handled jars are possibly connected to similar ceramics found in eastern Xinjiang (Aufshnaiter 1956; Lu 2015). Interestingly, no signs of their counterparts are found in western Tibet. Both the PCI network and ceramic network show that central Tibet's connections with eastern Tibet prevail, channeled by the mountainous pathways.

10.3.3 The trans-Himalayan participation and model interpretation

Some researchers argue that cultural influences from outside of the Tibetan Plateau play a significant role in the material assemblages in Tibet (Lu 2015a; 2016; Tang 2014). Lu (2015b) further argues that the ceramics in the burials in the Phiyang-Dungkar site complex in Zanda County, dated to the first millennium BC, demonstrate significant similarities with those in Nepal, especially in the Mustang region (e.g., Massa et al., 2019). We see potential trans-

Himalayan contacts primarily in the material assemblages in western Tibet and central Tibet. Detailed analyses of the archaeological discoveries in Swat, Kashmir, and the Indian Himalayan Region resonate with this argument (Figure 10.5).

The black polished pottery in Qugong is the earliest ceramic tradition in central Tibet, and its origin remains debated. Previous research links this tradition to the Neolithic Mehrgarh site in Pakistan. However, the black polished pottery in Mehrgarh is at least 1000 years earlier than in Qugong (Tang 2014). Moreover, the "Mehrgarh to Qugong" hypothesis does not adequately explain the origin of the ceramic decoration tradition and the typology of vessels in the Qugong ceramics.

More convincing evidence surfaces from several Neolithic sites in Kashmir that dated slightly earlier than Qugong (Figure 10.5). The black-burnished ceramics in the archaeological sites in the second millennium BC, including Burzahom, Gurkral, and Kanispur, are similar to the ones in Qugong (Sharma 2013; Bandey 2009; Yatoo 2012). The flange and hollowed-out decorations in high-ring-based ceramics found in central Tibet in the Changguogou and Qugong sites are heavily influenced by the same tradition in the Kashmir Valley. I observe a widespread practice of using the cord pattern, usually on red and orange unburnished ceramics, among the western Tibet sites and broader western and southern Himalayan regions. This pattern indicates intensive trans-Himalayan participation in the institutional domain of ceramic manufacturing techniques.

During the first millennium BC, increasing evidence suggests trans-regional cultural communications. The co-occurrence of the spouted jars in Shindo Rizur, Bangga and Qugong indicates that this wave of cultural influence might have entered central Tibet from Xinjiang (Aufshnaiter 1956; Lu 2015). The influences of the exotic spouted pots persisted in central Tibet until the historic period, as shown in the findings in the Liuwu cemetery (Xizang et al., 2005). The spouted jars that are typologically similar across the western Himalayas, central Tibet, and western Tibet, may have their origin in the southern rim of the Tarim basin in the Chawuhu cemetery (Han 2007; Guo 2012). The pathways into the Himalayas may be the corridors along the southern periphery of the Inner Asian Mountain Corridor (Frachetti 2012).

The trans-Himalayan cultural exchanges between Tibet and the outside world may contribute to the discrepancies between the social network and the PCI network, shown in the centrality measurements of the western Tibet sites. The processing extent in the flow accumulation model does not cover the broader Himalayan regions including the southern rim of the Tarim basin, Kashmir Valley, Nepal, and the Indian Himalayas. The pastoral movement across the Himalayas can readily happen according to the ethnographical records (e.g., Goldstein and Messerschmidt 1980). It is also less likely that the connection between western Tibet and Xinjiang is bridged by massive direct movements across the no-man’s zone of the Changtang steppe since few human settlements serve as logistic locations on those routes. Therefore, movements from outside of the Tibetan Plateau, especially the trans-Himalayan movements, likely account for the social ties between western Tibet and central Tibet as seen in the ceramic network. People in western Tibet in the second and first millennium BC possibly did not participate directly in the dense pastoral networks within the Tibetan Plateau.

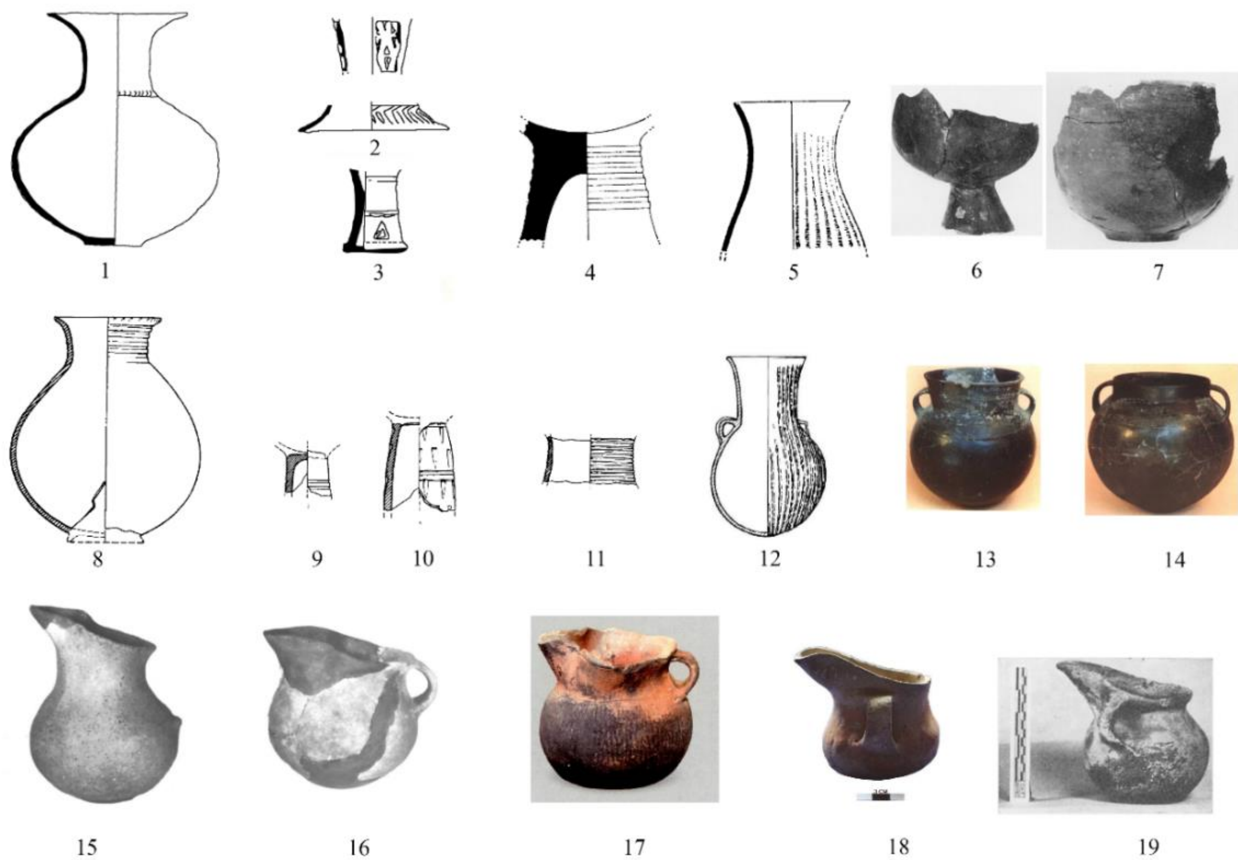

Figure 10.5: Comparisons between the ceramics from Tibet and its surrounding regions in the second and first millennium BC: 1-3. black burnished ceramics in Burzahom (Kashmir, India); 4, 6-7. black burnished ceramics in Loebanr (Swat, Pakistan); 5. vessel with cord pattern in Ghalighai (Swat, Pakistan); 8-11, 13-14. black polished ceramics in Qugong (central Tibet); 12. vessel with cord pattern in Phyi Dbang-Dung Kar (western Tibet); 15-16. spouted jars in Qugong (central Tibet); 17. spouted jar in Chuvthag (western Tibet); 18. spouted jar in the Spiti valley (Himachal Pradesh, India); 19. spouted jar in Shindo Rizur (central Tibet)

10.4 Summary

Previous archaeological research speculates on the possible existence of "(semi)nomadic groups" or "agropastoral groups" in several areas on the Tibetan Plateau, including sites of the Kayue Culture (Xu 2006), Nuomuhong Culture (Dong et al., 2016), the stone-cist graves in the upper Min River and Yalong River (Luo 2012; Chen 2005), and western and northern Tibet (Huo 2013). Recent archaeobotanical and zooarchaeological evidence suggests that most of the ancient people on the Tibetan Plateau practiced agriculture to varying degrees (e.g., Gao et al., 2021; Tang et al., 2021). The predominant crops included millet, wheat, and barley. As a result, new research emphasizes the crucial role of agriculture, especially barley, in facilitating the broad settlement pattern after 3600 BP (Chen et al., 2015).

Based on the novel network models, my research indicates that a mobility network based on vegetation ecology is another independent factor that contributes to the settlement pattern. The pathways mostly consist of grasslands except for southeastern Tibet, which could be highly correlated with pastoralists and herd-related movements. The geographical network is broadly similar to the cultural interaction networks, suggesting the existence of intensive participation in the institutional domains of bronze manufacture, ceramic production, and subsistence economy on the entire Tibetan Plateau. The network structure may have facilitated the shaping of the cultural landscapes we see today in the archaeological records.

My analysis of the material cultural remains indicates that potential trans-Himalayan participation, especially in western Tibet, accounts for the discrepancies between the geographical network and the social network. This pattern of cultural interactions across both sides of the Himalayas has been discussed by several scholars (e.g., Lu 2015; Tong 2013), while new data have kept updating our knowledge of the timing and routes of this phenomenon. In the next chapter, I discuss new evidence of this network of participation based on an analysis of newly discovered bronze mirrors in Tibet.

Chapter 11: Tibet's participation in the Eurasian network: new evidence of bronze mirrors

Handled bronze mirrors once lay at the center of academic debates as evidence of exotic cultural influences in central Tibet in the first millennium BC (Zhao 1994; Huo 1994). Scholars frequently discuss the handled bronze mirror and the trans-regional interactions from the Qugong site since the 1990s (CASS 1999). The Qugong mirror is commonly dated to the second half of the first millennium BC. Two similar handled mirrors from private collections in Germany and France are reported as well (Belleza 2020). The provenance and cultural affiliation of the handled bronze mirrors, however, remain debated in Tibetan archaeology. Most scholars emphasize that the central Tibet mirrors are typologically different from the Chinese mirror with knobs. This tradition of using handled mirrors originates in Central Asia (Zhao 1994; Huo 1994). Some scholars argue that the central Tibetan mirror motifs silghtly differ from the Central Asian ones. The decorations may indicate local adaptations (Lu 2009) or be influenced by the bronze decorations from the Yunnan region (Tong 2010). Morphologically, the three handled mirrors discovered to date are so morphologically similar that Tong (2010) proposes the term "Tibetan style handled mirror". Although the exact origin of the handled mirrors in central Tibet remains debated, the significance of the bronze mirrors as evidence of exotic cultural influences has never been questioned. The case study of the handled bronzes mirrors offers an excellent example of Tibet's participation in a large geographical extent and the structural syntax in burials (e.g., Shelach 2016; Frachetti and Bullion 2018) that aims at reproducing the mortuary practices.

In July 2021, I visited the Shannan Museum and the Yak Museum in the Tibet Autonomous Region and examined two handled bronze mirrors curated there (Abbreviated as the Yak mirror,

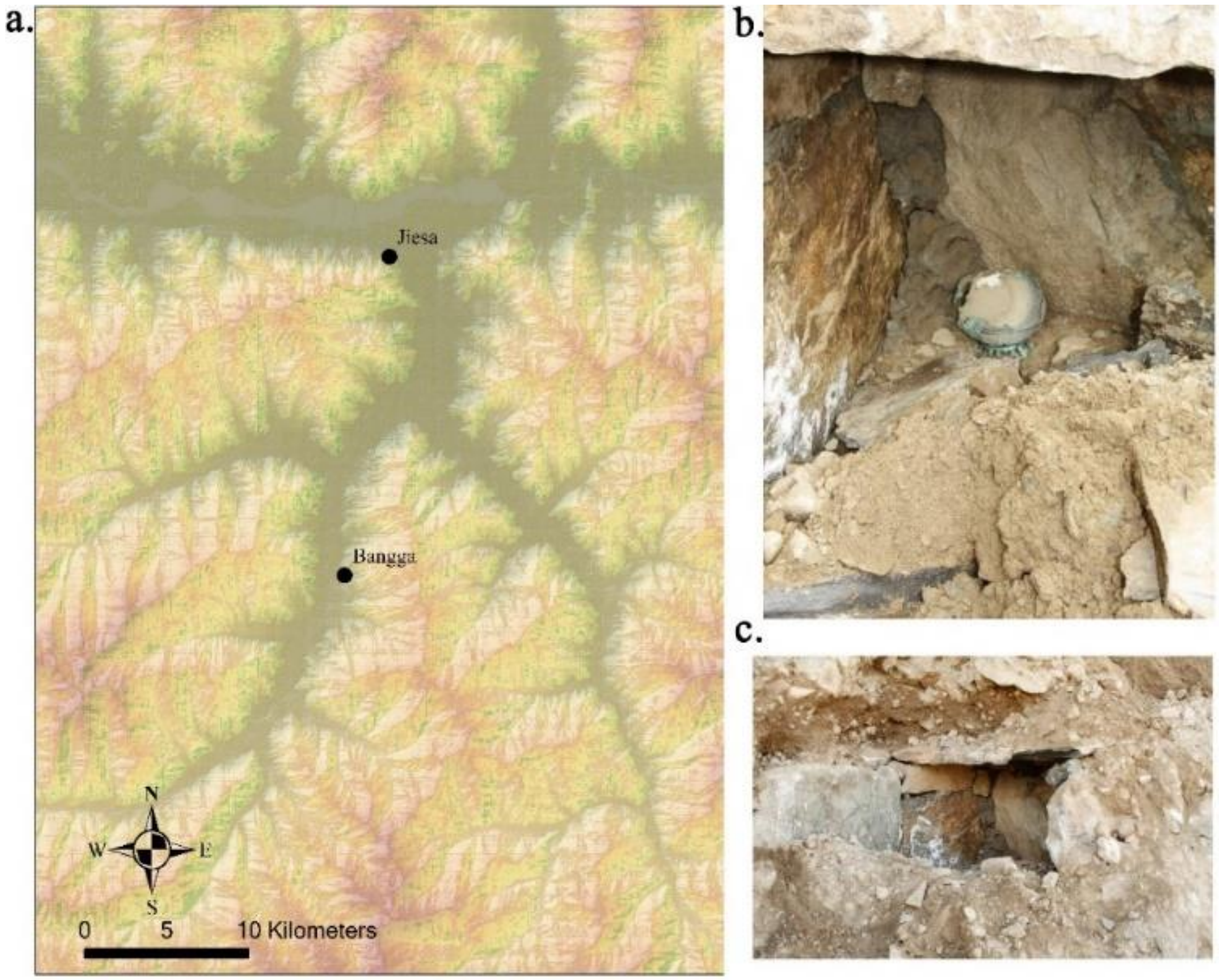

Figure 11.1: The Jiesa cemetery: a. the location of the Jiesa cemetery; b-c. the burial 2009NJWM1 during the salvage excavation in 2009 (photographs b-c by courtesy of Norbu Tashi)

Figure 11.1: 1-3; the Jiesa mirror, Figure 11.1: 4). The handled bronze mirror in the Yak Museum was in the exhibition, so I only took some photographs. I sampled the Jiesa mirror for P-XRF and lead isotopic analysis. Researchers at Sichuan University will conduct a scientific analysis of the Jiesa mirror based on compositional data. Here I mainly discuss the typological and contextual comparisons between the two mirrors and other bronze mirrors from surrounding regions in the context of trans-Eurasian participation.

11.1 The newly discovered bronze mirrors in Tibet

The Jiesa cemetery (29.24°N, 91.74°E) is located in the Jiesa village in Naidong County, Shannan (Figure 11.1). The cemetery was discovered in 2009 during a construction project. The Shannan Bureau of Cultural Relics then conducted a small-scale salvage excavation on the destroyed burials and collected some bronze artifacts, including this mirror. Therefore, no contextual information is available now concerning the position of the mirror in the burial. The Institute of Archaeology and Cultural Relic Preservation of the Tibetan Autonomous Region, Sichuan University, and Shannan Bureau of Cultural Relics conducted a formal excavation at Jiesa later in 2016. The two salvage excavations discovered eleven stone-cist burials, some ceramics, and bronze artifacts (Xizang et al., 2022).

The newly discovered Jiesa mirror is not typologically similar to any of the previously reported handled bronze mirrors in central Tibet, because it consists of a Y-shape short handle with two holes, a feature that was rarely seen in this region (Figure 11.2). The central Tibetan bronze mirrors all have sockets on the bases for inserting long handles, which are thought to be connected with the mirrors in the southern part of Central Asia, such as Afganistan (Lu 2009). Some typological characteristics of the Jiesa mirror are notable and may provide clues to its cultural affiliation to Central Asia and eastern Tibet. First, the circular carving line decoration on the back of the mirror is most seen in central Asia. The carving line circles often separate bands of geometric motifs, such as volutes, diamonds, and zoomorphic patterns. The mirror is heavily rusted so I cannot further comment on the motifs besides the concentric circles themselves. The mirror decorations previously reported are generally considered to be a local tradition. This circular incision also presents in the Eurasian steppe, such as on the handled mirror in Filippovka (Pschenichnuik 2020). Second, the Y-shaped mirror handle makes the mirror suitable to be suspended with a string or cord. This portable design resembles the mirrors in the eastern Tibetan Plateau, Central Asia, and the northern-style bronze found in Siberia, Altai, and northern China (e.g., Tishkin and Seregin 2011). The eastern Tibetan Plateau mirrors often have one or more holes on the short handles, indicating a similar function as well. Based on the typological evidence above, I argue that the Jiesa mirror is a novel type of mirror found in central Tibet for the first time. The typology of this mirror represents weak cultural connections with Central Asia and the eastern Tibetan Plateau, suggesting Tibet's participation within a broad geographical exchange network.

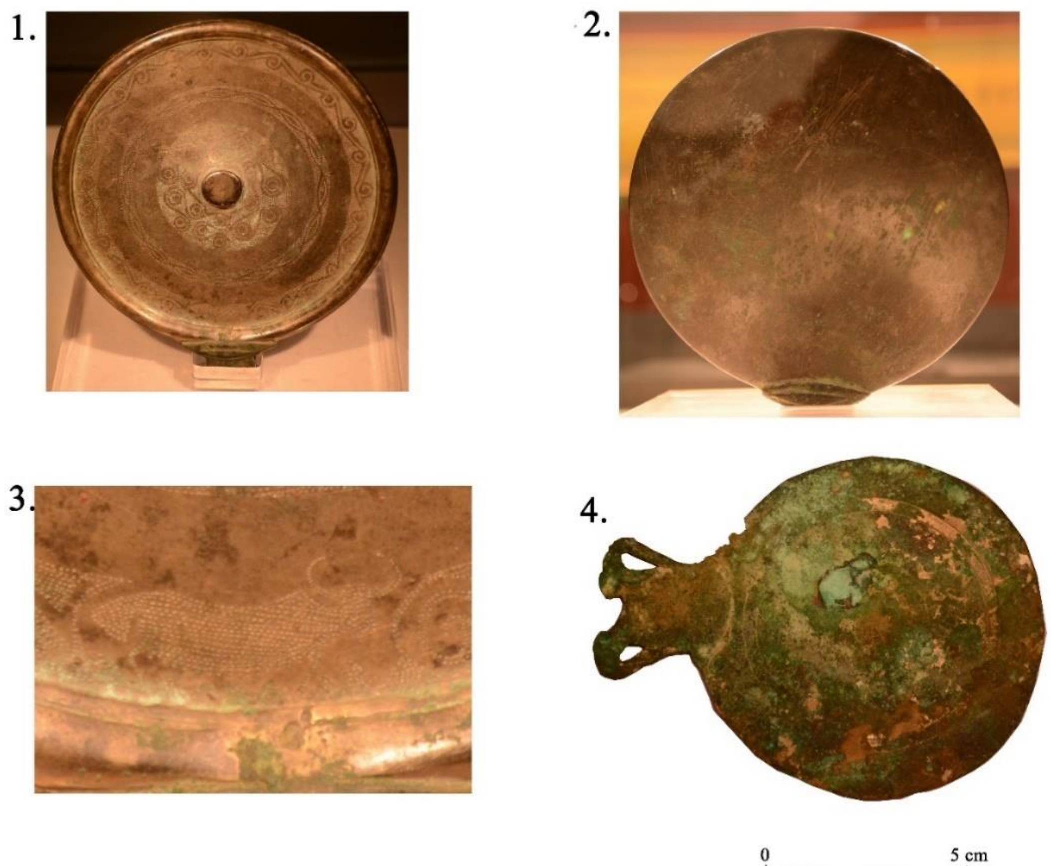

Figure 11.2: The newly discovered mirrors in central Tibet. 1-2. The handled mirror in Yak Museum; 3. The yak motif on the mirror; 4. The Jiesa mirror, photographs by Xinzhou Chen.

The Yak mirror was collected by the Yak Museum in 2016 from a monastery in Nyingchi (Xue 2021, Figure 11.2: 1-3). This mirror is similar to other handled mirrors discovered so far in central Tibet (Figure 11.3). Because the Yak mirror is from a private collection, some scholars speculate that its original archaeological context is more likely the Lhasa region instead of Nyingchi (e.g., Lu 2009). As previous research correctly pointed out, the Qugong mirror and the mirrors owned by N. G. Ronge (CASS 1999; Lu 2009; Bellezza 2020) all share several similar stylistic traits such as the iron handle, the mirror socket, and whirlpool motif separated by the concentric linear bands. We see almost identical stylistic traits on the Yak mirror. One of the noteworthy parts of the Yak mirror is the silhouette portrait of a yak above the socket. Modern yak is mainly distributed in the Himalayan regions and some high-altitude mountainous regions in Xinjiang, Afghanistan, and Pakistan. The presence of the yak motif raises the possibility that the central Tibet mirrors may belong to a local bronze stylistic tradition or a local variant of the Central Asian bronze tradition. This local adaptation of the handled mirrors may result in the vague typological similarity between the central Tibet mirrors and the surrounding regions.

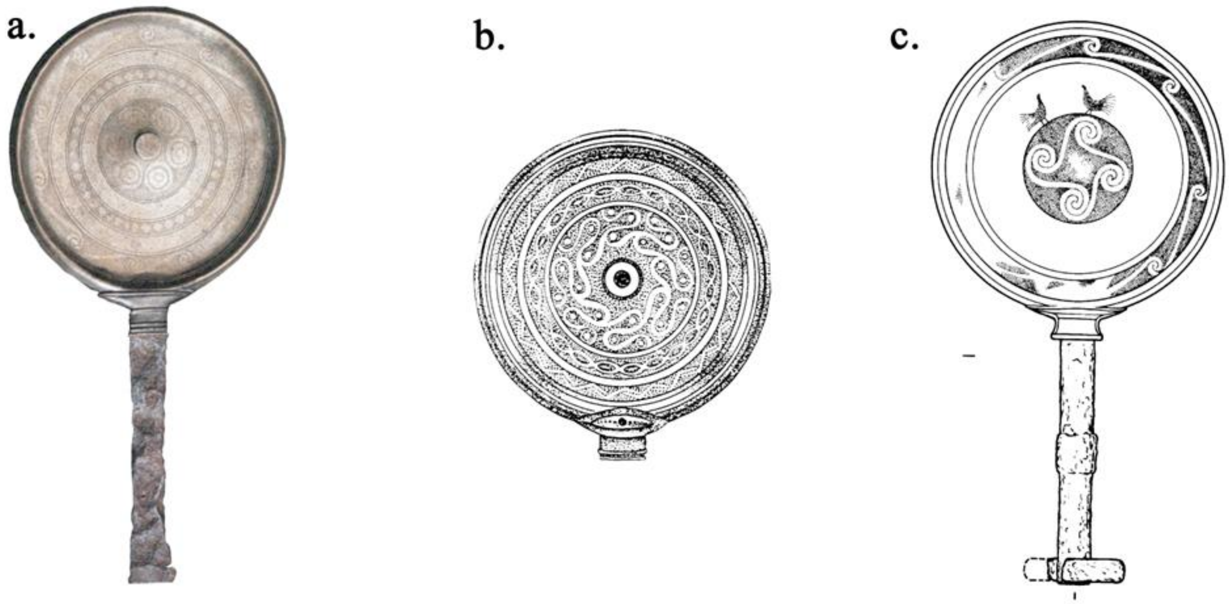

Figure 11.3: The bronze mirror in central Tibet: a. N. G. Ronge Tibet mirror 1 (After Bellezza 2020); b. N. G. Ronge Tibet mirror 2 (After Lu 2009); c. Qugong mirror (After CASS 1999)

11.2 Trans-regional participation between central Tibet and the Eurasia continent: contextual comparisons

The handled mirrors are widely distributed on the Eurasian continent including the southern Russian steppe, the Urals, the Altai region, Central Asia, the Tibetan Plateau and its surrounding regions, Xinjiang, and several provinces in northern China. What are the implications of the two mirrors and their varying stylistic traditions, in the context of the large-scale trans-regional participation among the Eurasian continent in the first millennium BC? Since a considerable number of mirrors in China are found through salvage excavations with little contextual information, previous research mostly focuses on the morphological aspect of the mirrors in this region. However, in the institutional domain of funeral practices, we see distinctions and similarities in the spatial arrangement and the morphology of mirrors in the burials. After comparing the mirrors with known archaeological contextual information, an ideal model of mirror arrangement shared by ancient people over a vast territory in the funeral context emerges.

In most burials with mirrors, the mirrors, body ornaments and weapons are the closest grave goods relative to the human body, placed next to the hands, head, pelvis, and femur. On the contrary, other grave goods such as ceramics and animal bones are usually above the head and around the feet. One of the possible explanations is that the mirror may be closely associated with the deceased's personal identity, rather than merely serving as a symbol of private property. This resonates with the arguments that those handled mirrors, especially the rattle mirrors, are used as instruments of shamans (Vassilkov 2010). In the burial context across Eurasia, the position of the mirror may be a reproduction of its practical function in the afterlife.

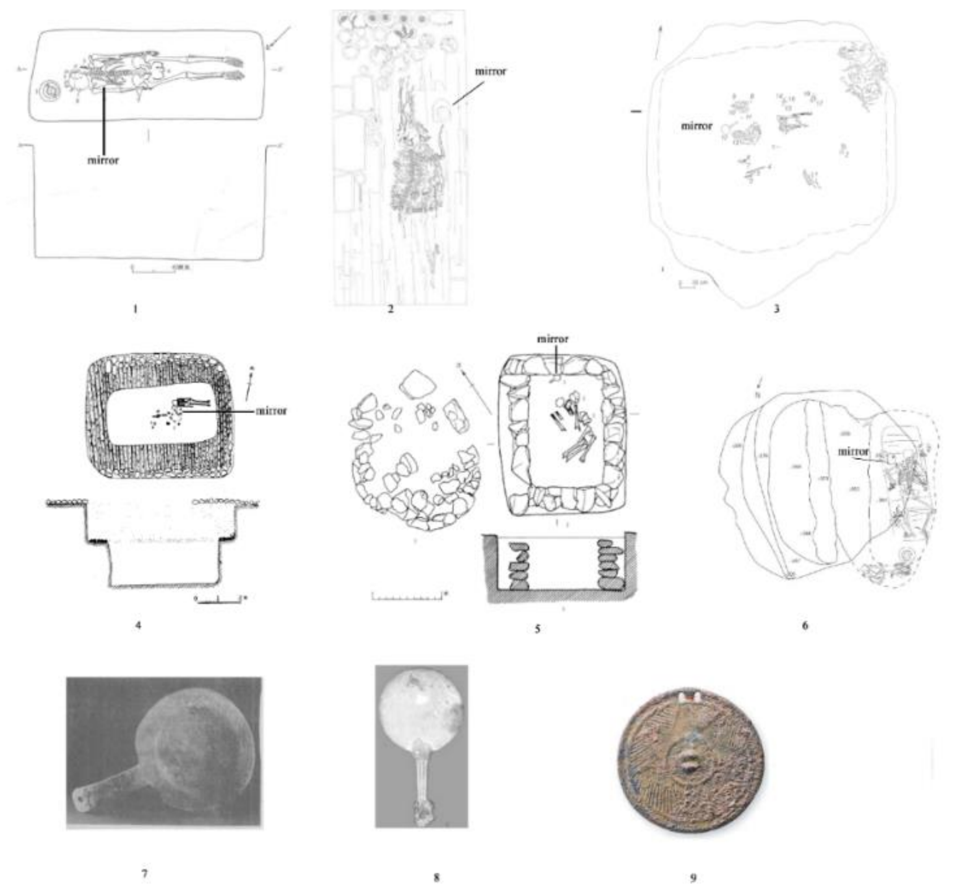

Figure 11.4: Handled mirrors placed next to the skull or scapula 1, 9. Gamatai (Qinghai, China, after Qinghai and Beijing 2015); 2. the Issyk burial (Kazakhstan, after Menghin and Parzinger 2007) 3, 8. Lebedevka II Mound 6 burial (Kazakhstan, after Gutsalov 2007) 4, 7. Tiemulike (Xinjiang, China, after Xinjiang 1988) 5. Qugong (Tibet, China, after CASS 1999) 6. Prokhorovka Structure B burial 3 (Orenburg, Russia, after Balakhvantsev and Yablonskii 2009)

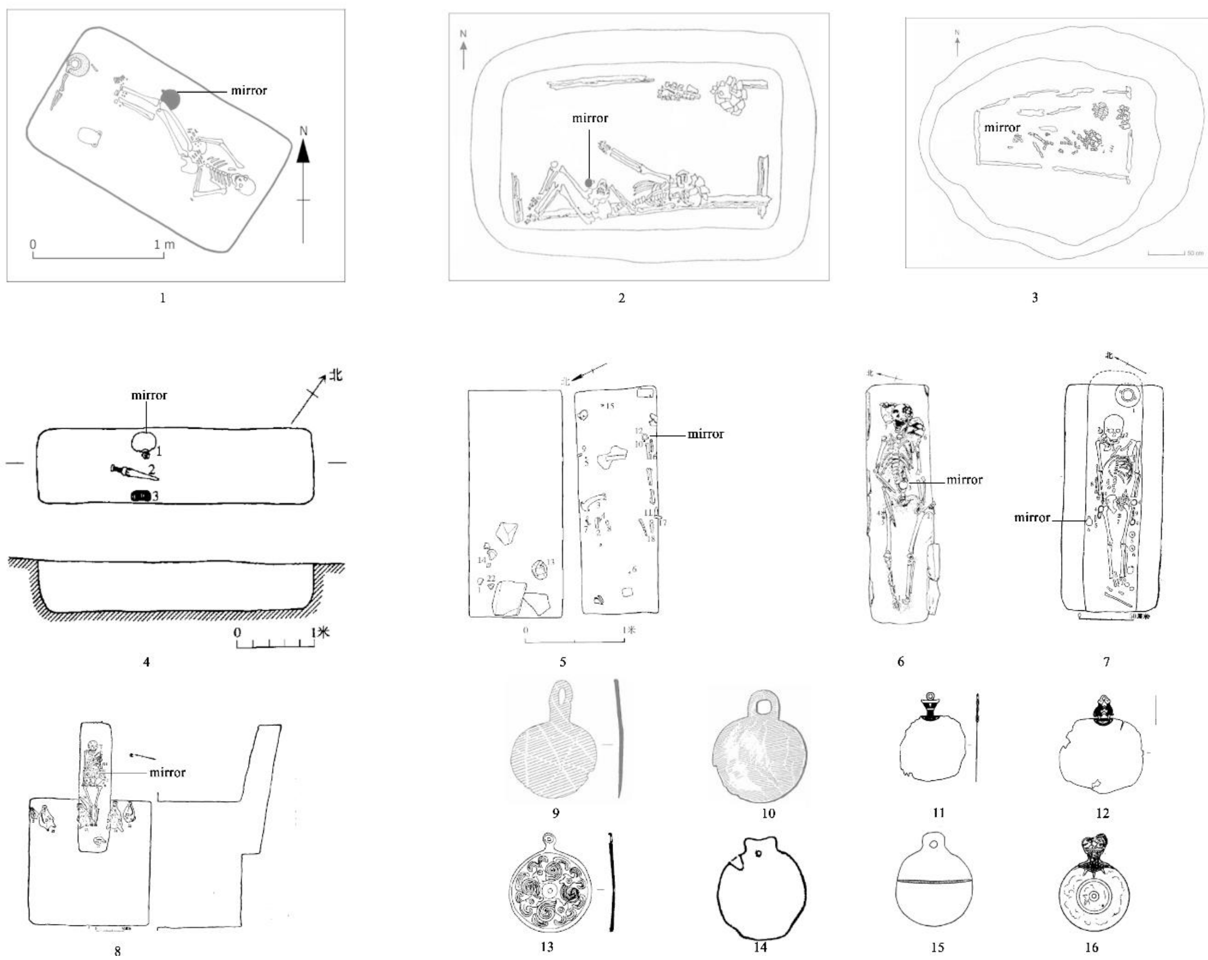

Figure 11.5: Handled mirrors placed next to the pelvis or femur. 1. Aksai Kurgan 8, Burial 15 (Altai, Russia, after Kubarev 2001); 2, 10. Bike III Kurgan 8 (Altai, Russia, after Kubarev 2001); 3, 9. Bike III Kurgan 1 (Altai, Russia, after Kubarev 2001); 4, 11, 12. Feninggan (Yunnan, China, after Yunnan 2005); 5, 13. Galazong M2 (Sichuan, China, after Sichuan et al. 2012); 6, 16. Hantashan (Sichuan, China, after Sichuan et al. 1999); 7, 15. Yaozi M6 (Inner Mongolia, China, after Neimenggu 1989); 8, 14. Yujiazhuang M15 (Ningxia, China, after Ningxia 1995)

There are two major practices of placing mirrors in the burials in the Eurasian steppe. Some are placed close to the palm, skull, and scapula (the upper part of the human body, Figure 11.4) while others are placed next to the pelvis or femur (the middle or lower part of the human body; Figure 11.5). A tentative pattern is that the long-handled mirror with sockets tends to be placed close to the palm, skull, or scapula, while the short-handled mirrors with holes are usually placed next to the femur or pelvis. A reasonable guess is that short-handled mirrors are hung on the belt for portability, while long-handled mirrors next to the skull are not usually used as pedants (as seen on the Scythian plate in Ukraine, Figure 11.6: c-e). Certainly, this pattern is not deterministic. We also see a few cases where long mirrors are placed next to the feet or short mirrors are placed next to the skull. Although ethnographic records suggest several occasions of using mirrors in Eurasian (rituals, marriage, travel, etc., see Vertiienko 2021; Tishkin and Seregin 2011), the contextual information of mirror placement indicates at least two primary functions, which can be seen from the iconographic evidence (Figure 11.6). The eastern Tibet short-handled mirrors are mostly placed next to the pelvis or in the middle part of the burial. Thus, the Jiesa mirror may be functionally akin to the eastern Tibet ones. The stylistic differences between the Jiesa mirror and other central Tibet mirrors possibly indicate a different way of participation in the institutional domain of funeral rites. Previous research hypothesizes that the Qugong mirror may be related to shamanic practices (Lu 2009). This hypothesis agrees with the fact that the mirror is placed distant from the femur in the stone-cist grave. People across a vast territory share a broadly similar notion of properly using mirrors the funeral context. The knowledge of how to arrange the mirror is possibly acquired through active participation within a broader exchange network of ideas. I further discuss the common ideas of the mirror arrangement in the analysis of the iconographic evidence below.

The path dependency of using mirrors as pendants or shamanic (religious) instruments persisted on the Tibetan Plateau several hundred years later in the historic Tubo period. Several pieces of iconographic evidence shown on the figurines, clothing plates, and khirgisuurs in the Eurasian steppe further suggest that people may use mirrors for similar religious and decorative purposes (Jacobson 1995; Volkov 1981; Pan 2006). In Tibet, we see iconographic evidence of using mirrors as clothing ornaments or religious instruments. In the Dung Kar Buddhist grottos site complex in western Tibet, the excavator claims that there is a mural painting that depicts a Buddhist deity holding a handled mirror and a cymbal (Sichuan 2008). However, the image of the mural is not published in the excavation report. The gilt gold ornament curated in the Qinghai Tibet Medicine Culture Museum, dated to the Tubo empire period, demonstrates that the handled mirror is used as a pendant (Figure 11.6: a-b). This practice is also similar to the tradition of mirror usage as seen on the khirgisuurs (deer stone) of the Mongolian steppe (Volkov 1981). Pan (2006) argues that the solid circles usually seen near the belt on the Mongolian khirgisuurs are also pendant mirrors. Previous research (Chen 2020; Zhang 2002) notes that those mirrors in bronze and iron age northern China are usually misinterpreted as "bronze plates" in the excavation reports. The northern China mirrors are usually placed near the human skull or pelvis in the burials and are sometimes wrapped with a linen cloth. Similarly, the Jiesa mirror is also covered with a small piece of linen cloth of 6 cm^2, indicating that it may be functionally similar to the northern China mirrors (Xizang et al., 2022). The only difference between the northern China mirrors with the Tibet mirrors is that the former ones usually do not have handles.

Several clothing plates from the western Eurasian in the first millennium BC provide evidence of the mirrors used as magical or religious instruments (Jacobson 1995). Vassilkov (2010) notes that the golden plate in the Chertomlyk kurgan may depict the ceremony of consecration. The daughter of the Sun, Tabiti, sits on the throne holding a mirror and the Scythian king stands in front of her. Vertiienko (2021) argues that the plates in Chertomlyk and Sakhnivka depict the process of the king resurrecting from death. The mirror held in the hands of Tabiti is possibly used as a medium to convert the king into another status of existence.

Similar to the function of mirrors in the western Eurasia, the Tibetan mirrors may also be used for religious purposes. Although the excavators of the bronze mirrors from the Chuvthag site in western Tibet argue that the mirrors may serve as decorative objects, Karmay (2022) argues that the historical documents of Bon religion (an early and local Tibetan religion, possibly associated with Zoroastrianism, see Thar 1988) show that the mirror is institutionalized as a crucial ritual object during the Bon burial ceremony. The iconographic evidence suggests that the common usage of mirrors across Eurasia might indicate some similarities in the religious practices.

11.3 Summary

The stylistic and contextual analysis of the newly discovered Jiesa mirror again validates the trans-Hiamlayan participation on diverse institutional domains, which resonates with the geospatial analysis presented in previous chapters. It also provides evidence for a more intimate relationship among central Tibet, Central Asian, and eastern Tibet mirror traditions for the first time in Tibetan Archaeology. The mirror is typologically different from other mirrors reported in central Tibet to date. The Yak mirror provides further evidence for the existence of the local Tibetan mirrors, in line with the previous research on the ancient Tibetan mirrors. Similarities in the mirrors' morphology and spatial arrangement may further indicate the trans-regional participation as a result of shared community identity or social norms across a vast territory. This shared material tradition including bronze, ceramics, and burial practices is due to the intensified participation across Eurasia, as already pointed out by archaeologists working in the Eurasian steppe and Tibet based on typological evidence (Frachetti and Bullion 2018; Lu 2015). Different lines of evidence suggest a similar yet non-uniform way of using mirrors in the institutional domains of burial practices and religion across Tibet.

Figure 11.6: Iconographic evidence of mirror usage in Tibet and the Eurasian steppe: a-b. the glit gold figurine depicting a standing man with a handled mirror on his belt (Tibet, Tubo empire period, adapted from China Silk Road Museum); c. the golden plate depicting a standing woman holding a mirror (the Chertomlyk kurgan, Ukraine, 4th century BC, after Jacobson 1995); d. the golden plate depicting a goddess (Tabiti) holding a mirror with a Scythian king (the Chertomlyk kurgan, Ukraine, 4th century BC, after Jacobson 1995); e. the golden plate depicting a goddess (Tabiti) holding a mirror with a Scythian king in a ceremony (Sakhnivka barrow 2, Ukraine, 4th century BC, after Vertiienko 2021)

Chapter 12: Conclusion and future work

12.1 The legacies and the reproduction of pastoralism

Pastoralists' land use legacies are much-debated questions in recent years. The analysis in Bangga revealed that pastoralism has been a long-term tradition spanning transitions in cultural phases, when the ancient people combined a diverse mix of farming and herding to shape their economic institutions and mobility patterns. My analysis of the environmental pattern of the regional ethnographic pastoral sites suggests that the modern pastoral corrals are built with specific locational preferences, and the high NDVI and visibility values of the corrals suggest they are built in areas with high vegetation biomass and low predation risk from wild animals. When compared with the archaeological records in the study area, the documented geography of the pastoral land use reflects repeated patterns of pastoralist ecology and human occupation, leading to the generation of pastoral hotspots. The exploratory survey of corrals in the Yarlung Valley demonstrates archaeological remains of ancient pastoral activity under the modern corrals, which provides further evidence of the long-term use of pastoral sites since the first millennium BC and alludes to continuity in the mobility pattern between prehistoric and ethnographic populations. The UAV-based high-resolution DEM mapping and the soil erosion model reveal how the corrals may act as facilities for soil retention that may lead to this repeated human occupation pattern.

The pastoral corral location pattern and their long-term usage demonstrate how pastoralists' land use may reflect a form of institutional reproduction through the formation of *landscape anchors* (Hammer 2014) that people reuse through generations. The ancient pastoralists in the river valleys may have already routinely engaged in short-distance herding in the nearby mountainous region and agriculture. The first millennium BC subsistence economy and the mobility pattern may be similar to the modern residents in this region. This research resonates with the previous conclusion that pastoral land use serves as a social institution that shapes large-scale cultural landscapes. The site-specific historical continuities depict the mechanism of pastoralists' reproduction of its land use patterns, which is conditioned by human-environmental interactions both on local and trans-regional scales.

12.2 Pastoralism as an institution in Tibet

Several researchers discuss the surge of trans-continental cultural interactions since the second millennium BC across Eurasian. Scholars usually attribute the broad pattern of cultural connectivity to an earlier origin in the Neolithic period (e.g., Han 2013) or suggest that the cultural landscape is associated with the rise of pastoralism or nomadism in the changing paleoenvironmental contexts (e.g., Yang 2016; Guo 2012; Shui 2001). In the case studies of material cultural analysis in central Tibet, I provide evidence that inter-regional participation in pastoralism shaped a widespread institutional domain of subsistence economy but also shaped inter-regional networks of ceramic and bronze production, funerary rites, and landuse dynamics (more generally). Through the modeling of network structures of both settlement patterns and cultural diversities on a trans-regional scale in the second and first millennium BC, I also revealed similarities between the geographical network shaped by pastoralist mobility dynamics (the flow accumulation model and the resultant PCI network) and the social networks reflected in ceramics styles and forms. Simulated mobility along the best vegetation may have shaped both the location of sites across the Tibet Plateau and the degree to which regional communities interacted with each other. This process is possibly correlated with the increased adoption of pastoralism, the use of pack animals, and the increasingly large-scale of human movement starting at least in the 2nd millennium BC.

The network analysis further resonates with the material cultural analysis that the trans-Himalayan exchange plays a significant role in the shaping of the cultural landscapes, especially for central and western Tibet. The Himalayas are not a geographical barrier but a porous corridor. The Himalayans function in a similar way to the Inner Asian Mountain Corridor (Frachetti 2012). Pastoralism, as a social institution, activates the corridors throughout the Himalayas by equipping ancient communities with resilient lifeways and innovative strategies of cultural interactions. As a result, trans-regional participation may reproduce itself and allow for expansion and assimilation of economic, social, and material institutions across widening geographical extents through time. The process by which pastoralism reproduces social relations may even create a path dependency in the historic period, as the Tibetan Plateau Silk Road has been facilitating the exchange of Buddhist arts through time (e.g., Zhang 2007).

12.3 Future work

This dissertation provides a systematic analysis of the social and environmental role of pastoralism on the Tibetan Plateau. Owing to the lack of archaeological data and high-resolution paleoenvironmental records, many questions remain under-explored. On the trans-regional level, other social institutions that may play a role in this process of trans-regional participation are not discussed here. For example, the manufacture and transportation of potential prestige goods such as bronzes, beads, jade, and gold artifacts may play a key role during the formation of social complexity (a recent case see the discussions on the gold masks in Tibet, Tong and Li 2015). There is increasing evidence that extensive trade networks may have already taken shape in Tibet since at least the first millennium BC, within which the prestige goods and secondary products of herd animals may circulate widely (e.g., Zhang et al., 2023). Therefore, the social roles of specialized markets in different environmental regimes and their relationships with emerging complex societies are worthy questions in the future. Agriculture practices may also act as a social institution when people bearing food production techniques entered Tibet, as discussed in the context of food globalization (e.g., Liu et al., 2019). A combination of multiple geospatial methods including network analysis, GIS, and agent-based modeling have great potential to contribute to the discussions.

On the regional level, the identification of pastoralist sites is still a challenging task in Tibet, especially for the archaeological remains of ancient highland herders and cave sites. The archaeological fieldwork and research presented here mainly focus on the herding component within multi-resourced agropastoral areas in the Yarlung and Qongyyai Valleys. Due to my limited excavation and survey areas, I cannot fully document all possible remains that may contribute to the settlement and mobility practices of the pastoralists (e.g., for hydrological facilities, see Li et al., 2017; Lane et al., 2022). Reliable and multi-disciplinary criteria, including high-resolution landscape mapping with LiDAR, geoarchaeology, and ethnoarchaeology, for identifying pastoral remains based on a more detailed survey are much needed in all regions in Tibet. More archaeological surveys are yet to be conducted in other areas, such as western Tibet, to compare the patterns of pastoralist-environmental interactions in different regions.

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Appendix 1. The Python script for converting the viewshed raster of a single point to a feature class with measured geometry

```
# Import libraries

import arcpy # ArcGIS pro must be installed

import os

import sys

from arcpy import env

from arcpy.sa import *

#setup the variables and the working environment

path ="model"

gdb = os.path.join(path,"corral.gdb")

polygon = os.path.join(gdb, "polygon_dangxiong")

# Setting the environment

arcpy.env.workspace = gdb

arcpy.env.overwriteOutput = True

#The code below should only be run once to generate pts from the total corral feature class

##for n in range (1,42,1):

##    fc_corral_where = str("OBJECTID")+ "=" + str(n) #sometimes the objectid can be called as oid

##    print(fc_corral_where)

##    name_corral = str("corral_")+ str(n)#number of iteration should be changed when using different datasets

##    print(name_corral)
```

```
##    arcpy.conversion.FeatureClassToFeatureClass(fc_corral, gdb, name_corral,
fc_corral_where)

##sys.exit()

ndvi = os.path.join(gdb,"ndvi_all")

dem = os.path.join(gdb,"dem_srtm_aoi_project")

twi = os.path.join(gdb,"twi2")

slope = os.path.join(gdb,"slope")

for n in range (1,101,1):

    #create rdm

    rdm_name = "rdm"

    rdm = arcpy.CreateRandomPoints_management(gdb, rdm_name, polygon, "", 41)

    ExtractMultiValuesToPoints(rdm, [[dem,"dem"],[ndvi,"ndvi"],[twi,"twi"],[slope,"slope"]])

    print(n)

    for j in range (1,42,1):

        name_corral = str("corral_")+ str(j)  #number of iteration should be changed when using
different datasets

        outbuf = "buffer"

        vis_raster = "vs"

        query = "OBJECTID" + "=" + str(j)

        clip_raster = "vs_clip"

        clip_null = "clip_null"

        domain = "domain" + str(j)

        pt = arcpy.management.MakeFeatureLayer(rdm, name_corral, query)
```

```
        vis = arcpy.sa.Visibility(dem, pt, "", "", "", "", "", "", "0.8", "", "2")
        vis.save(vis_raster)
        buffer = arcpy.analysis.Buffer(pt,outbuf,"5 KILOMETERS")
        clip = arcpy.management.Clip(vis_raster,"",clip_raster, buffer,"", "ClippingGeometry")
        outSN = SetNull(clip, 1, "VALUE = 0")
        outSN.save(clip_null)
        raster_domain = arcpy.RasterDomain_3d("clip_null", domain, "POLYGON")
    merge = "merge_domain_rdm_dx"
    fc_list = arcpy.ListFeatureClasses("domain*")
    fc_merge = arcpy.management.Merge(fc_list, merge)
    for feature in fc_list:
        arcpy.Delete_management(feature)
    join_name = "join"+ str(n)
    join = arcpy.management.AddJoin(rdm, "OBJECTID", fc_merge, "OBJECTID")
    arcpy.CopyFeatures_management(join, join_name)
    arcpy.Delete_management(fc_merge)
merge_rdm_name = "merge_rdm_" + str(n)
fc_all_list = arcpy.ListFeatureClasses("join*")
fc_all_merge = arcpy.management.Merge(fc_all_list, merge_rdm_name)
```

Appendix 2. The Python script for the USPED model

```
# this script follows the workflow of Mitosova(1996)

# setting the environment

import arcpy

import os

import sys

from arcpy.sa import *

path = " the directory of the model "

gdb = os.path.join(path,"erosionModel.gdb")

corral_wall = os.path.join(gdb,"dem_badong_walls_project")

sed_flow = "bd_sed_flow"

arcpy.env.workspace = gdb

arcpy.env.overwriteOutput = True

arcpy.env.extent = dem

arcpy.env.snapRaster = dem

dem = os.path.join(gdb,"bd_dem_project")

#setting the values of the constants

c_factor = 0.15 #Yang et al. 2018

soil_density = "1.4"

k_factor = 0.052

r_factor = 701

outaspect = Aspect(dem)

outslope = Slope(dem)
```

```
#compute hydrology

outfill = arcpy.sa.Fill(dem, None)

#computing aspect and slope

outFlowDirection = FlowDirection(outfill,"FORCE")

outFlowAccumulation = FlowAccumulation(outFlowDirection)

#compute sediment transport capacity LST

output_topoflow = Raster(outFlowAccumulation)* 0.114 * Sin(Raster(outslope) * 0.01745)

  #compute sediment flow

  output_sedflow = Raster(output_topoflow)* k_factor * r_factor * c_factor;

  output_sedflow.save(sed_flow)

  #Compute components of sediment flow in x and y direction

  output_sedflow_x = Raster(output_sedflow)* Cos((-Raster(outaspect)+ 450) * 0.01745)

output_sedflow_y = Raster(output_sedflow)* Sin((-Raster(outaspect)+ 450) * 0.01745)

#compute components of change in sediment flow in x and y direction as partial derivatives of
sediment     flow field, derived from slope and aspect

  sedflow_x_slope = Slope(output_sedflow_x)

  sedflow_x_aspect = Aspect(output_sedflow_x)

    sedflow_y_slope = Slope(output_sedflow_y)

    sedflow_y_aspect = Aspect(output_sedflow_y)

    sedflow_dx = Cos((-Raster(sedflow_x_aspect)+ 450) * 0.01745) *
Tan(Raster(sedflow_x_slope) * 0.01745)

    sedflow_dy = Sin((-Raster(sedflow_y_aspect)+ 450) * 0.01745) *
Tan(Raster(sedflow_y_slope) * 0.01745)
```

```
net_erosion_deposition = Raster(sedflow_dx) + Raster(sedflow_dy)

net_erosion_deposition.save("net_erosion_deposition")

#delete the files used in the workflow

delete_list = arcpy.ListRasters("Aspect*","GRID")

for fc in delete_list:

    arcpy.Delete_management(fc)

delete_list = arcpy.ListRasters("Fill*","GRID")

for fc in delete_list:

    arcpy.Delete_management(fc)

delete_list = arcpy.ListRasters("Flow*","GRID")

for fc in delete_list:

    arcpy.Delete_management(fc)
```

Appendix 3. The Python script for the flow accumulation model and calculating the PCI values between pairwise points to generate a network matrix

```
# setting the environment

import arcpy

import os

import sys

from arcpy.sa import *

path = "the directory of the model"

gdb = os.path.join(path, "name of the geodatabase.gdb")

cost_raster_grass = os.path.join(gdb,"name of the NDVI raster")

out_fa_sum_name = "fa_raster_sum_grass_crop_1_6549_highres" #name of the output sum of all flow accumulation raster"

arcpy.env.workspace = gdb

arcpy.env.overwriteOutput = True

arcpy.env.scratchWorkspace = gdb


# Start the iterator.

# The number of the iteration depends on the number of vectorized cropland points

for n in range(1,6550,1):

    #supply the names of the variables in the iteration

    fc = os.path.join(gdb,"cropland_pts_tp")

    fc_pt_name = "pt" + str(n)

    query =  "OBJECTID = " + str(n)
```

```
fc_pt = arcpy.management.MakeFeatureLayer(fc, "pt_lyr",query)
#create flow accumulation raster
    output_dist_raster = "codis"
    output_fd_raster = "fd"
out_fa_raster = "fa" + str(n)
    out_distance_raster = arcpy.sa.CostDistance(fc_pt, cost_raster_grass);
    out_distance_raster.save(output_dist_raster)
    out_flow_direction_raster = arcpy.sa.FlowDirection(output_dist_raster, "NORMAL", None,
"D8");
    out_flow_direction_raster.save(output_fd_raster)
    out_accumulation_raster = arcpy.sa.FlowAccumulation("fd", None, "FLOAT", "D8");
out_accumulation_raster.save(out_fa_raster)
#Sum all the raster from the flow accumulation iterator
rasterList = arcpy.ListRasters("fa*", "GRID")
print(rasterList)
outCellStatistics = CellStatistics(rasterList, "SUM", "DATA","SINGLE_BAND")
outCellStatistics.save(out_fa_sum_name)
#the cost raster is the pathways of pastoralists along the best vegetation, derived from the flow accumulation model. The cost raster of optimal vegetation pathways should be flipped to accommodate the least cost path function of ArcGIS
cost_raster = os.path.join(gdb," fa_raster_sum_grass_crop_1_6506_highres_flip ")
fc = os.path.join(gdb,"network_sites")
table = os.path.join(gdb,"table_clean_network")
```

#prepare a table with 26 rows and 26 columns, coded by the ID of the site. The column name starts with F, because the table in ArcGIS does not allow duplicated field names.

#start the iterator n of iteration 26, representing 26 archaeological sites on the Tibetan Plateau, and convert the flow accumulation model to a matrix.

```
for n in range(1,27,1):
    output_dist_raster = "dis_raster"
    output_bklink = "bklink"
    pt_origin_query = "OBJECTID" + "=" + str(n)
    pt_origin = arcpy.management.MakeFeatureLayer(fc, "pt_origin", pt_origin_query)
    #create cost distance
    out_distance_raster = arcpy.sa.CostDistance(pt_origin,cost_raster, None, output_bklink, None, None, None, None, '');
    out_distance_raster.save(output_dist_raster)


    for m in range(1,27,1):
        if m != n:
            print(m)
            field_dest =["F" +str(m)]
            print(field_dest)
            outpath = "path"
            pt_dest_query = "OBJECTID" + "=" + str(m)
            pt_dest = arcpy.management.MakeFeatureLayer(fc, "pt_dest", pt_dest_query)
            path = CostPathAsPolyline(pt_dest, output_dist_raster, output_bklink, outpath)
```

```
#update the table with the path cost
with arcpy.da.SearchCursor(outpath, ['PathCost'])as cursor1:
    for row in cursor1:
        value = row[0]


with arcpy.da.UpdateCursor(table,field_dest,pt_origin_query) as cursor2:
    for row in cursor2:
        row[0] = value
        print(row[0])
        cursor2.updateRow(row)
```

Appendix 4. The list of 1434 archaeological sites between 3600-2000 BP for the validation of the flow accumulation model

Name_CN	Name_ENG	Period	Site_type	Source
石达秋遗址	Shidaqiu	Bronze age	Settlement	Aba et al. 2015
曲贡遗址	Qugong	Stone age to Early metal age	Settlement	CASS 1999
布瓦遗址	Buwa	Neolithic to Warring State	Settlement	Chengdu et al. 2018
塔温塔里哈	Tawendaliha	Nuomuhong	Settlement	Dong et al. 2016
夏日雅玛可布	Xiariyamakebu	Nuomuhong	Settlement	Dong et al. 2016
塔里塔里哈	Dalitaliha	Nuomuhong	Settlement	Dong et al. 2016
格隆尕木合遗址	Galonggamuhe	Neolithic to Bronze age	Settlement	Gansu Atlas
阿米欧拉遗址	Amioula	Neolithic to Bronze age	Settlement	Gansu Atlas
唐龙多遗址	Tanglongduo	Bronze age	Settlement	Gansu Atlas
青科遗址	Qingke	Bronze age	Settlement	Gansu Atlas
加日根遗址	Jiarigen	Bronze age	Settlement	Gansu Atlas

根岔遗址	Gencha	Bronze age	Settlement	Gansu Atlas
创巴遗址	Chuangba	Neolithic to Bronze age	Settlement	Gansu Atlas
加尕塘遗址	Jiagatang	Neolithic to Bronze age	Settlement	Gansu Atlas
白云遗址	Baiyun	Neolithic to Bronze age	Settlement	Gansu Atlas
谢协遗址	Xiexie	Neolithic to Bronze age	Settlement	Gansu Atlas
萨让遗址	Sarang	Neolithic to Bronze age	Settlement	Gansu Atlas
亚古遗址	Yagu	Bronze age	Settlement	Gansu Atlas
电尕寺遗址	Dianggasi	Neolithic to Bronze age	Settlement	Gansu Atlas
然闹遗址	Rannao	Neolithic to Bronze age	Settlement	Gansu Atlas
旺藏遗址	Wangcang	Neolithic to Bronze age	Settlement	Gansu Atlas
巴傲桑巴遗址	Baaosangba	Neolithic to Bronze age	Settlement	Gansu Atlas
哈吾卡遗址	Hawuka	Neolithic to Bronze age	Settlement	Gansu Atlas
尼傲遗址	Niao	Neolithic to Bronze age	Settlement	Gansu Atlas
卡坝遗址	Kaba	Neolithic to Bronze age	Settlement	Gansu Atlas

桑坝遗址	Sangba	Neolithic to Bronze age	Settlement	Gansu Atlas
吉扎遗址	Jiza	Bronze age	Settlement	Gansu Atlas
麻尕遗址	Maga Site	Bronze age	Settlement	Gansu Atlas
加当遗址	Gadang	Neolithic to Bronze age	Settlement	Gansu Atlas
多加遗址	Duojia	Neolithic to Bronze age	Settlement	Gansu Atlas
大族遗址	Dazu	Bronze age	Settlement	Gansu Atlas
鹿儿台遗址	Luertai	Siwa	Settlement	Gansu Atlas
下巴木遗址	Xiabamu	Bronze age	Settlement	Gansu Atlas
闹站遗址	Naozhan	Bronze age	Settlement	Gansu Atlas
木多台遗址	Muduotai	Siwa	Settlement	Gansu Atlas
录巴遗址	Luba	Neolithic to Bronze age	Settlement	Gansu Atlas
吉昂遗址	Jiang	Bronze age	Settlement	Gansu Atlas
甘达（干塘）遗址	Ganda	Bronze age	Settlement	Gansu Atlas
录日岔遗址	Luricha	Bronze age	Settlement	Gansu Atlas

牛头城遗址	Niutoucheng	Neolithic to Bronze age	Settlement	Gansu Atlas
安果遗址	Anguo	Neolithic to Bronze age	Settlement	Gansu Atlas
上阿滩遗址	Shangatan	Neolithic to Bronze age	Settlement	Gansu Atlas
甘布塔遗址	Ganbuta	Neolithic to Bronze age	Settlement	Gansu Atlas
新堡遗址	Xinbao	Neolithic to Bronze age	Settlement	Gansu Atlas
那尼遗址	Nani	Bronze age to Han	Settlement	Gansu Atlas
琵琶遗址	Pipa	Neolithic to Bronze age	Settlement	Gansu Atlas
叶儿遗址	Yeer	Neolithic to Bronze age	Settlement	Gansu Atlas
冰角遗址	Bingjiao	Neolithic to Bronze age	Settlement	Gansu Atlas
白塔遗址	Baita	Bronze age	Settlement	Gansu Atlas
冰崖遗址	Bingya	Neolithic to Bronze age	Settlement	Gansu Atlas
庄子（临潭）	Zhuangzi(Lintan)	Siwa	Settlement	Gansu Atlas
河头布林	Hetoubulin	Nuomuhong	Settlement	Gansu Atlas
恰日	Qiari	Bronze_age	Settlement	Gansu Atlas

上草褡裢湖西	Shangcaodalianhuxi	Kayue	Settlement	Jia 2012
塔龙滩	Talongtan	Kayue	Settlement	Jia 2012
红卫	Hongwei	Kayue	Settlement	Jia 2012
庙儿沟	Miaoergou	Kayue	Settlement	Jia 2012
上崖根	Shangyagen	Kayue	Settlement	Jia 2012
丁科	Dingke	Kayue_Han	Settlement	Jia 2012
卡索	Kasuo	Kayue	Settlement	Jia 2012
卡约	Kayue	Kayue	Burial	Jia 2012
嘛呢杆	Manigan	Kayue	Settlement	Jia 2012
恰卡顶东	Qiakadingdong	Kayue	Settlement	Jia 2012
魏家堡	Weijiabao	Kayue	Settlement	Jia 2012
下哇台	Xiawatai	Kayue	Settlement	Jia 2012
红崖下阴坡	Hongyaxiayinpo	Kayue	Settlement	Jia 2012
南山	Nanshan	Kayue	Settlement	Jia 2012
龙山	Longshan	Qijia_Kayue	Settlement	Jia 2012
拉卡石树湾	Lakashishuwan	Kayue	Settlement	Jia 2012
新庄(甲)	Xinzhuang	Kayue	Settlement	Jia 2012
大敦滩	Daduntan	Kayue	Settlement	Jia 2012
甲龙堂	Jialongtang	Kayue	Settlement	Jia 2012
尕盖（贵德）	Gagai	Kayue	Settlement	Jia 2012
加让村西	Jiarangcunxi	Kayue	Settlement	Jia 2012
拉日岗	Larigang	Kayue	Settlement	Jia 2012

拉隆哇	Lalongwa	Kayue	Settlement	Jia 2012
沙吾昂	Shawuang	Kayue	Settlement	Jia 2012
团结	Tuanjie	Majiayao_Kayue	Settlement	Jia 2012
东风西南	Dongfengxinan	Kayue	Settlement	Jia 2012
马尔坡	Maerpo	Kayue	Settlement	Jia 2012
拉木嘴	Lamuzui	Machang_Qijia_Kayue	Settlement	Jia 2012
阿河滩	Ahetan	Kayue	Settlement	Jia 2012
巴燕（化隆）	Bayan	Kayue_Tangwang	Settlement	Jia 2012
红庄西滩	Hongzhuangxitan	Banshan_Kayue	Settlement	Jia 2012
盐沟	Yangou	Kayue	Settlement	Jia 2012
新村（化隆）	Xincun	Qijia_Kayue	Settlement	Jia 2012
交日当	Jiaoridang	Bashan_Machang_Kayue	Settlement	Jia 2012
段堡	Duanbao	Kayue_Xindian	Settlement	Jia 2012
西坪台	Xipingtai	Xindian	Settlement	Jia 2012
营盘嘴	Yingpanzui	Xindian	Settlement	Jia 2012
西岗	Xigang	Xindian	Settlement	Jia 2012
灰堆	Huidui	Xindian	Settlement	Jia 2012
双二东坪（乐都)	Shuangerdongping(Ledu)	Banshan_Machang_Qijia_Kayue_Tangwang_Xindian(Mainly Xindian)	Settlement	Jia 2012
丁克台	Dingketai	Kayue	Settlement	Jia 2019
皮央东嘎遗址	Piyang_dongga	Early metal age	Settlement	Lu 2007
丁东遗址	Dingdong	Early metal age	Settlement	Lu 2007

阿梢垴	Ashaonao	Neolithic to Han	Settlement	Lu 2017
石门子	Shimenzi	Bronze age	Burial	Lu and Cheng 2017
绒布寨	Rongbuzhai	Bronze age	Burial	Lu and Cheng 2017
邦嘎遗址	Bangga	Early metal age	Settlement	Lu et al. 2021
顶琼洞穴	SdingChung	Early metal age	Burial	Lu et al. 2022
加日塘遗址	Jiaritang	Early metal age	Settlement	National Bureau of Cultural Relics et al. 2005
三角台地	Sanjiaotaidi	Kayue	Settlement	Qinghai Atlas
青禾羊	Qingheyang	Kayue	Settlement	Qinghai Atlas
登土亥	Dengtuhai	Kayue	Settlement	Qinghai Atlas
尕拉	Gala	Bronze age	Settlement	Qinghai Atlas
扎毛北遗址	Zamaobei	Bronze age	Settlement	Qinghai Atlas
宗科尔遗址	Zongkeer	Bronze age	Settlement	Qinghai Atlas

瓜什则遗址	Guashize	Bronze age	Settlement	Qinghai Atlas
多哇遗址	Duowa	Bronze age	Settlement	Qinghai Atlas
完路乎遗址	Wanluhu	Bronze age	Settlement	Qinghai Atlas
过尕遗址	Guoga	Bronze age	Settlement	Qinghai Atlas
江龙西北遗址	Jianglongxibei	Bronze age	Settlement	Qinghai Atlas
江龙沟口遗址	Jianglonggoukou	Bronze age	Settlement	Qinghai Atlas
江什家遗址	Jiangshijia	Bronze age	Settlement	Qinghai Atlas
唯哇墓群	Weiwa	Bronze age	Burial	Qinghai Atlas
唯洼遗址	Weiwa	Bronze age	Settlement	Qinghai Atlas
小庄村遗址	Xiaozhuangcun	Bronze age	Settlement	Qinghai Atlas
唯洼西北遗址	Weiwaxibei	Bronze age	Settlement	Qinghai Atlas
隆务遗址	Longwu	Bronze age	Settlement	Qinghai Atlas
苏日遗址	Suri	Bronze age	Settlement	Qinghai Atlas
加毛遗址	Jiamao	Bronze age	Settlement	Qinghai Atlas

霍尔加遗址	Huoerjia	Bronze age	Settlement	Qinghai Atlas
金子沟遗址	Jinzigou	Bronze age	Settlement	Qinghai Atlas
拉尕遗址	Laga	Bronze age	Settlement	Qinghai Atlas
砂松遗址	Shasong	Bronze age	Settlement	Qinghai Atlas
切定朗巴沟遗址	Qiedinglangbagou	Bronze age	Settlement	Qinghai Atlas
塘达	Tangda	Bronze age	Settlement	Qinghai Atlas
久革遗址	Jiuge	Bronze age	Settlement	Qinghai Atlas
梅诺遗址	Meinuo	Bronze age	Settlement	Qinghai Atlas
直门达遗址	Zhimenda	Bronze age	Settlement	Qinghai Atlas
桥北遗址	Qiaobei	Bronze age	Settlement	Qinghai Atlas
桥南遗址	Qiaonan	Bronze age	Settlement	Qinghai Atlas
让拉遗址	Rangla	Bronze age	Settlement	Qinghai Atlas
晒经台东遗址	Shaijingtaidong	Bronze age	Settlement	Qinghai Atlas
军功遗址	Junkung Site	Bronze age	Settlement	Qinghai Atlas

马吾滩遗址	Mawutan	Bronze age	Settlement	Qinghai Atlas
子木山遗址	Zimushan	Bronze age	Settlement	Qinghai Atlas
滩子遗址	Tanzi	Bronze age	Settlement	Qinghai Atlas
姜子沟遗址	Jiangzigou	Bronze age	Settlement	Qinghai Atlas
哇东沟遗址	Wadonggou	Bronze age	Settlement	Qinghai Atlas
尼啥拉木沟遗址	Nishalamugou	Bronze age	Settlement	Qinghai Atlas
江日堂遗址	Jiangritang	Bronze age	Settlement	Qinghai Atlas
保育遗址	Baoyu	Bronze age	Settlement	Qinghai Atlas
加洛贡麻遗址	Jialuogongma	Bronze age	Settlement	Qinghai Atlas
亚尔堂遗址	Yaertang	Bronze age	Settlement	Qinghai Atlas
班前遗址	Banqian	Bronze age	Settlement	Qinghai Atlas
久格遗址	Jiuge	Bronze age	Settlement	Qinghai Atlas
资日切遗址	Ziriqie	Bronze age	Settlement	Qinghai Atlas

杂甫萨遗址	Zapusa	Bronze age	Settlement	Qinghai Atlas
德布河遗址	Debuhe	Bronze age	Settlement	Qinghai Atlas
甫合锐遗址	Puherui	Bronze age	Settlement	Qinghai Atlas
甘玛日遗址	Ganmari	Bronze age	Settlement	Qinghai Atlas
加勒甘玛遗址	Galeganma	Bronze age	Settlement	Qinghai Atlas
夏塘	Xiatang	Kayue	Settlement	Qinghai Atlas
那尔干遗址	Naergan	Kayue	Settlement	Qinghai Atlas
梁下	Liangxia	Kayue	Settlement	Qinghai Atlas
中村（兴海）	Zhongcun	Kayue	Settlement	Qinghai Atlas
莫多滩遗址	Modotan	Kayue	Settlement	Qinghai Atlas
野马台	Yematai	Kayue	Settlement	Qinghai Atlas
才乃亥	Cainaihe	Kayue	Settlement	Qinghai Atlas
下鹿圈	Xialuquan	Kayue	Settlement	Qinghai Atlas

上庄遗址（兴海）	Shangzhuang(Xinhai)	Kayue	Settlement	Qinghai Atlas
狼舌头遗址（大米滩遗址）	Langshetou	Majiayao_Kayue	Settlement	Qinghai Atlas
黄河沿	Huangheyan	Kayue	Settlement	Qinghai Atlas
池塘台	Chidangdae	Kayue	Settlement	Qinghai Atlas
尼迈遗址	Nimai	Kayue	Settlement	Qinghai Atlas
杜宗遗址	Duzong	Kayue	Settlement	Qinghai Atlas
中铁	Zhongtie	Kayue	Settlement	Qinghai Atlas
恰青遗址	Qiaqing	Kayue	Settlement	Qinghai Atlas
吉浪台遗址	Jilangtai	Kayue	Settlement	Qinghai Atlas
阿什则沟遗址（泽库）	Ashizegou	Kayue	Settlement	Qinghai Atlas
柳树湾（乐都）	Liushuwan(Ledu)	Machang_Kayue	Settlement	Qinghai Atlas
月牙山	Yueyashan	Kayue	Settlement	Qinghai Atlas
冶家沟	Yejiagou	Machang_Kayue	Settlement	Qinghai Atlas

杨家	Yangjia	Xindian	Burial	Qinghai Atlas
坡多岭	Poduoling	Kayue	Settlement	Qinghai Atlas
大地湾	Dadiwan	Kayue	Burial	Qinghai Atlas
马家山	Majiashan	Machang_Qijia	Settlement	Qinghai Atlas
张家（乐都）	Zhangjia(Ledu)	Xindian	Settlement	Qinghai Atlas
祁家堡	Qijiabao	Kayue	Settlement	Qinghai Atlas
中岭	Zhongling	Xindian	Settlement	Qinghai Atlas
单本	Danben	Kayue	Settlement	Qinghai Atlas
虎林	Hulin	Kayue	Settlement	Qinghai Atlas
庙台子（乐都）	Miaotaizi	Kayue	Burial	Qinghai Atlas
宁过	Ningguo	Kayue_Xindian	Burial	Qinghai Atlas
牛头山	Niutoushan	Kayue_Xindian	Settlement	Qinghai Atlas
达拉滩	Dalatan	Kayue	Settlement	Qinghai Atlas
前半沟	Qianbangou	Kayue	Burial	Qinghai Atlas
龙沟	Longgou	Kayue	Settlement	Qinghai Atlas

卡金门	Kajinmen	Kayue	Settlement	Qinghai Atlas
河西（乐都）	Hexi(Ledu)	Kayue	Settlement	Qinghai Atlas
红麻嘴	Hongmazui	Kayue	Settlement	Qinghai Atlas
上阳洼	Shangyangwa	Xindian	Burial	Qinghai Atlas
下滩（乐都）	Xiatan(Ledu)	Kayue	Settlement	Qinghai Atlas
下账房	Xiazhangfang	Kayue	Settlement	Qinghai Atlas
下营（乐都）	Xiaying(Ledu)	Kayue	Settlement	Qinghai Atlas
余家庄	Yujiazhuang	Xindian	Settlement	Qinghai Atlas
麻岭转	Malingzhuan	Majiayao_Kayue	Burial	Qinghai Atlas
北山	Beishan	Kayue	Settlement	Qinghai Atlas
头庄	Touzhuang	Kayue	Burial	Qinghai Atlas
山桃	Shantao	Qijia_Kayue	Settlement	Qinghai Atlas
后坡	Houpo	Kayue	Settlement	Qinghai Atlas
青崖嘴	Qingyazui	Machang_Qijia	Burial	Qinghai Atlas

营盘地	Yingpandi	Machang_Kayue	Settlement	Qinghai Atlas
申家台西	Shenjiataixi	Qijia_Xindian_Kayue	Settlement	Qinghai Atlas
申家	Shenjia	Kayue	Burial	Qinghai Atlas
赵家	Zhaojia	Kayue	Settlement	Qinghai Atlas
石坡沟	Shipogou	Kayue	Settlement	Qinghai Atlas
石岭子遗址	Shilingzi	Machang_Qijia	Settlement	Qinghai Atlas
上王家	Shangwangjia	Qijia_Kayue_Han	Settlement	Qinghai Atlas
雷盛家	Leishengjia	Machang_Qijia	Burial	Qinghai Atlas
西坪	Xiping	Machang_Qijia	Burial	Qinghai Atlas
段堡子	Duanbaozi	Qijia_Kayue	Burial	Qinghai Atlas
交界湾	Jiaojiewan	Xindian	Settlement	Qinghai Atlas
下庄（乐都）	Xiazhuang(Ledu)	Xindian	Settlement	Qinghai Atlas
祁家（乐都）	Qijia(Ledu)	Kayue	Settlement	Qinghai Atlas
中岭北	Zhonglingbei	Kayue	Settlement	Qinghai Atlas

大湾遗址	Dawan	Xindian	Settlement	Qinghai Atlas
格达麻西	Gedamaxi	Kayue	Settlement	Qinghai Atlas
塔格尕当	Tagegadang	Kayue	Settlement	Qinghai Atlas
上扎陵	Shangzhaling	Kayue	Settlement	Qinghai Atlas
下洛哇	Xialuowa	Kayue	Settlement	Qinghai Atlas
穆格滩南坎沿	Mugetannankanyan	Kayue	Settlement	Qinghai Atlas
那然北	Naranbei	Kayue	Settlement	Qinghai Atlas
塔哇	Tawa	Kayue	Settlement	Qinghai Atlas
仓木兰	Cangmulan	Kayue	Settlement	Qinghai Atlas
上藏	Shangcang	Kayue	Settlement	Qinghai Atlas
下玛台	Xiamatai	Kayue	Settlement	Qinghai Atlas
加土乎西	Jiatuhuxi	Kayue	Settlement	Qinghai Atlas
吴堡湾北	Wubaowanbei	Kayue	Settlement	Qinghai Atlas
茫拉	Mangla	Kayue	Settlement	Qinghai Atlas
加土乎	Jiatuhu	Kayue	Settlement	Qinghai Atlas

达玉	Dayu	Kayue	Settlement	Qinghai Atlas
达玉西北	Dayuxibei	Kayue	Settlement	Qinghai Atlas
黄沙沿	Huangshayan	Kayue	Settlement	Qinghai Atlas
军马场二队东北	Junmachangerduidongbei	Majiayao_Kayue	Settlement	Qinghai Atlas
吉那滩	Jinatan	Kayue	Settlement	Qinghai Atlas
拿塞尔滩	Nasaiertan	Kayue	Settlement	Qinghai Atlas
扎德堂	Zhadetang	Kayue	Settlement	Qinghai Atlas
东坎沿（贵南）	Dongkanyan(Guinan)	Kayue	Settlement	Qinghai Atlas
过马营	Guomaying	Kayue	Settlement	Qinghai Atlas
过芒	Guomang	Kayue	Settlement	Qinghai Atlas
子吾	Ziwu	Kayue	Settlement	Qinghai Atlas
切扎	Qiezha	Kayue	Settlement	Qinghai Atlas
堂群	Tangqun	Kayue	Settlement	Qinghai Atlas
东吾羊	Dongwuyang	Kayue	Settlement	Qinghai Atlas
哇洛合相	Waluohaxiang	Kayue	Settlement	Qinghai Atlas

木河口	Muhekou	Kayue	Settlement	Qinghai Atlas
寺尔堂	Siertang	Kayue	Settlement	Qinghai Atlas
岗日压	Gangriya	Kayue	Settlement	Qinghai Atlas
大峡口	Daxiakou	Kayue	Settlement	Qinghai Atlas
拉乙然其	Layiranqi	Kayue	Settlement	Qinghai Atlas
扎麻尼哈	Zhamaniha	Kayue	Settlement	Qinghai Atlas
斜口贡哇	Xiekougongwa	Kayue	Settlement	Qinghai Atlas
冬季口	Dongjikou	Kayue	Settlement	Qinghai Atlas
唐乃亥	Tangnaihai	Kayue	Settlement	Qinghai Atlas
德芒	Demang	Kayue	Settlement	Qinghai Atlas
关塘遗址	Guantang	Kayue	Settlement	Qinghai Atlas
关塘墓群	Guantang	Kayue	Burial	Qinghai Atlas
三十里铺	Sanshilipu	Kayue	Burial	Qinghai Atlas
西上庄墓群	Xishangzhuang	Kayue	Burial	Qinghai Atlas
西上庄遗址	Xishangzhuang	Qijia_Kayue	Settlement	Qinghai Atlas

上红庄	Shanghongzhuang	Kayue	Burial	Qinghai Atlas
新庄遗址（平安）	Xinzhuang(Pingan)	Kayue	Settlement	Qinghai Atlas
新庄南	Xinzhuangnan	Qijia_Kayue_Han	Settlement	Qinghai Atlas
三合遗址	Sanhe	Machang_Qijia	Settlement	Qinghai Atlas
三合南	Sanhenan	Kayue	Settlement	Qinghai Atlas
黎明（平安）	LIming(Pingan)	Kayue	Settlement	Qinghai Atlas
仲家墓群	Zhongjia	Kayue_Han	Burial	Qinghai Atlas
仲家遗址	Zhongjia	Kayue_Han	Settlement	Qinghai Atlas
河东	Hedong	Kayue	Settlement	Qinghai Atlas
下河滩遗址（平安）	Xiahetan(Pingan)	Kayue	Settlement	Qinghai Atlas
下河滩墓群	Xiahetan(Pingan)	Kayue	Burial	Qinghai Atlas
湾子东	Wanzidong	Kayue	Settlement	Qinghai Atlas
湾子（平安）	Wanzi(Pingan)	Kayue	Settlement	Qinghai Atlas

湾子南	Wanzinan	Kayue	Settlement /Burial	Qinghai Atlas
寺台东南	Sitaidongnan	Kayue	Settlement	Qinghai Atlas
寺沟沿	Sigouyan	Kayue	Settlement	Qinghai Atlas
沙卡	Shaka	Kayue	Settlement	Qinghai Atlas
山城村（平安）	Shanchengcun(Pingan)	Kayue	Settlement	Qinghai Atlas
古城沟	Guchenggou	Kayue	Settlement	Qinghai Atlas
牌楼沟遗址	Pailougou	Kayue	Settlement	Qinghai Atlas
牌楼沟墓群	Pailougou	Kayue	Burial	Qinghai Atlas
沙沟（平安）	Shagou(Pingan)	Kayue	Settlement	Qinghai Atlas
芦草沟台	Lucaogoutai	Kayue	Settlement	Qinghai Atlas
沙沟尕庄	Shagougazhuang	Kayue_Xindian	Settlement	Qinghai Atlas
尕庄墓群	Gazhuang(Pingan)	Kayue	Burial	Qinghai Atlas
白家	Baijia	Kayue	Burial	Qinghai Atlas
沈家遗址	Shenjia	Kayue	Settlement	Qinghai Atlas

西营坝西	Xiyingbaxi	Kayue	Settlement	Qinghai Atlas
西营坝	Xiyingba	Kayue	Burial	Qinghai Atlas
东村	Dongcun	Banshan_Machang_Kayue	Settlement	Qinghai Atlas
骆驼堡遗址	Luotuobao	Machang_Qijia	Settlement	Qinghai Atlas
古城崖	Guchengya	Kayue	Burial	Qinghai Atlas
石家营东南	Shijiayingdongnan	Kayue	Burial	Qinghai Atlas
石家营西	Shijiayingxi	Kayue	Settlement	Qinghai Atlas
平安	Pingan	Kayue	Burial	Qinghai Atlas
上滩西	Shangtanxi	Kayue	Burial	Qinghai Atlas
张家寨墓群	Zhangjiazhai	Kayue	Burial	Qinghai Atlas
张家寨遗址	Zhangjiazhai	Kayue	Settlement	Qinghai Atlas
寺台北	Sitaibei	Banshan_Qijia_Kayue	Settlement	Qinghai Atlas
然去乎北	Ranquhubei	Kayue	Settlement	Qinghai Atlas
然去乎南	Ranquhunan	Kayue	Settlement	Qinghai Atlas

然去乎	Ranquhu	Kayue	Settlement	Qinghai Atlas
大崖沿	Dayayan	Kayue	Settlement	Qinghai Atlas
哇玉香卡	Wayuxiangka	Kayue	Settlement	Qinghai Atlas
祁加	Qijia	Kayue	Settlement	Qinghai Atlas
木日沟	Murigou	Kayue	Burial	Qinghai Atlas
浪娘	Langniang	Kayue	Settlement	Qinghai Atlas
扎布达	Zhabuda	Kayue	Settlement	Qinghai Atlas
北台	Beitai	Kayue	Settlement	Qinghai Atlas
耐海塔	Naihaita	Machang_Kayue	Settlement	Qinghai Atlas
上村	Shangcun	Kayue	Settlement	Qinghai Atlas
知亥台	Zhihaitai	Kayue	Settlement	Qinghai Atlas
朱乃亥台	Zhunaihaitai	Kayue	Settlement	Qinghai Atlas
大东角哇	Dadongjiaowa	Kayue	Settlement	Qinghai Atlas
措索麻	Cuosuoma	Kayue_Tangwang	Settlement	Qinghai Atlas
口子台	Kouzitai	Kayue_Tangwang	Settlement	Qinghai Atlas

卡岗台	Kagangtai	Kayue	Settlement	Qinghai Atlas
尖巴	Jianba	Kayue	Settlement	Qinghai Atlas
尕巴赛当	Gabasaidang	Kayue	Settlement	Qinghai Atlas
纳尔赛当	Naersaidang	Kayue	Settlement	Qinghai Atlas
下卡力岗南	Xiakaligangnan	Kayue	Settlement	Qinghai Atlas
更尕海	Genggahai	Kayue	Settlement	Qinghai Atlas
英德尔（共和）	Yingdeer(Gonghe)	Kayue	Settlement	Qinghai Atlas
西台（共和）	Xitai(Gonghe)	Majiayao_Kayue	Settlement	Qinghai Atlas
下西台	Xiaxitai	Kayue	Burial	Qinghai Atlas
龙哇切吉滩	Longwaqiejitan	Kayue	Settlement	Qinghai Atlas
索吉亥	Suojihai	Kayue	Settlement	Qinghai Atlas
西台峡沿	Xitaixiayan	Kayue	Settlement	Qinghai Atlas
俄博台	Ebotai	Majiayao_Kayue	Settlement	Qinghai Atlas
托勒台南	Tuoletainan	Kayue	Settlement	Qinghai Atlas

红山顶	Hongshanding	Kayue	Settlement	Qinghai Atlas
拉才	Lacai	Paleolithic	Settlement	Qinghai Atlas
如其台	Ruqitai	Paleolithic	Settlement	Qinghai Atlas
拉才南	Lacainan	Kayue	Settlement	Qinghai Atlas
崖巴沿	Yabayan	Kayue	Settlement	Qinghai Atlas
铁盖	Tiegai	Kayue	Settlement	Qinghai Atlas
那亥烈遗址	Nahailie	Kayue	Settlement	Qinghai Atlas
湖东	Hudong	Kayue	Settlement	Qinghai Atlas
黄科	Huangke	Kayue	Settlement	Qinghai Atlas
东什梁	Dongshiliang	Kayue	Settlement	Qinghai Atlas
群科加拉	Qunkejiala	Kayue	Settlement	Qinghai Atlas
群科加拉西	Qunkejialaxi	Kayue	Settlement	Qinghai Atlas
甲乙村	Jiayicun	Kayue	Settlement	Qinghai Atlas
江盖	Jianggai	Kayue	Settlement	Qinghai Atlas
大仓	Dacang	Kayue	Settlement	Qinghai Atlas

雄先	Xiongxian	Kayue	Settlement	Qinghai Atlas
向贡北	Xiangongbei	Kayue	Settlement	Qinghai Atlas
石乃亥	Shinaihai	Kayue	Settlement	Qinghai Atlas
向贡遗址	Xianggong	Kayue	Settlement	Qinghai Atlas
向公墓群	Xiangong	Kayue	Burial	Qinghai Atlas
唐俄毛	Tangemao	Kayue	Settlement	Qinghai Atlas
切格扎	Qiegezha	Kayue	Settlement	Qinghai Atlas
阿岗台	Agangtai	Kayue	Settlement	Qinghai Atlas
尖巴台	Jianbatai	Kayue	Settlement	Qinghai Atlas
东沟滩	Donggoutan	Kayue	Settlement	Qinghai Atlas
知亥	Zhihai	Kayue	Settlement	Qinghai Atlas
佩正	Peizheng	Kayue	Burial	Qinghai Atlas
巴燕峡	Bayanxia	Kayue	Settlement	Qinghai Atlas
莫合寺	Mohesi	Kayue	Settlement	Qinghai Atlas
福海	Fuhai	Kayue	Settlement	Qinghai Atlas

龚家营	Gongjiaying	Kayue	Settlement	Qinghai Atlas
阳坡湾	Yangpowan	Kayue	Settlement	Qinghai Atlas
巴燕（湟源）	Bayan(Huangyuan)	Kayue	Settlement	Qinghai Atlas
下莫吉	Xiamoji	Kayue	Burial	Qinghai Atlas
俊家	Junjia	Kayue	Settlement	Qinghai Atlas
下胡旦度	Xiahudandu	Kayue	Settlement	Qinghai Atlas
石嘴（湟源）	Shizui(Huangyuan)	Kayue	Settlement	Qinghai Atlas
崖根（湟水北）	Yagen	Kayue	Settlement	Qinghai Atlas
申中	Shenzhong	Kayue	Settlement	Qinghai Atlas
前沟（湟源）	Qiangou(Huangyuan)	Kayue	Settlement	Qinghai Atlas
星家	Xingjia	Kayue	Settlement	Qinghai Atlas
蚂蚁嘴	Mayizui	Kayue	Burial	Qinghai Atlas
韭菜沟	Jiucaigou	Kayue	Settlement	Qinghai Atlas
垭豁山	Yahuoshan	Kayue	Settlement	Qinghai Atlas

卡路	Kalu	Kayue	Settlement	Qinghai Atlas
阿家图墓群	Ajiatu	Kayue	Burial	Qinghai Atlas
花鼻梁	Huabuliang	Kayue	Burial	Qinghai Atlas
上尕庄	Shanggazhuang	Kayue	Settlement	Qinghai Atlas
阿家图遗址	Ajiatu	Kayue	Settlement	Qinghai Atlas
朱家湾	Zhujiawan	Kayue	Settlement	Qinghai Atlas
下山根	Xiashangen	Kayue	Settlement	Qinghai Atlas
大华中庄墓群	Dahuazhongzhuang	Kayue	Burial	Qinghai Atlas
中庄遗址	Zhongzhuang	Kayue	Settlement	Qinghai Atlas
大华遗址	Dahua	Kayue	Settlement	Qinghai Atlas
星泉	Xingquan	Kayue	Burial	Qinghai Atlas
窑庄	Yaozhuang	Kayue	Settlement	Qinghai Atlas
李大	Lida	Kayue	Settlement	Qinghai Atlas
大河拉	Dahela	Kayue	Settlement	Qinghai Atlas

村北	Cunbei	Kayue	Settlement	Qinghai Atlas
石崖庄村北	Shiyazhuangcunbei	Kayue	Settlement	Qinghai Atlas
莫布拉	Mobula	Kayue	Settlement	Qinghai Atlas
地窝	Diwo	Kayue	Settlement	Qinghai Atlas
上北崖	Shangbeiya	Kayue	Settlement	Qinghai Atlas
波航	Bohang	Kayue	Settlement	Qinghai Atlas
阳坡根	Yangpogen	Kayue	Burial	Qinghai Atlas
纳隆墓地	Nalong	Kayue	Burial	Qinghai Atlas
元台	Yuantai	Kayue	Settlement	Qinghai Atlas
胡地槽	Hudicao	Kayue	Settlement	Qinghai Atlas
纳隆	Nalong	Kayue	Settlement	Qinghai Atlas
塔斯浪	Tasilang	Kayue	Settlement	Qinghai Atlas
蒙古道	Menggudao	Kayue	Settlement	Qinghai Atlas
元山	Yuanshan	Kayue	Settlement	Qinghai Atlas
玛尼湾口	Maniwankou	Kayue	Settlement	Qinghai Atlas

大高陵	Dagaoling	Kayue	Settlement	Qinghai Atlas
大湾口	Kayue	Kayue	Burial	Qinghai Atlas
尕庄（湟源）	Gazhuang(Huangyuan)	Kayue	Settlement	Qinghai Atlas
茶汉素遗址	Chahansu	Kayue	Settlement	Qinghai Atlas
茶汉素墓群	Chahansu	Kayue	Burial	Qinghai Atlas
兰占巴沟口	Lanzhanbagoukou	Kayue	Settlement	Qinghai Atlas
石崖	Shiya	Kayue	Settlement	Qinghai Atlas
响河	Xianghe	Kayue	Settlement	Qinghai Atlas
响河东	Xianghedong	Kayue	Settlement	Qinghai Atlas
崖根（湟水南）	Yagen	Kayue	Settlement	Qinghai Atlas
拉沙沟	Lashagou	Kayue	Settlement	Qinghai Atlas
小高陵	Xiaogaoling	Kayue	Settlement	Qinghai Atlas
马家大湾	Majiadawan	Kayue	Settlement	Qinghai Atlas
冶人村	Yerencun	Kayue	Settlement	Qinghai Atlas

元菜口	Yuancaikou	Kayue	Settlement	Qinghai Atlas
马家湾	Majiawan	Kayue	Settlement	Qinghai Atlas
马家湾西	Majiawanxi	Kayue	Settlement	Qinghai Atlas
宗吾西	Zongwuxi	Kayue	Settlement	Qinghai Atlas
占群	Zhanqun	Majiayao_Kayue	Settlement	Qinghai Atlas
宗吾	Zongwu	Kayue	Settlement	Qinghai Atlas
中庄（循化）	Zhongzhuang(Xunhua)	Majiayao_Kayue	Settlement /Burial	Qinghai Atlas
白土山	Baitushan	Machang_Qijia	Settlement	Qinghai Atlas
中庄墓群	Zhongzhuang(Xunhua)	Machang_Kayue	Burial	Qinghai Atlas
下庄遗址(循化)	Xiazhuang(Xunhua)	Majiayao_Qijia_Kayue	Settlement	Qinghai Atlas
下庄墓群	Xiazhuang	Qijia_Kayue	Burial	Qinghai Atlas
伊玛亥	Yimahai	Kayue	Settlement	Qinghai Atlas
苏志沟	Suzhigou	Kayue	Settlement	Qinghai Atlas
苏志	Suzhi	Kayue	Settlement	Qinghai Atlas
哈大亥	Hadahai	Kayue	Settlement	Qinghai Atlas

盐沟	Yangou	Qijia_Kayue	Settlement	Qinghai Atlas
塘古提	Tangguti	Kayue	Settlement	Qinghai Atlas
老曲	Laoqu	Machang_Qijia	Settlement	Qinghai Atlas
沙坝塘	Shabatang	Kayue	Settlement	Qinghai Atlas
加玛山	Jiamashan	Kayue	Burial	Qinghai Atlas
波拉海	Bolahai	Kayue	Settlement	Qinghai Atlas
塘坊	Tangfang	Kayue	Settlement	Qinghai Atlas
西沟坪	Xigouping	Kayue	Settlement	Qinghai Atlas
塘坊西南	Tangfangximen	Kayue	Settlement	Qinghai Atlas
古吉来墓群	Gujilai	Kayue	Burial	Qinghai Atlas
切力旱台	Qielihantai	Kayue	Settlement	Qinghai Atlas
西沟坪南	Xigoupinnan	Machang_Qijia	Settlement	Qinghai Atlas
西沟上庄	Xigoushangzhuang	Machang_Qijia	Settlement	Qinghai Atlas
西沟坪南	Xigoupingnan	Machang_Qijia	Settlement	Qinghai Atlas
果什滩北	Guoshitanbei	Kayue	Settlement	Qinghai Atlas

背其	Beiqi	Machang_Kayue	Settlement	Qinghai Atlas
相玉沟	Xiangyugou	Qijia_Kayue	Settlement	Qinghai Atlas
加多玛尕	Jiaduomaga	Majiayao_Kayue	Burial	Qinghai Atlas
高至	Gaozhi	Kayue	Settlement	Qinghai Atlas
西沟	Xigou	Qijia_Kayue	Settlement	Qinghai Atlas
黑门嘴	Heimenzui	Kayue	Settlement	Qinghai Atlas
骆嘴	Luozui	Kayue	Burial	Qinghai Atlas
桑坡乙亥	Sangpoyihai	Kayue	Settlement	Qinghai Atlas
孟达	Mengda	Kayue_Tangwang	Settlement	Qinghai Atlas
孟达山	Mengdashan	Kayue	Settlement	Qinghai Atlas
孟达山东南	Mengdashandongnan	Kayue	Settlement	Qinghai Atlas
中库沟	Zhongkugou	Qijia_Kayue	Settlement	Qinghai Atlas
阿杂日沟	Azarigou	Machang_Qijia_Kayue	Settlement	Qinghai Atlas
江加	Jiangjia	Kayue	Settlement	Qinghai Atlas
江加拉卡	Jiangjialaka	Kayue	Settlement	Qinghai Atlas

日茫	Rimang	Kayue	Settlement	Qinghai Atlas
哇库北	Wakubei	Kayue	Settlement	Qinghai Atlas
相玉	Xiangyu	Kayue	Settlement	Qinghai Atlas
恰牛	Qianiu	Kayue	Settlement	Qinghai Atlas
河哇	Hewa	Kayue	Settlement	Qinghai Atlas
洛哇东北	Luowadongbei	Kayue	Settlement	Qinghai Atlas
红秀	Hongxiu	Kayue	Settlement	Qinghai Atlas
洛哇北	Luowabei	Kayue	Settlement	Qinghai Atlas
洛哇遗址	Luowa	Kayue	Settlement	Qinghai Atlas
洛哇墓群	Luowa	Kayue	Burial	Qinghai Atlas
尕楞	Galeng	Kayue	Settlement	Qinghai Atlas
相沙墓群	Xiangsha	Majiayao_Kayue	Burial	Qinghai Atlas
相沙遗址	Xiangsha	Kayue	Settlement	Qinghai Atlas
三麻里	Sanmali	Kayue	Settlement	Qinghai Atlas
白浪滩	Bailangtan	Kayue	Settlement	Qinghai Atlas

下滩(循化)	Xiatan(Xunhua)	Kayue	Settlement	Qinghai Atlas
石巷	Shixiang	Kayue	Settlement	Qinghai Atlas
红庄	Hongzhuang	Kayue	Settlement	Qinghai Atlas
棺材坡	Guancaipo	kAYUE	Burial	Qinghai Atlas
大寺古迁移村	Dasiguqianyicun	Kayue	Settlement	Qinghai Atlas
扎木泉	Zhamuquan	Kayue	Burial	Qinghai Atlas
拉木沟	Lamugou	Qijia_Kayue	Settlement	Qinghai Atlas
上拉边	Shanglabian	Kayue	Settlement	Qinghai Atlas
下拉边	Xialabian	Kayue	Burial	Qinghai Atlas
乙日亥	Yirihai	Bronze age	Burial	Qinghai Atlas
赛曼沟	Saimangou	Kayue_Tang	Settlement	Qinghai Atlas
加仓	Jiacang	Kayue	Settlement	Qinghai Atlas
下扎岗	Xiazhagang	Kayue	Settlement	Qinghai Atlas
堡集拉尕	Baojilaga	Kayue	Settlement	Qinghai Atlas
德漫东	Demandong	Kayue	Settlement	Qinghai Atlas

德漫	Deman	Qijia_Kayue	Settlement	Qinghai Atlas
循哇	Xunwa	Kayue	Settlement	Qinghai Atlas
拉木龙哇	Lamulongwa	Kayue	Settlement	Qinghai Atlas
俄家	Ejia	Kayue	Settlement	Qinghai Atlas
张家台	Zhangjiatai	Kayue	Settlement	Qinghai Atlas
哇科	Wake	Majiayao_Kayue	Settlement	Qinghai Atlas
多什则北	Duoshizebei	Kayue	Settlement	Qinghai Atlas
多什则	Duoshize	Kayue	Settlement	Qinghai Atlas
多什则南	Duoshizenan	Kayue	Settlement	Qinghai Atlas
古雷	Gulei	Kayue	Settlement	Qinghai Atlas
上庄（循化）	Shangzhuang(Xunhua)	Kayue	Settlement	Qinghai Atlas
贺庄北	Hezhuangbei	Kayue	Settlement	Qinghai Atlas
吾曼	Wuman	Kayue	Settlement	Qinghai Atlas
夕冲北	Xichongbei	Kayue	Settlement	Qinghai Atlas
夕冲	Xichong	Kayue	Settlement	Qinghai Atlas

贺庄	Hezhuang	Kayue	Settlement	Qinghai Atlas
起台堡	Qitaibao	Kayue	Settlement	Qinghai Atlas
专堂	Zhuantang	Kayue	Settlement	Qinghai Atlas
塔沙坡	Tashapo	Kayue	Settlement	Qinghai Atlas
乙寺日西	Yisirixi	Kayue	Settlement	Qinghai Atlas
乙寺日	Yisiri	Qijia_Kayue	Settlement	Qinghai Atlas
江扎	Jiangzha	Kayue	Settlement	Qinghai Atlas
谢玛东	Xiemadong	Kayue	Settlement	Qinghai Atlas
格则堂	Gezetang	Kayue	Settlement	Qinghai Atlas
高尔玛	Gaoerma	Kayue	Settlement	Qinghai Atlas
唐春	Tangchun	Kayue	Settlement	Qinghai Atlas
唐春西南	Tangchunxinan	Kayue	Settlement	Qinghai Atlas
朱子昂	Zhuziang	Kayue	Settlement	Qinghai Atlas
半主哇墓群	Banzhuwa	Kayue	Burial	Qinghai Atlas
角加	Jiaojia	Kayue	Burial	Qinghai Atlas

雅格堂	Yagetang	Kayue	Settlement	Qinghai Atlas
完谢	Wanxie	Majiayao_Kayue	Settlement	Qinghai Atlas
索拉台	Suolatai	Kayue	Burial	Qinghai Atlas
下曲加墓群	Xiaqujia	Kayue	Burial	Qinghai Atlas
下曲加遗址	Xiaqujia	Kayue	Settlement	Qinghai Atlas
纳尕（化隆）	Naga(Hualong)	Kayue	Settlement	Qinghai Atlas
岗斜	Gangxie	Kayue	Settlement	Qinghai Atlas
来洞	Laidong	Kayue	Settlement	Qinghai Atlas
加干拉尕	Jiaganlaza	Kayue	Settlement	Qinghai Atlas
玛尕	Maga	Kayue	Settlement	Qinghai Atlas
唐沙墓群	Tangsha	Kayue	Burial	Qinghai Atlas
唐沙遗址	Tangsha	Kayue	Settlement	Qinghai Atlas
曲入麻卡	Qurumaka	Kayue	Settlement	Qinghai Atlas
曲入麻卡东	Qurumakadong	Kayue	Settlement	Qinghai Atlas

参果滩墓群	Shengguotan	Kayue	Burial	Qinghai Atlas
牙什尕	Yashiga	Qijia_Kayue	Settlement	Qinghai Atlas
南滩	Nantan	Kayue	Settlement	Qinghai Atlas
扎拉毛	Zhalamao	Kayue	Settlement	Qinghai Atlas
扎巴南	Zhabanan	Kayue	Settlement	Qinghai Atlas
扎巴	Zhaba	Kayue	Settlement	Qinghai Atlas
阿代	Adai	Kayue	Settlement	Qinghai Atlas
谢卡拉卡	Xiekalaka	Kayue	Settlement	Qinghai Atlas
泉固拉	Quangula	Kayue	Settlement	Qinghai Atlas
浪隆滩	Langlongtan	Kayue	Settlement	Qinghai Atlas
扎辛卡	Zhaxinka	Kayue	Settlement	Qinghai Atlas
扎让滩	Zharangtan	Kayue	Burial	Qinghai Atlas
窑洞村	Yaodongcun	Kayue	Settlement	Qinghai Atlas
拉曲二滩	Laquertan	Kayue	Settlement	Qinghai Atlas
城车村遗址	Chengche	Kayue	Settlement	Qinghai Atlas

城车墓群	Chengche	Kayue	Burial	Qinghai Atlas
阳坡（化隆）	Yangpo(Hualong)	Kayue	Settlement	Qinghai Atlas
拉公麻	Lagongma	Majiayao_Kayue	Settlement	Qinghai Atlas
水库滩	Shuikutan	Kayue	Settlement	Qinghai Atlas
哇尔江	Waerjiang	Kayue	Settlement	Qinghai Atlas
下哆吧	Xiaduoba	Kayue	Burial	Qinghai Atlas
群科北	Qunkebei	Kayue	Burial	Qinghai Atlas
文卜具	Wenbuju	Machang_Kayue	Settlement	Qinghai Atlas
乙沙尔	Yishaer	Kayue	Burial	Qinghai Atlas
科毛其	Kemaoqi	Kayue	Settlement	Qinghai Atlas
若加	Ruojia	Qijia_Kayue	Settlement	Qinghai Atlas
不藏昂	Buzangang	Kayue_Tangwang	Settlement	Qinghai Atlas
先口	Xiankou	Kayue	Settlement	Qinghai Atlas
格尔麻	Geerma	Majiayao_Qijia_Kayue	Settlement	Qinghai Atlas
群科	Qunke	Kayue	Settlement	Qinghai Atlas

喇嘛龙哇	Lamalongwa	Kayue	Settlement	Qinghai Atlas
大豆台	Dadoutai	Kayue	Settlement	Qinghai Atlas
吉亥唐	Jihaitang	Kayue	Settlement	Qinghai Atlas
日兰西北	Rilanxibei	Kayue	Settlement	Qinghai Atlas
日兰	Rilan	Kayue	Settlement	Qinghai Atlas
关沙	Guansha	Kayue	Settlement	Qinghai Atlas
麻卡拉	Makala	Majiayao_Kayue	Settlement	Qinghai Atlas
哈力玛卡台	Halimakatai	Majiayao_Kayue	Settlement	Qinghai Atlas
梅加	Meijia	Qijia_Kayue	Settlement	Qinghai Atlas
尼昂昂沟	Nianganggou	Kayue	Settlement	Qinghai Atlas
沙吾昂西	Shawuangxi	Kayue_Tangwang	Settlement	Qinghai Atlas
白土庄（化隆）	Baituzhuang(Hualong)	Kayue	Settlement	Qinghai Atlas
日干墓群（德恒隆墓群）	Rigan	Kayue	Burial	Qinghai Atlas
团结村南	Tuanjiecunnan	Majiayao_Kayue	Settlement	Qinghai Atlas

沙加台	Shajiatai	Kayue	Settlement	Qinghai Atlas
山卡拉	Shankala	Kayue	Settlement	Qinghai Atlas
尔尕昂	Ergaang	Kayue	Settlement	Qinghai Atlas
亚曲	Yaqu	Kayue	Settlement	Qinghai Atlas
亚曲滩西	Yaqutanxi	Kayue	Settlement	Qinghai Atlas
东加	Dongjia	Kayue	Settlement	Qinghai Atlas
亚曲滩五社	Yaqutanwushe	Majiayao_Kayue_Tangwang	Settlement	Qinghai Atlas
哇加滩墓群	Wajiatan	Kayue	Burial	Qinghai Atlas
浪隆沟	Langlonggou	Kayue	Burial	Qinghai Atlas
关巴	Guanba	Kayue	Settlement	Qinghai Atlas
上拉干台	Shanglagantai	Kayue	Burial	Qinghai Atlas
香里胡拉	Xianglihula	Kayue	Settlement	Qinghai Atlas
克麻	Kema	Kayue_Tangwang	Settlement	Qinghai Atlas
克麻西	Kemaxi	Kayue_Tangwang	Settlement	Qinghai Atlas
土桥口	Tuqiaokou	Kayue	Settlement	Qinghai Atlas

湾门	Wanmen	Kayue	Settlement	Qinghai Atlas
旦庄	Danzhuang	Kayue	Settlement	Qinghai Atlas
石大仓	Shidacang	Kayue	Settlement	Qinghai Atlas
支哈堂	Zhihatang	Kayue	Settlement	Qinghai Atlas
东坡	Dongpo	Kayue	Settlement	Qinghai Atlas
群卜吾具	Qunbuwuju	Kayue	Settlement	Qinghai Atlas
角相列	Jiaoxianglie	Kayue	Settlement	Qinghai Atlas
高跃	Gaoyue	Kayue	Settlement	Qinghai Atlas
白土窝	Baituwo	Kayue	Settlement	Qinghai Atlas
窑洞湾	Yadongwan	Kayue	Settlement	Qinghai Atlas
阿藏吾具	Azangwuju	Kayue	Settlement	Qinghai Atlas
列布加墓群	Liebujia	Qijia_Kayue	Burial	Qinghai Atlas
列布加遗址	Liebujia	Kayue	Settlement	Qinghai Atlas
拉木	Lamu	Kayue	Settlement	Qinghai Atlas
沙兰果	Shalanguo	Kayue	Settlement	Qinghai Atlas

拉吉盖	Lajigai	Kayue	Burial	Qinghai Atlas
贡什加村南墓群	Gongshijiacunnan	Machang_Qijia	Burial	Qinghai Atlas
峡口（化隆）	Xiakou	Kayue	Settlement	Qinghai Atlas
西滩新村	Xitanxincun	Kayue	Settlement	Qinghai Atlas
水车村	Shuichecun	Kayue	Settlement	Qinghai Atlas
下西滩	Xiaxitan	Kayue	Settlement	Qinghai Atlas
白土山	Baitushan	Machang_Qijia_Kayue	Burial	Qinghai Atlas
四合省	Sihesheng	Kayue	Settlement	Qinghai Atlas
东三村	Dongsancun	Kayue	Settlement	Qinghai Atlas
鲁西	Lagaluxi	Kayue	Settlement	Qinghai Atlas
拉尕堂	Lagatang	Kayue	Settlement	Qinghai Atlas
扎西庄	Zhaxi	Kayue	Burial	Qinghai Atlas
扎西庄北	Zhazhuangxibei	Kayue	Settlement	Qinghai Atlas
尕庄（化隆）	Gazhuang(Hualong)	Kayue	Settlement	Qinghai Atlas

支哈加	Zhihaga	Kayue	Settlement	Qinghai Atlas
康桑垭豁	Kasangyahuo	Kayue	Settlement	Qinghai Atlas
者麻昂村东墓群	Zhemaangcundong	Kayue	Burial	Qinghai Atlas
者麻昂遗址	Zhemaang	Kayue	Settlement	Qinghai Atlas
洛乙海	Luoyihai	Kayue	Settlement	Qinghai Atlas
江拉	Jiangla	Majiayao_Kayue	Settlement	Qinghai Atlas
积烈岗	Jiliegang	Kayue	Settlement	Qinghai Atlas
纳尕（贵德）	Naga	Kayue	Settlement	Qinghai Atlas
亦杂石	Yizashi	Kayue	Burial	Qinghai Atlas
俄加	Ejia	Kayue_Tangwang	Settlement	Qinghai Atlas
俄加北	Ejiabei	Kayue	Settlement	Qinghai Atlas
角羊卡	Jiaoyangka	Kayue	Settlement	Qinghai Atlas
俄加台	Ejiatai	Kayue	Settlement	Qinghai Atlas
东坎沿（贵德）	Dongkanyan	Kayue	Settlement	Qinghai Atlas

南坎沿	Nankanyan	Kayue	Settlement	Qinghai Atlas
查达	Chada	Kayue_Tangwang	Settlement	Qinghai Atlas
查达村东	Chadacundong	Kayue	Settlement	Qinghai Atlas
干结堂	Ganjietang	Kayue	Settlement	Qinghai Atlas
阿当山	Adangshan	Kayue	Settlement	Qinghai Atlas
野毛香	Yemaoxiang	Kayue	Settlement	Qinghai Atlas
查达墓群	Chada	Kayue	Burial	Qinghai Atlas
查干头	Chagantou	Kayue	Settlement	Qinghai Atlas
新村（贵德）	Xincun	Kayue	Settlement	Qinghai Atlas
张家湾	Zhangjiawan	Kayue	Settlement	Qinghai Atlas
崖头沿	Yatouyan	Kayue	Settlement	Qinghai Atlas
南海殿	Nanhaidian	Kayue	Settlement	Qinghai Atlas
寺台地	Sitaidi	Kayue	Settlement	Qinghai Atlas
拉岌盖	Lajigai	Kayue	Settlement	Qinghai Atlas
堂乃后	Tangnaihou	Kayue	Settlement	Qinghai Atlas

下排西	Xiapaixi	Kayue	Settlement	Qinghai Atlas
山坪台	Shanpingtai	Kayue	Burial	Qinghai Atlas
上刘屯	Shangliutun	Kayue	Settlement	Qinghai Atlas
河西（贵德）	Hexi(Guide)	Tangwang	Settlement	Qinghai Atlas
热水沟	Reshuigou	Kayue	Settlement	Qinghai Atlas
西山湾	Xishanwan	Kayue	Burial	Qinghai Atlas
扎仓	Zhacang	Kayue	Settlement	Qinghai Atlas
温泉	Wenquan	Kayue	Settlement	Qinghai Atlas
西山根	Xishangen	Kayue	Burial	Qinghai Atlas
贡拜	Gongbai	Majiayao_Kayue	Settlement	Qinghai Atlas
黎明（贵德）	Liming(Guide)	Kayue	Settlement	Qinghai Atlas
单岔	Dancha	Majiayao_Kayue	Settlement	Qinghai Atlas
尼那	Nina	Qijia_Kayue	Settlement	Qinghai Atlas
农场西	Nongchangxi	Majiayao_Kayue	Settlement	Qinghai Atlas
尼那北	Ninabei	Kayue	Settlement	Qinghai Atlas

尼那南	Ninanan	Kayue	Settlement	Qinghai Atlas
唐加里	Tangjiali	Kayue	Settlement	Qinghai Atlas
尼那墓群	Nina	Qijia_Kayue	Burial	Qinghai Atlas
亚哇	Yawa	Kayue	Settlement	Qinghai Atlas
卡日	Kari	Kayue	Settlement	Qinghai Atlas
尼那西南	Ninaxinan	Kayue_Tangwang	Settlement	Qinghai Atlas
拉谷口	Lagukou	Kayue_Tangwang	Settlement	Qinghai Atlas
昨那	Zuoza	Kayue	Settlement	Qinghai Atlas
都木查日	Dumuchari	Majiayao_Kayue	Settlement	Qinghai Atlas
罗汉堂东	Luohantangdong	Kayue	Settlement	Qinghai Atlas
加龙卡亚南	Jialongkayanan	Kayue	Settlement	Qinghai Atlas
阿什则沟（贵德）	Ashizegou	Kayue	Settlement	Qinghai Atlas
唐纳亥	Tangnahai	Kayue	Settlement	Qinghai Atlas
拉德口	Ladekou	Kayue	Settlement	Qinghai Atlas
红德口	Hongdekou	Kayue	Settlement	Qinghai Atlas

羊日口	Yangrikou	Kayue	Settlement	Qinghai Atlas
豆后浪	Douhoulang	Kayue	Settlement	Qinghai Atlas
沙索麻	Shasuoma	Kayue	Settlement	Qinghai Atlas
拉堂拉麻	Latanglama	Kayue	Settlement	Qinghai Atlas
下加东	Xiajiadong	Kayue	Settlement	Qinghai Atlas
拉塘	Latang	Kayue	Settlement	Qinghai Atlas
叶后浪沟东	Yehoulanggoudong	Kayue_Tangwang	Settlement	Qinghai Atlas
叶后浪	Yehoulang	Kayue	Settlement	Qinghai Atlas
叶后浪沟西	Yehoulanggouxi	Kayue_Tangwang	Settlement	Qinghai Atlas
叶后浪沟	Yehoulanggou	Kayue_Tangwang	Settlement	Qinghai Atlas
尼沙希	Nishaxi	Kayue	Settlement	Qinghai Atlas
多勒仓墓群	Duolecang	Kayue_Tangwang	Burial	Qinghai Atlas
多勒仓遗址	Duolecang	Tangwang	Settlement	Qinghai Atlas
俄当沟	Edanggou	Tangwang	Settlement	Qinghai Atlas

仍果	Renguo	Kayue	Settlement	Qinghai Atlas
仍果北	Renguobei	Kayue	Settlement	Qinghai Atlas
阿什贡	Ashigong	Kayue	Settlement	Qinghai Atlas
奴后秀	Nuhouxiu	Majiayao_Kayue	Settlement	Qinghai Atlas
奴后秀村东	Nuhouxiucundong	Kayue	Settlement	Qinghai Atlas
边都墓群	Biandu	Kayue_Tangwang	Burial	Qinghai Atlas
边都遗址	Biandu	Kayue_Tangwang	Settlement	Qinghai Atlas
尕拉玛次山墓群	Galamaci	Machang_Kayue_Han	Burial	Qinghai Atlas
尕旦	Gadan	Kayue	Settlement	Qinghai Atlas
尕旦寺北	Gadansibei	Kayue	Settlement	Qinghai Atlas
哇里	Wali	Kayue_Tangwang	Settlement	Qinghai Atlas
哇里东北	Walidongbei	Kayue_Tangwang	Settlement	Qinghai Atlas
哇里北	Walibei	Kayue	Settlement	Qinghai Atlas
金巴	Jinba	Kayue	Settlement	Qinghai Atlas
哇里根	Waligen	Kayue	Settlement	Qinghai Atlas

鲁卜亥	Lubuhai	Kayue	Settlement	Qinghai Atlas
赵家沟	Zhaojiagou	Kayue_Tangwang	Settlement	Qinghai Atlas
哇宗东	Wazongdong	Tangwang	Settlement	Qinghai Atlas
哇宗	Wazong	Majiayao_Kayue	Settlement	Qinghai Atlas
拉不查墓群	Labucha	Kayue_Tangwang	Burial	Qinghai Atlas
大沟山墓群	Dagoushan	Kayue	Burial	Qinghai Atlas
王屯	Wangtun	Kayue_Tangwang	Settlement	Qinghai Atlas
哇龙山	Walongshan	Kayue	Burial	Qinghai Atlas
才堂	Caitang	Kayue	Settlement	Qinghai Atlas
兰泉坪遗址	Lanquanping	Kayue	Settlement	Qinghai Atlas
兰泉坪墓群	Lanquanping	Kayue	Burial	Qinghai Atlas
下兰角北	Xialanjiaobei	Kayue	Settlement	Qinghai Atlas
下兰角遗址	Xialanjiao	Kayue	Settlement	Qinghai Atlas
下兰角西	Xialanjiao	Kayue	Settlement	Qinghai Atlas

上兰角遗址	Shanglanjiao	Majiayao_Kayue	Settlement	Qinghai Atlas
尕什再来	Gashizailai	Kayue	Burial	Qinghai Atlas
上兰角墓群	Shanglanjiao	Qijia_Kayue	Burial	Qinghai Atlas
石沟（贵德）	Shigou	Kayue	Burial	Qinghai Atlas
周屯遗址	Zhoutun	Kayue	Settlement	Qinghai Atlas
瓦岗山	Wagangshan	Kayue	Burial	Qinghai Atlas
曹古沟	Caogugou	Majiayao_Kayue	Settlement	Qinghai Atlas
周屯墓群	Zhoutun	Kayue	Settlement	Qinghai Atlas
加卜查西	Jiabuchaxi	Kayue	Settlement	Qinghai Atlas
年豆漏	Niandoulou	Kayue	Settlement	Qinghai Atlas
加卜查	Jiabucha	Majiayao_Kayue	Settlement	Qinghai Atlas
却加	Quejia	Kayue	Burial	Qinghai Atlas
新沟口	Xingoukou	Kayue	Settlement	Qinghai Atlas
加卜查南	Jiabuchanan	Kayue	Settlement	Qinghai Atlas

后登门卡	Houdengmenka	Kayue	Burial	Qinghai Atlas
卡拉	Kala	Kayue	Settlement	Qinghai Atlas
卷木	Juanmu	Kayue	Settlement	Qinghai Atlas
吾隆	Wulong	Kayue	Settlement	Qinghai Atlas
干果羊	Ganguoyang	Kayue_Tangwang	Settlement	Qinghai Atlas
下庄（贵德）	Xiazhuang(Guide)	Kayue	Settlement	Qinghai Atlas
干果羊下庄	Ganhuoyangxiazhuang	Kayue	Burial	Qinghai Atlas
瓦家	Wajia	Kayue	Settlement	Qinghai Atlas
先锋	Xianfeng	Tangwang	Settlement	Qinghai Atlas
多哇一社	Duowayishe	Majiayao_Kayue	Settlement	Qinghai Atlas
多哇	Duowa	Kayue	Settlement	Qinghai Atlas
土乎台	Tuhutai	Kayue	Settlement	Qinghai Atlas
中麻吾	Zhongmawu	Kayue	Settlement	Qinghai Atlas
阿堤	Adi	Tangwang	Settlement	Qinghai Atlas
新街	Xinjie	Majiayao_Han	Settlement	Qinghai Atlas

高红崖	Gaohongya	Kayue	Settlement	Qinghai Atlas
祁家庄	Qiajiazhuang	Kayue	Settlement	Qinghai Atlas
南门峡白崖	Nanmenxiabaiya	Kayue	Settlement	Qinghai Atlas
大老虎口	Dalaohukou	Kayue	Settlement	Qinghai Atlas
泥麻	Nima	Kayue	Settlement	Qinghai Atlas
火烧沟口	Huoshaogoukou	Kayue	Settlement	Qinghai Atlas
黑庄	Heizhuang	Kayue	Settlement	Qinghai Atlas
山城村（互助）	Shanchengcun	Kayue	Settlement	Qinghai Atlas
贺尔	Heer	Kayue	Settlement	Qinghai Atlas
魏家滩	Weijiatang	Kayue	Settlement	Qinghai Atlas
尕马吉	Gamaji	Kayue	Settlement	Qinghai Atlas
尕寺加	Gasijia	Kayue	Settlement	Qinghai Atlas
善马沟	Shanmagou	Kayue	Settlement	Qinghai Atlas
格隆	Gelong	Kayue_Tang	Settlement	Qinghai Atlas
上台	Shangtai	Tangwang	Settlement	Qinghai Atlas

下台北	Xiataibei	Kayue	Settlement	Qinghai Atlas
下台南	Xiatainan	Kayue	Settlement	Qinghai Atlas
七塔尔	Qitaer	Kayue	Settlement	Qinghai Atlas
新庄（互助）	Xinzhuang(Huzhu)	Kayue	Settlement	Qinghai Atlas
新庄北	Xinzhuangxi	Kayue	Settlement	Qinghai Atlas
新庄西	Xinzhuangbei	Kayue	Settlement	Qinghai Atlas
小河儿	Xiaoheer	Kayue	Settlement	Qinghai Atlas
寺尔坪	Sierping	Kayue	Settlement	Qinghai Atlas
陈家台	Chenjiatai	Kayue	Burial	Qinghai Atlas
靳家台	Jinjiatai	Kayue	Settlement	Qinghai Atlas
上马圈	Shangmajuan	Kayue_Tangwang	Settlement	Qinghai Atlas
豆尔加阳坡	Douerjiayangpo	Kayue	Settlement	Qinghai Atlas
董家台	Dongjiatai	Kayue	Settlement	Qinghai Atlas
丰台沟口	Fengtaigoukou	Kayue_Han	Settlement	Qinghai Atlas
红崖	Hongya	Kayue	Settlement	Qinghai Atlas

班家湾	Banjiawan	Tangwang	Settlement	Qinghai Atlas
丰台	Fengtai	Kayue	Settlement	Qinghai Atlas
白崖（互助）	Baiya	Kayue_Tangwang	Settlement	Qinghai Atlas
崖头（互助）	Yatou(Huzhu)	Kayue	Settlement	Qinghai Atlas
周家西	Zhoujiaxi	Kayue	Settlement	Qinghai Atlas
周家西南	Zhoujiaxinnan	Kayue	Settlement	Qinghai Atlas
大通苑（乙）	Datongyuanyi	Kayue	Settlement	Qinghai Atlas
大通苑北	Datongyuanbei	Majiayao_Kayue	Settlement	Qinghai Atlas
大通苑东北	Datongyuandongbei	Qijia_Kayue	Settlement	Qinghai Atlas
董家	Dongjia	Kayue	Settlement	Qinghai Atlas
殷家泉	Yinjiaquan	Kayue	Burial	Qinghai Atlas
下店壕	Xiadianhao	Kayue_Han	Settlement	Qinghai Atlas
前山根	Qianshangen	Kayue	Settlement	Qinghai Atlas
下庄子	Xiazhuangzi	Kayue_Han	Settlement	Qinghai Atlas

大庄北	Dazhuangbei	Kayue	Settlement	Qinghai Atlas
王家（互助）	Wangjia(Huzhu)	Kayue	Settlement	Qinghai Atlas
和平	Heping	Kayue	Settlement	Qinghai Atlas
刘家沟	Liujiagou	Kayue	Settlement	Qinghai Atlas
郑家沟	Zhengjiagou	Kayue	Settlement	Qinghai Atlas
大庄	Dazhuang	Kayue	Settlement	Qinghai Atlas
大庄南	Dazhuangnan	Kayue	Settlement	Qinghai Atlas
高羌	Gaoqiang	Kayue	Settlement	Qinghai Atlas
新元	Xinyuan	Kayue	Settlement	Qinghai Atlas
北寺台	Beisitai	Kayue	Settlement	Qinghai Atlas
总寨西北	Zongzhaixibei	Kayue	Settlement	Qinghai Atlas
总寨	Zongzhai	Kayue	Settlement	Qinghai Atlas
总寨西	Zongzhaixi	Kayue	Settlement	Qinghai Atlas
包家口	Baojiakou	Kayue	Settlement	Qinghai Atlas
包家口南	Baojiakounan	Kayue	Settlement	Qinghai Atlas

上山城墓群	Shangshancheng	Kayue	Buiral	Qinghai Atlas
上山城遗址	Shangshancheng	Kayue	Settlement	Qinghai Atlas
刘家（互助）	Liujia(Huzhu)	Kayue	Settlement	Qinghai Atlas
三其	Sanqi	Kayue	Settlement	Qinghai Atlas
兰家	Lanjia	Kayue	Settlement	Qinghai Atlas
余家	Yujia	Kayue	Settlement	Qinghai Atlas
白崖东	Baiyadong	Kayue	Settlement	Qinghai Atlas
红嘴西	Hongzuixi	Kayue	Settlement	Qinghai Atlas
红嘴	Hongzui	Kayue	Settlement	Qinghai Atlas
纳家	Najia	Tangwang	Settlement	Qinghai Atlas
尕山	Gashan	Kayue_HanJin	Settlement	Qinghai Atlas
大寺	Dasi	Kayue	Settlement	Qinghai Atlas
凉州营	Liangzhouying	Kayue	Settlement	Qinghai Atlas
麻吉	Maji	Kayue	Settlement	Qinghai Atlas

宋家庄	Songjiazhuang	Kayue	Settlement	Qinghai Atlas
洛少北	Luoshaobei	Kayue_Tangwang	Settlement	Qinghai Atlas
洛少	Luoshao	Kayue_Tangwang	Settlement	Qinghai Atlas
东沟大庄	Donggoudazhuang	Tangwang	Settlement	Qinghai Atlas
东沟北	Donggoubei	Tangwang	Settlement	Qinghai Atlas
恰卡山顶	Qiakashanding	Kayue	Settlement	Qinghai Atlas
恰卡山根	Qiakshangen	Kayue	Settlement	Qinghai Atlas
白土垭豁	Baituyahuo	Tangwang	Settlement	Qinghai Atlas
新庄墓群（互助）	Xinzhuang	Kayue	Burial	Qinghai Atlas
下元保	Xiayuanbao	Tangwang_Han	Settlement	Qinghai Atlas
东山	Dongshan	Kayue	Settlement	Qinghai Atlas
西丹麻	Xidanma	Kayue	Settlement	Qinghai Atlas
丹麻西南	Danmaxinan	Kayue	Settlement	Qinghai Atlas
上石大门	Shangshidamen	Kayue	Settlement	Qinghai Atlas
拉庄	Lazhuang	Kayue	Settlement	Qinghai Atlas

公麻	Gongma	Kayue	Settlement	Qinghai Atlas
桦林	Hualin	Kayue	Settlement	Qinghai Atlas
东源山	Dongyuanshan	Kayue	Settlement	Qinghai Atlas
过河滩	Guohetan	Kayue	Settlement	Qinghai Atlas
下甘滩	Xiagantan	Kayue	Settlement	Qinghai Atlas
上甘滩	Shanggantan	Kayue	Settlement	Qinghai Atlas
仙强台	Xianqiangtai	Kayue	Settlement	Qinghai Atlas
郎家（互助）	Langjia	Kayue	Settlement	Qinghai Atlas
藏寿	Cangshou	Kayue	Settlement	Qinghai Atlas
索卜滩	Suobutan	Kayue	Settlement	Qinghai Atlas
索卜滩北	Suobutanbei	Kayue	Settlement	Qinghai Atlas
六里头	Liulitou	Kayue	Settlement	Qinghai Atlas
站家台	Zhanjiatai	Kayue	Settlement	Qinghai Atlas
东山城	Dongshancheng	Kayue	Settlement	Qinghai Atlas
东哈家	Donghajia	Kayue	Settlement	Qinghai Atlas

东哈家东	Donghajiadong	Kayue	Settlement	Qinghai Atlas
新添堡（互助）	Xintianbao(Huzhu)	Kayue	Settlement	Qinghai Atlas
岔尔沟口	Chaergoukou	Kayue	Settlement	Qinghai Atlas
岔尔沟门	Chaergoumen	Kayue	Settlement	Qinghai Atlas
东河	Donghe	Kayue	Settlement	Qinghai Atlas
上坪	Shangping	Kayue	Settlement	Qinghai Atlas
魏家	Weijia	Kayue_Tangwang	Settlement	Qinghai Atlas
马家(互助)	Majia	Qijia_Kayue	Settlement	Qinghai Atlas
马家庄北	Majizhuangbei	Kayue	Settlement	Qinghai Atlas
马家庄墓群	Majiazhuang	Kayue	Burial	Qinghai Atlas
蒋家	Jiangjia	Qijia_Kayue	Settlement	Qinghai Atlas
水槽沟	Shuicaogou	Majiayao_Kayue	Settlement	Qinghai Atlas
麻花嘴	Mahuazui	Kayue	Settlement	Qinghai Atlas
杏元	Xingyuan	Qijia_Kayue	Settlement	Qinghai Atlas

西庄	Xizhuang	Kayue	Settlement	Qinghai Atlas
沿子沟	Yanzigou	Kayue	Settlement	Qinghai Atlas
台上	Taishang	Kayue	Settlement	Qinghai Atlas
上巴洪	Shangbahong	Tangwang	Settlement	Qinghai Atlas
桑寺哥	Sangsige	Kayue	Settlement	Qinghai Atlas
里家台	Lijiatai	Kayue	Settlement	Qinghai Atlas
保家台	Baojiatai	Kayue	Settlement	Qinghai Atlas
保家	Baojia	Kayue	Settlement	Qinghai Atlas
张卡山	Zhangkashan	Tangwang	Settlement	Qinghai Atlas
庙古台	Miaogutai	Kayue	Settlement	Qinghai Atlas
老幼堡	Laoyoubao	Kayue	Settlement	Qinghai Atlas
上湾	Shangwan	Kayue	Settlement	Qinghai Atlas
上转嘴	Shangzhuanzui	Kayue	Settlement	Qinghai Atlas
糜子湾	Miziwan	Kayue	Settlement	Qinghai Atlas
下寨	Xiazhai	Kayue	Settlement	Qinghai Atlas

旱沟	Hangou	Qijia_Kayue	Settlement	Qinghai Atlas
曹家（互助）	Caojia(Huzhu)	Kayue	Settlement	Qinghai Atlas
石梯	Shiti	Kayue	Settlement	Qinghai Atlas
华科	Huake	Kayue	Settlement	Qinghai Atlas
拉目台	Lamutai	Kayue	Settlement	Qinghai Atlas
西纳	Xina	Kayue	Settlement	Qinghai Atlas
纳亚湾	Nayawan	Kayue	Settlement	Qinghai Atlas
杨巴台	Yangbatai	Kayue	Settlement	Qinghai Atlas
小寺沟	Xiaosigou	Kayue	Settlement	Qinghai Atlas
拉科	Lake	Kayue	Settlement	Qinghai Atlas
大寺沟	Dasigou	Kayue	Settlement	Qinghai Atlas
卡阳	Kayang	Kayue	Settlement	Qinghai Atlas
马家台	Majiatai	Kayue	Settlement	Qinghai Atlas
白阳口	Baiyangkou	Kayue	Settlement	Qinghai Atlas
白崖（湟中）	Baiya	Kayue	Settlement	Qinghai Atlas

峡口（湟中）	Xiakou	Kayue	Burial	Qinghai Atlas
白崖湾	Baiyawan	Kayue	Settlement	Qinghai Atlas
民族村	Minzucun	Kayue_Han	Settlement	Qinghai Atlas
红林西	Honglinxi	Kayue	Settlement	Qinghai Atlas
南门	Nanmen	Kayue	Settlement	Qinghai Atlas
红林遗址	Honglin	Kayue	Settlement	Qinghai Atlas
红林墓群	Honglin	Kayue_Han	Burial	Qinghai Atlas
千西	Qianxi	Kayue	Burial	Qinghai Atlas
塔干	Tagan	Kayue	Settlement	Qinghai Atlas
上鲁尔加遗址	Shangluerjia	Kayue	Settlement	Qinghai Atlas
上鲁尔加墓群	Shangluerjia	Kayue	Burial	Qinghai Atlas
农科	Nongke	Kayue	Settlement	Qinghai Atlas
曼古坡	Mangupo	Kayue	Settlement	Qinghai Atlas
塔尔沟	Taergou	Kayue	Burial	Qinghai Atlas

马营	Maying	Kayue	Burial	Qinghai Atlas
丁家崖	Dingjiaya	Kayue	Burial	Qinghai Atlas
甘家（湟中县北部）	Ganjia	Kayue	Burial	Qinghai Atlas
大路	Dalu	Kayue	Burial	Qinghai Atlas
新添堡（湟中）	Xintianbao(Huangzhong)	Kayue	Settlement	Qinghai Atlas
河湾	Hewan	Kayue	Burial	Qinghai Atlas
牛家台	Niujiatai	Kayue	Burial	Qinghai Atlas
包家	Baojia	Kayue	Settlement	Qinghai Atlas
王家（湟中）	Wangjia(Huangzhong)	Kayue_Han	Settlement	Qinghai Atlas
柳树湾（湟中）	Liushuwan(Huangzhong)	Kayue	Burial	Qinghai Atlas
董家湾	Dongjiawan	Kayue	Burial	Qinghai Atlas
泉台地	Quantaidi	Kayue	Burial	Qinghai Atlas
崖头（湟中）	Yatou	Kayue	Burial	Qinghai Atlas

小河湾	Xiaohewan	Kayue	Burial	Qinghai Atlas
庙嘴	Miaozui	Kayue	Settlement	Qinghai Atlas
毛儿刺沟	Maoercigou	Kayue	Settlement	Qinghai Atlas
合尔营遗址	Heerying	Kayue	Settlement	Qinghai Atlas
合尔营墓群	Heerying	Kayue_Han	Burial	Qinghai Atlas
下营（湟中）	Xiaying	Kayue	Settlement	Qinghai Atlas
上寺南	Shangsinan	Qijia_Kayue	Settlement	Qinghai Atlas
花家台	Huajiatai	Tangwang_Han	Settlement	Qinghai Atlas
羊圈北	Yangjuanbei	Kayue_Han	Settlement	Qinghai Atlas
松木石	Songmushi	Kayue	Settlement	Qinghai Atlas
扎洞口	Zhadongkou	Kayue	Burial	Qinghai Atlas
丰胜	Fengsheng	Majiayao_Kayue	Settlement	Qinghai Atlas
下石城	Xiashicheng	Kayue_Tangwang	Settlement	Qinghai Atlas
石板沟	Shibangou	Kayue	Settlement	Qinghai Atlas

拉卡山墓群	Lakashan	Kayue	Burial	Qinghai Atlas
拉卡山遗址	Lakashan	Kayue	Settlement	Qinghai Atlas
本布台	Benbutai	Qijia_Kayue	Settlement	Qinghai Atlas
白崖山	Baiyashan	Kayue	Settlement	Qinghai Atlas
大崖沟	Dayagou	Kayue	Burial	Qinghai Atlas
小寨(湟中)	Xiaozhai(Huangzhong)	Kayue	Burial	Qinghai Atlas
韦家庄	Weijiazhuang	Kayue_Han	Burial	Qinghai Atlas
黑嘴	Heizui	Qijia_Kayue_Han	Settlement	Qinghai Atlas
奔巴口遗址	Benbakou	Kayue	Settlement	Qinghai Atlas
目尔加	Muerjia	Kayue	Settlement	Qinghai Atlas
芦草坡	Lucaopo	Tangwang	Settlement	Qinghai Atlas
中村	Zhongcun	Kayue	Settlement	Qinghai Atlas
下油房	Xiayoufang	Kayue	Burial	Qinghai Atlas
甘氏	Ganshi	Kayue	Burial	Qinghai Atlas

泉沟	Quangou	Kayue	Burial	Qinghai Atlas
麻尔	Maer	Kayue	Burial	Qinghai Atlas
朱路湾	Zhuluwan	Kayue	Settlement	Qinghai Atlas
石城	Shicheng	Kayue	Burial	Qinghai Atlas
苏尔吉	Suerji	Kayue	Burial	Qinghai Atlas
盘道	Pandao	Kayue	Settlement	Qinghai Atlas
窑洞坡	Yaodongpo	Kayue	Settlement	Qinghai Atlas
南村	Nancun	Kayue	Burial	Qinghai Atlas
上马申	Shangmashen	Kayue_Han	Settlement	Qinghai Atlas
新庄（湟中）	Xinzhuang(Huangzhong)	Kayue_Han	Settlement	Qinghai Atlas
泉湾	Quanwan	Kayue	Settlement	Qinghai Atlas
曼达台	Mandatai	Kayue	Burial	Qinghai Atlas
萱麻湾	Xuanmawan	Kayue	Settlement	Qinghai Atlas
甘河	Ganhe	Kayue	Settlement	Qinghai Atlas
旱滩	Hantan	Kayue	Burial	Qinghai Atlas

上朱家	Shangzhujia	Kayue	Settlement	Qinghai Atlas
下扎扎	Xiazhazha	Kayue	Burial	Qinghai Atlas
马洞门	Madongmen	Kayue	Settlement	Qinghai Atlas
坡东	Podong	Kayue	Settlement	Qinghai Atlas
前窑	Qianyao	Kayue	Settlement	Qinghai Atlas
下麻尔	Xiamaer	Kayue	Settlement	Qinghai Atlas
冰沟口	Binggoukou	Kayue	Settlement	Qinghai Atlas
上扎扎	Shangzhazha	Kayue	Burial	Qinghai Atlas
羊毛村	Yangmaocun	Kayue	Burial	Qinghai Atlas
尕阳坡	Gayangpo	Kayue	Settlement	Qinghai Atlas
半截沟	Banjiegou	Kayue	Settlement	Qinghai Atlas
大才坡	Dacaipo	Kayue	Burial	Qinghai Atlas
大才	Dacai	Kayue	Settlement	Qinghai Atlas
甘家（湟中县中部）	Ganjia(Central Huangzhong)	Kayue	Settlement	Qinghai Atlas

墩背后	Dunbeihou	Kayue	Settlement	Qinghai Atlas
前沟（湟中）	Qiangou	Kayue	Burial	Qinghai Atlas
扎子	Zhazi	Kayue	Burial	Qinghai Atlas
白土庄（湟中）	Baituzhuang	Kayue_Han	Settlement	Qinghai Atlas
下营西	Xiayingxi	Kayue	Settlement	Qinghai Atlas
葛二	Ger	Kayue	Settlement	Qinghai Atlas
西两其	Xiliangqi	Kayue	Burial	Qinghai Atlas
东两其	Dongliangqi	Kayue	Burial	Qinghai Atlas
斜路	Xielu	Kayue	Settlement	Qinghai Atlas
张家（湟中）	Zhangjia	Kayue	Settlement	Qinghai Atlas
柴沟台	Chaigoutai	Kayue	Burial	Qinghai Atlas
柳树湾（湟中）	Liushuwan	Kayue_Han	Settlement	Qinghai Atlas
祁家（湟中）	Qijia(Huangzhong)	Kayue	Settlement	Qinghai Atlas
清河	Qinghe	Kayue	Settlement	Qinghai Atlas

清水河	Qingshuihe	Bronze age	Settlement	Qinghai Atlas
杏树园	Xingshuyuan	Kayue	Burial	Qinghai Atlas
水口地	Shuikoudi	Kayue	Settlement	Qinghai Atlas
山城湾	Shanchengwan	Kayue	Burial	Qinghai Atlas
总南	Zongnan	Kayue_Han	Settlement	Qinghai Atlas
泉儿湾	Quanerwan	Kayue	Burial	Qinghai Atlas
新庄（湟中)	Xinzhuang(Huangzhong)	Kayue	Burial	Qinghai Atlas
黄泥滩	Huangnitan	Kayue	Settlement	Qinghai Atlas
逯家寨	Lujiazhai	Kayue	Burial	Qinghai Atlas
西花园	Xihuayuan	Kayue	Settlement	Qinghai Atlas
东花园	Donghuayuan	Kayue	Settlement	Qinghai Atlas
东沟	Donggou	Kayue	Burial	Qinghai Atlas
寺尔寨西	Sierzhaixi	Kayue	Settlement	Qinghai Atlas
西堡	Xibao	Kayue	Settlement	Qinghai Atlas
下塬	Xiayuan	Qijia_Kayue	Burial	Qinghai Atlas

南山沟	Nanshangou	Kayue	Burial	Qinghai Atlas
庙台子（湟中）	Miaotaizi	Kayue	Burial	Qinghai Atlas
西堡村	Xipucun	Kayue	Settlement	Qinghai Atlas
新平	Xinping	Kayue	Settlement	Qinghai Atlas
谢家台	Xiejiatai	Kayue	Settlement	Qinghai Atlas
石沟（湟中）	Shigou(Huangzhong)	Kayue	Settlement	Qinghai Atlas
梁家墓群	Liangjia	Kayue	Burial	Qinghai Atlas
梁家遗址	Liangjia	Kayue	Settlement	Qinghai Atlas
李家台	Lijiatai	Kayue	Settlement	Qinghai Atlas
新村（湟中）	Xincun(Huangzhong)	Kayue	Settlement	Qinghai Atlas
永丰遗址	Yongfeng	Kayue	Settlement	Qinghai Atlas
下河滩遗址（湟中）	Xiahetan	Kayue	Settlement	Qinghai Atlas
下方地	Xiafangdi	Kayue	Settlement	Qinghai Atlas

尕盖（湟中）	Gagai(Huangzhong)	Kayue	Settlement	Qinghai Atlas
上营	Shangying	Kayue	Burial	Qinghai Atlas
张家（湟中）	Zhangjia(Huangzhong)	Kayue	Settlement	Qinghai Atlas
窑洞	Yaodong	Kayue	Burial	Qinghai Atlas
坪台南	Pingtainan	Kayue	Burial	Qinghai Atlas
坪台	Pingtai	Kayue	Burial	Qinghai Atlas
永丰墓群	Yongfeng	Kayue	Burial	Qinghai Atlas
贾家台	Jiajiatai	Kayue	Settlement	Qinghai Atlas
台口岭	Taikouling	Kayue	Settlement	Qinghai Atlas
丹麻	Danma	Kayue	Burial	Qinghai Atlas
毛家台遗址	Maojiatai	Kayue	Settlement	Qinghai Atlas
毛家台墓群	Maojiatai	Kayue	Burial	Qinghai Atlas
业隆沟	Yelonggou	Kayue	Settlement	Qinghai Atlas
泗尔河	Sierhe	Kayue	Burial	Qinghai Atlas

庙后台	Miaohoutai	Qijia_Kayue	Settlement	Qinghai Atlas
大斜路台	Daxielutai	Kayue	Settlement	Qinghai Atlas
庙儿嘴台	Miaoerzuitai	Kayue	Burial	Qinghai Atlas
山崖头	Shanyatou	Kayue	Settlement	Qinghai Atlas
张家沟	Zhangjiagou	Kayue	Settlement	Qinghai Atlas
毛家寨	Maojiazhai	Kayue	Settlement	Qinghai Atlas
东沟窑滩	Donggouyaotan	Kayue	Burial	Qinghai Atlas
南门庄	Nanmenzhuang	Kayue	Settlement	Qinghai Atlas
上新庄	Shangxinzhuang	Kayue	Burial	Qinghai Atlas
南门北	Nanmenbei	Kayue	Settlement	Qinghai Atlas
申南	Shennan	Kayue	Settlement	Qinghai Atlas
下营门	Xiayingmen	Kayue	Settlement	Qinghai Atlas
下滩（湟中）	Xiatan	Kayue	Settlement	Qinghai Atlas
上庄（湟中）	Shangzhuang	Kayue	Burial	Qinghai Atlas

东台（湟中）	Dongtai	Kayue	Burial	Qinghai Atlas
下台遗址	Xiatai	Kayue	Settlement	Qinghai Atlas
下台墓群	Xiatai	Kayue	Burial	Qinghai Atlas
石嘴（湟中）	Shizui	Kayue	Settlement	Qinghai Atlas
地窑村	Diyaocun	Kayue_Jin	Settlement	Qinghai Atlas
下庄（湟中）	Xiazhuang	Kayue	Settlement	Qinghai Atlas
马脊梁	Majiliang	Kayue	Burial	Qinghai Atlas
庙儿坡	Miaoerpo	Kayue_Han	Settlement	Qinghai Atlas
徐家寨	Xujiazhai	Kayue	Burial	Qinghai Atlas
青峰	Qingfeng	Kayue	Settlement	Qinghai Atlas
莫家沟	Mojiagou	Kayue	Settlement	Qinghai Atlas
桦树湾	Huashuwan	Kayue	Burial	Qinghai Atlas
将台坡	Jiangtaipo	Kayue	Burial	Qinghai Atlas
土康	Tukang	Kayue	Settlement	Qinghai Atlas

龙依梁	Longyiliang	Kayue	Settlement	Qinghai Atlas
转嘴	Zhuanzui	Kayue	Settlement	Qinghai Atlas
下马申	Xiamashen	Kayue	Settlement	Qinghai Atlas
曲麻沟遗址	Qumagou	Bronze age	Settlement	Qinghai Atlas
年都乎村北遗址	Niangduhucunbei	Bronze age	Settlement	Qinghai Atlas
恰巴遗址	Qiaba	Bronze age	Settlement	Qinghai Atlas
杂庄遗址	Gazhuang	Bronze age	Settlement	Qinghai Atlas
年都乎墓群	Niangdughu	Neolithic to Bronze age	Burial	Qinghai Atlas
尚木德遗址	Shangmude	Bronze age	Settlement	Qinghai Atlas
加查麻遗址	Jiachama	Bronze age	Settlement	Qinghai Atlas
后台墓群	Houtai	Bronze age	Burial	Qinghai Atlas
尕庄北遗址	Gazhuangbei	Bronze age	Settlement	Qinghai Atlas
尚木德西遗址	Shangmudexi	Bronze age	Settlement	Qinghai Atlas
北坡台墓群	Beipotai	Bronze age	Burial	Qinghai Atlas

勒加遗址	Lejia	Bronze age	Settlement	Qinghai Atlas
西台遗址（同仁）	Xitai(Tongren)	Bronze age	Settlement	Qinghai Atlas
曲玛遗址	Quma	Bronze age	Settlement	Qinghai Atlas
隆务河遗址	Longwuhe	Neolithic to Bronze age	Settlement	Qinghai Atlas
旦太遗址	Dantai	Neolithic to Bronze age	Settlement	Qinghai Atlas
下吾屯西遗址	Xiawutunxi	Bronze age	Settlement	Qinghai Atlas
尕则遗址	Gaze	Neolithic to Bronze age	Settlement	Qinghai Atlas
下吾屯东北遗址	Xiawutundongbei	Bronze age	Settlement	Qinghai Atlas
双出口遗址	Shuangchukou	Bronze age	Settlement	Qinghai Atlas
杂加日遗址	Zajiari	Neolithic to Bronze age	Settlement	Qinghai Atlas
透毛遗址	Toumao	Bronze age	Settlement	Qinghai Atlas
郭羌遗址	Guoqiang	Bronze age	Settlement	Qinghai Atlas
下吾屯遗址	Xiawutun	Bronze age	Settlement	Qinghai Atlas
什哈龙遗址	Shihalong	Bronze age	Settlement	Qinghai Atlas

郭麻日东北遗址	Guomaridongbei	Bronze age	Settlement	Qinghai Atlas
什哈龙北遗址	Shihalongbei	Bronze age	Settlement	Qinghai Atlas
南当台遗址	Nandangtai	Bronze age	Settlement	Qinghai Atlas
白汉堂遗址	Baihantang	Bronze age	Settlement	Qinghai Atlas
完毛崖遗址	Wanmaoya	Bronze age	Settlement	Qinghai Atlas
新麻遗址	Xinma	Bronze age	Settlement	Qinghai Atlas
浪加遗址	Langjia	Bronze age	Settlement	Qinghai Atlas
新城东北遗址	Xinchengdongbei	Neolithic to Bronze age	Settlement	Qinghai Atlas
香拉卡遗址	Xianglaka	Bronze age	Settlement	Qinghai Atlas
杂沙日遗址	Zashari	Neolithic to Bronze age	Settlement	Qinghai Atlas
铁城山遗址	Tiechengshan	Neolithic to Bronze age	Settlement	Qinghai Atlas
城外遗址	Chengwai	Bronze age	Settlement	Qinghai Atlas
下庄西南遗址	Xiazhuangxinan	Neolithic to Bronze age	Settlement	Qinghai Atlas

保安遗址	Baoan	Neolithic to Bronze age	Settlement	Qinghai Atlas
银扎木滩遗址	Yinzhamutan	Neolithic to Bronze age	Settlement	Qinghai Atlas
尕旱地墓群	Gahandi	Bronze age	Burial	Qinghai Atlas
保安北遗址	Baoanbei	Bronze age	Settlement	Qinghai Atlas
阿吾乎墓群	Awuhu	Bronze age	Burial	Qinghai Atlas
朝阳遗址	Chaoyang	Neolithic to Bronze age	Settlement	Qinghai Atlas
哈日拉尕遗址	Harilaga	Neolithic to Bronze age	Settlement	Qinghai Atlas
下庄西北遗址	Xiazhuangxibei	Neolithic to Bronze age	Settlement	Qinghai Atlas
群吾遗址	Qunwu	Bronze age	Settlement	Qinghai Atlas
巴图遗址	Batu	Bronze age	Settlement	Qinghai Atlas
尖克遗址	Jianke	Bronze age	Settlement	Qinghai Atlas
唐克遗址	Tangke	Bronze age	Settlement	Qinghai Atlas
麻巴	Maba	Kayue	Settlement	Qinghai Atlas
东干木西遗址	Dongganmuxi	Bronze age	Settlement	Qinghai Atlas

东干木遗址	Dongganmudong	Bronze age	Settlement	Qinghai Atlas
勒合加遗址	Lehejia	Bronze age	Settlement	Qinghai Atlas
勒合加西遗址	Lehejiaxi	Bronze age	Settlement	Qinghai Atlas
勒合加北遗址	Lehejiabei	Bronze age	Settlement	Qinghai Atlas
哈区遗址	Haqu	Nuomuhong	Settlement	Qinghai Atlas
河东村东北	Hedongcundongbei	Nuomuhong	Settlement	Qinghai Atlas
东台遗址（乌兰）	Dongtai(Wulan)	Nuomuhong	Settlement	Qinghai Atlas
东台北遗址	Dongtaibei	Nuomuhong	Settlement	Qinghai Atlas
河东村西遗址	Heduodongcunxi	Nuomuhong	Settlement	Qinghai Atlas
岗梁	Gangliang	Nuomuhong	Settlement	Qinghai Atlas
下杂巴遗址	Xiazaba	Nuomuhong	Settlement	Qinghai Atlas
下杂巴西南遗址	Xiazabaxinan	Nuomuhong	Settlement	Qinghai Atlas
杂巴坎沿遗址	Zabakanyan	Nuomuhong	Settlement	Qinghai Atlas

阿伊河	Ayihe	Nuomuhong	Settlement	Qinghai Atlas
金子海	Jinzihai	Nuomuhong	Settlement	Qinghai Atlas
白水河遗址	Baishuihe	Nuomuhong	Settlement	Qinghai Atlas
宗务隆	Zongwulong	Nuomuhong	Settlement	Qinghai Atlas
塔日木里	Tarimuli	Nuomuhong	Settlement	Qinghai Atlas
德令哈遗址	Delingha	Nuomuhong	Settlement	Qinghai Atlas
白水河西遗址	Baishuihexi	Nuomuhong	Settlement	Qinghai Atlas
茶布加格齐	Chabujiageqi	Nuomuhong	Settlement	Qinghai Atlas
金泉	Jinquan	Nuomuhong	Settlement	Qinghai Atlas
香日德西遗址	Xiangridexi	Nuomuhong	Settlement	Qinghai Atlas
柴新西遗址	Chaixinxi	Nuomuhong	Settlement	Qinghai Atlas
下柴开遗址	Xiachaikai	Nuomuhong	Settlement	Qinghai Atlas
柴新南遗址	Chaixinnan	Nuomuhong	Settlement	Qinghai Atlas
拔拉毛	Balamao	Nuomuhong	Settlement	Qinghai Atlas

察汗乌苏遗址	Chahanwusu	Nuomuhong	Settlement	Qinghai Atlas
沙坎沿遗址	Shakanyan	Nuomuhong	Settlement	Qinghai Atlas
香日德遗址	Xiangride	Nuomuhong	Settlement	Qinghai Atlas
铁木	Tiemu	Nuomuhong	Settlement	Qinghai Atlas
夏日他拉	Xiaritala	Nuomuhong	Settlement	Qinghai Atlas
河北遗址（都兰）	Hebei(Dulan)	Nuomuhong	Settlement	Qinghai Atlas
河北村西遗址	Hebeicunxi	Nuomuhong	Settlement	Qinghai Atlas
河北村南遗址	Hebeicunnan	Nuomuhong	Settlement	Qinghai Atlas
沙珠玉	Shazhuyu	Nuomuhong	Settlement	Qinghai Atlas
英德尔（都兰）	Yingdeer	Nuomuhong	Settlement	Qinghai Atlas
科日	Keri	Nuomuhong	Settlement	Qinghai Atlas
宗加	Zonga	Nuomuhong	Settlement	Qinghai Atlas
红旗遗址	Hongqi	Kayue	Settlement	Qinghai Atlas
宁曲加拉遗址	Ningqujiala	Kayue	Settlement	Qinghai Atlas

龙曲	Longqu	Kayue	Settlement	Qinghai Atlas
河西（兴海）	Hexi(Xinghai)	Kayue	Settlement	Qinghai Atlas
东果滩	Donggodan	Majiayao_Kayue	Settlement	Qinghai Atlas
羊曲	Yangqu	Majiayao_Kayue	Settlement	Qinghai Atlas
南坎沿（乙）遗址	NankangyanB	Majiayao_Kayue	Settlement	Qinghai Atlas
红土坡（兴海）	Hongtupo(Xinhai)	Majiyao_Kayue	Settlement	Qinghai Atlas
乔什旦	Qiaoshidan	Kayue	Settlement	Qinghai Atlas
东拉坡	Donglapo	Kayue	Settlement	Qinghai Atlas
加拉遗址	Jiala	Kayue	Settlement	Qinghai Atlas
下塘台	Xiatangtai	Kayue	Settlement	Qinghai Atlas
郭米	Goumi	Kayue	Settlement	Qinghai Atlas
河北遗址（祁连）	Hebei(Qilian)	Kayue	Settlement	Qinghai Atlas
寺沟口	Sigoukou	Kayue	Settlement	Qinghai Atlas
绵沙湾	Mianshawan	Kayue	Settlement	Qinghai Atlas

八宝	Babao	Kayue	Settlement	Qinghai Atlas
白石崖	Baishiya	Kayue	Settlement	Qinghai Atlas
祁连	Qilian	Kayue	Settlement	Qinghai Atlas
俄博	Ebo	Kayue	Settlement	Qinghai Atlas
清水沟	Qingshugou	Kayue	Settlement	Qinghai Atlas
三角城西	Sanjiaochengxi	Kayue	Settlement	Qinghai Atlas
沙柳河桥西遗址	Shaliuheqiaoxi	Qijia_Kayue	Settlement	Qinghai Atlas
刚察	Guncha	Kayue	Settlement	Qinghai Atlas
扎卡拉瓦	Zhakalawa	Kayue	Settlement	Qinghai Atlas
沙柳河遗址	Shaliuhe	Kayue_Tangwang	Settlement	Qinghai Atlas
石崖（祁连）	Shiya	Kayue	Settlement	Qinghai Atlas
鸟岛遗址	Niaodao	Kayue	Settlement	Qinghai Atlas
立新东	Lixindong	Kayue	Settlement	Qinghai Atlas
立新西北	Lixinxibei	Kayue	Settlement	Qinghai Atlas

海晏	Haiyan	Kayue	Settlement	Qinghai Atlas
银滩	Yintan	Kayue	Settlement	Qinghai Atlas
小山坡	Xiaoshanpo	Kayue	Settlement	Qinghai Atlas
海峰	Haifeng	Kayue	Settlement	Qinghai Atlas
建设掌	Jianshezhang	Kayue	Settlement	Qinghai Atlas
俄博掌	Ebozhang	Kayue	Settlement	Qinghai Atlas
仓开	Cangkai	Kayue	Settlement	Qinghai Atlas
月落石崖	Yueluoshiya	Kayue	Settlement	Qinghai Atlas
新庄坡遗址	Xinzhuangpo	Tangwang	Settlement	Qinghai Atlas
山城坪遗址	Shanchengping	Tangwang	Settlement	Qinghai Atlas
李二堡遗址	Lierbao	Machang_Tangwang	Settlement	Qinghai Atlas
草台遗址	Caotai	Machang_Kayue	Settlement	Qinghai Atlas
阴山遗址	Yinshan	Majiayao_Banshan_Machang_Tangwang	Settlement	Qinghai Atlas
康家寨墓群	Kangjiazhai	Kayue	Burial	Qinghai Atlas

康家遗址	Kangjia	Kayue	Settlement	Qinghai Atlas
上孙家寨遗址	Shangsunjiazhai	Majiayao_Qijia_Kayue_Xindian	Settlement	Qinghai Atlas
寺沟	Sigou	Qijia_Tangwang	Settlement	Qinghai Atlas
韩家山	Hanjiashan	Kayue	Settlement	Qinghai Atlas
旧庄台	Jiuzhuangtai	Kayue	Settlement	Qinghai Atlas
宋家庄	Songjiazhuang	Kayue	Settlement	Qinghai Atlas
尕庙	Gamiao	Kayue	Settlement	Qinghai Atlas
龙王庙台	Longwangmiaotai	Kayue	Settlement	Qinghai Atlas
鲍家寨	Baojiazhai	Kayue	Burial	Qinghai Atlas
黄东	Huangdong	Qijia_Kayue_Han	Burial	Qinghai Atlas
黄西	Huangxi	Kayue	Settlement	Qinghai Atlas
新添堡（大通）	Xintianbao(Datong)	Kayue	Settlement	Qinghai Atlas
贺家寨	Hejiazhai	Kayue	Settlement	Qinghai Atlas
平乐北	Pinglebei	Kayue	Settlement	Qinghai Atlas
山城台	Shanchengtai	Kayue	Settlement	Qinghai Atlas

菜子口	Caizikou	Kayue	Settlement	Qinghai Atlas
龙眼口	Longyankou	Kayue	Settlement	Qinghai Atlas
阿家堡	Ajiabao	Majiayao_Han	Settlement	Qinghai Atlas
玛尼台	Manitai	Kayue_Tangwang	Settlement	Qinghai Atlas
猫儿刺坡	Maoercipo	Kayue	Settlement	Qinghai Atlas
台子（大通）	Taizi(Datong)	Kayue	Settlement	Qinghai Atlas
元墩子	Yuandunzi	Kayue	Burial	Qinghai Atlas
园台	Yuantai	Kayue	Settlement	Qinghai Atlas
田家沟	Tianjiagou	Kayue	Burial	Qinghai Atlas
流水口	Liushuikou	Kayue_Tangwang	Burial	Qinghai Atlas
东庄(大通)	Dongzhuang(大通)	Kayue	Settlement	Qinghai Atlas
寺鼻梁	Sibiliang	Kayue	Settlement	Qinghai Atlas
王庄东	Wangzhuangdong	Kayue	Settlement	Qinghai Atlas
王庄	Wangzhuang	Kayue	Burial	Qinghai Atlas
上尖巴	Shangjianba	Kayue	Settlement	Qinghai Atlas

上旧庄	Shangjiuzhuang	Kayue	Settlement	Qinghai Atlas
业坝台	Yebatai	Kayue	Settlement	Qinghai Atlas
庙台	Miaotai	Kayue	Burial	Qinghai Atlas
河滩庄	Hetanzhuang	Kayue	Settlement	Qinghai Atlas
本康滩	Benkangtan	Kayue	Settlement	Qinghai Atlas
桥尔沟	Qiaoergou	Kayue	Settlement	Qinghai Atlas
甘沟	Gangou	Kayue	Settlement	Qinghai Atlas
向阳	Xiangyang	Kayue	Settlement	Qinghai Atlas
口子庄	Kouzizhuang	Kayue	Settlement	Qinghai Atlas
上柴	Shangchai	Kayue	Settlement	Qinghai Atlas
故鲁坡	Gulupo	Kayue	Settlement	Qinghai Atlas
阳坡根(大通)	Yangpogen(Datong)	Kayue	Settlement	Qinghai Atlas
王庙台	Wangmiaotai	Kayue	Settlement	Qinghai Atlas
小寨西北	Xiaozhaixibei	Kayue	Settlement	Qinghai Atlas
小寨	Xiaozhai	Kayue	Settlement	Qinghai Atlas

山城遗址	Shancheng	Kayue_Xindian	Settlement	Qinghai Atlas
苏家堡	Sujiabao	Kayue	Settlement	Qinghai Atlas
甘树湾	Ganshuwan	Kayue	Settlement	Qinghai Atlas
苏家（大通）	Sujia(Sujia)	Kayue	Burial	Qinghai Atlas
岗冲	Gangchong	Kayue	Burial	Qinghai Atlas
上关（大通）	Shangguan(Datong)	Kayue	Settlement	Qinghai Atlas
前二村	Qianercun	Kayue	Settlement	Qinghai Atlas
下和衷	Xiahezhong	Kayue	Settlement	Qinghai Atlas
逊布台	Xunbutai	Kayue	Settlement	Qinghai Atlas
塔哇（大通）	Tawa(Datong)	Kayue	Settlement	Qinghai Atlas
张家庄	Zhangjiazhuang	Kayue	Settlement	Qinghai Atlas
阳坡庄	Yangpozhuang	Kayue	Settlement	Qinghai Atlas
冶家庄	Yejiazhuang	Kayue	Settlement	Qinghai Atlas
上崖根	Shangyagen	Kayue_Han	Settlement	Qinghai Atlas

沙巴图	Shabatu	Kayue_Tangwang	Settlement	Qinghai Atlas
龙卧尕庄	Longwogazhuang	Kayue	Settlement	Qinghai Atlas
下宽	Xiakuan	Kayue_Tangwang	Settlement	Qinghai Atlas
中庄（大通）	Zhongzhuang(大通)	Kayue	Settlement	Qinghai Atlas
贺家庄	Hejiazhuang	Kayue	Settlement	Qinghai Atlas
吕顺	Lushun	Kayue_Tangwang	Burial	Qinghai Atlas
马场村	Machangcun	Kayue	Settlement	Qinghai Atlas
瓦窑滩	Wayaotan	Kayue	Settlement	Qinghai Atlas
水草滩	Shuicaotan	Kayue	Settlement	Qinghai Atlas
宝库	Baoku	Kayue	Settlement	Qinghai Atlas
泉儿湾	Quanerwan	Kayue	Burial	Qinghai Atlas
上寺嘴	Shangsizui	Kayue	Settlement	Qinghai Atlas
苏呼沙（撒）	Suhusa	Kayue	Burial	Qinghai Atlas
尕庄	Gazhuang	Machang_Qijia	Settlement	Qinghai Atlas
德能	Deneng	Kayue	Settlement	Qinghai Atlas

阿什扎河口	Ashizhahekou	Kayue	Settlement	Qinghai Atlas
哈尔干台	Haergantai	Kayue	Settlement	Qinghai Atlas
阳坡（乐都）	Yangpo(Ledu)	Kayue	Settlement	Qinghai Atlas
普卡贡玛	Pukagongma	Bronze age	Burial	Ren et al. 2017
罕额依遗址	Haneyi	Neolithic	Settlement	Sichuan Atlas
金川县商周遗址群	Jinchuan site complex	Neolithic	Settlement	Sichuan Atlas
庄上村遗址	Zhuangshangcun	Neolithic to Warring State	Settlement	Sichuan Atlas
舍联村遗址	Sheliancun	Shang to Warring State	Settlement	Sichuan Atlas
为舍村遗址	Weishecun	Shang to Warring State	Settlement	Sichuan Atlas
汤坝村遗址	Tangbacun	Shang to Warring State	Settlement	Sichuan Atlas
塔子坪遗址	Taziping	Shang to Warring State	Settlement	Sichuan Atlas
四嘎坝遗址	Sigaba	Neolithic to Tang	Settlement	Sichuan Atlas
坪上遗址（泸定）	Pingshang	Shang to Warring State	Settlement	Sichuan Atlas

小咱里遗址	Xiaozali	Shang to Warring State	Settlement	Sichuan Atlas
扎金顶石棺葬群	Zhajinding	Warring State to Han	Burial	Sichuan Atlas
汤古石棺葬群	Tanggu	Warring State to Han	Burial	Sichuan Atlas
呷拉石棺葬群	Gala	Qin to Han	Burial	Sichuan Atlas
卡莎湖	Kashahu	Bronze age	Burial	Sichuan Atlas
城中石棺葬	Chengzhong	Shang to Spring and Autumn	Burial	Sichuan Atlas
城西石棺葬	Chengxi	Warring State	Burial	Sichuan Atlas
喇格石棺葬群	Lage	Warring State	Burial	Sichuan Atlas
格学遗址	Gexue	Shang to Zhou	Settlement	Sichuan Atlas
格学石棺葬	Gexue	Warring State to Han	Burial	Sichuan Atlas
喇格石棺葬群	Lage	Warring State to Han	Burial	Sichuan Atlas
石波寨遗址	Shibozhai	Shang to Zhou	Settlement	Sichuan Atlas
夏古寨遗址	Xiaguzhai	Shang to Zhou	Settlement	Sichuan Atlas

吞木多遗址	Tunmuduo	Shang to Zhou	Settlement	Sichuan Atlas
地俄寨遗址	Diezhai	Shang to Zhou	Settlement	Sichuan Atlas
吉拉遗址	Jila	Shang to Zhou	Settlement	Sichuan Atlas
布康木达遗址	Bukangmuda	Shang to Zhou	Settlement	Sichuan Atlas
旦木克寨遗址	Danmukezhai	Shang to Zhou	Settlement	Sichuan Atlas
夏炎遗址	Xiayan	Shang to Zhou	Settlement	Sichuan Atlas
满地黑寨遗址	Mandiheizhai	Shang to Zhou	Settlement	Sichuan Atlas
啄昆遗址	Pecun site	Shang to Zhou	Settlement	Sichuan Atlas
通化石棺葬墓群	Tonghua	Warring State to Han	Burial	Sichuan Atlas
大坪石棺葬墓群	Daping	Warring State to Han	Burial	Sichuan Atlas
马奔石棺葬墓群	Maben	Warring State to Han	Burial	Sichuan Atlas
昭店石棺葬墓群	Zhaodian	Spring and Autumn	Burial	Sichuan Atlas
涂禹山石棺葬墓群	Tuyushan	Warring State to Han	Burial	Sichuan Atlas

阳岭石棺葬墓群	Yangling	Warring State to Han	Burial	Sichuan Atlas
无极黑石棺葬墓群	Wujihei	Warring State to Han	Burial	Sichuan Atlas
牟托石棺葬墓群	Muto	Warring State	Burial	Sichuan Atlas
拖布石棺葬墓群	Tuobu	Warring State to Han	Burial	Sichuan Atlas
石鼓石棺葬墓群	Shigu	Warring State to Han	Burial	Sichuan Atlas
宗渠石棺葬墓群	Zongqu	Warring State to Han	Burial	Sichuan Atlas
马良坪石棺葬墓群	Maliangping	Warring State to Han	Burial	Sichuan Atlas
营盘山石棺葬墓群	Yingpanshan	Warring State to Han	Burial	Sichuan Atlas
马良坪遗址	Maliangping	Neolithic to Bronze age	Settlement	Sichuan Atlas
纳窝石棺墓群	Rongwo	Warring State to Han	Burial	Sichuan Atlas
河心坝西石棺墓群	Hexinbaxi	Warring State to Han	Burial	Sichuan Atlas
河心坝石棺葬墓群	Hexinba	Spring and Autumn to Warring State	Burial	Sichuan Atlas
勒石	Leshi	Bronze_age to Han	Settlement	Sichuan Atlas

蒲角顶	Pujiaoding	Bronze_age	Settlement	Sichuan Atlas
吉里龙	Jililong	Bronze_age	Burial	Sichuan Atlas
孔龙	Konglong	Bronze age	Settlement	Sichuan Atlas
热底垄墓群	Redilong	Early metal age	Burial	Sichuan Univ
格林塘墓地	Gelintang	Early metal age	Burial	Sichuan University and Xizang et al. 2008
萨松塘墓群	Sasongtang	Early metal age	Burial	Sichuan University and Xizang et al. 2008
格布赛鲁遗址	Gebusailu	Early metal age	Burial	Sichuan University et al. 2001
吉翁遗址	Jiwen	Early metal age	Settlement	Sichuan University Unpublished Data
日波遗址	Ribo(site)	Early metal age	Settlement	Sichuan University

				Unpublished Data
日波墓地	Ribo(cemetery)	Early metal age	Burial	Sichuan University Unpublished Data
吉翁墓地	Jiwen(cemetery)	Early metal age	Burial	Sichuan University Unpublished Data
日巴冈遗址	Ribagang	Early metal age	Settlement	Sichuan University Unpublished Data
卡基墓地	Kaji	Early metal age	Burial	Sichuan University Unpublished Data
扎布遗址	Zhabu	Early metal age	Settlement	Sichuan University Unpublished Data
却丹嘎琼遗址	Quedangaqiong (site)	Early metal age	Settlement	Sichuan University

				Unpublished Data
却丹嘎琼墓地	Quedangaqiong (cemetery)	Early metal age	Burial	Sichuan University Unpublished Data
果札遗址	Guozha(site)	Early metal age	Settlement	Sichuan University Unpublished Data
果札墓地	Guozha(cemetery)	Early metal age	Burial	Sichuan University Unpublished Data
萨若遗址	Saruo	Early metal age	Settlement	Sichuan University Unpublished Data
冷嘎塘墓地	Lenggatang	Early metal age	Burial	Sichuan University Unpublished Data
札布墓地	Zhabu(cemetery)	Early metal age	Burial	Sichuan University

				Unpublished Data
朗布钦墓地	Langbuqin	Early metal age	Burial	Sichuan University Unpublished Data
曲松果墓群	Qusongguo	Early metal age	Burial	Sichuan_Univ
昌果沟遗址	Changguogou	Early metal age	Settlement	Tang et al. 2020
邦唐布	Bangtangbu	Early metal age	Settlement	Tang et al. 2021
泽本遗址	Zeben	Stone age	Settlement	Tibet Atlas
纳恰墓群	Naqia	Early metal age	Burial	Tibet Atlas
查库尔墓群	Chakuer	Early metal age	Burial	Tibet Atlas
拉托墓群	Latuo	Early metal age	Burial	Tibet Atlas
宗朵墓地	Zongduo	Early metal age	Burial	Tibet Atlas
甲尼玛列石遗址	Jianima	Early metal age	Standing_stone	Tibet Atlas
角如列石遗址	Jiaoru	Early metal age	Standing_stone	Tibet Atlas

扎西岛岩画	Zhaxidao	Early metal age	Rock_art	Tibet Atlas
其多山岩画	Qiduoshan	Early metal age	Rock_art	Tibet Atlas
嘎冲遗址	Gachong	Early metal age	Settlement	Tibet Atlas
益其遗址	Yiqi	Early metal age	Settlement	Tibet Atlas
达龙查遗址	Dalongcha	Early metal age	Settlement	Tibet Atlas
乌坚古如	Wujianguru	Early metal age	Burial	Tibet Atlas
章达宁布	Zhangdaningbu	Early metal age	Burial	Tibet Atlas
柔扎	Rouzha	Early metal age	Settlement	Tibet Atlas
查加沟	Chajiagou	Early metal age	Burial	Tibet Atlas
玛尼当	Manidang	Early metal age	Burial	Tibet Atlas
聂荣	Nierong	Early metal age	Burial	Tibet Atlas
库久塔	Kujiuta	Early metal age	Burial	Tibet Atlas
加拉曲下	Jialaquxia	Early metal age	Burial	Tibet Atlas
布玛	Buma	Early metal age	Burial	Tibet Atlas

帕嘎	Paga	Early metal age	Burial	Tibet Atlas
加错拉	Jiacuola	Early metal age	Settlement	Tibet Atlas
打拉绒	Dalarong	Early metal age	Settlement	Tibet Atlas
其布隆沟墓群	Qibulonggou	Early metal age	Burial	Tibet Atlas
江钦遗址	Jiangqin	Stone age	Settlement	Tibet Atlas
江热墓葬	Jiangre	Early metal age	Burial	Tibet Atlas
森格墓群	Senge	Early metal age	Burial	Tibet Atlas
相皮墓群	Xiangpi	Early metal age	Burial	Tibet Atlas
查那秀墓地	Chanaxiu	Early metal age	Burial	Tibet Atlas
卡定遗址	Kading	Early metal age	Settlement	Tibet Atlas
帕拉岗	Palagang	Bronze age	Burial	Tibet Atlas
芦布湖岩画	Lubuhu	Early metal age	Rock_art	Tibet Atlas
左用湖岩画	Zuoyonghu	Early metal age	Rock_art	Tibet Atlas
下曲垄岩画	Xiaqulong	Early metal age	Rock_art	Tibet Atlas

卡尔普墓群	Kaerpu	Early metal age	Settlement	Tibet Atlas
昂札布遗址	Angzhabu	Early metal age	Settlement	Tibet Atlas
陇布沟墓地	Longbugou	Early metal age	Burial	Tibet Atlas
辛卡遗址	Xinka	Early metal age	Settlement	Tibet Atlas
日冬墓地	Ridong	Early metal age	Burial	Tibet Atlas
门土墓葬	Mentu	Early metal age	Burial	Tibet Atlas
色宁沟	Seninggou_	Early metal age	Rock_art	Tibet Atlas
萨冈岩画	Sagang	Early metal age	Rock_art	Tibet Atlas
朵让	Duorang	Early metal age	Settlement	Tibet Atlas
江扎遗址	Jiangzha	Early metal age	Settlement	Tibet Atlas
琼宗遗址	Qiongzong	Early metal age	Settlement	Tibet Atlas
N/A	Zhajiongema	Early metal age	Settlement	Tibet Atlas
加林山岩画	Jialinshan	Early metal age	Rock_art	Tibet Atlas
军雄岩画	Junxiong	Early metal age	Rock_art	Tibet Atlas

乃若山墓群	Nairuoshan	Early metal age	Burial	Tibet Atlas
江热	Jiangre	Early metal age	Burial	Tibet Atlas
莫仲	Mozhong	Early metal age	Burial	Tibet Atlas
钦巴	Qinba	Early metal age	Settlement	Tibet Atlas
加热	Jiare	Early metal age	Settlement	Tibet Atlas
阿垄沟	Alonggou	Early metal age	Burial	Tibet Atlas
亚通	Yatong	Kayue	Settlement	Tibet Atlas
故如甲木墓地	Gumujiamu	Early metal age	Burial	Tong et al. 2015
曲踏墓地	Quta	Early metal age	Burial	Tong et al. 2015
下林卡墓群	Xialinka	Early metal age	Burial	TP_Atlas
曲龙遗址	Qulong	Early metal age	Settlement	Unpublished Data
加嘎子墓地	Jiagazi	Early metal age	Burial	Unpublished Data
琼窿	Khyung Lung	Early metal age	Settlement	Unpublished Data
结萨墓地	Jisa	Early metal age	Burial	Unpublished Data

阿岗绒墓地	Agangrong	Early metal age	Burial	Unpublished Data
梅隆达普洞穴遗址	Meilongdapu	Stone age	Settlement	Unpublished Data
桑达隆果墓地	Sangdalongguo	Early metal age	Burial	Unpublished Data
玛琅	Malang	Early metal age	Burial	Unpublished Data
长宁	Changning	Banshan_Qijia_Kayue_Han	Settlement	Wang 2017
拉颇遗址	Lapo	Stone age	Settlement	Wang et al. 2021
泥池村剖面 P2（NCC-P2）	NCC-P2	Early metal age	Settlement	Wang et al. 2021
加拉马（加喇嘛）遗址	Jialama	Early metal age	Settlement	Wang et al. 2021
林芝村遗址	Linzhi	Early metal age	Settlement	Wang et al. 2021
甲木卡遗址	Jiamuka	Early metal age	Settlement	Wang et al. 2021
立定遗址	Liding(site)	Stone age	Settlement	Wang et al. 2021
立定墓葬	Liding(cemetery)	Early metal age	Burial	Wang et al. 2021

居木/巴果绕村遗址	Jumu	Early metal age	Settlement	Wang et al. 2021
都普（多布）遗址	Dupu	Early metal age	Settlement	Wang et al. 2021
昌吉果墓地	Changjiguo	Early metal age	Burial	Wang et al. 2021
大具村墓群	Dajucun	Bronze age	Burial	Yunnan Atlas
格子墓群	Gezi	Bronze age	Burial	Yunnan Atlas
红岩墓群	Hongyan	Bronze age	Burial	Yunnan Atlas
比虾墓群	Bixia	Bronze age	Burial	Yunnan Atlas
克乡村墓群	Kexiang	Bronze age	Burial	Yunnan Atlas
纳古墓群	Nagu	Bronze age	Burial	Yunnan Atlas
石底墓群	Shidi	Bronze age	Burial	Yunnan Atlas
永芝	Yongzhi	Bronze age	Burial	Yunnan Atlas
布塔雄曲墓地	Butaxiongqu	Early metal age	Burial	Zhang et al. 2015
廓雄遗址	Kuoxiong	Early metal age	Settlement	Zhang et al. 2022

Appendix 5. The R script for the validation of the flow accumulation model

```
# setting the environment

setwd("the workspace of the excel sheet" )

data<- read.csv("rdm_flow_for_validation.csv")

#one sided student’s t test to see if the flow values of sites are significantly larger than random points

t.test(data$rdm,data$sites,mu=0,alt="less",conf=0.95,
    var.eq=F,paired=F)
```

Appendix 6. The matrix of ceramic attributes of the 26 selected archaeological sites for the social network analysis

Source	Target	Path_cost_scale_invert	Jaccard
Ashaonao	Bangga	0.870596467	0.567164179
Ashaonao	Banzhuwa	0.699897677	0.567164179
Ashaonao	Changguogou	0.718365836	0.586956522
Ashaonao	Chuvthag	0.693071056	0.594594595
Ashaonao	Dahuazhongzhuang	0.742258942	0.655172414
Ashaonao	Galazong	0.173806118	0.595744681
Ashaonao	Gebusailu	0.711850066	0.595238095
Ashaonao	Haneyi_third_phase	0.715492359	0.591836735
Ashaonao	Huangjiazhai	0.736402383	0.608695652
Ashaonao	Jiaritang	0.793596776	0.557377049
Ashaonao	Jililong	0.920264425	0.558139535
Ashaonao	Nagu	0.866714443	0.64
Ashaonao	Panjialiang	0.660766766	0.625
Ashaonao	Piyang_dongga	0.851870707	0.595238095
Ashaonao	Pukagongma	0.48025498	0.585365854
Ashaonao	Qugong_early_phase	0.088205421	0.633333333
Ashaonao	Shangbanzhuwa	0.500793024	0.591836735
Ashaonao	Shanpingtai	0.504544344	0.591836735
Ashaonao	Shidaqiu	0.534047284	0.594594595
Ashaonao	Shidi	0.089374505	0.583333333
Ashaonao	Suhusa	0.088812889	0.6
Ashaonao	Talitaliha	0.711843658	0.6
Ashaonao	Yingpanshan	0.718350123	0.620689655
Ashaonao	Yongzhi	0.69717473	0.642857143
Ashaonao	Zhajinding	0.517911496	0.655172414
Bangga	Ashaonao	0.61247403	0.672131148
Bangga	Banzhuwa	0.605834454	0.672131148

Bangga	Changguogou	0.624302613	0.632653061
Bangga	Chuvthag	0.599007833	0.638297872
Bangga	Dahuazhongzhuang	0.597017287	0.642857143
Bangga	Galazong	0.24331617	0.647058824
Bangga	Gebusailu	0.645747351	0.654545455
Bangga	Haneyi_third_phase	0.654269155	0.654545455
Bangga	Huangjiazhai	0.684942789	0.625
Bangga	Jiaritang	0.679635578	0.615384615
Bangga	Jililong	0.583373385	0.666666667
Bangga	Nagu	0.567821043	0.603773585
Bangga	Panjialiang	0.730276817	0.586956522
Bangga	Piyang_dongga	0.675864198	0.62962963
Bangga	Pukagongma	0.534047284	0.622641509
Bangga	Qugong_early_phase	0.879325448	0.607843137
Bangga	Shangbanzhuwa	0.303518309	0.693877551
Bangga	Shanpingtai	0.933737512	0.693877551
Bangga	Shidaqiu	0.95415165	0.632653061
Bangga	Shidi	0.29936199	0.711111111
Bangga	Suhusa	0.291755862	0.653061224
Bangga	Talitaliha	0.617780435	0.666666667
Bangga	Yingpanshan	0.6242869	0.6
Bangga	Yongzhi	0.603111508	0.596153846
Bangga	Zhajinding	0.58742158	0.638297872
Banzhuwa	Ashaonao	0.676951271	0.636363636
Banzhuwa	Bangga	0.972913727	0.636363636
Banzhuwa	Changguogou	0.999999986	0.647058824
Banzhuwa	Chuvthag	0.966087111	0.578947368
Banzhuwa	Dahuazhongzhuang	0.948884535	0.735294118
Banzhuwa	Galazong	0.332513245	0.783783784
Banzhuwa	Gebusailu	0.510997359	0.805555556

Banzhuwa	Haneyi_third_phase	0.521802753	0.769230769
Banzhuwa	Huangjiazhai	0.563407357	0.666666667
Banzhuwa	Jiaritang	0.638381944	0.666666667
Banzhuwa	Jililong	0.711751633	0.742857143
Banzhuwa	Nagu	0.656560924	0.630434783
Banzhuwa	Panjialiang	0.81947386	0.595238095
Banzhuwa	Piyang_dongga	0.732208053	0.659574468
Banzhuwa	Pukagongma	0.718350123	0.6
Banzhuwa	Qugong_early_phase	0.636050796	0.6
Banzhuwa	Shangbanzhuwa	0.246912548	0.631578947
Banzhuwa	Shanpingtai	0.639425483	0.666666667
Banzhuwa	Shidaqiu	0.624154176	0.644444444
Banzhuwa	Shidi	0.6242869	0.66
Banzhuwa	Suhusa	0.248081631	0.62745098
Banzhuwa	Talitaliha	0.247519951	0.66
Banzhuwa	Yingpanshan	0.984859708	0.608695652
Banzhuwa	Yongzhi	0.970190783	0.642857143
Banzhuwa	Zhajinding	0.765943946	0.630434783
Changguogou	Ashaonao	0.576751969	1
Changguogou	Bangga	0.605701761	0.672131148
Changguogou	Banzhuwa	0.624169889	0.655172414
Changguogou	Chuvthag	0.598875141	0.629032258
Changguogou	Dahuazhongzhuang	0.596884563	0.633802817
Changguogou	Galazong	0.25200747	0.636363636
Changguogou	Gebusailu	0.608907597	0.671875
Changguogou	Haneyi_third_phase	0.617429401	0.656716418
Changguogou	Huangjiazhai	0.648103035	0.6875
Changguogou	Jiaritang	0.642795824	0.625
Changguogou	Jililong	0.553870413	0.634920635
Changguogou	Nagu	0.530981289	0.629032258

Changguogou	Panjialiang	0.744994913	0.567164179
Changguogou	Piyang_dongga	0.643113693	0.684210526
Changguogou	Pukagongma	0.504544344	0.630769231
Changguogou	Qugong_early_phase	0.92270728	0.606060606
Changguogou	Shangbanzhuwa	0.344725319	0.75
Changguogou	Shanpingtai	0.97515153	0.727272727
Changguogou	Shidaqiu	0.95415165	0.672727273
Changguogou	Shidi	0.340568935	0.637681159
Changguogou	Suhusa	0.332962808	0.672413793
Changguogou	Talitaliha	0.617647711	0.683333333
Changguogou	Yingpanshan	0.624154176	0.6
Changguogou	Yongzhi	0.602978815	0.597014925
Changguogou	Zhajinding	0.59611288	0.629032258
Chuvthag	Ashaonao	0.655775911	0.637681159
Chuvthag	Bangga	0.985679542	0.637681159
Chuvthag	Banzhuwa	0.971462634	0.711111111
Chuvthag	Changguogou	0.982965786	0.596491228
Chuvthag	Dahuazhongzhuang	0.927709155	0.652173913
Chuvthag	Galazong	0.345104431	0.654545455
Chuvthag	Gebusailu	0.489821966	0.66
Chuvthag	Haneyi_third_phase	0.500627392	0.649122807
Chuvthag	Huangjiazhai	0.542231996	0.649122807
Chuvthag	Jiaritang	0.617206584	0.597222222
Chuvthag	Jililong	0.690576241	0.611111111
Chuvthag	Nagu	0.635385531	0.604166667
Chuvthag	Panjialiang	0.798298484	0.615384615
Chuvthag	Piyang_dongga	0.71103266	0.583333333
Chuvthag	Pukagongma	0.69717473	0.610169492
Chuvthag	Qugong_early_phase	0.614875404	0.590163934
Chuvthag	Shangbanzhuwa	0.259503734	0.589285714

Chuvthag	Shanpingtai	0.618250123	0.633333333
Chuvthag	Shidaqiu	0.602978815	0.649122807
Chuvthag	Shidi	0.603111508	0.666666667
Chuvthag	Suhusa	0.260672818	0.743589744
Chuvthag	Talitaliha	0.260111202	0.727272727
Chuvthag	Yingpanshan	0.965818309	0.568965517
Chuvthag	Yongzhi	0.970190783	0.592592593
Chuvthag	Zhajinding	0.792311518	0.6
Dahuazhongzhuang	Ashaonao	0.658498857	0.634920635
Dahuazhongzhuang	Bangga	0.676967016	0.634920635
Dahuazhongzhuang	Banzhuwa	0.651672237	0.666666667
Dahuazhongzhuang	Changguogou	0.691780904	0.588235294
Dahuazhongzhuang	Chuvthag	0.223144422	0.675675676
Dahuazhongzhuang	Galazong	0.80442727	0.697674419
Dahuazhongzhuang	Gebusailu	0.81523268	0.742857143
Dahuazhongzhuang	Haneyi_third_phase	0.857170657	0.666666667
Dahuazhongzhuang	Huangjiazhai	0.923331604	0.666666667
Dahuazhongzhuang	Jiaritang	0.951172456	0.6875
Dahuazhongzhuang	Jililong	0.871973887	0.642857143
Dahuazhongzhuang	Nagu	0.71010507	0.608695652
Dahuazhongzhuang	Panjialiang	0.915912657	0.58974359
Dahuazhongzhuang	Piyang_dongga	0.870596467	0.682926829
Dahuazhongzhuang	Pukagongma	0.53059329	0.612244898
Dahuazhongzhuang	Qugong_early_phase	0.137543725	0.634146341
Dahuazhongzhuang	Shangbanzhuwa	0.570808569	0.647058824
Dahuazhongzhuang	Shanpingtai	0.576751969	0.666666667
Dahuazhongzhuang	Shidaqiu	0.61247403	0.622222222
Dahuazhongzhuang	Shidi	0.138712809	0.607142857
Dahuazhongzhuang	Suhusa	0.138151193	0.592592593
Dahuazhongzhuang	Talitaliha	0.670444838	0.607142857

Dahuazhongzhuang	Yingpanshan	0.676951271	0.648648649
Dahuazhongzhuang	Yongzhi	0.655775911	0.641025641
Dahuazhongzhuang	Zhajinding	0.5672498	0.675675676
Galazong	Ashaonao	0.138712809	0.606060606
Galazong	Bangga	0.245935435	0.606060606
Galazong	Banzhuwa	0.248097344	0.607843137
Galazong	Changguogou	0.243221633	0.568627451
Galazong	Chuvthag	0.220811986	0.648648649
Galazong	Dahuazhongzhuang	0.688594614	0.586206897
Galazong	Gebusailu	0.001169097	0.6
Galazong	Haneyi_third_phase	0.009690901	0.611111111
Galazong	Huangjiazhai	0.045026283	0.611111111
Galazong	Jiaritang	0.120000902	0.575757576
Galazong	Jililong	0.138700573	0.6
Galazong	Nagu	0.090918128	0.703703704
Galazong	Panjialiang	0.422768574	0.604651163
Galazong	Piyang_dongga	0.206711501	0.633333333
Galazong	Pukagongma	0.089374505	0.684210526
Galazong	Qugong_early_phase	0.399120615	0.65
Galazong	Shangbanzhuwa	0.995390171	0.666666667
Galazong	Shanpingtai	0.352337629	0.62745098
Galazong	Shidaqiu	0.340568935	0.6
Galazong	Shidi	0.29936199	0.589285714
Galazong	Suhusa	0.992265357	0.588235294
Galazong	Talitaliha	0.241575166	0.603773585
Galazong	Yingpanshan	0.248081631	0.677419355
Galazong	Yongzhi	0.260672818	0.638888889
Galazong	Zhajinding	0.414346136	0.676470588
Gebusailu	Ashaonao	0.931091449	0.672413793
Gebusailu	Bangga	0.638108477	0.672413793

Gebusailu	Banzhuwa	0.656576637	0.653061224
Gebusailu	Changguogou	0.631281857	0.630434783
Gebusailu	Chuvthag	0.671390557	0.617021277
Gebusailu	Dahuazhongzhuang	0.175349741	0.625
Gebusailu	Galazong	0.837499202	0.62745098
Gebusailu	Haneyi_third_phase	0.839610334	0.636363636
Gebusailu	Huangjiazhai	0.859827547	0.620689655
Gebusailu	Jiaritang	0.887065894	0.609375
Gebusailu	Jililong	0.94054041	0.596153846
Gebusailu	Nagu	0.662310357	0.625
Gebusailu	Panjialiang	0.854493594	0.636363636
Gebusailu	Piyang_dongga	0.866714443	0.6
Gebusailu	Pukagongma	0.481798603	0.611111111
Gebusailu	Qugong_early_phase	0.089749044	0.603773585
Gebusailu	Shangbanzhuwa	0.510567147	0.588235294
Gebusailu	Shanpingtai	0.530981289	0.653846154
Gebusailu	Shidaqiu	0.567821043	0.653846154
Gebusailu	Shidi	0.090918128	0.735294118
Gebusailu	Suhusa	0.090356512	0.743589744
Gebusailu	Talitaliha	0.650054459	0.743589744
Gebusailu	Yingpanshan	0.656560924	0.58
Gebusailu	Yongzhi	0.635385531	0.627906977
Gebusailu	Zhajinding	0.519455119	0.636363636
Haneyi_third_phase	Ashaonao	0.651672237	0.727272727
Haneyi_third_phase	Bangga	0.993728303	0.727272727
Haneyi_third_phase	Banzhuwa	0.967358962	0.693877551
Haneyi_third_phase	Changguogou	0.923605481	0.634615385
Haneyi_third_phase	Chuvthag	0.327653247	0.707317073
Haneyi_third_phase	Dahuazhongzhuang	0.485718292	0.679245283
Haneyi_third_phase	Galazong	0.496523718	0.666666667

Haneyi_third_phase	Gebusailu	0.538128322	0.655172414
Haneyi_third_phase	Huangjiazhai	0.613102909	0.692307692
Haneyi_third_phase	Jiaritang	0.686472567	0.655737705
Haneyi_third_phase	Jililong	0.587861612	0.653061224
Haneyi_third_phase	Nagu	0.794194809	0.596153846
Haneyi_third_phase	Panjialiang	0.706928986	0.659574468
Haneyi_third_phase	Piyang_dongga	0.693071056	0.591836735
Haneyi_third_phase	Pukagongma	0.610771729	0.6875
Haneyi_third_phase	Qugong_early_phase	0.242052614	0.704545455
Haneyi_third_phase	Shangbanzhuwa	0.614146449	0.62745098
Haneyi_third_phase	Shanpingtai	0.598875141	0.76744186
Haneyi_third_phase	Shidaqiu	0.599007833	0.634615385
Haneyi_third_phase	Shidi	0.243221633	0.649122807
Haneyi_third_phase	Suhusa	0.242660017	0.653846154
Haneyi_third_phase	Talitaliha	0.961714635	0.708333333
Haneyi_third_phase	Yingpanshan	0.966087111	0.659090909
Haneyi_third_phase	Yongzhi	0.982965786	0.632653061
Haneyi_third_phase	Zhajinding	0.778731386	0.707317073
Huangjiazhai	Ashaonao	0.53059329	0.629032258
Huangjiazhai	Bangga	0.61759835	0.629032258
Huangjiazhai	Banzhuwa	0.636066509	0.638297872
Huangjiazhai	Changguogou	0.610771729	0.595744681
Huangjiazhai	Chuvthag	0.608781183	0.717948718
Huangjiazhai	Dahuazhongzhuang	0.298608789	0.735294118
Huangjiazhai	Galazong	0.534081383	0.681818182
Huangjiazhai	Gebusailu	0.542603187	0.707317073
Huangjiazhai	Haneyi_third_phase	0.573276821	0.596774194
Huangjiazhai	Jiaritang	0.578675155	0.685714286
Huangjiazhai	Jililong	0.529581081	0.675675676
Huangjiazhai	Nagu	0.481798603	0.666666667

Huangjiazhai	Panjialiang	0.76480257	0.655172414
Huangjiazhai	Piyang_dongga	0.597591976	0.651162791
Huangjiazhai	Pukagongma	0.48025498	0.604166667
Huangjiazhai	Qugong_early_phase	0.403276999	0.648648649
Huangjiazhai	Shangbanzhuwa	0.943734617	0.64
Huangjiazhai	Shanpingtai	0.92270728	0.707317073
Huangjiazhai	Shidaqiu	0.879325448	0.613636364
Huangjiazhai	Shidi	0.399120615	0.652173913
Huangjiazhai	Suhusa	0.391514488	0.617021277
Huangjiazhai	Talitaliha	0.629544331	0.652173913
Huangjiazhai	Yingpanshan	0.636050796	0.638888889
Huangjiazhai	Yongzhi	0.614875404	0.631578947
Huangjiazhai	Zhajinding	0.637589364	0.666666667
Jiaritang	Ashaonao	0.915912657	0.655172414
Jiaritang	Bangga	0.713755606	0.655172414
Jiaritang	Banzhuwa	0.732223766	0.632653061
Jiaritang	Changguogou	0.706928986	0.595744681
Jiaritang	Chuvthag	0.747037686	0.580645161
Jiaritang	Dahuazhongzhuang	0.291143114	0.578947368
Jiaritang	Galazong	0.766035569	0.590163934
Jiaritang	Gebusailu	0.776840963	0.603448276
Jiaritang	Haneyi_third_phase	0.818445567	0.636363636
Jiaritang	Huangjiazhai	0.893420154	0.576923077
Jiaritang	Jililong	0.902276064	0.588235294
Jiaritang	Nagu	0.854493594	0.566037736
Jiaritang	Panjialiang	0.778103746	0.594594595
Jiaritang	Piyang_dongga	0.851870707	0.607843137
Jiaritang	Pukagongma	0.597591976	0.571428571
Jiaritang	Qugong_early_phase	0.205542417	0.568627451
Jiaritang	Shangbanzhuwa	0.637170261	0.618181818

Jiaritang	Shanpingtai	0.643113693	0.634615385
Jiaritang	Shidaqiu	0.675864198	0.627906977
Jiaritang	Shidi	0.206711501	0.596491228
Jiaritang	Suhusa	0.206149885	0.630434783
Jiaritang	Talitaliha	0.725701588	0.611111111
Jiaritang	Yingpanshan	0.732208053	0.56
Jiaritang	Yongzhi	0.71103266	0.586956522
Jiaritang	Zhajinding	0.635248492	0.58
Jililong	Ashaonao	0.223144422	0.630769231
Jililong	Bangga	0.330367048	0.630769231
Jililong	Banzhuwa	0.332528958	0.622641509
Jililong	Changguogou	0.327653247	0.571428571
Jililong	Chuvthag	0.3052436	0.604166667
Jililong	Dahuazhongzhuang	0.08560071	0.6
Jililong	Galazong	0.094122514	0.6
Jililong	Gebusailu	0.129457896	0.610169492
Jililong	Haneyi_third_phase	0.204432515	0.641509434
Jililong	Huangjiazhai	0.223132186	0.627118644
Jililong	Jiaritang	0.131929496	0.58490566
Jililong	Nagu	0.507200155	0.590909091
Jililong	Panjialiang	0.291143114	0.588235294
Jililong	Piyang_dongga	0.173806118	0.585365854
Jililong	Pukagongma	0.298608789	0.674418605
Jililong	Qugong_early_phase	0.68277386	0.65
Jililong	Shangbanzhuwa	0.273693089	0.704545455
Jililong	Shanpingtai	0.25200747	0.704545455
Jililong	Shidaqiu	0.24331617	0.6
Jililong	Shidi	0.688594614	0.590163934
Jililong	Suhusa	0.697585945	0.603773585
Jililong	Talitaliha	0.32600678	0.634615385

Jililong	Yingpanshan	0.332513245	0.666666667
Jililong	Yongzhi	0.345104431	0.634146341
Jililong	Zhajinding	0.498777749	0.694444444
Nagu	Ashaonao	0.658498857	0.629032258
Nagu	Bangga	0.97418558	0.629032258
Nagu	Banzhuwa	0.993728303	0.638297872
Nagu	Changguogou	0.930432101	0.58
Nagu	Chuvthag	0.330367048	0.666666667
Nagu	Dahuazhongzhuang	0.492544912	0.62745098
Nagu	Galazong	0.503350338	0.630434783
Nagu	Gebusailu	0.544954942	0.622641509
Nagu	Haneyi_third_phase	0.61992953	0.64
Nagu	Huangjiazhai	0.693299187	0.596774194
Nagu	Jiaritang	0.594688232	0.595744681
Nagu	Jililong	0.638108477	0.675675676
Nagu	Panjialiang	0.713755606	0.619047619
Nagu	Piyang_dongga	0.699897677	0.655172414
Nagu	Pukagongma	0.61759835	0.675
Nagu	Qugong_early_phase	0.244766351	0.694444444
Nagu	Shangbanzhuwa	0.620973069	0.676470588
Nagu	Shanpingtai	0.605701761	0.659574468
Nagu	Shidaqiu	0.605834454	0.707317073
Nagu	Shidi	0.245935435	0.613636364
Nagu	Suhusa	0.245373819	0.6
Nagu	Talitaliha	0.968541253	0.636363636
Nagu	Yingpanshan	0.972913727	0.632653061
Nagu	Yongzhi	0.985679542	0.740740741
Nagu	Zhajinding	0.781445139	0.724137931
Panjialiang	Ashaonao	0.138151193	0.625
Panjialiang	Bangga	0.245373819	0.625

Panjialiang	Banzhuwa	0.247535664	0.615384615
Panjialiang	Changguogou	0.242660017	0.576923077
Panjialiang	Chuvthag	0.22025037	0.685714286
Panjialiang	Dahuazhongzhuang	0.697585945	0.64
Panjialiang	Galazong	0.00060748	0.666666667
Panjialiang	Gebusailu	0.009129285	0.618181818
Panjialiang	Haneyi_third_phase	0.044464667	0.653061224
Panjialiang	Huangjiazhai	0.119439286	0.636363636
Panjialiang	Jiaritang	0.138138957	0.642857143
Panjialiang	Jililong	0.046936267	0.6
Panjialiang	Nagu	0.422206958	0.558139535
Panjialiang	Piyang_dongga	0.206149885	0.625
Panjialiang	Pukagongma	0.088812889	0.58490566
Panjialiang	Qugong_early_phase	0.391514488	0.6
Panjialiang	Shangbanzhuwa	0.986383721	0.618181818
Panjialiang	Shanpingtai	0.344731437	0.653061224
Panjialiang	Shidaqiu	0.332962808	0.627906977
Panjialiang	Shidi	0.291755862	0.611111111
Panjialiang	Suhusa	0.992265357	0.596153846
Panjialiang	Talitaliha	0.24101355	0.611111111
Panjialiang	Yingpanshan	0.247519951	0.574468085
Panjialiang	Yongzhi	0.260111202	0.586956522
Panjialiang	Zhajinding	0.41378452	0.595744681
Piyang_dongga	Ashaonao	0.71010507	0.683333333
Piyang_dongga	Bangga	0.80102143	0.683333333
Piyang_dongga	Banzhuwa	0.819489573	0.666666667
Piyang_dongga	Changguogou	0.794194809	0.611111111
Piyang_dongga	Chuvthag	0.792204247	0.652173913
Piyang_dongga	Dahuazhongzhuang	0.507200155	0.654545455
Piyang_dongga	Galazong	0.572561358	0.66

Piyang_dongga	Gebusailu	0.581083162	0.666666667
Piyang_dongga	Haneyi_third_phase	0.616418576	0.666666667
Piyang_dongga	Huangjiazhai	0.691393163	0.608695652
Piyang_dongga	Jiaritang	0.710092834	0.611111111
Piyang_dongga	Jililong	0.618890112	0.607142857
Piyang_dongga	Nagu	0.778103746	0.652173913
Piyang_dongga	Panjialiang	0.660766766	0.6
Piyang_dongga	Pukagongma	0.76480257	0.625
Piyang_dongga	Qugong_early_phase	0.42159949	0.634615385
Piyang_dongga	Shangbanzhuwa	0.760266221	0.603773585
Piyang_dongga	Shanpingtai	0.744994913	0.68627451
Piyang_dongga	Shidaqiu	0.730276817	0.708333333
Piyang_dongga	Shidi	0.422768574	0.666666667
Piyang_dongga	Suhusa	0.422206958	0.727272727
Piyang_dongga	Talitaliha	0.812967411	0.743589744
Piyang_dongga	Yingpanshan	0.81947386	0.596153846
Piyang_dongga	Yongzhi	0.798298484	0.625
Piyang_dongga	Zhajinding	0.851305565	0.632653061
Pukagongma	Ashaonao	0.570808569	0.606557377
Pukagongma	Bangga	0.620973069	0.606557377
Pukagongma	Banzhuwa	0.639441197	0.591836735
Pukagongma	Changguogou	0.614146449	0.581395349
Pukagongma	Chuvthag	0.612155871	0.65625
Pukagongma	Dahuazhongzhuang	0.273693089	0.6
Pukagongma	Galazong	0.588493454	0.641025641
Pukagongma	Gebusailu	0.597015259	0.630434783
Pukagongma	Haneyi_third_phase	0.627688892	0.596153846
Pukagongma	Huangjiazhai	0.622381682	0.6
Pukagongma	Jiaritang	0.550119093	0.6
Pukagongma	Jililong	0.458916403	0.638888889

Pukagongma	Nagu	0.760266221	0.64
Pukagongma	Panjialiang	0.637170261	0.641025641
Pukagongma	Piyang_dongga	0.500793024	0.590909091
Pukagongma	Qugong_early_phase	0.943734617	0.703703704
Pukagongma	Shangbanzhuwa	0.356493948	0.630434783
Pukagongma	Shanpingtai	0.97515153	0.596153846
Pukagongma	Shidaqiu	0.933737512	0.647058824
Pukagongma	Shidi	0.352337629	0.604166667
Pukagongma	Suhusa	0.344731437	0.625
Pukagongma	Talitaliha	0.632919051	0.622222222
Pukagongma	Yingpanshan	0.639425483	0.625
Pukagongma	Yongzhi	0.618250123	0.678571429
Pukagongma	Zhajinding	0.617798531	0.628571429
Qugong_early_phase	Ashaonao	0.137543725	1
Qugong_early_phase	Bangga	0.244766351	0.672131148
Qugong_early_phase	Banzhuwa	0.246928261	0.655172414
Qugong_early_phase	Changguogou	0.242052614	0.629032258
Qugong_early_phase	Chuvthag	0.219642903	0.633802817
Qugong_early_phase	Dahuazhongzhuang	0.68277386	0.636363636
Qugong_early_phase	Galazong	1.28796E-08	0.671875
Qugong_early_phase	Gebusailu	0.008521882	0.656716418

Qugong_early_phase	Haneyi_third_phase	0.043857263	0.6875
Qugong_early_phase	Huangjiazhai	0.118831818	0.625
Qugong_early_phase	Jiaritang	0.137531554	0.634920635
Qugong_early_phase	Jililong	0.046328799	0.606557377
Qugong_early_phase	Nagu	0.42159949	0.567164179
Qugong_early_phase	Panjialiang	0.205542417	0.684210526
Qugong_early_phase	Piyang_dongga	0.088205421	0.630769231
Qugong_early_phase	Pukagongma	0.403276999	0.606060606
Qugong_early_phase	Shangbanzhuwa	0.356493948	0.75
Qugong_early_phase	Shanpingtai	0.344725319	0.727272727
Qugong_early_phase	Shidaqiu	0.303518309	0.672727273
Qugong_early_phase	Shidi	0.995390171	0.637681159
Qugong_early_phase	Suhusa	0.986383721	0.672413793
Qugong_early_phase	Talitaliha	0.240406083	0.683333333
Qugong_early_phase	Yingpanshan	0.246912548	0.6

Qugong_early_phase	Yongzhi	0.259503734	0.597014925
Qugong_early_phase	Zhajinding	0.413177117	0.629032258
Shangbanzhuwa	Ashaonao	0.676967016	0.633802817
Shangbanzhuwa	Bangga	0.97418558	0.633802817
Shangbanzhuwa	Banzhuwa	0.967358962	0.642857143
Shangbanzhuwa	Changguogou	0.948900253	0.580645161
Shangbanzhuwa	Chuvthag	0.332528958	0.717948718
Shangbanzhuwa	Dahuazhongzhuang	0.511013072	0.783783784
Shangbanzhuwa	Galazong	0.521818498	0.7
Shangbanzhuwa	Gebusailu	0.563423102	0.723404255
Shangbanzhuwa	Haneyi_third_phase	0.638397689	0.661016949
Shangbanzhuwa	Huangjiazhai	0.711767346	0.64
Shangbanzhuwa	Jiaritang	0.613156392	0.697674419
Shangbanzhuwa	Jililong	0.656576637	0.6
Shangbanzhuwa	Nagu	0.732223766	0.595744681
Shangbanzhuwa	Panjialiang	0.718365836	0.636363636
Shangbanzhuwa	Piyang_dongga	0.636066509	0.6
Shangbanzhuwa	Pukagongma	0.246928261	0.586206897
Shangbanzhuwa	Qugong_early_phase	0.639441197	0.629032258
Shangbanzhuwa	Shanpingtai	0.624169889	0.679245283
Shangbanzhuwa	Shidaqiu	0.624302613	0.622641509
Shangbanzhuwa	Shidi	0.248097344	0.654545455
Shangbanzhuwa	Suhusa	0.247535664	0.625
Shangbanzhuwa	Talitaliha	0.986131559	0.654545455
Shangbanzhuwa	Yingpanshan	0.999999986	0.607843137
Shangbanzhuwa	Yongzhi	0.971462634	0.603773585
Shangbanzhuwa	Zhajinding	0.767215793	0.62745098
Shanpingtai	Ashaonao	0.670444838	0.656716418

Shanpingtai	Bangga	0.968541253	0.656716418
Shanpingtai	Banzhuwa	0.986131559	0.654545455
Shanpingtai	Changguogou	0.961714635	0.603448276
Shanpingtai	Chuvthag	0.942378079	0.707317073
Shanpingtai	Dahuazhongzhuang	0.32600678	0.723404255
Shanpingtai	Galazong	0.504490894	0.769230769
Shanpingtai	Gebusailu	0.51529632	0.76744186
Shanpingtai	Haneyi_third_phase	0.556900924	0.672413793
Shanpingtai	Huangjiazhai	0.631875511	0.653061224
Shanpingtai	Jiaritang	0.705245168	0.666666667
Shanpingtai	Jililong	0.606634214	0.596153846
Shanpingtai	Nagu	0.812967411	0.608695652
Shanpingtai	Panjialiang	0.725701588	0.648148148
Shanpingtai	Piyang_dongga	0.711843658	0.641509434
Shanpingtai	Pukagongma	0.629544331	0.611111111
Shanpingtai	Qugong_early_phase	0.240406083	0.655172414
Shanpingtai	Shangbanzhuwa	0.632919051	0.692307692
Shanpingtai	Shidaqiu	0.617647711	0.618181818
Shanpingtai	Shidi	0.617780435	0.649122807
Shanpingtai	Suhusa	0.241575166	0.620689655
Shanpingtai	Talitaliha	0.24101355	0.666666667
Shanpingtai	Yingpanshan	0.984859708	0.62
Shanpingtai	Yongzhi	0.965818309	0.6
Shanpingtai	Zhajinding	0.761571474	0.64
Shidaqiu	Ashaonao	0.951172456	0.629032258
Shidaqiu	Bangga	0.693299187	0.629032258
Shidaqiu	Banzhuwa	0.711767346	0.603773585
Shidaqiu	Changguogou	0.686472567	0.566037736
Shidaqiu	Chuvthag	0.726581266	0.666666667
Shidaqiu	Dahuazhongzhuang	0.223132186	0.645833333

Shidaqiu	Galazong	0.785676048	0.630434783
Shidaqiu	Gebusailu	0.789318342	0.622641509
Shidaqiu	Haneyi_third_phase	0.817015381	0.64
Shidaqiu	Huangjiazhai	0.874172769	0.596774194
Shidaqiu	Jiaritang	0.899131753	0.613636364
Shidaqiu	Jililong	0.94054041	0.608695652
Shidaqiu	Nagu	0.902276064	0.625
Shidaqiu	Panjialiang	0.920264425	0.612244898
Shidaqiu	Piyang_dongga	0.529581081	0.588235294
Shidaqiu	Pukagongma	0.137531554	0.604651163
Shidaqiu	Qugong_early_phase	0.550119093	0.659574468
Shidaqiu	Shangbanzhuwa	0.553870413	0.659574468
Shidaqiu	Shanpingtai	0.583373385	0.613636364
Shidaqiu	Shidi	0.138700573	0.615384615
Shidaqiu	Suhusa	0.138138957	0.636363636
Shidaqiu	Talitaliha	0.705245168	0.652173913
Shidaqiu	Yingpanshan	0.711751633	0.615384615
Shidaqiu	Yongzhi	0.690576241	0.609756098
Shidaqiu	Zhajinding	0.567237596	0.619047619
Shidi	Ashaonao	0.80442727	0.6
Shidi	Bangga	0.492544912	0.6
Shidi	Banzhuwa	0.511013072	0.6
Shidi	Changguogou	0.485718292	0.56
Shidi	Chuvthag	0.518353331	0.638888889
Shidi	Dahuazhongzhuang	0.08560071	0.607843137
Shidi	Galazong	0.99046643	0.608695652
Shidi	Gebusailu	0.947040559	0.589285714
Shidi	Haneyi_third_phase	0.868849088	0.62
Shidi	Huangjiazhai	0.785676048	0.580645161
Shidi	Jiaritang	0.772641915	0.574468085

Shidi	Jililong	0.837499202	0.648648649
Shidi	Nagu	0.766035569	0.615384615
Shidi	Panjialiang	0.711850066	0.620689655
Shidi	Piyang_dongga	0.534081383	0.627906977
Shidi	Pukagongma	1.28796E-08	0.666666667
Shidi	Qugong_early_phase	0.588493454	0.677419355
Shidi	Shangbanzhuwa	0.608907597	0.659090909
Shidi	Shanpingtai	0.645747351	0.659090909
Shidi	Shidaqiu	0.001169097	0.574468085
Shidi	Suhusa	0.00060748	0.568965517
Shidi	Talitaliha	0.504490894	0.58
Shidi	Yingpanshan	0.510997359	0.596153846
Shidi	Yongzhi	0.489821966	0.689655172
Shidi	Zhajinding	0.42970612	0.740740741
Suhusa	Ashaonao	0.691780904	0.671875
Suhusa	Bangga	0.930432101	0.671875
Suhusa	Banzhuwa	0.948900253	0.654545455
Suhusa	Changguogou	0.923605481	0.590163934
Suhusa	Chuvthag	0.3052436	0.681818182
Suhusa	Dahuazhongzhuang	0.518353331	0.7
Suhusa	Galazong	0.529158726	0.805555556
Suhusa	Gebusailu	0.57076333	0.76744186
Suhusa	Haneyi_third_phase	0.645737917	0.672413793
Suhusa	Huangjiazhai	0.726581266	0.618181818
Suhusa	Jiaritang	0.627970312	0.666666667
Suhusa	Jililong	0.671390557	0.630434783
Suhusa	Nagu	0.747037686	0.591836735
Suhusa	Panjialiang	0.742258942	0.666666667
Suhusa	Piyang_dongga	0.608781183	0.610169492
Suhusa	Pukagongma	0.219642903	0.611111111

Suhusa	Qugong_early_phase	0.612155871	0.655172414
Suhusa	Shangbanzhuwa	0.596884563	0.655172414
Suhusa	Shanpingtai	0.597017287	0.653061224
Suhusa	Shidaqiu	0.220811986	0.649122807
Suhusa	Shidi	0.22025037	0.636363636
Suhusa	Talitaliha	0.942378079	0.666666667
Suhusa	Yingpanshan	0.948884535	0.589285714
Suhusa	Yongzhi	0.927709155	0.615384615
Suhusa	Zhajinding	0.723462304	0.622641509
Talitaliha	Ashaonao	0.5672498	0.6875
Talitaliha	Bangga	0.781445139	0.6875
Talitaliha	Banzhuwa	0.767215793	0.625
Talitaliha	Changguogou	0.778731386	0.636363636
Talitaliha	Chuvthag	0.723462304	0.596774194
Talitaliha	Dahuazhongzhuang	0.498777749	0.661016949
Talitaliha	Galazong	0.42970612	0.666666667
Talitaliha	Gebusailu	0.438227924	0.672413793
Talitaliha	Haneyi_third_phase	0.473563306	0.672413793
Talitaliha	Huangjiazhai	0.548537893	0.636363636
Talitaliha	Jiaritang	0.567237596	0.6875
Talitaliha	Jililong	0.476034874	0.6
Talitaliha	Nagu	0.851305565	0.557377049
Talitaliha	Panjialiang	0.635248492	0.649122807
Talitaliha	Piyang_dongga	0.517911496	0.627118644
Talitaliha	Pukagongma	0.637589364	0.575757576
Talitaliha	Qugong_early_phase	0.413177117	0.655737705
Talitaliha	Shangbanzhuwa	0.617798531	0.655737705
Talitaliha	Shanpingtai	0.59611288	0.636363636
Talitaliha	Shidaqiu	0.58742158	0.597222222
Talitaliha	Shidi	0.414346136	0.609375

Talitaliha	Suhusa	0.41378452	0.608695652
Talitaliha	Yingpanshan	0.761571474	0.580645161
Talitaliha	Yongzhi	0.765943946	0.603448276
Talitaliha	Zhajinding	0.792311518	0.596774194
Yingpanshan	Ashaonao	0.871973887	0.75
Yingpanshan	Bangga	0.594688232	0.75
Yingpanshan	Banzhuwa	0.613156392	0.693877551
Yingpanshan	Changguogou	0.587861612	0.618181818
Yingpanshan	Chuvthag	0.627970312	0.64
Yingpanshan	Dahuazhongzhuang	0.131929496	0.629032258
Yingpanshan	Galazong	0.772641915	0.631578947
Yingpanshan	Gebusailu	0.774357272	0.655172414
Yingpanshan	Haneyi_third_phase	0.794574469	0.655172414
Yingpanshan	Huangjiazhai	0.817779674	0.655737705
Yingpanshan	Jiaritang	0.899131753	0.618181818
Yingpanshan	Jililong	0.931877646	0.647058824
Yingpanshan	Nagu	0.81107335	0.659574468
Yingpanshan	Panjialiang	0.876723627	0.591836735
Yingpanshan	Piyang_dongga	0.438378358	0.666666667
Yingpanshan	Pukagongma	0.046328799	0.704545455
Yingpanshan	Qugong_early_phase	0.458916403	0.666666667
Yingpanshan	Shangbanzhuwa	0.46266769	0.76744186
Yingpanshan	Shanpingtai	0.499081741	0.634615385
Yingpanshan	Shidaqiu	0.047497883	0.633333333
Yingpanshan	Shidi	0.046936267	0.653846154
Yingpanshan	Suhusa	0.606634214	0.68627451
Yingpanshan	Talitaliha	0.613140679	0.659090909
Yingpanshan	Yongzhi	0.591965286	0.632653061
Yingpanshan	Zhajinding	0.476034874	0.659574468
Yongzhi	Ashaonao	0.81523268	0.597014925

Yongzhi	Bangga	0.503350338	0.597014925
Yongzhi	Banzhuwa	0.521818498	0.596153846
Yongzhi	Changguogou	0.496523718	0.586956522
Yongzhi	Chuvthag	0.529158726	0.631578947
Yongzhi	Dahuazhongzhuang	0.094122514	0.603773585
Yongzhi	Galazong	0.99046643	0.642857143
Yongzhi	Gebusailu	0.957845966	0.615384615
Yongzhi	Haneyi_third_phase	0.879654491	0.6
Yongzhi	Huangjiazhai	0.789318342	0.603448276
Yongzhi	Jiaritang	0.774357272	0.586956522
Yongzhi	Jililong	0.839610334	0.641025641
Yongzhi	Nagu	0.776840963	0.609756098
Yongzhi	Panjialiang	0.715492359	0.642857143
Yongzhi	Piyang_dongga	0.542603187	0.642857143
Yongzhi	Pukagongma	0.008521882	0.634146341
Yongzhi	Qugong_early_phase	0.597015259	0.638888889
Yongzhi	Shangbanzhuwa	0.617429401	0.632653061
Yongzhi	Shanpingtai	0.654269155	0.632653061
Yongzhi	Shidaqiu	0.009690901	0.625
Yongzhi	Shidi	0.009129285	0.592592593
Yongzhi	Suhusa	0.51529632	0.627906977
Yongzhi	Talitaliha	0.521802753	0.625
Yongzhi	Yingpanshan	0.500627392	0.689655172
Yongzhi	Zhajinding	0.438227924	0.724137931
Zhajinding	Ashaonao	0.923331604	0.684210526
Zhajinding	Bangga	0.61992953	0.684210526
Zhajinding	Banzhuwa	0.638397689	0.62962963
Zhajinding	Changguogou	0.613102909	0.607843137
Zhajinding	Chuvthag	0.645737917	0.651162791
Zhajinding	Dahuazhongzhuang	0.204432515	0.636363636

Zhajinding	Galazong	0.868849088	0.659574468
Zhajinding	Gebusailu	0.879654491	0.666666667
Zhajinding	Haneyi_third_phase	0.921259095	0.648148148
Zhajinding	Huangjiazhai	0.874172769	0.649122807
Zhajinding	Jiaritang	0.817779674	0.625
Zhajinding	Jililong	0.887065894	0.682926829
Zhajinding	Nagu	0.893420154	0.612244898
Zhajinding	Panjialiang	0.793596776	0.595238095
Zhajinding	Piyang_dongga	0.578675155	0.674418605
Zhajinding	Pukagongma	0.118831818	0.684210526
Zhajinding	Qugong_early_phase	0.622381682	0.666666667
Zhajinding	Shangbanzhuwa	0.642795824	0.6875
Zhajinding	Shanpingtai	0.679635578	0.666666667
Zhajinding	Shidaqiu	0.120000902	0.610169492
Zhajinding	Shidi	0.119439286	0.611111111
Zhajinding	Suhusa	0.631875511	0.625
Zhajinding	Talitaliha	0.638381944	0.627906977
Zhajinding	Yingpanshan	0.617206584	0.642857143
Zhajinding	Yongzhi	0.548537893	0.675

Appendix 7. The centrality measurements of the PCI network (derived from the flow accumulation model) and the ceramic social network

Site	Degree ceramic	Eigenvector ceramic	Betweeness ceramic	Degree PCI	Eigenvector PCI	Between_ PCI
Qugong	8.533	0.252	14.915	3.613	0.028	0
Changguogou	8.533	0.252	14.915	3.597	0.027	0
Bangga	6.739	0.216	3.941	4.182	0.038	5.887
Jiaritang	1.310	0.043	0	3.511	0.027	0
Huangjiazhai	9.511	0.228	46.422	9.455	0.240	1.306
Shangbanzhu wa	6.272	0.198	2.149	9.597	0.484	1.306
Banzhuwa	7.816	0.229	5.844	9.591	0.244	1.306
Suhusa	9.589	0.295	9.306	10.045	0.253	3.197
Shanpingtai	8.942	0.275	9.475	9.527	0.242	1.306
Dalitaliha	6.046	0.203	2.176	6.222	0.155	0
Panjialiang	2.659	0.093	0	9.515	0.242	1.306
Dahuazhongzh uang	6.829	0.208	5.042	9.493	0.241	1.306
Pukar Gongma	2.039	0.027	3.187	12.379	0.239	63.801
Shidaqiu	2.638	0.095	0.143	13.515	15.441	19.618
Ashaonao	1.310	0.031	0	12.324	0.283	15.486
Zhajinding	8.083	0.220	20.963	8.551	1.291	4.132
Jililong	3.445	0.095	0.267	13.437	0.307	19.618
Galazong	3.408	0.065	4.637	9.343	0.213	5.773
Yingpanshan	10.284	0.268	33.340	7.550	0.172	0
Haneyi_third_ phase	13.072	0.341	47.960	7.949	0.180	0
Chuvthag	4.815	0.130	3.715	2.665	0	0
Gebusailu	5.528	0.167	2.418	2.676	0	0

Piyang_Dongga	9.518	0.273	14.361	2.676	0	0
Shidi	4.093	0.082	7.052	7.484	0.167	0
Yongzhi	2.092	0.023	1.056	7.539	0.168	0
Nagu	6.875	0.139	26.798	8.395	0.174	9.650