

Article

Living Together, Living Apart: Residential Structures in Late Bronze Age Shirezigou, Xinjiang

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Abstract: The spatial organization within ancient settlements offers valuable insights into the evolution of social complexity. This paper examines spatially and chronologically contextualized architectural structures and artifacts uncovered at the Late Bronze Age Shirezigou site to explore the relationship between the use of space and underlying social dynamics in the Eastern Tianshan Mountains of Xinjiang (China). Central to our findings is a distinctive centripetal compound structure, consisting of a larger non-domestic building surrounded by smaller dwellings. This arrangement, along with the variety and distribution of the artifacts, reveals a complex interplay between private and communal spaces at the site, reflecting a growing complexity within the social fabric of the community. The formation of conglomerates of houses around a central communal structure which occurs across the Tianshan Mountains appears to be a strategic adaptation in response to environmental challenges and socio-political transformations across this region at the end of the second millennium BCE.

Keywords: Shirezigou; spatial organization; social complexity; Eastern Tianshan Mountains; Late Bronze Age



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1. Introduction

The study of space use and organization is crucial to our appreciation of the development of past societies [1–3]. The layout of the settlements and the location, form, and size of the buildings, sometimes (cautiously) comparable with ethnographic evidence, can provide critical understanding of the living strategies, economic activities, social interactions, and other facets of ancient communities [4–7]. Recent studies have underscored the significance of the materials and methods used in construction to gain insights into ancient lifestyles [8–10]. On an even smaller scale, examining the spatial arrangement of artifacts at archeological sites has proven crucial for pinpointing areas of specific activities, thereby aiding in the reconstruction of past behaviors and social interactions [11–13].

In the last century, Chang [14–16] introduced the concepts of ‘microstructure’ (i.e., the cultural and social system of a settlement) and ‘macrostructure’ (i.e., the broader culture and social organization) in settlement patterns in China and drew attention to the importance of anthropological approaches to address issues of social organization and complexity. His works were critical for the reevaluation of traditional theories and definitions related to social complexity in Chinese archeology, challenging established notions of states, cities, and their material implications [17,18]. Despite advancements, critiques highlight biased data from surveys favoring accessible, large, low-elevation sites, overlooking

diverse environments, and a lack of control over the chronology of the findings [19–21]. While recent works in the Chifeng region, in present-day Inner Mongolia, and the high-altitude Ngawa area of Western China have broadened archeological methodologies and challenged traditional site selection and dating methodologies [22–24], research still largely relies on extensive surveys and analyses of published preliminary excavation reports, focusing on large-scale variations, with much less attention paid to small-scale studies.

The Eastern Tianshan region of Xinjiang, a crucial prehistoric cultural crossroad connecting the Hexi Corridor with the eastern Steppe and the Inner Asian Mountains [25–28], too has seen research emphasizing long-distance interactions and large-scale cultural variations. In-depth analysis of individual sites and localized social phenomena is scarce (but see [13]), which has significantly limited our understanding of the social contexts that underlay the development of these ancient societies.

The Late Bronze Age in the Eastern Tianshan Mountains (ca. 1300–800 BCE) witnessed an intensification of pastoralism [29], the expansion of crop exchange [30–32], the spread of new technologies [33,34], and the emergence of a greater social complexity, which was largely driven by the increasing diversity in pastoral mobility patterns [35,36]. Over 200 sites, dating between the second and first millennium BCE, were identified in the grasslands across both slopes of the Eastern Tianshan Range, allowing a preliminary understanding of human–environment relationships and settlement preferences [37,38]. These sites typically featured stone houses and graves, with many yielding an array of artifacts indicative of significant population growth and cultural flourishing [38,39]. The discovery of painted pottery [40–43], cast bronze items [44–48], and crops, such as wheat, barley, and millets [40,49,50], points to heightened interactions with neighboring regions to the east and west. Over 30 of these sites have been carefully surveyed revealing a unique structure, referred to as ‘centripetal compound buildings’ (向心式复合建筑) [51], distinctively shaped radially or as an isosceles triangle or a fan, with a central building encircled by smaller houses. Previous research has suggested that this architecture may signify a hierarchical society [52], sacred spaces [53,54], defensive strongholds [38], communication hubs [51,55] or labor division within the site [56]. However, insufficient evidence and the lack of detailed studies of the individual sites, including the architectural structures and artifacts found therein, continue to obscure the underlying function of these buildings and their potential socio-political implications on a local and regional scale.

In order to fill this gap, this article focuses on the late Bronze Age settlement of Shirenzigou, on the northern foothills of the Eastern Tianshan Mountains. Systematic excavations conducted by Northwest University and the Xinjiang Institute of Archaeology, among others, in 2006 and 2007 uncovered a distinctive centripetal compound building at the site [57]. This study compiles and examines the data from the excavation of Shirenzigou, incorporating both previously published findings and fresh insights from the excavation records, within a precise chronological and spatial framework to explore the relationship between the material sphere and the multifaceted social dynamics at the site. In doing so, it offers important insights into the complexity of the pastoral societies in the Eastern Tianshan Range in the first millennium BCE.

The Site

The site of Shirenzigou, also known as Dongheigou, lies on the northern side of the Tianshan Mountains, in present-day Balikun County (Figure 1). The landscape around the site includes meadows and areas covered in gravel from ancient glaciers. Towards the north, there is a large valley with wide areas of alluvial fans. The elevation of the lower river plain ranges between 1800 and 2000 m asl. While today it supports irrigated wheat farming, there is no evidence to suggest historical irrigation practices. The northern mountains, rising above 3600 m, are covered in forests and have peaks that are frozen year-round. The reliable water sources and efficient drainage system render this locale an optimal grazing area during summer. The inhabitants seem to have practiced transhu-

mance [29], congregating in the lower lands during winter and migrating to the mountain foothills in summer, a lifestyle documented in various regions [7,58].

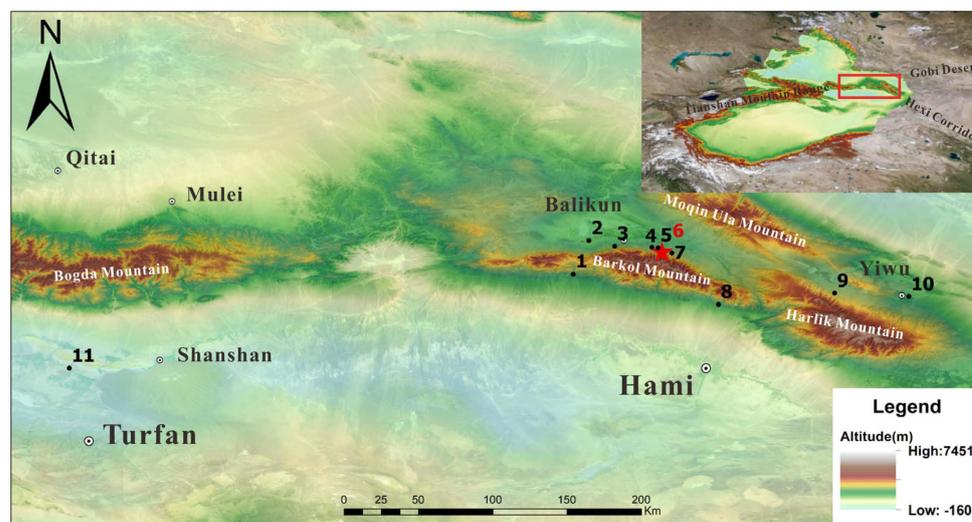


Figure 1. Location of Shirenzigou and other sites associated with this study. 1. Liushugou; 2. Haiziyan; 3. Yuegongtai-Xiheigou site group; 4. Xiaoheigou; 5. Xigou; 6. Shirenzigou; 7. Hongshankou No. 1; 8. Wulanbuluke; 9. Kuola northern building complex; 10. Baiqier; 11. Yanghai. The image was made using QGIS 2024 (www.qgis.org) and CorelDRAW Graphics Suite 2016 (www.corel.com).

First discovered in 1957, with initial examinations carried out in 1958 and 1981 [59], Shirenzigou underwent a thorough investigation and was mapped in the summer of 2005 by the Cultural Heritage and Archaeology Research Center of Northwest University, the Hami District Cultural Relics Bureau, and the Barkol County Cultural Management Office [60]. A large context covering roughly 8.75 km² was revealed, including mound-platforms, architectural structures, burials, and sacrificial pits. The site is believed to have been used by pastoral communities on a seasonal basis. Scattered radiocarbon dates situate the habitation of the site between 1300 BCE and 300 CE, spanning the local Bronze to Iron Ages [32,36,61].

In 2006 and 2007, a team comprising Northwest University, the Xinjiang Institute of Archaeology, and other institutions embarked on meticulous excavations of a radially structured compound building in Shirenzigou. Located in isolation on the southern section of the site, this structure comprised diverse features such as wooden and stone walls, postholes, hearths, and multifunctional pits, along with a significant collection of artifacts and bioarcheological material. Preliminary findings have been reported [57], and various studies on selected archeological evidence from the site have shed light on local livelihoods and cultural exchanges [13,29–31,35,36]. Yet, a comprehensive and detailed analysis of this unique complex within a chronological and spatial context is still pending and is the focus of the discussion in this article.

2. Materials and Methods

Seven excavation seasons have yielded extensive archeological insights at the site, with thorough investigations into the living spaces of F7 and F2. In the case of units F1, F5, F8, and F10, only the rear sections were excavated to preserve the slope of F7 and its overall structure. Excavations of units F3, F4, F6, and F9 were only partially conducted, limited by the scope of the excavation permit. Early findings have been documented in a series of preliminary reports and scholarly articles by the Shirenzigou research team [51,53,54,57,59]. Integrating this previously published information with new insight from the excavation record, we have compiled a detailed architectural overview of the centripetal compound structure. Through spatial analysis and statistical tools, we investigated the layout and interrelationships of various structural elements [8,62].

All artifacts and botanical and faunal remains recovered at the site were recorded (Figure 2). The artifacts were firstly divided into four large categories according to relevant activities (Food, Production, Leisure, and Others). These large divisions were further split into 16 smaller groups on the basis of the specific function of the recovered artifacts, according to published references on the topic (e.g., [63]) (Table 1). When appropriate, the evidence was further divided according to sub-type (e.g., grain processing tools were further classified into ‘grinding stone plate’, ‘grinding stone pestles’, and ‘smashers’) and size as follows: extra-large vessel: belly diameter ≥ 50 cm and height ≥ 50 cm; large vessel: belly diameter between 50 cm and 40 cm and height between 50 cm and 30 cm; medium vessel: belly diameter between 40 cm and 30 cm and height between 30 and 25 cm; small vessel: belly diameter ≤ 30 cm and height ≤ 25 cm. Bioarcheological material was divided in cereals grains and weed, all under the category of botanical findings and faunal remains (Table 1).

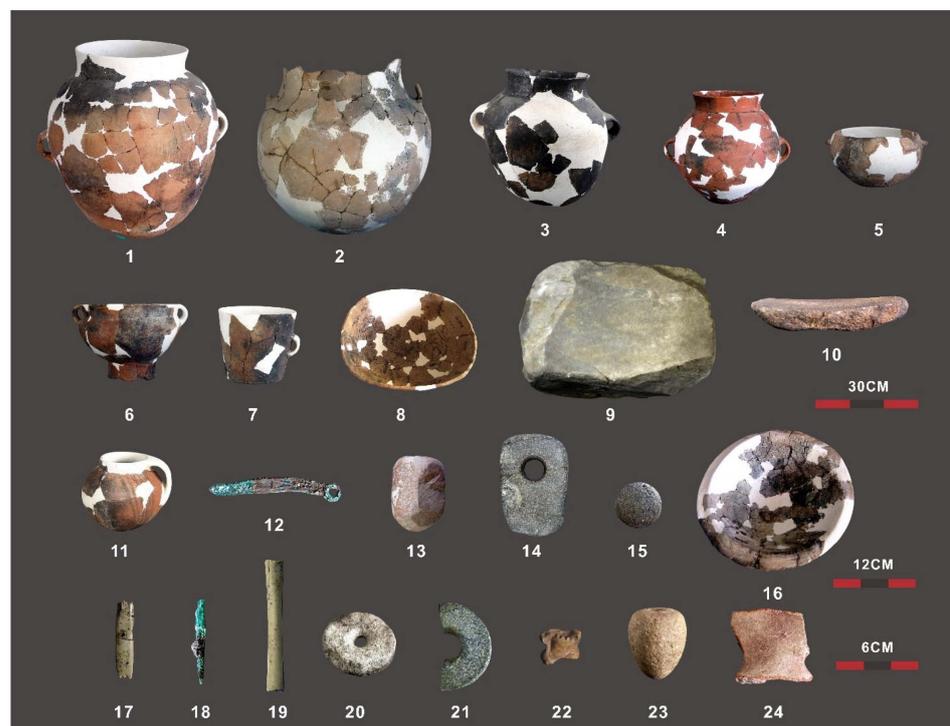


Figure 2. Artifacts excavated from various structures of the centripetal compound building in Shirenzigou: 1. double-handle jar (F7); 2. four-handle pot (F7); 3. double-belly pot with two handles (F7); 4. painted double-belly pot with two handles (F7); 5. double-ring flat-bottomed cauldron (F2); 6. double-handle ring-footed pot (F7); 7. single-handle cup (F7); 8. basin (F3); 9. stone grinding plate (F7); 10. stone grinding rod (F7); 11. painted single-handle pot (F4); 12. bronze knife (F7); 13. stone pestle (F1); 14. stone hoe (F1); 15. stone ball (F2); 16. crucible (F7); 17. tooth harpoon (F7); 18. bronze awl (F7); 19. bone tube (F7); 20. stone spindle whorl (F7); 21. scepter head (F7); 22. toy made out of a sheep astragalus (F3); 23. stone spinning top (F3); 24. pottery shard (F4). The image was made using CoreDRAW Graphics Suite 2016 (www.corel.com).

During the excavation, the contexts of the artifacts and bioarcheological material were recorded to the nearest cm. The number and type of artifacts were recorded to the layer or feature in which they were recovered. These features were identified as ash pits, ash heaps, post holes, stoves, and kilns. These elements were mapped in-field and the plan digitized using CorelDRAW Graphics Suite 2016 (www.corel.com). This plan was then annotated to show the arrangement of finds within the site. The analysis of artifacts and bioarcheological evidence, considering both quantity and the temporal and spatial distribution of the finds, was carried out to identify potential activity areas [11–13].

Table 1. Classification of the artifacts and bioarcheological material (botanical and faunal findings) from Shirezigou used in this study.

Category	Artifacts
Grain storage	Double-belly pots, double-handled jars, etc.
Food cooking	Pots, double-handled jars, etc.
Food serving	Basins, large single-handled cups, etc.
Individual dining	Small single-handled jars, bowls, cups, etc.
Grain processing	Grinding stone plates, grinding stone rods, pestles, stone beaters, etc.
Food cutting	Bronze and bone knives, etc.
Hunting	Stone balls, etc.
Construction	Stone hoes, stone axes, etc.
Pottery	Pottery discs, stone discs, etc.
Smelting	Crucibles
Drilling	Bone and bronze drills, etc.
Grinding	Whetstones, etc.
Textile	Spinning wheels, bone needles, etc.
Raw material	Chalcedony, etc.
Toys	Sheep and deer astragalus bones (often found in groups), stone tops, etc.
Others	Stone scepter heads and items that do not belong to the above categories, in addition to a small number of artifacts with unclear function.
Category	Biological remains
Botanical findings	Cereals and weeds
Faunal remains	Animal bones, teeth, and antlers

In order to chronologically contextualize the site and to better understand the patterns of occupation of the houses, we introduced 5 new radiocarbon dates, which were generated at the Accelerator Mass Spectrometry Dating Laboratory of Peking University. Our results were re-evaluated in light of previously published AMS C14 dating. All the dates were calibrated using the most recent calibration curves, OxCal and IntCal20 [64,65] (OxCal online version 4.4.4). Given the well-documented stratigraphic sequence of all the samples, the Bayesian modeling primarily adhered to the sequence model proposed by Ramsey [66], which enabled the integration of excavation stratigraphy to obtain the most precise dating resolution possible. Radiocarbon dates, organized according to their excavation layers, were grouped into a single phase when originating from the same stratigraphic layer.

3. Results

3.1. Layout and Buildings

The multi-space structure spanned 73 m in length from north to south and 58 m at its widest from east to west. It was composed of 10 houses, an open space (possibly a square), and several pathways (Figure 3). The largest building was F7. It was located at the highest altitude in the south, with its entrance facing east and consisted of two rooms distributed on a north–south axis. Adjacent to F7 on the east, southeast, and south sides were four small, single-room annex structures (F5, F8–F10). Further east was an open space encircled by arranged stones. To the northwest of F7, a group of four smaller units (F1–F4) were distributed from north to south, also divided into two rooms with their doors opening on the eastern walls. These buildings were placed next to each other in a sequential order, with each subsequent structure positioned slightly higher or lower than the one before it. To their east and separated by a pathway, another small house, F6, was found. F6 was divided into two rooms and had a door to the north side.

The archeological excavation revealed that this group of structures had undergone two main phases of use. Two layers of ground floors (lower and upper) were identified in F2, F3, and F7, while in F4 only one floor was found, with the late occupation occurring directly on the early ground. It is apparent that after the lower floor was abandoned, soil was added to form an upper layer of floor, while continuing to use the existing walls (Table 2). The standing walls of F7 are notably tall, exceeding 4 m in height and varying from 2.3 m to 3.6 m in thickness. In contrast, the wall heights of the smaller buildings range from 0.5 m to 0.7 m, with thicknesses between 0.7 m and 1 m [59].



Figure 3. Plan (A) and stratigraphy (B) of the buildings at the Shirenzigou site as per excavation records. The images were made using CorelDRAW Graphics Suite 2016 (www.corel.com) on the basis of the data recorded in the field.

Table 2. Excavation details and relationship between floor levels from two identified phases at Shirenzigou.

Unit	Lower Level	Upper Level
Core building	F7	Excavated—ground floor
Ordinary building	F1	Only rear part excavated
	F2	Excavated—ground floor
	F3	Only rear part excavated
	F4	Only rear part excavated
	F6	Not excavated
Others	F8	Partially excavated—ground floor
	F5, F9, F10	Not excavated
	Pathway	Not excavated
	Open space (square)	Not excavated

In the first phase, the smaller structures F1–F4 and F6 were semi-subterranean, while F7 and its annex F8 were built at ground-level. The status of units F9 and F10, whether they were also ground-level constructions, remains unclear due to limited excavation data. In the later phase, the floor level of the smaller houses was raised slightly, approximately 0.45 m to 0.5 m, while the floor of F7 was elevated by 2 m, effectively turning it into a platform structure encircled by retaining walls. A sloping pathway leading to F7's original entrance was built, linking this central structure with the rest of the settlement. In the late occupation phase, this path began 9 m below F7's highest point, highlighting a sig-

nificant elevation difference between the smaller structures and the central building. The walls of F7 pressed down F1 and the annexes F5, F8, and F10, which suggests that these structures had already been abandoned by the later period. The buildings retained abundant relics and artifacts in their original positions, supporting a rapid abandonment with minimal disturbance. Both layers of ground floor above F7 showed collapsed accumulations of burned wooden structure roofs, indicating that likely the abandonment was due to fire [51,53,54,57] (Figure 3).

The indoor layout of all the structures is consistent across the lower and upper phases, with a division into two spaces, a spacious front room and a rear room, which contained most of the artifacts [57]. The smaller dwellings (F1–F4, F6) show little variation in size, maintaining a consistent ratio of indoor floor space to the overall footprint area at 1:2 (Figure 4). The interior space of F7 does not stand out when compared to the smaller units, being comparable to that of F3 and F4. Yet, considering the walls, surrounding slopes, and additional architectural elements, F7's total area significantly exceeds that of the smaller structures in both periods (3 to 5 times larger in the early phase; 1.3 to 2 times larger in the later phase) (Figure 4; Table S1).

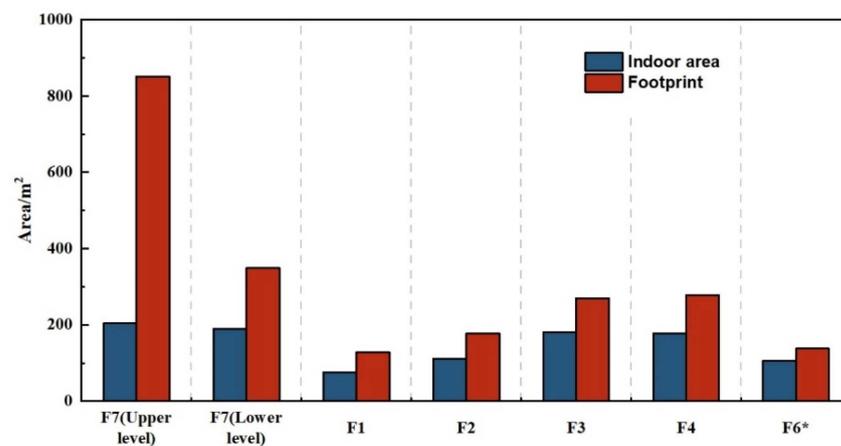


Figure 4. Ratio of the interior floor space to the total footprint area for each building in Shirenzigou (* walls not fully exposed during excavations). The figure was made using Origin 2024 (www.originlab.com).

3.2. Features and Artifacts

In all buildings, features were concentrated around the hearth, with grouped arrangements of large grinding stones, ash pits, and ash mounds distributed around it. Clustered collections of artifacts, including kitchenware and dining utensils, production and processing tools, and toys were found around the grinding stones, inside the ash pits, and under the foundations of the walls (Figure 5). Many of the features and artifacts showed signs of frequent use: for instance, the stones around the hearth were blackened and polished, some even cracked from the heat [57], and some pottery showed wear or repair marks. This suggests that these buildings were used for a relatively long period on a fairly regular basis.

In structures F1–F4 and F6, the amount and volume of various types of features and artifacts were roughly proportional to the interior floor space (Table 3; Figures 5 and 6A). The densities of pottery shards and other artifacts, including ceramic, stone, and metal items, as well as their distribution, type, size, ratio, and combination exhibited little variation across the smaller houses (Figures 5 and 6B,C; Tables S2 and S3), indicating their similar nature. Yet, significant disparities were observed when compared to the larger structure, F7 (Figure 6; Tables S2 and S3). The stove and ash pit areas were considerably larger compared to those in the smaller dwellings (Figure 6A; Table S2). The artifact count in F7 was markedly higher, with cooking and dining utensils found in quantities ranging from 7 to 23 times those found in the other buildings. The dimensions of cooking implements,

grain storage, and serving vessels in F7 were also substantially larger, with diameters and heights exceeding 0.5 m and some reaching up to 0.7 m in diameter and 0.6 m in height (Figure 2). Noteworthy were 11 and 9 large stone grinding plates found on the lower and upper floors of F7, respectively, along with 19 storage devices on each floor of the building. Unit F7 also contained unique relics and artifacts not found in other houses, including ceramic kilns, bronze ware, painted large pottery vessels, jars with double-looped ring feet, oversized single-handled goblets, crucibles, and stone scepter heads, among others (Figure 2; Table 3). These observations highlight the potential special function of F7 as a central architectural feature within the settlement.

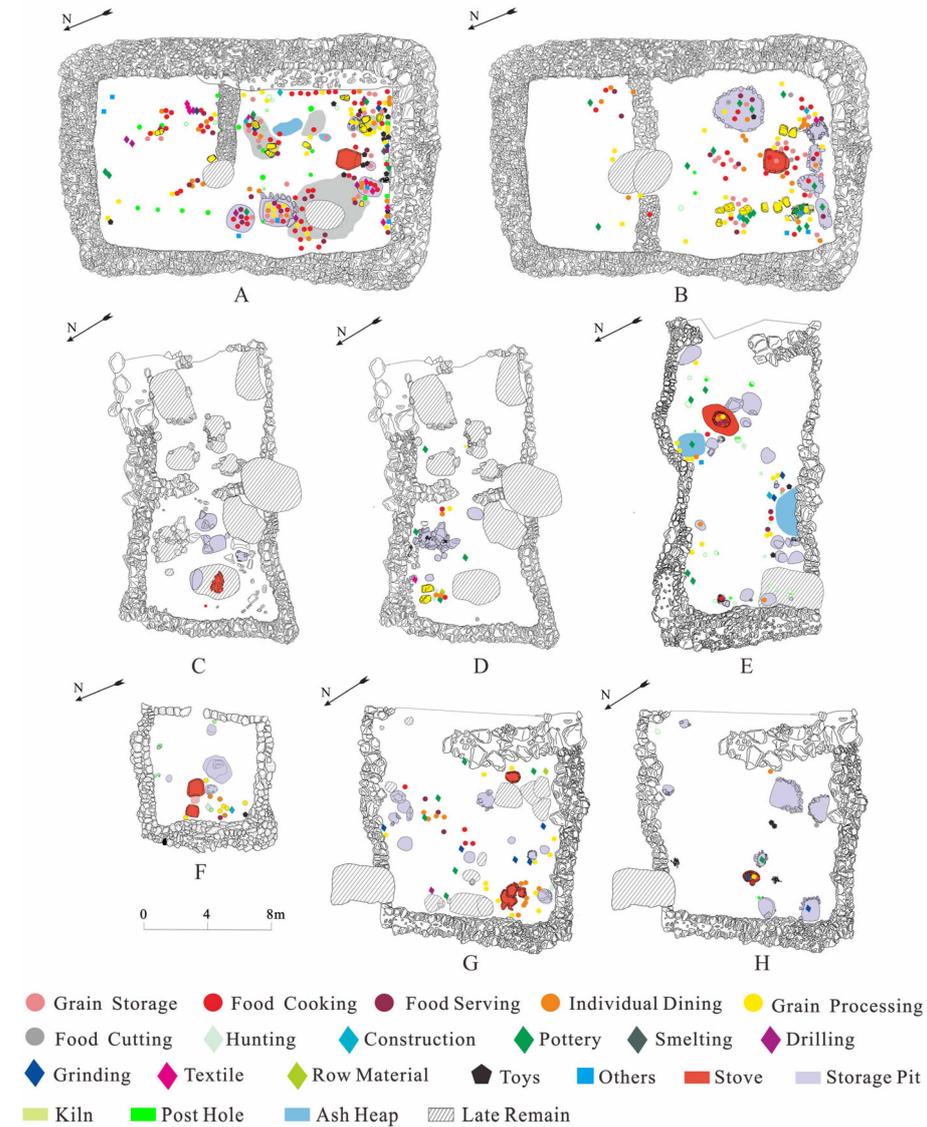


Figure 5. Plan of the structures uncovered in Shirenzigou divided according to stratigraphy with features and artifacts marked on each layer: (A). lower floor level of F7; (B). upper floor level of F7; (C). lower floor level of F2; (D). upper floor level of F2; (E). upper floor level of F4 (only one floor was present in F4); (F). lower floor level of F1; (G). lower floor level of F3; (H). upper floor level of F3. The figure was made using CorelDRAW Graphics Suite 2016 (www.corel.com).

Table 3. Types and quantities of artifacts excavated from different structures and floor levels in Shirenzigou (* partially excavated).

Type			Unit											
Category	Function	Relics	F7		F1		F2		F3		F4		F6	
			Early	Late	Early	Early *	Late	Early	Early *	Early *	Late	Early *		
Food	Grain storage		19	19								1	4	
	Food cooking	Extra-large cooker	1	2									0	
		Large cooker	7	3					3				1	
		Medium cooker	16	8					1				1	
		Small cooker	21	6	1	1	3						1	
	Food serving		20	10	3				3				4	
	Individual dining		19	16	3		3	11	1				4	
	Grain processing	Grinding stone plate		11	9			2	0	0				1
		Grinding stone pestle		24	13			1	1	1				3
		Smasher		21	10	5		1	11	0				9
Food cutting		1	3				0	1				0		
Production	Hunting		1	0	1		2	1	1				1	
	Construction		3	2	1			0	0				1	
	Pottery		6	17			3	6	1				8	
	Smelting		1	0				0	0				0	
	Drilling		8	0				1	0				0	
	Grinding		4	0	1			10	2				2	
	Textile		7	1			1	0	0				1	
	Row material		0	0			1	3	0				0	
Leisure	Toy		14	1	1			1	2				2	
Others		7	3						0				0	
Total			211	123	16	1	17	52	9	0		40	4	

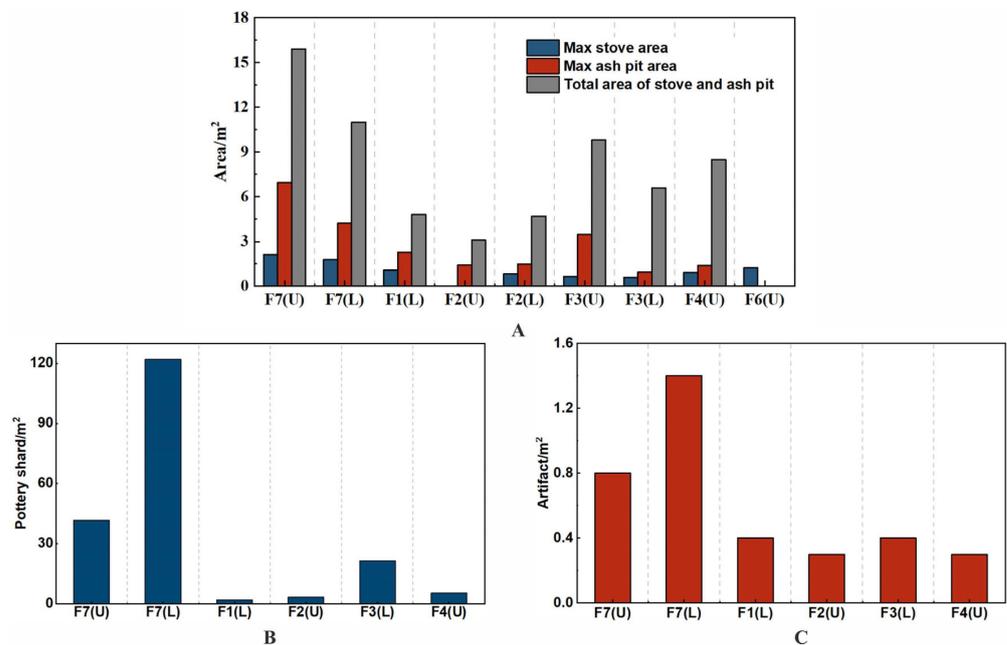


Figure 6. Relationship between structures and artifacts excavated in Shirenzigou: (A). density of the features in each structure; (B). density of ceramics in the lower and upper floor of each structure; (C). density of artifacts (pottery, stone and metal items) in the lower and upper floor of each structure. Because it was only partially excavated, F6 was excluded from the counts. U = upper level; L = lower level. The figures were made using Origin 2024 (www.originlab.com).

During the first phase, botanical and faunal remains in F7 far surpassed those found in the other structures. Apart from a single cereal grain in F1, no plant remains were dis-

covered in the smaller houses. In the subsequent phase, the quantity of plant and animal remains decreased in F7, with botanical findings being more prevalent in F3, hinting at a possible subtle shift in the dynamic between the two buildings (Table 4). Beneath both levels of F7, there was a notable concentration of large animal bone deposits, barley seeds, and pottery showing fire marks within ash pits. Directly under F7’s lower floor, pits H24 and H25 each contained seven relatively intact sheep skeletons bearing artificial marks [29]; pit H29 held a significant number of plant seeds, with around 4127 naked barley seeds extracted from about 40 L of soil [30]; pit H30 was rich in pottery fragments and animal bones [29]. Below the upper level, pit H19 was found to contain 681 animal bones and a large cache of barley seeds, estimated to total approximately 448,000 grains [30].

Table 4. Types and quantities of bioarcheological findings (plants seeds and animal bones, teeth, and antlers) excavated from different structures and floor levels in Shirenzigou.

Type of Bio-Remain	Location									
	Lower Level					Upper Level				
	F7	F1	F2	F3	F7	F2	F3	F4	F6	
Botanical	9425	1			53					
Cereals	348				83					
Weed	607	90	112	326	110	106	614	251	12	
Faunal remains										

3.3. Chronology

Our radiocarbon dates were consistent with previous results, supporting a long-term occupation of the site between 1200 BCE and 900 BCE (Figure 7), with an early phase around 1200–1000 BCE and a later phase around 1000–900 BCE. More details on the radiocarbon dates can be found in Table S3.

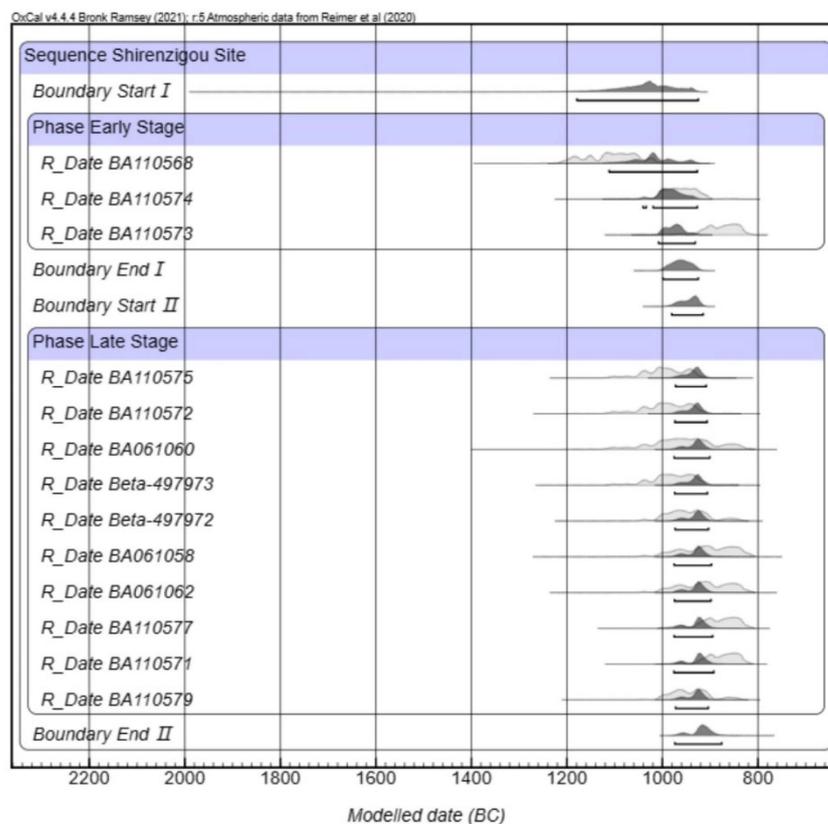


Figure 7. Calibrated radiocarbon dates for Shirenzigou. Accelerator Mass Spectrometry Dating Laboratory of Peking University and Beta Lab, calibrated using OxCal and IntCal20 [64,65] (OxCal online version 4.4.4).

4. Discussion

4.1. The Shirenzigou Community

The findings at Shirenzigou, marked by an abundance of caprine skeletal elements and plant remains, indicate that the late Bronze Age inhabitants led a pastoral lifestyle complemented by farming and hunting [13,31,57,67], a practice still observable in the area today [29,67].

The arrangement of the settlement, including the positioning, forms, and dimensions of the buildings, along with the organization of their internal areas, suggests a certain degree of intentional spatial division. Although it is challenging to determine the degree of the potential site planning at Shirenzigou, the alignment of buildings along pathways and the establishment of an open space in front of the larger building lend further credence to the notion that there was a deliberate conceptual framework guiding the construction of the site [9,68,69]. The arrangement of the site with devoted activities' areas, which is discussed below, provides additional support for this structured approach.

Units F1–F4 and F6 exhibited consistent architectural layout and spatial organization. Their parallel arrangement, lacking direct connection between them, suggests a deliberate effort to maintain a degree of autonomy [5,70]. Their dual-suite design further underscores this emphasis on privacy [8]. The larger front room likely fulfilled various roles, such as hosting guests, providing limited storage, and possibly serving as a temporary waste disposal area. The rear room, organized around the stove, was designated for cooking and probably sleeping. Near ash pits and walls, areas were seemingly assigned for food preparation, storage, and elementary crafts like weaving and pottery making. The significant number of basic cooking and dining utensils, greatly outnumbering other artifacts, along with animal bones bearing signs of processing, highlights the domestic nature of these spaces and their primary function as dwellings for small households. Comparable buildings have been found in nearby pastoralist Bronze Age settlements at Liushugou (F1 and F2; [71,72]) and Wulanbuluke (F5; [73]). Today similar structures are employed by small groups engaged in seasonal pastoralism for their routine living and dining needs across the Eastern Tianshan Mountains [7,29,67] (Figure 8). The archeological evidence and our observations of modern pastoralist households on-site suggest that these ancient spaces could potentially accommodate up to 4–6 people.



Figure 8. Dwelling of pastoralists in Xigou, Shirenzi village, Barkol. The photo was taken by Ren Meng in August 2015.

The variety of cultural material excavated from units F1–F4 and F6, including artifacts for cooking, production, and leisure, suggests a diverse community engagement in domestic life, potentially involving men, women, children, the elderly, and other identities. The consistency in the distribution and types of remains in the smaller houses indicates minimal wealth differentiation among the occupants. The coeval funerary contexts of Liushugou [71] and Baiqier [74], located on the northern slopes of the Eastern Tianshan Mountains in Barkol and Yiwu, respectively, suggest a similar scenario: burials were grouped in clusters of similar scales and included comparable grave goods, providing no evidence for social stratification.

Building F7 stands out due to its larger size and strategic placement. It was not only the tallest structure in the settlement but was also raised to a higher elevation in the second construction phase. A pathway ascended from the ordinary dwellings to F7, climbing 9 m and winding through terraced houses to reach this central structure, thereby emphasizing its prominence within the settlement. F8, with its small, single-room layout, likely functioned as F7's storage space for various cooking devices [57]. F5 and F10 were single-room spaces sharing their walls with F7. Their doors, when present, faced various directions. For this reason, it is suggested they were designed as annexes to support the main activities of the central building. The status of F9 is unclear, due to the lack of excavation data. The presence of these annexes indicates a complex centered around F7.

F7 stands also out for the greater scale and sophistication of its indoor facilities and artifacts. Notable is the inclusion of 19 unique grain storage devices, absent in standard residential units, which hints at a cohesive community structure in Shirenzigou, at least partially, reliant on shared food resources. Communal approaches to storage are usually more evident in strategic arrangements for 'livestock storage'—utilizing fenced areas, repurposed structures, and pens—which are fairly well documented for both historical and contemporary pastoral communities throughout the Eastern and Western Tianshan Mountains [7,29,75]. The identification of grain storage containers in unit F7 not only corroborates previous arguments about small-scale agriculture practices at the site [31,61,75], but also further challenges the notion of this building serving merely as dwelling. Instead, it repositions F7 as a potential communal hub, central to the sustenance and social interaction of the Shirenzigou residents.

F7 exhibited a clear abundance of artifacts, outnumbering those in other houses and surpassing what would be expected for ordinary household needs. For example, the presence of large stone grinding plates—11 on the lower floor and 9 on the upper floor—far exceeds the 1–2 plates typically found in ordinary houses in Shirenzigou and elsewhere [57,76]. This lends further credence to the notion that this building was dedicated to collective activities, potentially including foundation-laying events, food-sharing ceremonies, and feasts. The accumulation of large quantities of animal bones, seeds, and pottery deposits beneath both floors of F7 [29,30] corroborates this argument. Similar prehistoric sites with ceremonial activities, characterized by oversized cooking facilities and numerous animal and plant remains, have been identified across the Tianshan Mountain [77–79]. Notably, the late Bronze Age centripetal compound structures at Lanzhouwanzi [80], and Haiziyan [81,82], in Barkol County, featured these elements prominently in their core houses, suggesting they served as community gathering points. Ethnographic research on current pastoralist groups in Shirenzigou by [29,67] documents seasonal collective ceremonies involving food distribution and sharing within the community. One of these studies estimates that the seven sheep found beneath F7 (in H24 or H25) could have been consumed by about 70 people in a single event [29]. The existence of a plaza to the east of F7 reinforces the interpretation of this space as being designed for communal gatherings. Distinctive artifacts such as large painted pottery vessels, bronze items, and scepter heads, predominantly discovered in F7, mirror the types of objects typically found in late prehistoric high-status burial sites across the Eastern Tianshan Mountains, like Yanghai M21 and Xigou M1 [83,84], further hinting at F7's special role in the Shirenzigou settlement.

The architectural layout of the Shirenzigou centripetal compound building, characterized by strategic placement, varied forms and sizes of buildings around a central structure (F7), suggests a communal and possibly deliberate organization of space. Coupled with the extent, volume, and arrangement of relics and artifacts, this setup indicates different degrees of engagement in site activities, ranging from everyday tasks likely conducted at the household level in regular dwellings to broader participation in communal events associated with F7.

4.2. Centripetal Compound Buildings in the Eastern Tianshan Mountains: The Interplay between Environment and Social Change

The distinctive configuration of the centripetal compound building in Shirenzigou suggests an increasing complexity in the community's social organization. Similar late Bronze Age structures identified across the Tianshan Mountains, such as in Hongshankou [85], Lanzhouwanzi [80], and Haiziyan [81,82] (Figure 9), indicate a broader adoption of this architectural style, reflecting substantial social ramifications at a regional scale.

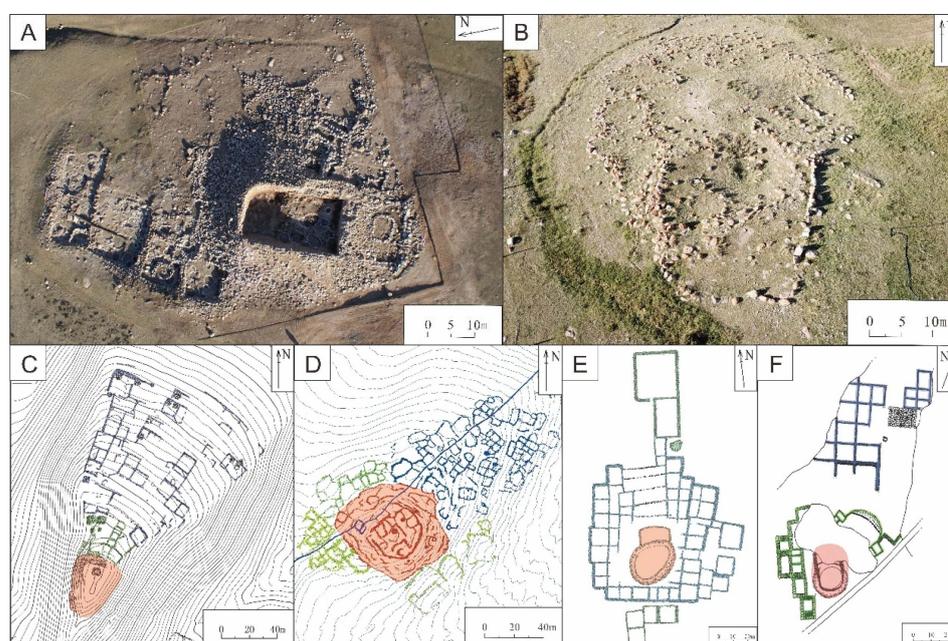


Figure 9. Centripetal compound structures identified in the Tianshan Mountains: (A). Shirenzigou [57]; (B). Xiaoheigou [86]; (C). Hongshankou [85,87]; (D). Kuola North Building Group [88]; (E). Yuegongtai-Xiheigou (Nijiaebo Group) [80,89]; (F). Yuegongtai-Xiheigou (Shuangzhe'ebo Group) [80,89].

[37] proposes that the selection of settlement locations and the site architectural arrangement during the late prehistory of Xinjiang were strategically based on climatic conditions, implying that these historical communities might have intentionally chosen their sites to mitigate the challenges of an increasingly hostile climate. The climate of Xinjiang during the late Holocene closely resembled its current state, being significantly more arid than in eastern China [90–92]. There is broad consensus that aridity in Northwest China has increased since 2000 BCE, leading to the expansion of deserts and the shrinkage of lake surface [93–96]. It has been argued that climatic deterioration in Xinjiang from the second millennium BCE was a crucial factor in settlement relocation, with a shift from lowland basins to the more sheltered mountain piedmonts and valleys [37]. This shift is evidenced by the decline and disappearance of the 'Xiaohé civilization' in the Lop Nur region around 1500 BCE [97]. Surveys across the Eastern Tianshan region have revealed various early burials, yet only one or two houses dating to 1500–1300 BCE have been identified in the Liushugou area [71]. While it is possible that the more obvious funerary contexts were

documented, whereas less visible residential sites might have been overlooked [98], the current archeological evidence suggests sparse occupation during the Neolithic and Early Bronze Age, with main human activities located in the lowlands of the Hami Basin [99,100]. The identification of numerous house conglomerates on the mountains' piedmonts and valleys of the Eastern Tianshan Range, dating to the Late Bronze Age, indicates a significant increase in the inhabitation of this area in the late second millennium BCE. Archaeological evidence shows that during this period, the Tianshan Beilu cultural groups, who had settled in the Hami oasis since around 2000 BCE [99,100], expanded northwards to the grasslands in front of the mountains on both the southern and northern slopes, forming the Nanwan and Shirenzigou cultures [101].

Climate deterioration has often spurred people to congregate around available (albeit increasingly diminishing) resources [102,103]. A growing number of studies have shown historical examples of such phenomena in Northwest China [104,105]. The steady water supply and good drainage in the Shirenzigou area make it an optimal summer pasture, allowing large herds to be grazed there. Additionally, until the middle of the last century, the area around the site was extensively covered with green forests and grass, making it suitable for hunting wild fauna [29]. It is probable that, in response to increasing aridity, ancient communities would have clustered around these key resources. Most of the centripetal compound buildings in the Eastern Tianshan Mountains are located in similar settings, suggesting they could have been structural adaptations aimed at strengthening communal bonds among the increasing number of occupants of these new key locations.

Between the second and first millennium BCE, the mountainous regions of Central Asia and Xinjiang saw significant transformations, including a growing demography, the emergence of different pastoral models, an increased degree of mobility, a greater dependence on herding—primarily of caprines and, to a lesser extent, cattle—low-investment agricultural practices, and the development of new metallurgical technologies [31,33,36,106,107]. These new socio-economic patterns would have prompted changes in the use of the landscape, as well as a re-negotiation of relationships within and between communities [28,108]. The pasture at Shirenzigou is expansive and allows prolonged grazing, therefore it could have been used simultaneously by multiple people, as it happens today. Research conducted in Central Asia and Xinjiang documents that winter and summer camps were central gathering spots for herders to share pastures, while engaging in social and political interactions face-to-face [7,98,108]. In the Neolithic period in Western Asia, the emergence of clustered neighborhoods, special buildings, and feasting practices were linked to growing cooperation in crop production and shared beliefs and identities, in response to enhanced aridity, aiming to ensure social cohesion to allow survival of increasingly populated communities [8,69,109,110]. In China, the historical *Yi Li* (仪礼 or *Liji* 礼记 Book of Rites) describes a social structure extant in Northern China in the first millennium BCE, characterized by family-based clans where people '异居而同财, 有余则归之宗, 不足则资之宗' (live separately but share wealth; the surplus goes to the clan, and in times of need, the clan supports) [111], emphasizing a blend of separate living with shared communal wealth and support to reinforce economic production and social cohesion. The development of centripetal compound buildings in the Eastern Tianshan Mountains could represent a regional adaptive strategy in response to emerging socio-political shifts. In Shirenzigou, this strategy would have particularly focused on reinforcing social cohesion among individuals and groups and securing resource availability by allocating individual tasks in ordinary houses and collective efforts in unit F7.

The Shirenzigou centripetal compound building, positioned in a valley surrounded by mountains and rivers with mountains at its back and facing steep slopes, is visible from a significant distance. During our surveys, we could see F7 from the highway in the lowlands north of the Tianshan Range, at a distance of at least 8 km. This strategic positioning likely added symbolic meaning to the structure, perhaps even serving as a social marker recognizable by nomadic pastoral groups from afar. This is in line with previous archeological and geomorphological research across Xinjiang, which has shown that during the Bronze and Iron Ages, special buildings devoted to collective ceremonies and rituals were strategi-

cally placed in locations like mountain peaks, open valleys, and occasionally alluvial fans, chosen for their ecological, climatic, environmental, and socio-political and symbolic significance [112–114]. Centripetal structures, which have been identified across the Eastern Tianshan region, were located in similar settings. For instance, the Yuegongtai-Xiheigou Group, in Barkol County, is sited on open slopes [52,80,89], while the Hongshankou Site No. 1, also in Barkol County, was atop a hill on an open slope [85]. The largest such structure identified to date—the Kuola Site North Building Group, in Yiwu County—lies on a piedmont slope with an extensive core house’s footprint of 70 m in diameter and a notable height of 6 m, emphasizing its prominence within the grasslands [88,115] (Figures 1 and 9). The prominence of these structures could suggest they were a manifestation of the power of an emerging elite [116]. The relationship between the ordinary dwellings and the main unit F7 in Shirenzigou, however, seem to indicate that the centripetal compound building was part of a comprehensive strategy to create a stable social landscape. This meant that pastoralists in the Eastern Tianshan Mountains could have fostered greater social and political integration among people (and groups of people) based on cooperation and the regularity of face to face interaction during seasonal communal ceremonies.

In addition, the strategically positioned centripetal compound buildings could have served as measures to manage and control the movement of people, as well as regulating access to pastures and the settlement. However, this function may have been secondary. A Bronze Age structure, located less than two kilometers from the centripetal compound building, was identified in a higher position (approximately 20 m higher). This building would have had a broader view of the landscape [117]. Nevertheless, a more thorough analysis needs to be conducted on-site to better understand its nature and potential function.

In the Late Bronze Age, a significant number of non-ordinary dwellings and non-residential structures, alongside ordinary houses, appeared in the Tianshan Mountains, reflecting a growing regional socio-political complexity [10,13,98,118]. From this perspective, the emergence of the centripetal compound buildings across the Tianshan region may reflect a broader social strategy of integration of, but also divisions between, pastoralist groups in response to socio-political shifts between the second and first millennium BCE.

5. Conclusions

The late Bronze Age site of Shirenzigou was characterized by the emergence of a distinctive structure known as the centripetal compound building. This configuration, featuring smaller, independent dwellings encircling a larger, centrally located communal structure, illustrates a nuanced balance between private living spaces and public, communal areas. The arrangement points to an evolving social complexity within the pastoral communities of the Eastern Tianshan region. The proliferation of such communal-centric dwellings across the region may reflect a broader social strategy aimed at enhancing communal bonds among pastoral groups, possibly in reaction to environmental pressures and socio-political shifts in the late second millennium BCE.

Yet, several aspects remain unclear. Investigations at Shirenzigou have uncovered a systematic spatial division, with uniformly sized living quarters suggesting an organized setup potentially linked to household units. The question of whether these units were family-based remains open. While ethnographic studies suggest the predominance of nuclear families [29], genetic analyses from various prehistoric Eurasian sites reveal complex dynamics of household compositions, hinting at both genetic ties and social relationships as key in the structuring of ancient communities [119–121]. Moreover, while this study has demonstrated the unique role of unit F7, the specifics of its accessibility—whether it was exclusive to certain individuals or open to the wider community—still need to be clarified, raising further questions about the nature of social relationships within and across households. Despite significant research effort [29,31,36,75], further examination of production activities at the site are essential to uncover the complex processes and interactions that influenced daily life in Shirenzigou over time.

On a broader scale, the development and diffusion of centripetal compound buildings across the Eastern Tianshan Mountains likely had significant regional social implications. While our study provides important insights into the social landscape at the end of the second millennium BCE, a deeper understanding of these regional transformations—and their implications for the emergence of complex, potentially even proto-urban and urban societies in Xinjiang—requires more comprehensive excavations and analyses at both macro and micro levels

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/land13050576/s1>, Table S1: Data relevant to the ratio of interior floor space to the total footprint area in the Shirenzigou structures; Table S2: Data relevant to the density of the features, ceramics, and other artifacts (pottery, stone and metal items) in the Shirenzigou structures; Table S3: Calibrated radiocarbon dates for Shirenzigou from the Accelerator Mass Spectrometry Dating Laboratory of Peking University and calibrated using OxCal and IntCal20 [64,65]. Reference [122] is cited in Supplementary Materials.

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