The Hamin Mangha Site: Mass Deaths and Abandonment of a Late Neolithic Settlement in Northeastern China

Yawei Zhou, Xiaohui Niu, Ping Ji, Yonggang Zhu, Hong Zhu, and Meng Zhang

ABSTRACT

The massive numbers of human skeletons within quickly abandoned Late Neolithic pithouses at the Hamin Mangha site in Northeast China seems to imply an event of prehistoric tragedy. Based on the results of bioarchaeological investigation, this article aims to explain the causes of abandonment of the settlement after several houses were burned and reasons for the large numbers of human skeletons found in several houses. Depositional, contextual, and bioarchaeological data are provided to test several hypotheses on the cause of mass human death at this site. Keywords: Hamin Mangha, mass deaths, site abandonment, plague, bioarchaeology.

INTRODUCTION

Variation and change in the Neolithic archaeological record in prehistoric China has received more attention by Chinese and international scholars since the multiregional pattern of archaeological cultures during the Neolithic and multiregional development of civilization in China theories have been proposed (Liu and Chen 2012; Su 2000). In recent decades, within the context of interdisciplinary research and international cooperation, the focus has turned from cultural-historical sequencing to studying human adaptation, social change, and cultural dynamics. A series of new theories, including the Palaeolithic to Neolithic Transition, Neolithization, identity formation, highland Longshan society, and others have been proposed to form new approaches (Chen 2014; Chen and Yu 2017; Li 2018; Liu and Chen 2012; Shelach 2008).

Compared with the much more fully-studied region of China around the Yellow and Yangtze rivers, considered the heart of Chinese civilization, the prehistory of northeastern China is much less known, though more and more archaeologists have been devoting themselves to this region over the past two decades (Shelach 2006; Zhao 2003; Zhu 2017). Before discussing the Hamin Mangha site, the subject of the current

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Fig. 1. Location of Liaoxi and Ke'erqin and two Late Neolithic sites, Hamin Mangha and Miaozigou (source base map: www.tuxingis.com).

research, we introduce the Liaoxi area because it is better known to archaeologists and the archaeological record at the site shows influence from Liaoxi. The Liaoxi area is located in the current southeast Inner Mongolia Autonomous Region and western Liaoning Province (Fig. 1). A great amount of data from systematic and intensive surface survey and well-controlled excavation has accumulated from this area (Chifeng 2003; Liaoning 2012; Neimenggu 2004; Shelach 2006). A full sequence of archaeological cultures has been built—Xinglongwa (6000–5000 B.C.E.), Zhaobaogou (5000–4500 B.C.E.), Hongshan (4500–3000 B.C.E.), and Xiaoheyan (3500–2500 B.C.E.)—showing the changes in archaeological assemblages from the Neolithic. Among them, Hongshan Culture shows a high level of social complexity, with evidence consisting of a splendid jade industry and ceramic funerary vessels, clay human statues and figurines, and ritualistic sites (Shelach 2006:73). The recently excavated Hamin Mangha site suggests a dominant influence from the south—that is, Hongshan Culture—especially with regard to various types of jade artifacts (Ji and Tang 2018).

Unlike the Liaoxi area, the Ke'erqin region (118–124.3°E, 42.40–45.15°N) where the Hamin Mangha site is located is associated with lower primary productivity, unsuitable for agriculture but ideal for a foraging economy (Chen et al. 2016). Typological research suggests a series of archaeological phases existed in this region (Table 1). The archaeological record recovered from the Hamin Mangha site is named Hamin Culture; it dates to approximately the same age as Late Hongshan Culture in the Liaoxi area (3500–3000 B.C.E.).

Until now, the interaction between environment and socio-political organization in Ke'erqin has been little known. Very few excavations or other research has been conducted in the region, making the discussion of the archaeological discovery at the

Table 1. Archaeological Sequence in the Ke'erqin Region

PHASE	ARCHAEOLOGICAL REMAINS	DATE B.C.E.
1	Xinglongwa cultural remains	6000–5000
2	Zhaobaogou cultural remains	5000–4500
3	Early Hongshan cultural remains	4500–3500
4	Hamin Culture (Late Hongshan Period)	3500–3000
5	Nanbaoligaotu type	2500–2000

Hamin Mangha site difficult because it lacks parallel sites for detailed comparison. However, the astonishing numbers of skeletons and associated artifacts that have been unearthed from pithouses at this site provide archaeologists with an impressive starting point for further research on broader anthropological issues such as craft specialization, funerary behavior, social organization and identity, and so on.

This article focuses on the most significant discovery at Hamin Mangha, the large number of individuals found in abandoned pithouses. We aim to suggest explanations for why this Late Neolithic site was abandoned and evaluate different hypotheses that might account for the evidence of mass deaths at this site. Until now, the only other site from prehistoric China showing a similar phenomenon of deposition of human skeletons in storage pits and living floors is the Miaozigou site in southern central Inner Mongolia (Fig. 1). Miaozigou (3500–3000 B.C.E.) dates to the same period as Hamin Mangha. The evidence of mass human death at Miaozigou has been explained as the consequence of a plague (Wei 1989). This is one of the hypotheses tested for Hamin Mangha in the current article.

THE HAMIN MANGHA SITE

Hamin Mangha (122.216°E, 43.982°N), a Neolithic site located at Kezuozhongqi in the Inner Mongolia Autonomous Region of northeastern China, is becoming known for the recent discovery of several quickly abandoned pithouses filled with a massive number of human skeletons (Zhou et al. 2012; Zhu et al. 2014; Zhu 2016; Zhu and Ji 2016*a*). To mitigate site disruption from railway construction, the Inner Mongolia Institute of Archaeology organized and conducted three seasons of excavation during the years 2010, 2011, and 2012 in collaboration with Jilin University and the Cultural Relics Management Division of Kezuozhongqi (Neimenggu 2015; Neimenggu and Jilin 2012; Neimenggu and Kezuozhongqi 2012).

The extent of Hamin Mangha is defined by surrounding ditches and covers a total area of 170,000 m^2, of which only 5900 m^2 (3.5% of the site) have been excavated. The site was excavated following the superposition principle. The strata of the site can be divided into three layers. The first layer is loose yellow aeolian sandy soil about 0.5–0.6 m thick. The second 0.15–0.45 m thick layer is the cultural layer; its soil is gray-black and dense. The third layer has not been completely uncovered out of concerns for cultural heritage protection. All the deposits were removed to expose the features and associated artifacts and human skeletons. The excavations at Hamin Mangha revealed many features of interest, including 54 pithouses, 57 pits, 12 burials (not within the burned houses, ordinary individual and collective graves), and 2 (possibly parallel) surrounding ditches (Fig. 2, Fig. 3). Following standard Chinese

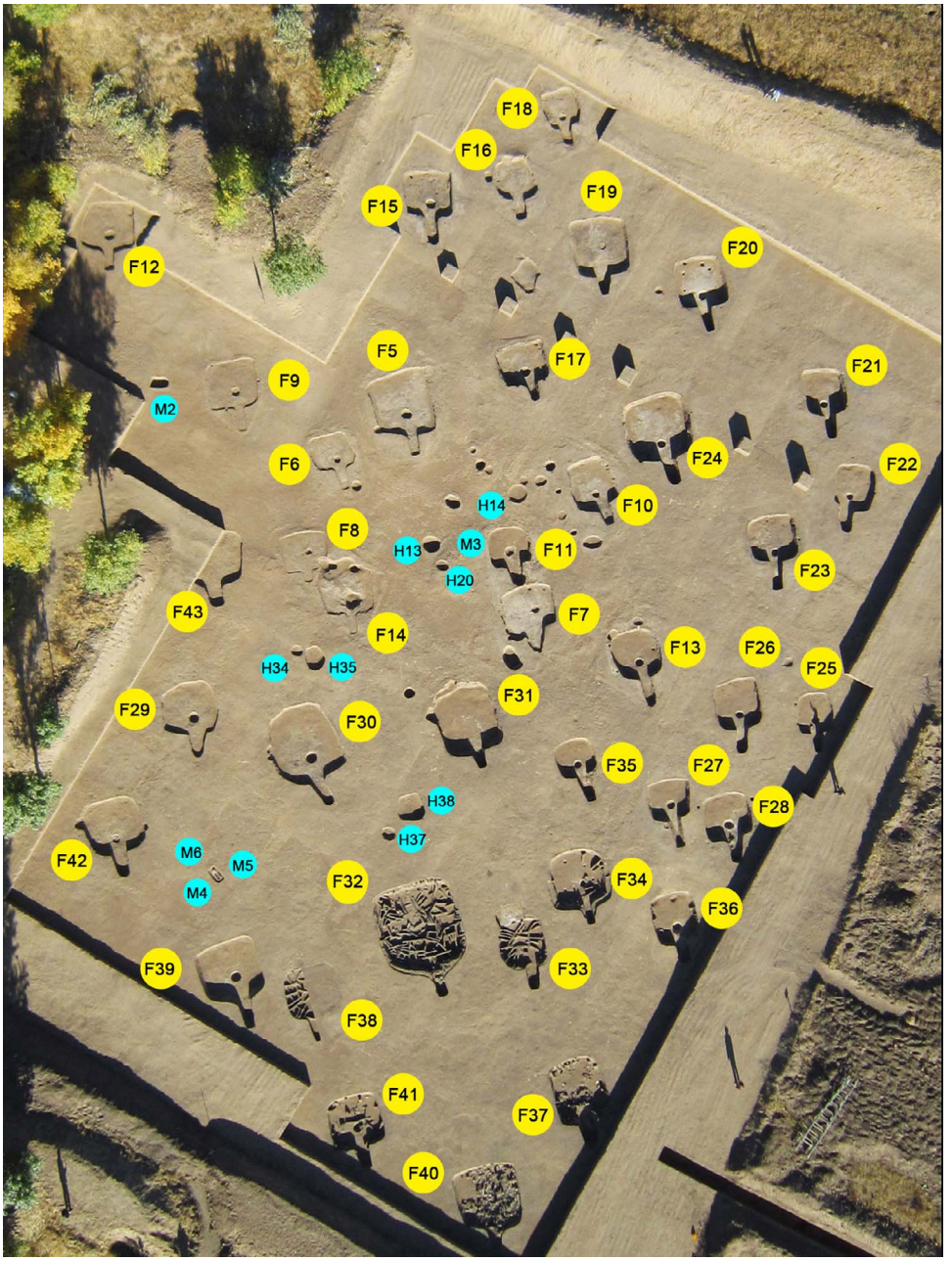

Fig. 2. Aerial photograph of Hamin Mangha excavation area in 2010 and 2011, showing location of pithouses (F), burials (M), and pits (H); F32, F37, F40 contain skeletons (Neimenggu and Jilin 2012: appendix fig. 2-1).

Fig. 3. Aerial photograph of the excavation area in 2012 (black line outlined lower right area) showing location of pithouses (F), burials (M), and pits (H); F44, F45, F46, F47 contain skeletons (Neimenggu 2015: fig. 3).

Table 2. Basic Information on Pit Tomb Burials at Hamin Mangha

Burial No.[a]	Location[b]	Number of Skeletons	Sex, Age	Burial Position and Notes	Grave Goods	Reference
M1	T022063	1	Unknown	Unknown, only skull fragments	–	Neimenggu & Kezuozhongqi 2010
M2	T001065	1	Female, 20±	Supine, knees bent to chest	Clam shell on left side of skull	Neimenggu & Kezuozhongqi 2010
M3[c]	T006066	1	Child	Supine, knees bent to chest, disturbed skeleton	–	Neimenggu & Kezuozhongqi 2010
M4	T005059	1	Female, adult	Supine, knees bent to chest	Clam shell on right side of skull	Neimenggu & Kezuozhongqi 2011
M6	T004060	3	Female, 35±	Prostrate, knees bent to chest	Marly grey-brown pottery cylinder	Neimenggu & Kezuozhongqi 2011
			Male, 35–40	Supine, knees bent to chest		
			Child, 6–7	Lying flexed		
M7	T016060	1	Unknown, 40±	Supine, knees bent to chest	Large clam shell on right side of skull	Neimenggu & Kezuozhongqi 2012
M8	T016059	1	Unknown, unknown	Supine, knees bent to chest	Clam shell inside patella	Neimenggu & Kezuozhongqi 2012
M9	T017057	1	Male, 25–30	Supine, knees bent to chest, missing ribs	Large clam shell on outside of right leg	Neimenggu & Kezuozhongqi 2012

[a] Burials M5, M10, M11, M12 remain unpublished.
[b] All burials (except for M3) were found in Layer 2 of the stratigraphy and dated to the Late Hongshan.
[c] M3 was located in the living floor of F11 and dated to the Modern period.

archaeological abbreviations, the pithouses were labeled 'F' for *fangzi* (house), burials 'M' for *muzang* (burial), and other pits 'H' for *huikeng* (pit). Approximately 1850 artifacts consisting of pottery, lithics, bone and antler or shell tools, jade, and so on were excavated from the site, with some houses containing many jade artifacts (Ji and Tang 2018). Radiocarbon dates have not yet been published (they will appear in the final excavation report), but the site is estimated to have been occupied 3500–3000 B.C.E. based on the typologies of the pottery and jade artifacts (Zhu and Ji 2016*b*).

All 54 pithouses were excavated. They are all features of Layer 2 in terms of stratigraphy and were all constructed in the same time range as determined by associated artifacts and stratigraphy (all beneath Layer 2). These semi-subterranean pithouses are rectangular or square with rounded corners, with a width of about 2.2–5.95 m, a depth of about 2.86–6.3 m, and an area of 20–40 m^2. They are nearly homogenous in terms of the direction of the doorways, with all pointing toward the southeast. There is almost no distributional overlap between any two pithouses among those excavated to date, and all of the pithouses are within the inner surrounding ditch, suggesting contemporaneity of the buildings (Fig. 2, Fig. 3). Some of them present clear evidence of burning (i.e., F1, F13, F17, F21, F32, F40, F45, F47, F52). One medium-sized house (F40) was filled with many skeletons ($n = 97$), suggesting there may have been a huge prehistoric tragedy at this site. The inter-house areas were also fully investigated; they contained pits and burials, but no evidence of unburied corpses having been left out in the open.

Some basic information on the 12 excavated burials is listed in Table 2. The evidence shows no significant difference between ordinary burials at Hamin Mangha and other Neolithic sites in the Ke'erqin region. All 12 tombs are vertical pit burials. The shape of the tombs was square or round and their length or diameter was between 1 and 2 meters. Except for burials M5 and M6, the deceased were all placed on their sides with knees bent up towards their chests. Few grave goods are associated with these burials except for some shells. There was no evidence of fire on the human skeletons in the burials, while many of the pithouses had traces of fire above the skeletons interred within.

QUICKLY ABANDONED PITHOUSES, WITH AND WITHOUT SKELETONS

Eight pithouses were associated with human skeletons, including F32 ($n = 13$ skeletons), F37 ($n = 22$), F40 ($n = 97$), F44 ($n = 14$), F45 ($n = 1$), F46 ($n = 22$), F47 ($n = 10$), and F48 ($n = 2$). Note that the letter '*n*' here represents the provisional Minimum Number of Individuals (MNI) based on the human bones that could be observed without removing individuals buried above underlying ones. According to our recent observation, all 8 pithouses mentioned above show evidence of minimal post-depositional modification (other houses are under investigation with regard to the potential taphonomic factors involved in site formation processes). It is noted that all the pithouses containing human skeletons seem to have been abandoned quickly, with evidence that they were deliberately set on fire before they were abandoned. We now describe the depositional conditions of four pithouses, three that contained skeletons and one that did not.

F32: This pithouse has a doorway at a 130° relationship to north (compass orientation) and is 6.3 m long, 5.95 m wide, and 40–70 cm deep. It has obvious signs of severe burning, namely carbonized beams that collapsed during or after the fire.

Among 13 identified human skeletons, several were located near the doorway. The right side of pelvis and leg bones of skeleton F32-2 is superimposed by collapsed beams. Except for a few limb bones, most of the bones of skeletons F32-11 and F32-12 are under some collapsed beams (Fig. 4, Fig. 5a). Traces of burning have been identified on some of the bones of skeletons F32-3, F32-4, and F32-10. A large number of ceramic, lithic, bone or antler tools, as well as jade artifacts, were found on the floor surface.

F40: This house represents the most prominent discovery in all three fieldwork seasons because so many skeletons (at least 97) were piled up in it (Fig. 5d). This pithouse has a doorway at 132° and is 4.25 m long, 4.44 m wide, and 35–50 cm deep. A compact dark layer of sediment existed above the skeletons and the areas without skeletons, suggesting that a burning event had occurred happened after the bodies were moved into the house. The density of human skeletons on the living floor increases near the doorway and some areas inside the north wall have more than three layers of skeletons. Body positions vary among the observable skeletons: some are supine, others prone, and others are positioned facing sideways. The directions of the heads relative to

Fig. 4. Four photographs of skeletons under collapsed beams in F32 at Hamin Mangha.

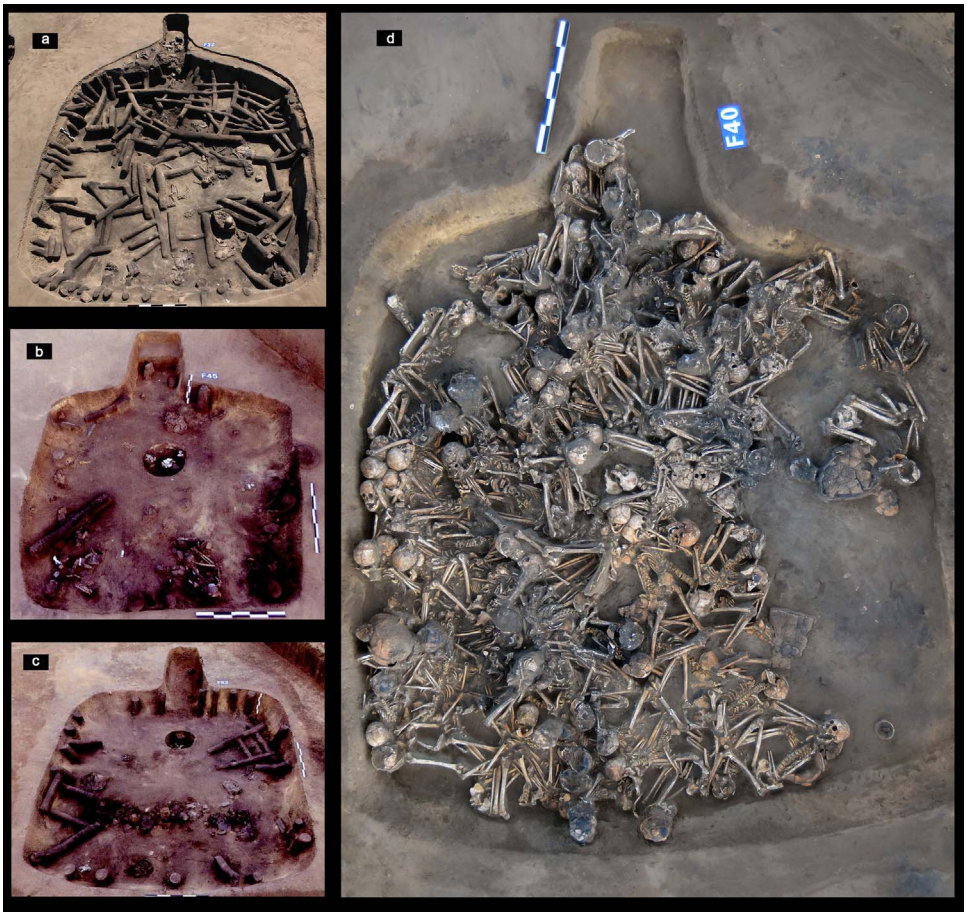

Fig. 5. Plan views of selected houses at the Hamin Mangha site (oriented northwest to southeast): (a) F32 (Neimenggu and Jilin 2012: appendix fig. 2-2); (b) F45 (Neimenggu 2015: fig. 6); (c) F52 (Neimenggu 2015: fig. 10); (d) F40 (Neimenggu and Jilin 2012: appendix fig. 3-1).

the bodies also vary. Most individuals' legs are bent. Separated from the individuals, sherds kept the original shapes of pots that had broken on the surface of the house floor; these broken vessels were found in areas where human skeletons are scarce, suggesting that the corpses might have been moved into the structure while it was still in use as a residence. The piling of bodies nearest the doorway indicates the termination of use life of the house (even as a "burial") and the burning event suggests total abandonment of this structure.

F45: This house, with only one skeleton, is one of those containing a large number of pieces of jade (Fig. 5b, Fig. 6). It has a doorway at 121° and is 3.64 m long, 3.94 m wide, and 40–42 cm deep. Some shells, sherds, and antler tools were found in the hearth. Seventeen pieces of finely-manufactured complete jade artifacts were distributed on the living floor, especially in the NW and SW quadrants. Thirteen ceramic vessels were found on the living floor, including cylinder jars, two-ear vases, and bowls. Other artifacts include 18 bone and antler tools and 9 lithic tools such as a grindstone used for food processing and some possible adzes used for woodworking.

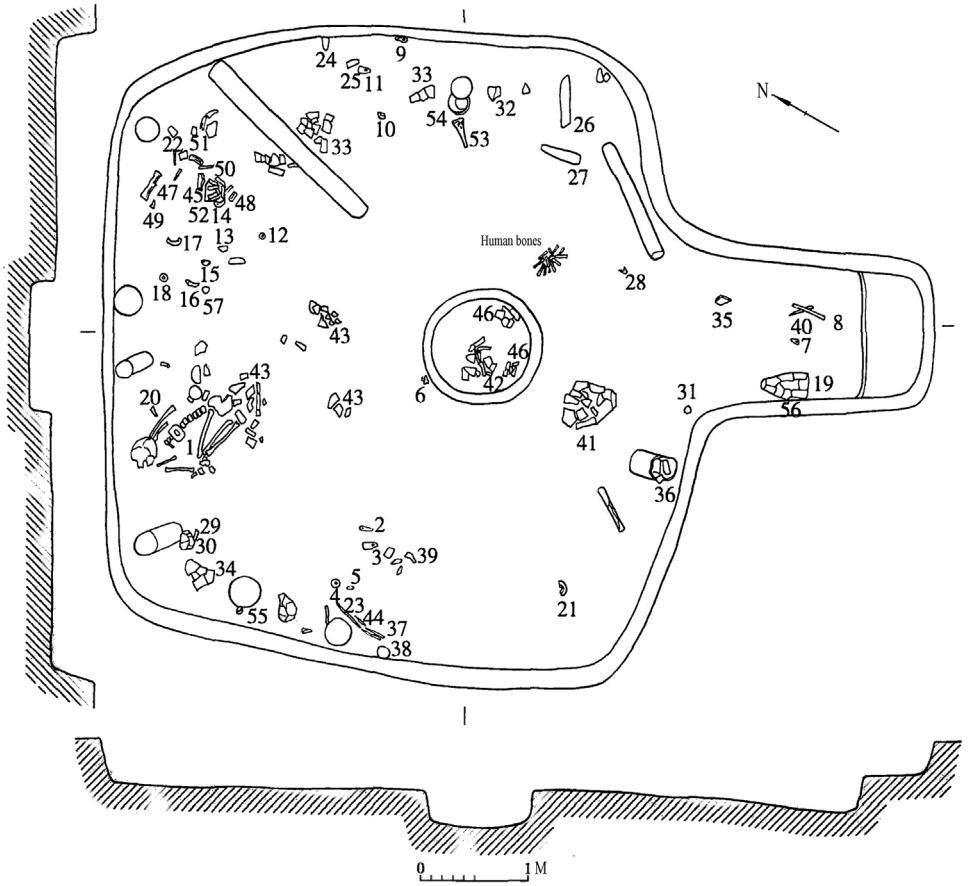

Fig. 6. Schematic illustration of house F45 showing location of associated artifacts: (1–7, 9, 11, 12, 14, 16–18) jade artifacts; (8) knife with stone edge; (10, 13) agate artifacts; (15) jade material; (19, 33, 34, 54) cylindrical jars; (20, 45, 47, 49) bone tools; (21) stone ring; (22, 24, 25) stone adzes; (23, 37, 38, 44) bone awls; (26, 27) stone picks (shi *si* 石耜); (28) bone fishhook; (29) bone spoon; (30, 41) clay pots; (31, 35) stone tools; (32, 36, 55, 57) pottery; (39, 40, 48, 51) bone material; (42, 50) antler tools; (43) jar; (46, 56) bowls; (52) stone mortar (modified from Neimenggu 2015: fig. 5).

The human skeleton was found near the northern wall; most of it had been heavily burned, leaving only limb bones, the pelvis, and vertebrae (under which was a jade artifact) in good condition. The collapsed carbonized poles and beams, combined with the existence of symbolic artifacts and utilitarian pots and tools, represents unquestionable evidence of sudden abandonment and *in situ* preservation.

F52: This house exemplifies houses without human skeletons that nevertheless present evidence of sudden abandonment. The pithouse is 5.5 m long, 5.16 m wide, and 42–56 cm deep, with 13 poles and 14 beams, mostly carbonized, found under the sediment that later filled the house (Fig. 5c, Fig. 7). The 63 artifacts found in this house consist of pots ($n = 27$), including cylinder jars, dishes, and two-ear vases, and lithics ($n = 28$), including adzes for woodworking, digging tools, mortars and pestles for food processing, and so on. One bone artifact and one shell were left on the living floor. Most of the artifacts are lineally arranged near the west wall of the house. The

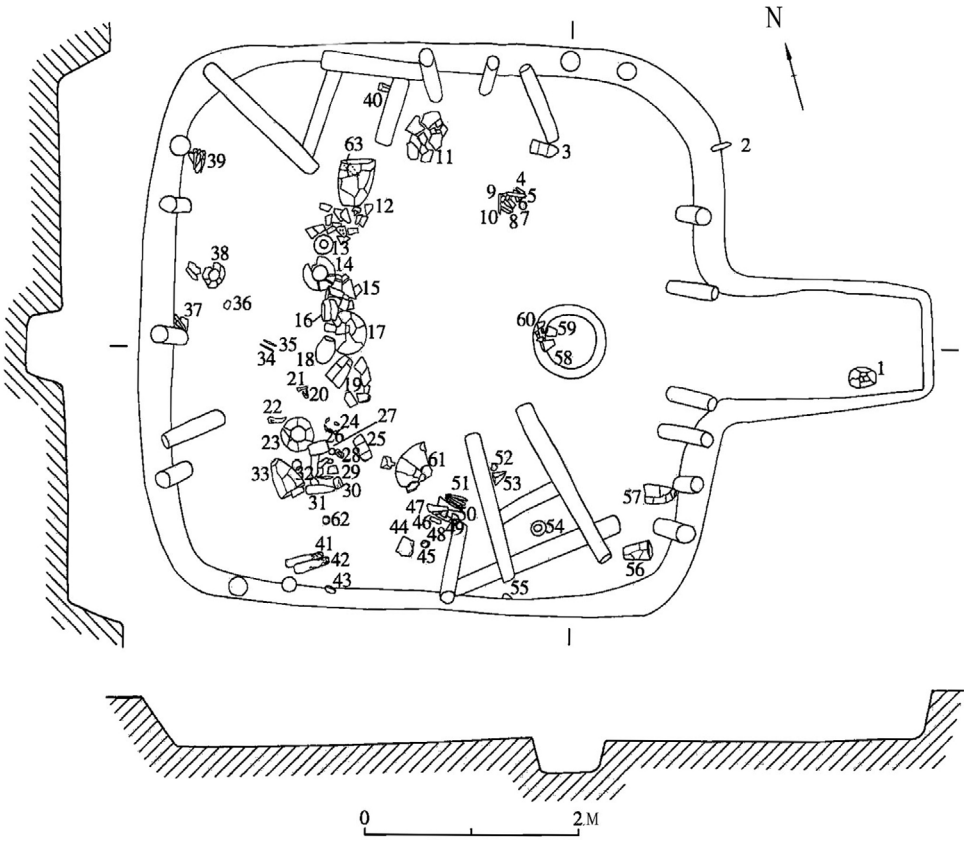

Fig. 7. Schematic illustration of house F52 showing location of associated artifacts: (1, 11, 12, 16, 29, 30, 36, 52) two-ear vases; (2, 55, 63) stone pestles; (3, 13, 19, 33, 54, 56–60) cylindrical jars; (4, 6–9, 20, 46, 48) stone adzes; (5, 21, 22, 51) bone tools; (10, 25, 27, 32, 28, 37, 40, 43, 45, 47, 49, 50, 53, 62) stone tools; (14, 15, 23) pottery dishes; (17) bowl; (18, 26) jars; (24, 38, 44) sherds; (31, 41, 42) stone picks (shi *si*); (34) bone needles; (35) bone hair clasp; (39) shell; (61) stone mortar (modified from Neimenggu 2015: fig. 9).

arrangement of durable artifacts ready for daily use and the carbonized wood structure indicate that the occupants left the house, possibly carrying only the most portable tools and artifacts (jade?), in a complete abandonment event.

BIOARCHAEOLOGICAL DATA FROM HAMIN MANGHA

Sampling Strategy and Methodology

This part of the article reports on bioarchaeological research conducted to investigate the causes of the massive deaths at the Hamin Mangha village site. The lead author (Yawei Zhou), has been in charge of bioarchaeological data collection, identification, and analysis at Hamin Mangha (Fig. 8). In December 2011, after several houses associated with human bones (i.e., F32, F37, F40) were excavated, Zhou went to the site on behalf of the team to conduct bioarchaeological research, especially on the identification of human bones.[1] All the data were collected *in situ*, since the site had to

Fig. 8. Collecting bioarchaeological data from pithouse F40 at Hamin Mangha.

be completely protected and the skeletons were not permitted to be removed, so it was impossible to identify and measure their characteristics in the lab. The researchers tried their best to outline the skeletons of specific individuals to avoid duplicating data in counting the individuals within each house, but the MNI is likely to be low in cases where many skeletons are piled up on top of one another as at house F40. That is, the actual number of individuals in F40 is likely to be far higher than the MNI of 97 that we calculated despite these limitations. Age and sex could not be identified for some individuals *in situ* because they were either partially covered by other skeletons or the anatomical parts essential for such identification were not exposed. The demographic statistics are therefore incomplete.

Several criteria are used to collect data on sex and age, mostly from the anatomical parts with sensitive indicators. Sex identification is mainly based on characteristics of the pelvis such as the greater sciatic notch, angle of the pubic symphysis, and the subpubic concavity, as well as characteristics of the skull such as the nuchal crest, mastoid process, supraorbital margins, mental eminence, prominence of glabella, and external occipital protuberance (Buikstra and Ubelaker 1994; White and Folkens 2005). Determining age at death mainly relies on the characteristics of the auricular articular surface, tooth eruption, degree of tooth wear, and degree of suture coalescence (Wu et al. 1984). The method we used to calculate the mortuary age averages was to assign a single age value to each individual, rather than the age range value.[2] Although we were unable to take measurements on many of the individuals, we are nevertheless confident that we have collected enough data to identify patterns in age and sex.

Demographic Results

Among the 181 individuals identified so far in the pithouses, 46 (25.4%) had definite sex indicators, resulting in 19 male and 27 female individuals (with a male to female ratio of 0.7:1), and 96 (53.0%) had definite mortuary age indicators (Table 3). (The

Table 3. Age and Sex of Individuals Recovered from Pithouses at Hamin Mangha

Stage	Age (years)	Male	%	Female	%	Known sex	%	Unknown sex	%	Total	%
Infancy	0–2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Early childhood	3–6	0	0.0	0	0.0	0	0.0	12	8.9	12	6.6
Juvenile period	7–14	0	0.0	0	0.0	0	0.0	11	8.1	11	6.1
Adolescence	15–23	0	0.0	4	14.8	4	8.7	6	4.4	10	5.5
Early adulthood	24–35	9	47.4	7	25.9	16	34.8	19	14.1	35	19.3
Middle age	36–55	5	26.3	6	22.2	11	23.9	17	12.6	28	15.5
Old age	>55	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Known age		14	73.7	17	62.9	31	67.4	65	48.1	96	53.0
Unknown age		5	26.3	10	37.1	15	32.6	70	51.9	85	47.0
Total		**19**	**100**	**27**	**100**	**46**	**100**	**135**	**100**	**181**	**100**

relatively small proportions of aged and sexed individuals results mainly from the difficulty of seeing diagnostic elements of any given individual when they are hidden by skeletons above it.)

Although the present research cannot provide exact and absolute demographic information on the age and sex profiles of all 181 individuals, some inferences can be made based on the current data, especially on the issue of cause of death, in part by taking into consideration their context within some houses.

First, judging from the age indicators on the bones, the average age at death of individuals within the pithouses at the Hamin Mangha site is 26.8 years old (based on the 96 individuals for which age data is available within the total sample of 181 individuals). Mortality age spans all age zones from 3 to 55 years. The slight difference in average age at death for F32 and F46 compared with other houses may be due to the small sample of individuals with age indicators in these houses (Table 4).

For further analysis, we performed a t-test on two groups of data by sex. We calculated the median age range of death for each group. (Since there are no sex indicators for minors, they are not included in the statistical tests.) The *t*-test on the small sample seems to support the pattern that there is no significant difference in mortuary age between males and females ($P > 0.05$). The small sample supports the pattern that males and females had a similar age at death distribution.

We also used statistical methods to find out whether there were any differences between F40 and Fn (all other houses) in terms of age of death.[3] We had observed that the number of skeletons ($n = 97$) in F40 is much higher than in any of the other houses and the thickness of their accumulation in F40 is also very high, while other houses do

Table 4. Average Age at Death of Individuals Recovered from Different Houses at Hamin Mangha

	F32	F37	F40	F44	F45	F46	F47	F48	Total
Minimum number of individuals (MNI)	13	22	97	14	1	22	10	2	181
Individuals with definite mortuary age	4	14	56	10	1	6	4	1	96
Average age at death	40.6	24.3	26.2	23.4	n/a	31.6	24.5	n/a	26.8

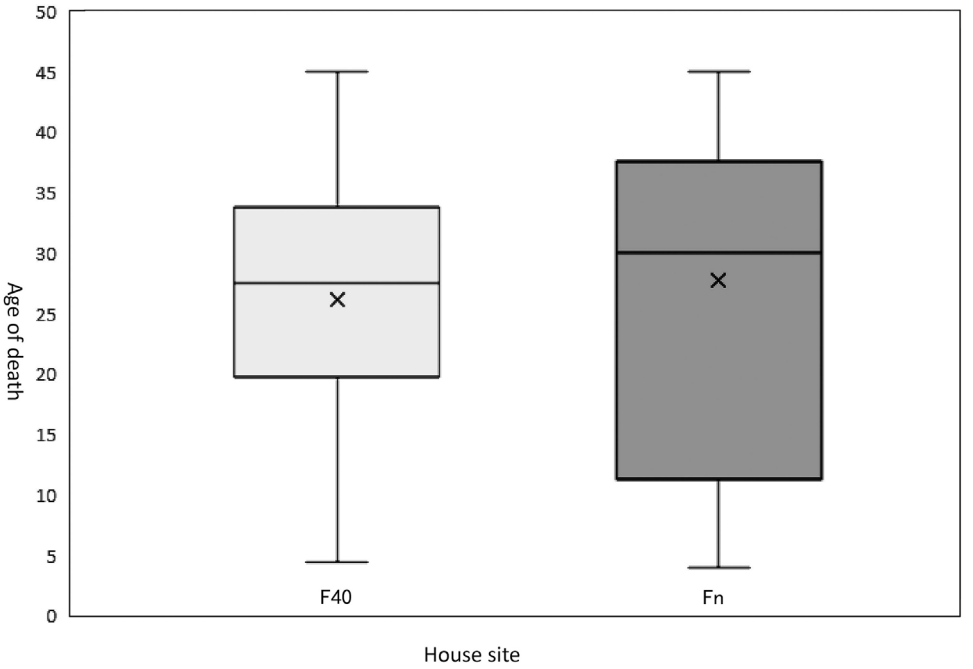

Fig. 9. Box plot showing difference in age at death of individuals from house F40 and the other houses Fn (X represents the median).

not see this phenomenon. F40 skeletons do not appear with burial goods, while most of the skeletons in the other houses appear to have been wearing jade ornaments. For these three reasons, the cause of skeletal accumulation in F40 might be different from that in other houses.

Among the 97 observable individuals in house F40, 21 (21.6%) had definite sex indicators, with 7 male and 14 female individuals represented (male:female ratio = 1:2). Based on the observable individuals with definite indicators of age at death, the average age is 26.1 years old ($n = 56$), which is close to the average age for those in all excavated houses. The average age at death for males is 33.3 years old, with a standard deviation of 7.2, and the average age at death for females is 26.7 years old, with a standard deviation of 6.4. The currently available data suggest that the individuals in house F40 are similar to those in other houses in terms of average age at death. However, the standard deviation and box plot suggest that the age of death of the individuals in house F40 is more concentrated than those in all the other houses together (Fig. 9).

EXPLAINING THE MASS DEATH EVENT AT HAMIN MANGHA

The evidence of massive death and the context of the skeletons in the houses at Hamin Mangha clearly indicate that these individuals did not die of occasional disease or old age. The skeletons are concentrated within abandoned rooms, the houses were burned, the age at death of most of the individuals, both sexes included, centered around stages of growth or prime middle age. Although there was some minor variation, the similarity among the quickly abandoned houses suggests that the individuals probably

co-existed contemporaneously in the same village and so their deaths might be attributed to the same cause.

Current evidence can be used to reject the possibility that their mass deaths were caused by fire. During the excavation and bioarchaeological investigation of the house F40, Zhou Yawei noticed that ash only existed on the top layer of the skeletons, while there was no trace of burning associated with the underlying ones. Though the possibility that some individuals, such as those found under collapsed beams, were killed by the fire or falling of burning beams cannot be totally eliminated, we rule out burning as the primary cause of most of the deaths observed in the abandoned houses. After excluding the possibility of burning leading to the deaths, several hypotheses can be proposed to account for the deaths and evidence of sudden abandonment: (1) conflict, (2) geological disaster, (3) ritual sacrifice, and (4) plague. Each of these hypotheses is reviewed below. Though we cannot reach a firm conclusion on the exact cause of the mass death event and rapid abandonment of the houses, this hypothesis-testing procedure has been employed to narrow down the possibilities.

Conflict Hypothesis

The current archaeological record, especially the existence of jade artifacts, makes conflict a reasonable hypothesis to test, especially taking into consideration the possibility of competition among individuals or groups for scarce resources. More specifically, there might have been internal conflict among the inhabitants of Hamin Mangha or an outside group may have entered the village to steal their resources. In either case, some of the inhabitants might have been killed *en masse*.

Regardless of whether this was inter- or intra- group conflict, this hypothesis needs several kinds of essential evidence to support it, including: trauma on the skeletons, existence of weapons, age at death favoring prime age of males (or a scarcity of males if they had left the settlement), and so forth (Harrod et al. 2012; Klaus 2012; Murphy et al. 2010; Willey 1990). No such evidence is recorded at the Hamin Mangha site. One of the authors (Zhou Yawei) checked the anatomical parts of the skeletons that are easily broken (certain limb bones and ribs), but there is no trace of trauma or even of healed broken bones. There are no parry fractures, for example. All the bones were in correct anatomical positions when they were exposed during the excavation, with no absences or dislocations in evidence. Moreover, no apparent weapons have been found in the artifact assemblages. All the artifacts are related to daily life, including utilitarian tools and vessels or artifacts with symbolic function such as jades. The demography of the individuals in the pithouses also tends to be normal in terms of male to female ratio[4]. Combining that ratio with the age profile (average age of death is about 26.8 years old and 24 percent of them are identified as individuals younger than 15 years old), we reject the possibility of all the members of the community participated in short-term social conflict or organized violence. Finally, the fact that several houses are associated with jade artifacts provides further evidence for rejecting the conflict hypothesis, since such labor-consuming and easily portable artifacts were not removed as trophies.

Geological Disaster Hypothesis

Two lines of evidence are essential for attributing the abandonment of sites to geological disasters, including geological forces and evidence of people's attempts to

escape. The most well-known sites that have evidence of abrupt geological disaster are the cases of Pompeii in southern Italy due to volcanic eruption, and the Late Neolithic Lajia sites in Qinghai province, Northwest China due to earthquake and flood (Yang et al. 2003). Both Pompeii and the Lajia sites show clear evidence of the geological disasters in the sedimentation and in the gestures and positions of the corpses as they attempted to shield themselves or escape.

According to the results of geological survey, there are no traces of flood or earthquake having occurred in the area surrounding the Hamin Mangha site and no geological force appears to have threatened the survival of the prehistoric residents at this site. The deposition process of the sandy sediment seems to have been slow, so the abandonment of the settlement and mass deaths there cannot be attributed to a heavy sandstorm either. The gestures of the individuals represented in the human skeletons and their positions relative to the carbonized poles and beams both suggest that people did not try to escape from the burning houses (Fig. 4). (There are too many individuals in house F40 for them to have been trying to escape from the house.) Since every evidence of burning is limited to some isolated pithouses, there is also no evidence that the fire that caused the burning was a natural event. Thus, the geological disaster hypothesis can be securely rejected.

Ritual Sacrifice Hypothesis

Were the individuals buried in the pithouses (especially the more than 97 persons whose skeletons overlapped in house F40) killed for some special ritual purpose? The practice of ritual killing or sacrifice is usually associated with specific sex and age groups and linked to the specific features of a ritual place. For example, some of the skeletons identified as young males that are buried under the plaza at Huacas de Moche in South America may have been captive warriors who were ritually killed (Toyne et al. 2014). The victims of post-conflict rituals in Iron Age Northern Europe are exclusively or dominantly young male individuals and they were mostly buried in specific locations such as the war bogs in Scandinavia (Løvschal and Holst 2018).

In contrast, the individuals buried in the pithouses at Hamin Mangha do not represent any particular sex or age group nor are they buried in specific places (Table 3). Rather they seem to be randomly distributed in some houses. This suggests that the ritual sacrifice hypothesis cannot be supported for Hamin Mangha.

Plague Hypothesis

The plague hypothesis is one of the last logical choices. It is not easy to reject based on currently available evidence, but will need many more kinds of evidence to be fully supported. The reasons why this possibility cannot be rejected are as follows.

First, the evidence at house F40, especially the multiple layers of skeletons, suggests that corpses were intentionally transported to and piled up in the house by other community members. An 18.9 m^2 house being filled with about 100 people cannot be explained if the individuals were alive and mobile when they were in the house and there is no evidence of their having been bound. If they were in the house alive, they should have been trying to escape from the house and heading to the doorway or another exit such as a smoke hole in the roof if the doorway were blocked. However, the statistical results suggest that the individual skeletons in this house were randomly

distributed in all directions (Fig. 10). This further implies that the bodies were carried into the house by other people. Another piece of evidence comes from the empty zone in house F40, suggesting that no individual (among the skeletal assemblage) went to that zone before the house was burned and abandoned.

Second, except in the case of house F40, the bodies of most of the individuals found in the other houses (Fn) seem to have been intact after their death and then they got buried in the burned houses. All the other houses (Fn) can be inferred to be the original scenes of death, with little movement. The possibility that people buried some deceased individuals before they realized the danger of the plague or that they moved corpses from some of the houses to F40 (or other unexcavated houses) cannot be excluded, but the evidence of unelaborate treatment of the bodies obviously suggests that the living people were forced to leave the dead in the houses and cover them with burnt, collapsed roofs.

Third, one of the prominent differences between house F40 and Fn (all the other houses associated with human skeletons) is the presence or absence of artifacts in association with the skeletons. For example, although the layer below the skeletons in F40 has not been excavated, it seems likely that no vessels will be found on the living floor beneath them. It is reasonable to speculate that this part of the house might have been cleared before the dead individuals were moved in and piled up there. The presence of jade artifacts in the other houses (Fn) and their near absence from F40 also suggest that survivors dealing with the dead were making decisions. Houses such as F32, F37, F45, and F46 are rich in jade artifacts. For example, Zhou Yawei discovered a pair of jade earrings near an individual's external auditory canal during the excavation of house F37. Such jade artifacts were likely used as personal adornments during life, rather than as funerary objects for the dead (Ji and Tang 2018). Assuming that every individual at Hamin Mangha owned jade artifacts (though variability in terms of age,

Fig. 10. Photo showing individuals in house F40 facing different directions; white dots represent individuals positioned face up (supine) or on their sides and black dots represent individuals positioned face down (prone).

sex, and social inequality might have existed), the jade artifacts of the individuals in house F40 might have been taken off before they were transported into this house. The fact that burnt houses with skeletons such as F32, F45, F47 are associated with various kinds of mostly intact artifacts (including jade) implies that people had given up the endeavor of clearing space and removing jade artifacts from those deceased individuals.[5]

Fourth, physical isolation is still used today to stop the transmission of pandemic disease. The mass accumulation of skeletons in house F40 followed by its being burned might indicate that survivors of a disease were taking measures to prevent other members of the community from being infected. The absence of human skeletal remains from the majority of the pithouses also supports the physical isolation hypothesis. Living people might have deliberately moved the dead to other houses before burning them in order to prevent cross-transmission, though other explanations exist.

CONCLUSIONS AND FURTHER RESEARCH

As a preliminary analysis of the Hamin Mangha site, this article only focuses on the possible explanation of the death of a very large number of individuals found in some quickly abandoned houses. It is noted that the contemporality of the pithouses with a mass death event is an assumption. Further research including intensive radiocarbon dating needs to be conducted to determine whether the event(s) happened within a narrow time range. Nevertheless, the current evidence both the bioarchaeological and demographic records and the associations among artifacts, features, and skeletons supports the assumption that the settlement was abandoned as a result of a very short-term event.

Four hypotheses—conflict, geological disaster, ritual, and plague—were proposed to explain the mass deaths and abandonment of Hamin Mangha; the fourth hypothesis is best supported by the current evidence. The plague hypothesis needs more direct evidence to be fully tested. Unfortunately, finding physical marks of a pathogen on the bones will be unlikely if death came very swiftly. Further palaeopathological and palaeogenetic studies would provide more information.

If it becomes possible, further excavation at the Hamin Mangha site would provide a much bigger sampling size, helping archaeologists more accurately estimate the demography of the whole site, especially the population loss and age and sex structure. Further excavation and new discoveries could also help archaeologists propose and evaluate other hypotheses such as the famine hypothesis. This hypothesis would have to be tested with data on physiological stress (i.e., nutrient acquisition and diet) leading up to the actual event. Until then, the plague hypothesis is supported by the current evidence, both from the perspective of contextual information and the bioarchaeological record, so cannot be successfully rejected at present.

We now return to the issue of abandonment of the houses. As argued above, all the burned houses associated with skeletons (F40 and Fn) appear to have been abandoned during an abrupt event, probably a plague. Taking into consideration that the exact timing of the deposition of the skeletons would have differed, since the individuals would not all have died at the same minute, it makes sense that the abandoned houses and their associations with human skeletons are diverse. This analysis reaches the preliminary conclusion that the behaviors associated with the abandonment of houses

Fn and F40 was all part of one event. We favor the possibility that house F40 was filled first (by survivors still dealing with the dead, moving them to a separate space), then the rest of the Fn houses were abandoned (without special treatment of the deceased, just a sanitizing fire), and finally, the survivors left the settlement seeking a new place to inhabit (taking with them only some easily portable tools and jade artifacts).

Relying on an analysis of lithic assemblages at this site, Shengqian Chen and colleagues (Chen et al. 2016) provide a culture-ecological model to explain this prehistoric tragedy. They argue that the people at Hamin Mangha were farming in a marginal environment that was really only suitable for hunting-gathering within a limited territory. They propose that, to supplement their diet beyond using limited cultivated and wild plant resources, the people ate some wild animals and got infected by a viral plague. Some animal species could have carried the plague and transmitted it into human groups. Their research supports the plague hypothesis proposed and preliminarily tested above. Recent studies based on the ancient genetic evidence on the bacteria *Yersinia pestis* as the etiological agent of plague suggests that plague infection was endemic in the human populations of Eurasia and can be traced back to at least 5000 years ago (Rasmussen et al. 2015). The same evidence has been found in Europe for the same time period (Rascovan et al. 2018). Although Chen and colleagues only attribute the mass deaths at Hamin Mangha to the possible use of dangerous wild resources, the timing of mass deaths at Hamin Mangha suggests it could have been caused by *Yersinia pestis*.

The building of ditches might suggest that the residents attempted to protect their territory from some form of threat. More evidence is needed to evaluate the function of the facilities (and the jade artifacts) in light of other social change occurring in Late Neolithic northeastern China.

Developing a better organized explanatory framework requires further interdisciplinary research. Combining bioarchaeology, palaeoenvironmental reconstruction, lab studies on various artifacts, research on site formation processes, models of changing social dynamics, and so forth at the Hamin Mangha site will provide archaeologists a window into how prehistoric residents made decisions in the face of a disaster, how they succeeded or failed to adapt to a suddenly changing environment, and how they bid goodbye to their dead and their past way of life as they (perhaps) moved forward to a better future.

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NOTES

1. Zhou did not participate in the excavations in 2011, but was involved as a field assistant in the July–August 2012 excavations, including being in charge of excavating house F46.
2. We recognize that relying on mid-points in each age range reduces the reliability of such interpretations.
3. The symbol Fn represents all other pithouses associated with human skeletons. When comparing to F40, it would be the sum of the MNIs in F32, F37, F44, F45, F46, F47, and F48.
4. Male to female ratio in the house F40 is 1:2 based on the current available data, but sex of the individuals who were placed below are unknown, making the ratio in F40 unconvincing.
5. Note that the hypothesis that some skeletons deposited in the collapsed pithouses represent the residents of those dwellings cannot be effectively supported by the currently released evidence. The current preliminary archaeological fieldwork reports only provide partial information on the excavated pithouses. Those houses associated with burnt skeletons (i.e., F37, F44, F46), let alone the ones without skeletons (i.e., F1, F13, F17, F21, F52, etc.), still lack a lot of information. Association of archaeological records and human skeletons only suggests possible ways in which the houses were abandoned. Such fuzziness can only be clarified after the final archaeological report is published in the following years.

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