Excavations at Daram and Tevsh Sites : A Report on Joint Mongolian-Japanese Excavations in Outer Mongolia

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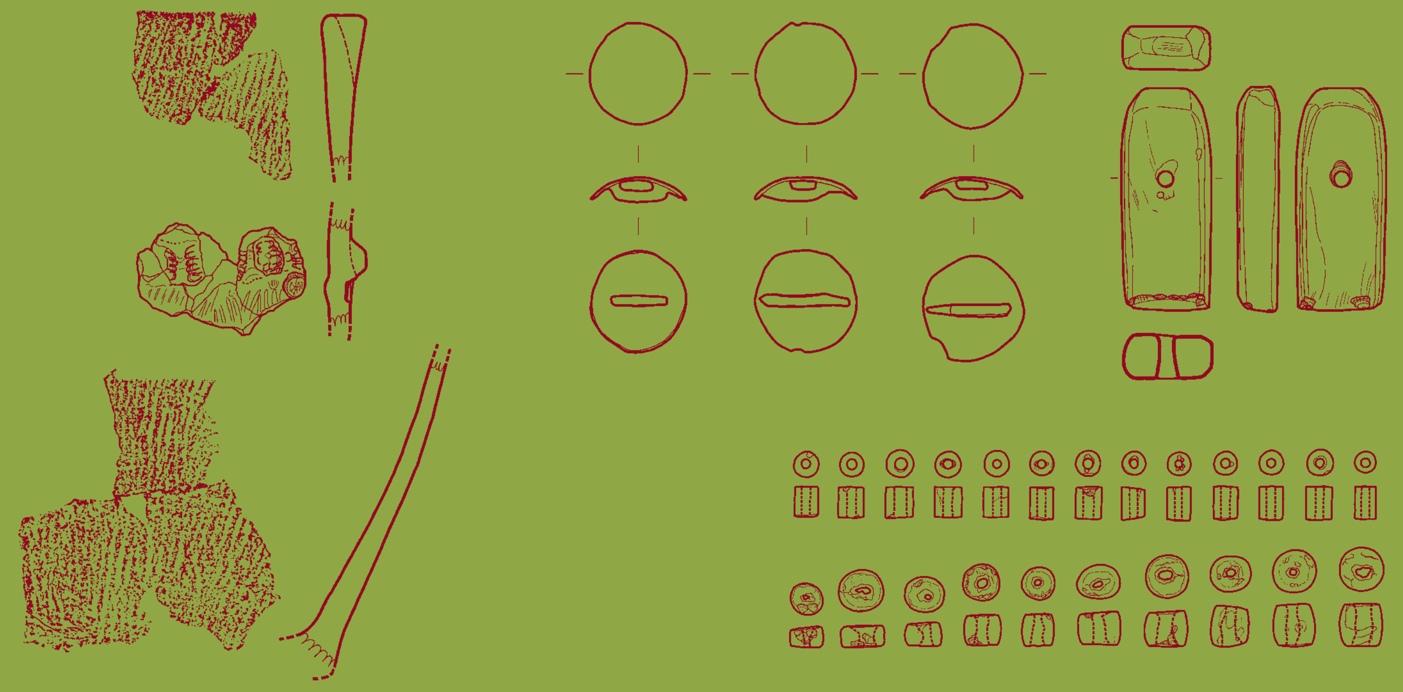

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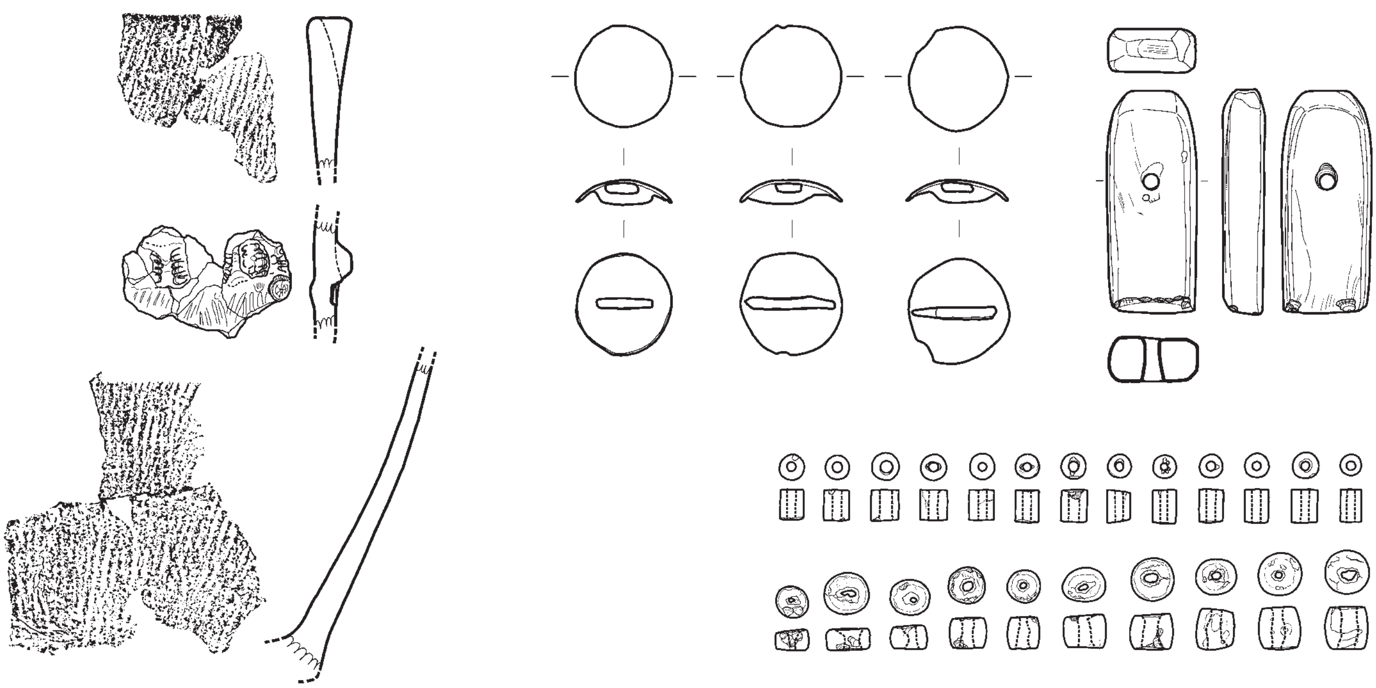

Edited by Kazuo MIYAMOTO and Hiroki OBATA

Excavations at Daram and Tevsh Sites: A Report on Joint Mongolian-Japanese Excavations in Outer Mongolia

June 2016

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Contents

Preface

These reports present the results of comprehensive excavations at Daram Site in Henty Aimag, and at Tevshi Site, Bogud sum of Uvurkhangai Aimag, Mongolia (Fig. 1). The excavations at Daram Site were carried out under a program of the Japan Society for the Promotion of Science (JSPS). The excavations at Tevsh Site were carried out under Kyushu University Interdisciplinary Programs in Education and Projects in Research Development (P&P).

The excavations at Daram Site were held between 2009 and 2011 as part of a JSPS research project called "Research on Human Exchanges on the Japanese Archipelago and Chinese Continent," of which Prof. Takahiro Nakahashi (The Faculty of Social and Cultural Studies, Kyushu University) was representative. The research project group was established under the "Mongolian Khun Project" for the purpose of studying prehistoric human bones in Mongolia. This research group consisted of members of Kyushu University, Kumamoto University and the Archeological Institute of Academia Scnica in Mongolia. A total of six stone - slab graves belonging to the Bronze Age were excavated between August 2009 and August 2011 at this site (Fig. 2).

Having finished excavations at Daram Site, the following title was proposed to Kyushu University Interdisciplinary Programs in Education and Projects in Research Development (P&P): "Interdisciplinary Research on immigration and reforms to grouping by ancient nomads on the Mongolian Plateau." Professor Kazuo Miyamoto (The Faculty of Humanities, Kyushu University) was the representative for this project. For this project, the Department of Archeology in the Faculty of Humanities, Kyushu University, and the Archeological Institute of Academia Scinica in Mongolia entered into an agreement to conduct research entitled "Mongolian Khun Project: The Physical Anthropological Study of Prehistoric Mongolian Populations, Joint Mongolian-Japanese Research Project." The excavations at Tevsh Site were conducted in August, 2012 (Fig. 3). Two stone-slab graves were excavated during these excavations.

These research projects were interdisciplinary in nature, covering not only archeology but also physical anthropology and chemical archeology. One of the goals of the research was to investigate the movability of Bronze Age herding people in Mongolia. As such, Mitochondrial DNA analysis of teeth samples from Daram Site and Strontium analysis on human skeletal remains were conducted. Chemical analysis for the identification of the production sites of raw materials was also performed on beads found at Daram Site. This interdisciplinary research was conducted with the goal of shedding light on the movement and reformation of groups of herding people in Bronze Age Mongolia, as well as establishing a burial chronology for the stone-slab burial culture.

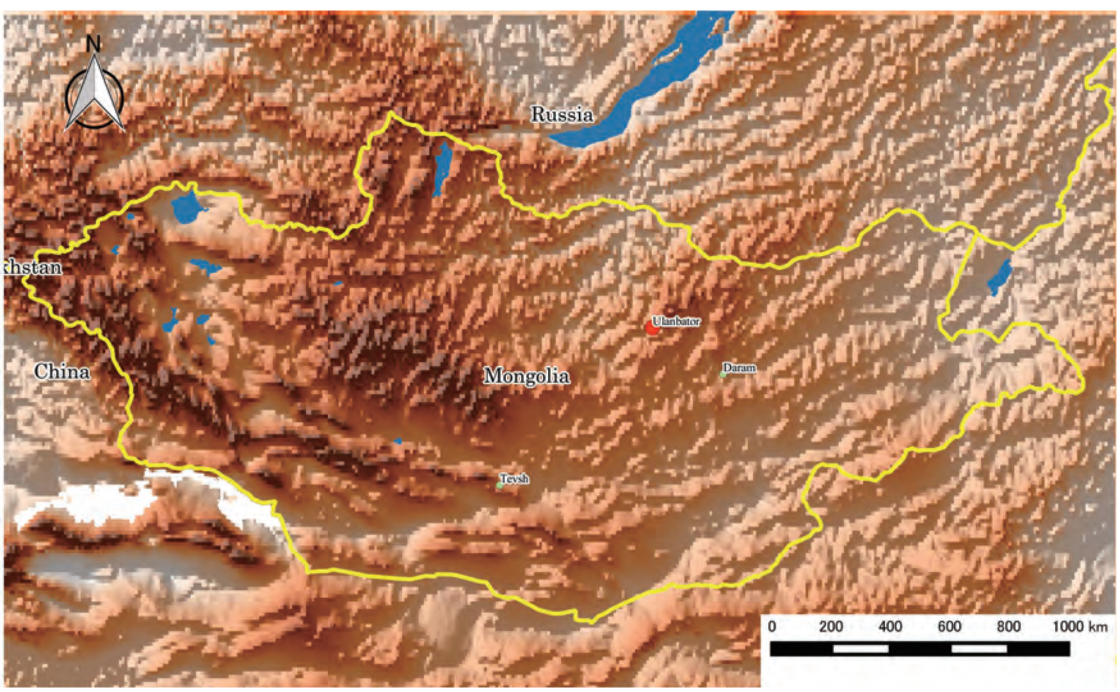


Fig.1 The location of excavations at Daram site and Tevsh site

Fig.2 The cemetery of Daram site

Fig.3 The cemetery of Tevsh site

1 Excavations at Daram Site

1. Background and Excavation Plans at Daram Site

We planned to investigate the physical anthropological relationship through the analysis of human bones, and to elucidate the movement of social groups through archaeological analysis via the JSPS research project, "Research on Human Exchanges on the Japanese Archipelago and Chinese Continent." The Mongolian plateau is one of most important research focuses of such research. For this project, Prof. Takahiro Nakahashi (The Faculty of Social and Cultural Studies, Kyushu University), Prof. Kazuo Miyamoto (The Faculty of Humanities, Kyushu University), Prof. Hiroki Obata (Faculty of Letters, Kumamoto University) visited the Archeological Institute of Mongolian Academy in order to conduct joint research between Japan and Mongolia. Prof. D. Tsveendorji, director of the Archeological Institute of Mongolian Academy, introduced us to Bronze Age stone-slab graves, and joint excavations commenced in 2009. In order to hold these joint excavations, we entered into an exchange agreement for a joint research project entitled, "Mongolian: Mongol Khun Project" for three years, from 2009 to 2011, and started to excavate in 2009.

We held a general survey on stone-slab graves and khirigsuuru in Henty Province on 18th and 19th August, 2009, and selected Daram Site as the location for excavations (Fig. 4). We started to excavate at Daram Site from 20th August of the same year. Present at these excavations were Hiroki Obata and Tosiko Ootsubo of Kumamoto University, and Kazuo Miyamoto of Kyushu University. In 2009, excavated two stone-slab graves and conducted morphological measurements at the cemetery of Daram Site, including the slope of Mt. Daram. Following these measurements, we found 20 previously undiscovered stone-slab graves and Mongolian graves on the slope of this mountain. We named the second area as Location 2 of Daram Cemetery. On the other hand, we named the original grave cemetery which we discovered during the general survey as Location 1 of Daram Cemetery. We excavated at Grave No.1 and Grave No. 2 at Location 1 of Daram Cemetery site in 2009. We finished these excavations on 28th August and examined the artifacts found during these excavations until 6th September in the Archeological Institute, Ulanbator.

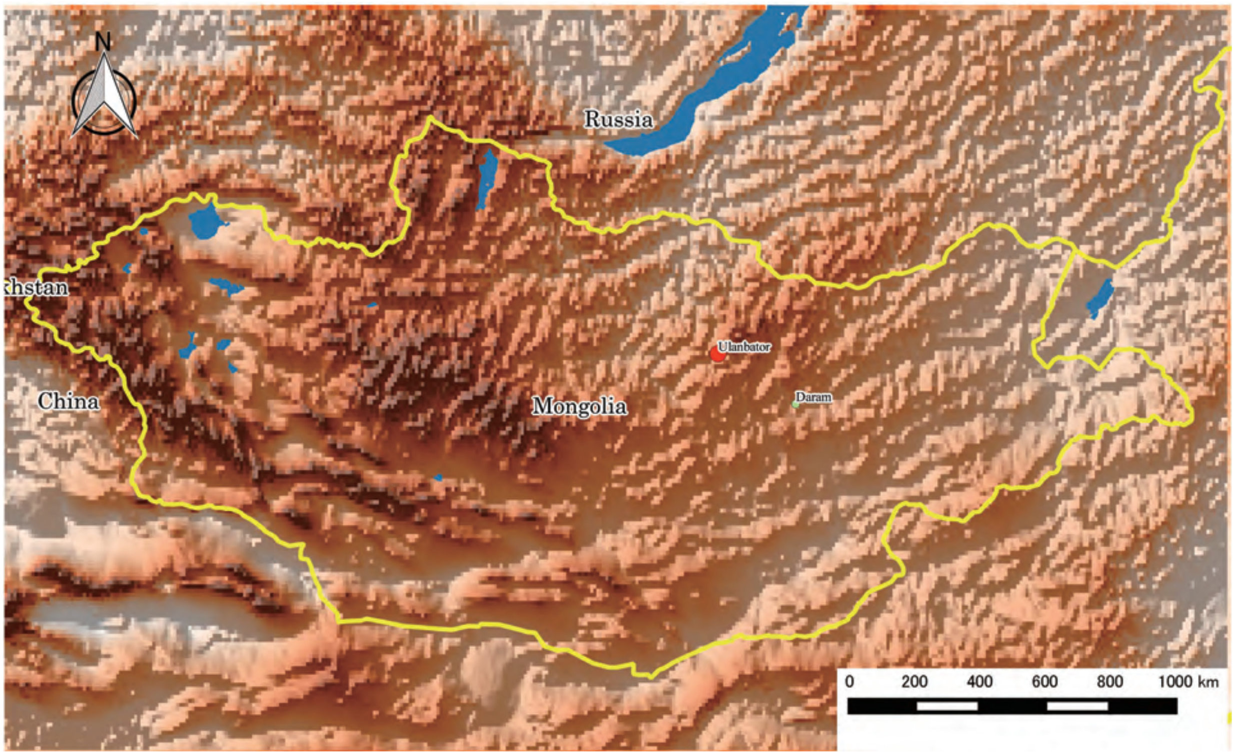
The same three Japanese members as the previous year's excavations attended the excavations at Daram Site from 17th to 29th August, 2010. That year's excavations were conducted at Grave No. 4 and Grave No. 8 at Location 1, and at Grave No. 41 at Location 2, Daram Site. We found skeletal fragments from two bodies along with grave goods consisting of around 1,000 beads, three bronze ornaments and pottery in Grave No. 4, Daram Site.

In the third year of our joint expedition at Daram Site, we conducted excavations at Grave No. 9, a square grave at Location 1 of Daram Cemetery, from 25th to 29th August, 2011. The excavations were conducted by Kazuo Miyamoto, Kyushu University, and Toshiko Ootsubo, Kumamoto University.

In the course of our joint research, we conducted DNA analysis and staple isotope analysis for diet analysis of the human bones and sacrificed animals, such as horses and cattle.

2. Grave distribution at Daram Cemetery site

The site is located at a distance of 160 km in a straight-line southeast from Ulanbator, and takes around four and a half of hours by car reach (Fig. 4). Mt. Daram, where the Daram graves are located, is one of a range of low mountains extending from the mountains in the northeastern section of the Khelren River Valley. The elevation of the mountain's summit is about 1,300 m. The graves are distributed mainly on the southern slope of Mt. Daram and is divided into two concentrated areas. In one area, Location 1, twelve stone-slab graves are located surrounding a low hill. In the other area, which is near the top of the mountain, about thirty stone graves containing ten



1 The location of Daram site

2 The distant view of Daram site

Fig.4 The location and the distant view of Daram site

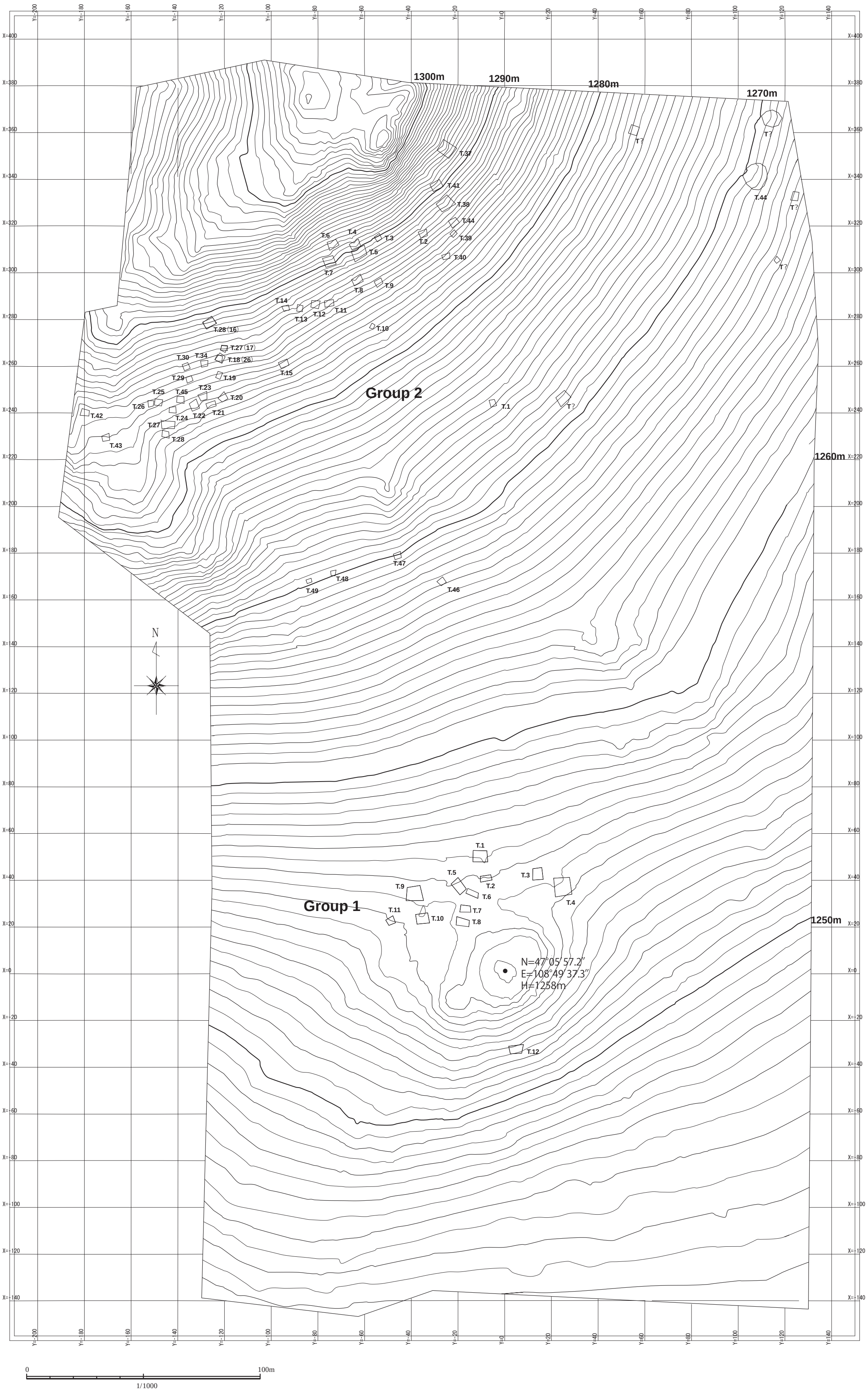
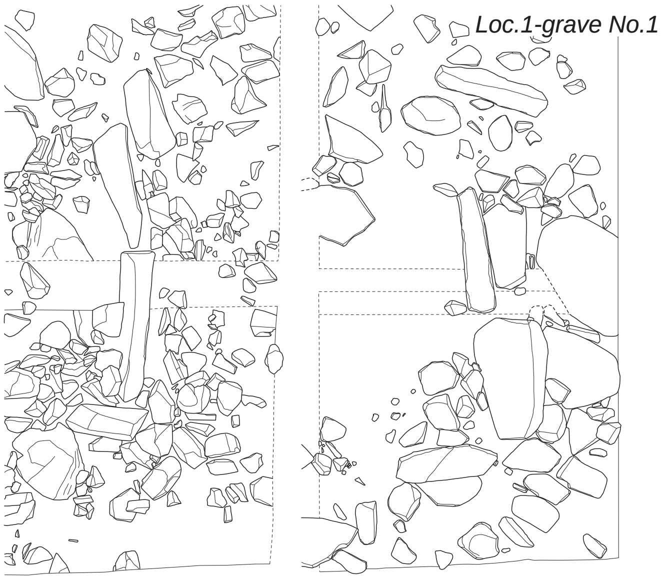
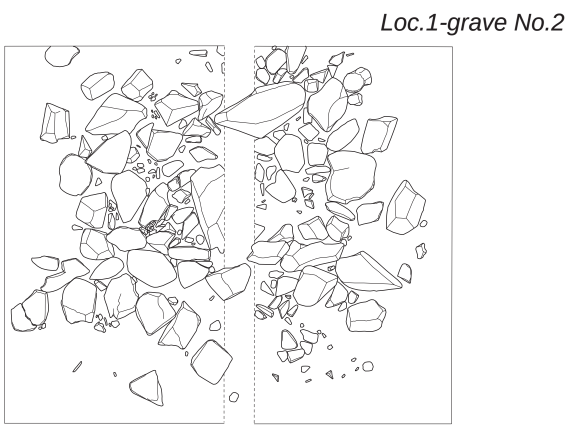


Fig.5 Distribution of graves in Daram site





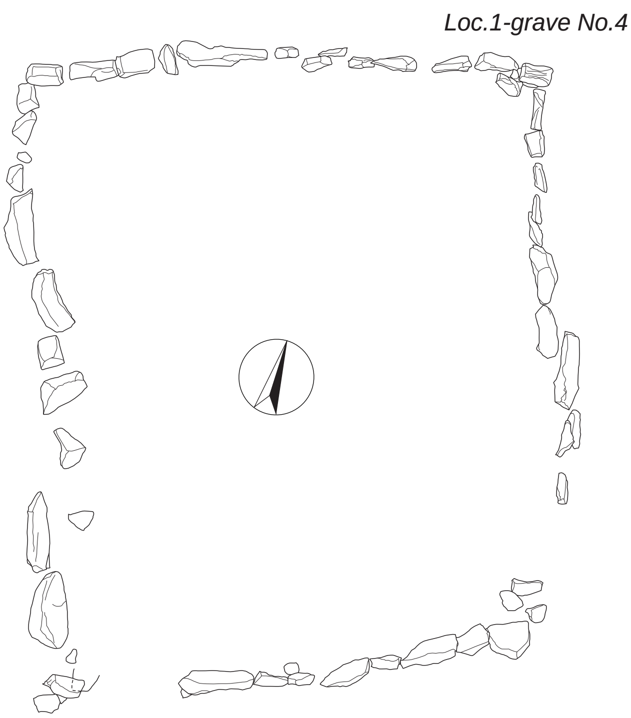


Fig.6 Grave No.1, No.2, No.4, Location 1 of Daram site

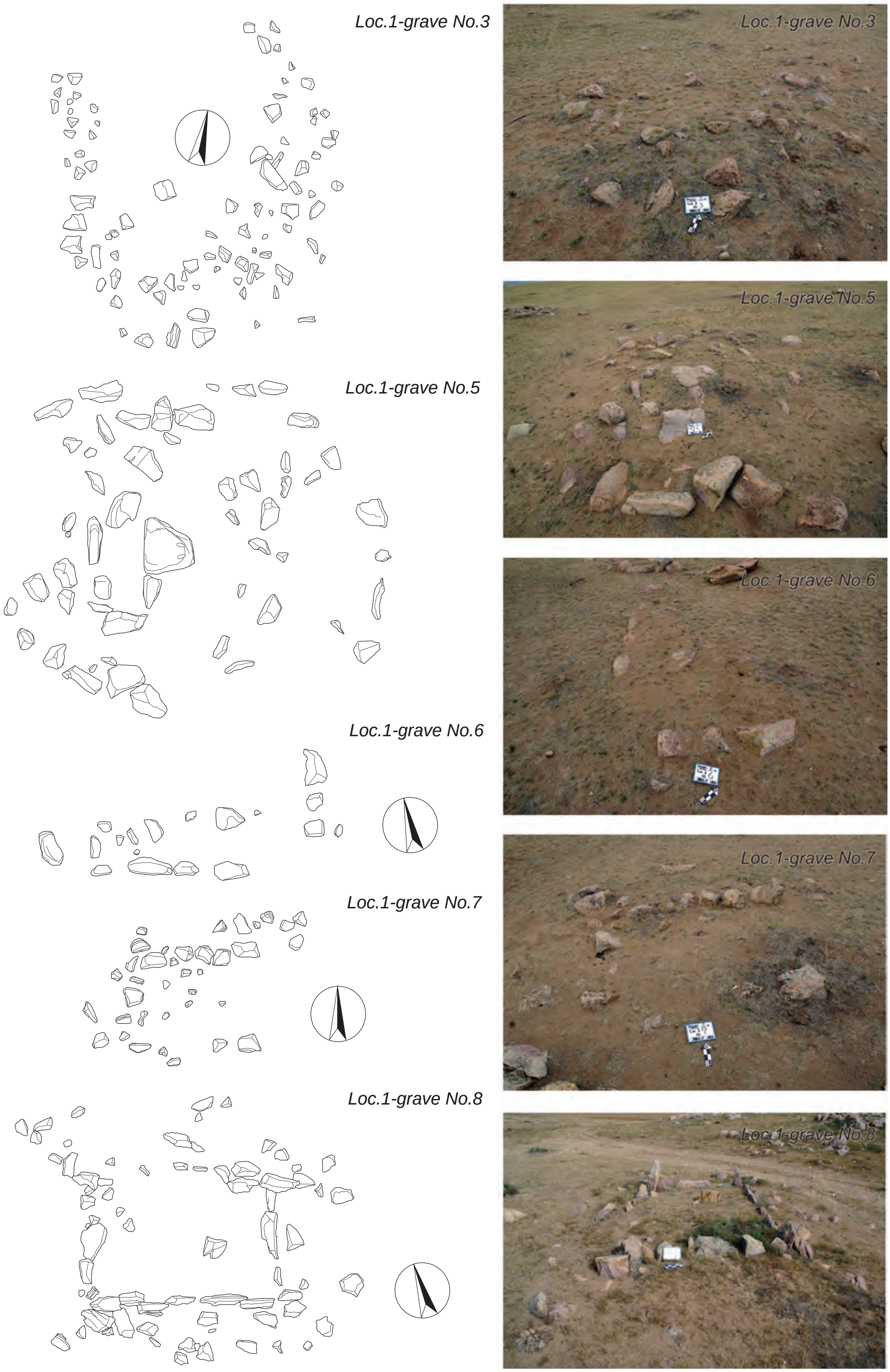


Fig.7 Grave No.3, No.5 - No.8, Location 1 of Daram site

Loc.1-grave No.9

Loc.1-grave No.10

Loc.1-grave No.11

Loc.1-grave No.12

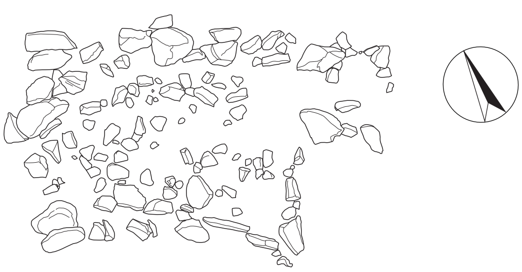
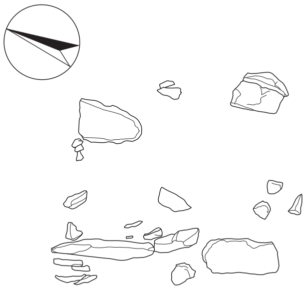
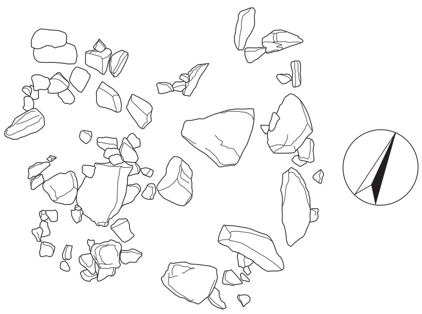


Fig.8 Grave No.9 - No.12, Location 1 of Daram site

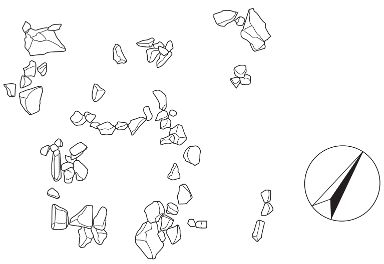
Loc.2-grave No.1



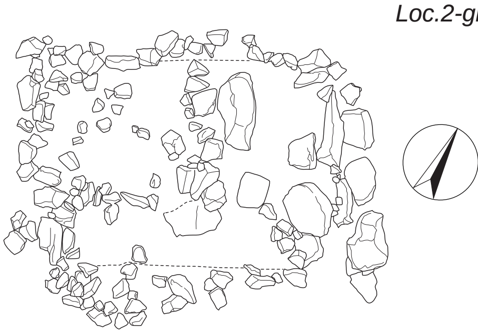
Loc.2-grave No.2



Loc.2-grave No.3



Loc.2-grave No.4



Loc.2-grave No.6

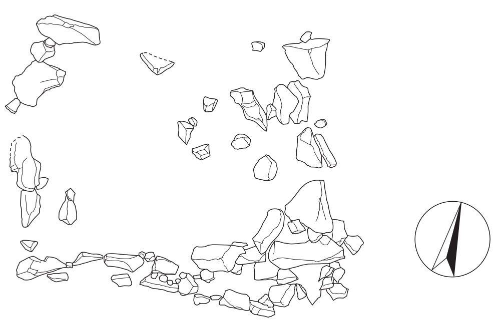
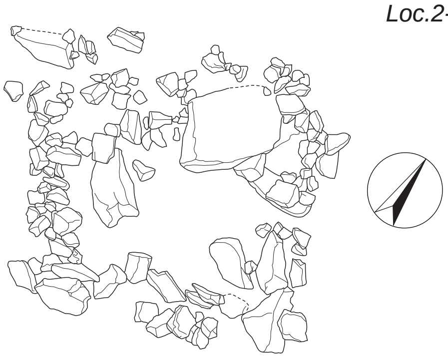
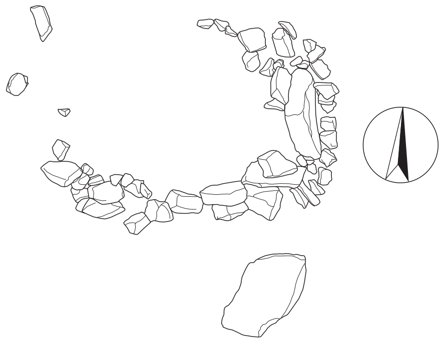


Fig.9 Grave No.1 - No.4, No.6, Location 2 of Daram site

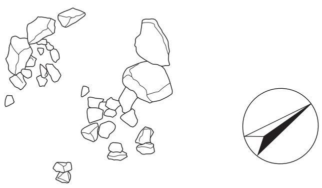
Loc.2-grave No.7



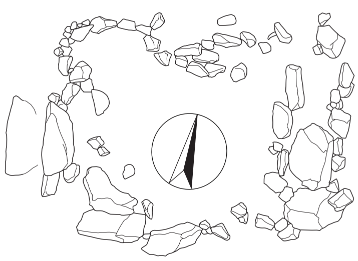
Loc.2-grave No.8



Loc.2-grave No.10



Loc.2-grave No.11



Loc.2-grave No.12

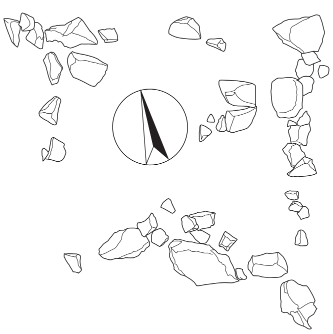


Fig.10 Grave No.7, No.8, No.10 - No.12, Location of Daram site

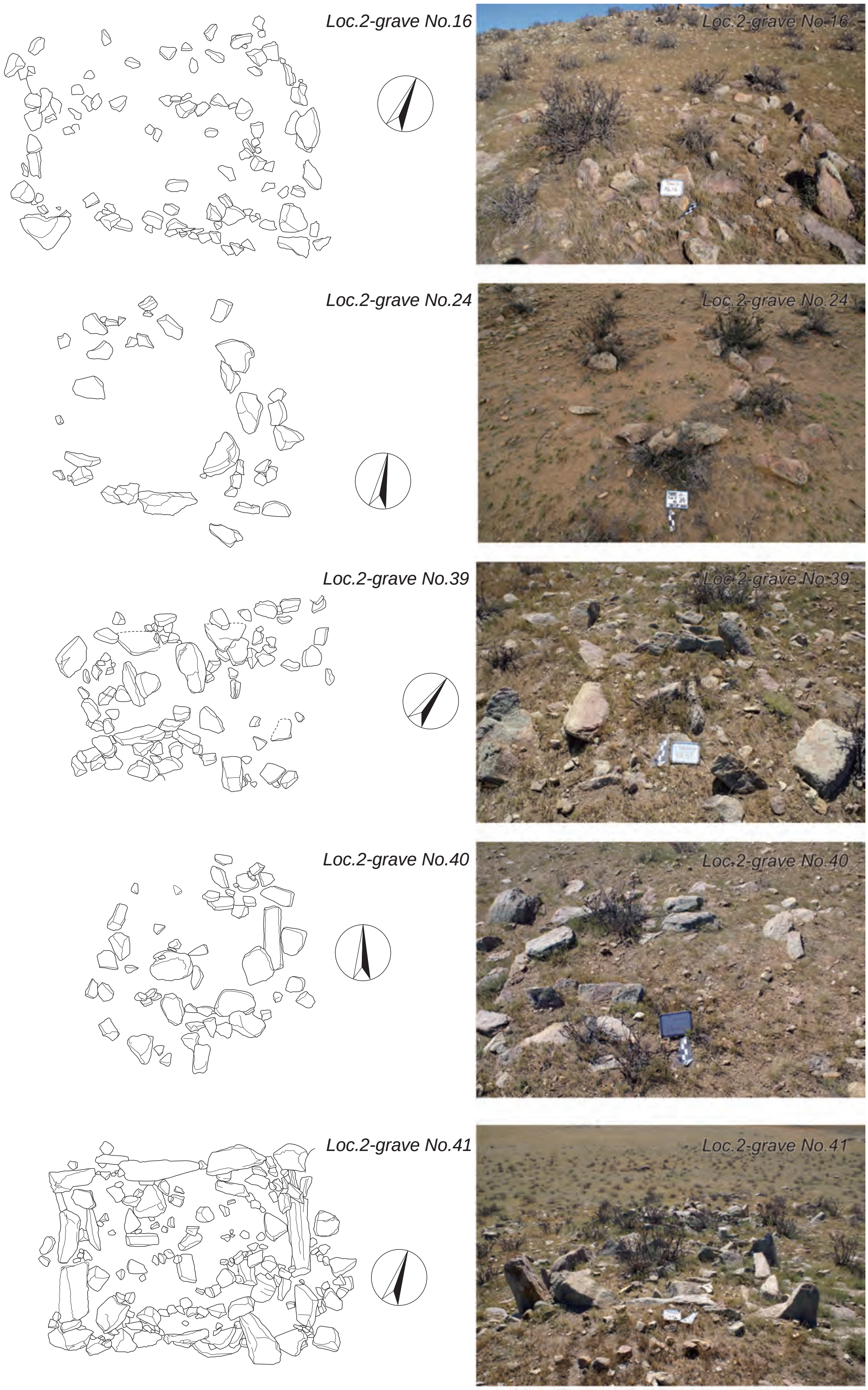


Fig.11 Grave No.16, No.24, No.39 - No.41, Location 2 of Daram site

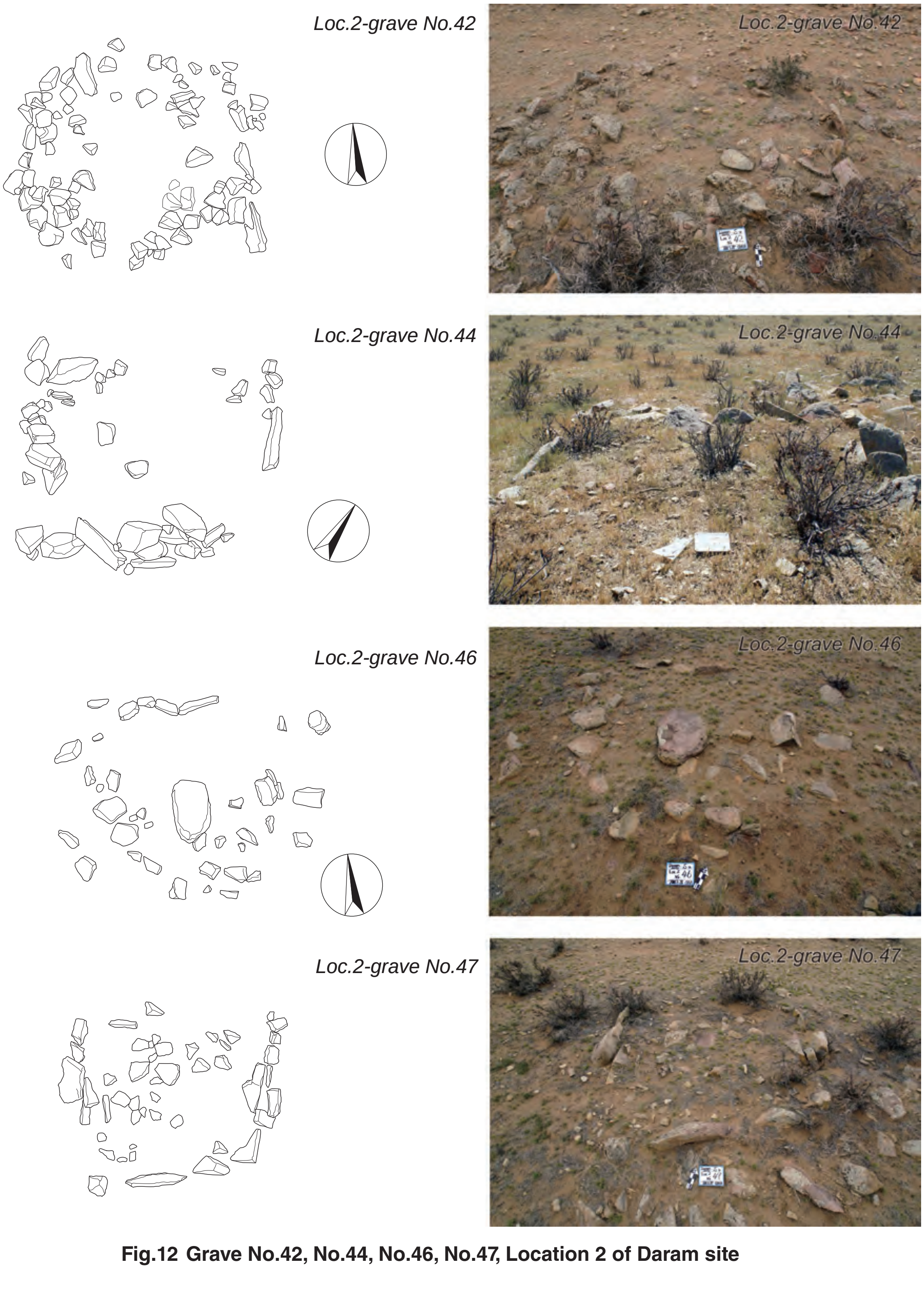


Fig.12 Grave No.42, No.44, No.46, No.47, Location 2 of Daram site

stone-slab graves belonging to the Bronze Age are located and named as Location 2 (Fig. 5). The distance between both areas is 300 m, and the difference of elevation is about 40 m. We were the first to discover the graves at Location 2. We also found a new cemetery consisting of four stone-slab graves on the western slope of the mountain that is Location 3.

We excavated Grave No. 1 and Grave No. 2 at Location 1 in 2009. We then excavated Grave No. 4 and Grave No. 8 at Location 1, and Grave No. 41 at Location 2 in 2010. Finally, we excavated Grave No. 9 at Location 1 in 2011.

Unexcavated graves might contain those belonging to another age, with the exception of the Bronze Age (for example, the Mongolian Age). However we cannot ascertain what age they are merely by their outer characteristics, and there is also some uncertainty surrounding our results regarding

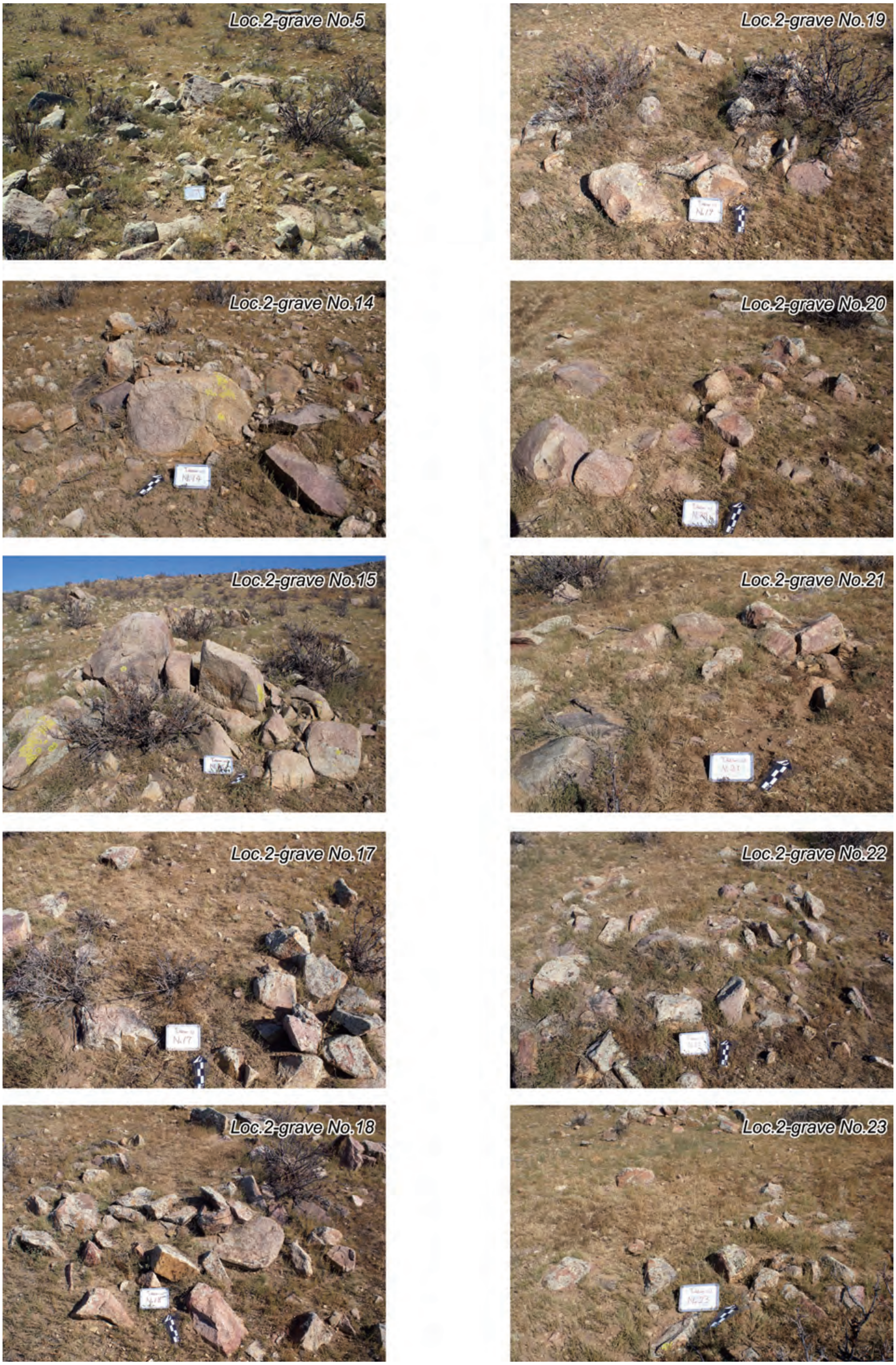


Fig.13 Grave No.5, No.14, No.15, No.17 - No.23, Location2 of Daram site

Fig.14 Grave No.29, No.30 - No.32, No.38, No.43, Location 2 and Grave No.1- N0.4, Location 3 of Daram site

Table.1 Grave lists of Daram site

Gruop	Number	Type	Length	Width	Measurement	GPS			Remarks
						Latitude	Longitude	Height	
1	1	Stone-slab grave	7	8	Excavated	47° 05′ 58.8″	108° 48′ 36.7″	1256.5	
1	2	Stone-slab grave	5	4	Excavated	47° 05′ 58.5″	108° 49′ 36.9″	1256	
1	3	Stone-slab grave	5	6	○	47° 05′ 58.5″	108° 49′ 37.9″	1255.7	
1	4	Stone-slab grave	8.5	7.5	Excavated	47° 05′ 58.3″	108° 49′ 38.4″	1255.3	
1	5	Stone-slab grave	6.5	6	○	47° 05′ 58.3″	108° 49′ 36.4″	1255.8	
1	6	Stone-slab grave	5.5	2.5	○	47° 05′ 58.3″	108° 49′ 36.7″	1255.7	
1	7	Stone-slab grave	4	2.5	○	47° 05′ 58.0″	108° 49′ 36.5″	1255.7	
1	8	Stone-slab grave	5.5	4.5	Excavated	47° 05′ 57.9″	108° 49′ 36.5″	1255.7	
1	9	Stone-slab grave	6.5	6.5	Excavated	47° 05′ 58.3″	108° 49′ 35.5″	1255.8	
1	10	Stone-slab grave	5	4	○	47° 05′ 57.9″	108° 49′ 35.7″	1255.3	
1	11	Stone-slab grave	3.5	3	○	47° 05′ 57.9″	108° 49′ 35.0″	1255	
1	12	Stone-slab grave	3	5	○	47° 05′ 56.1″	108° 49′ 37.6″	1253.8	
2	1	Stone-slab grave	3	2.5	○			1274.2	Natural?
2	2	Stone-slab grave	4	4	○			1287.5	
2	3	Stone-slab grave	3.5	3	○			1289.7	
2	4	Stone-slab grave	5	4	○			1290.5	
2	5	Stone-slab grave						1289.5	
2	6	Stone-slab grave	4.5	3.5	○			1291.5	
2	7	Stone-slab grave	3	4	○			1290.5	
2	8	Stone-slab grave	4.5	2.7	○			1286.7	
2	9	Stone-slab grave	-	-	-			1285.6	
2	10	Stone-slab grave	2.5	2	○			1282.7	
2	11	Stone-slab grave	4	3	○			1286.3	
2	12	Stone-slab grave	4	4.3	○			1286.6	
2	13	Uncertain	-	-	-			1287.2	
2	14	Mongolian tomb	-	-	-			1287.8	
2	15	Mongolian tomb	-	-	-			1283.9	
2	16	Stone-slab grave	5.5	4	-			1289	
2	17	Mongolian tomb	-	-	-			1286.5	
2	18	Mongolian tomb	-	-	-			1285.7	
2	19	Mongolian tomb	-	-	-			1284.5	
2	20	Mongolian tomb	-	-	-			1282.9	
2	21	Mongolian tomb	-	-	-			1282.6	
2	22	Mongolian tomb	-	-	-			1283.1	
2	23	Mongolian tomb	-	-	-			1283.3	
2	24	Mongolian tomb	4.5	4	○			1283.3	
2	25	Mongolian tomb	-	-	-			1284.3	
2	26	Mongolian tomb	-	-	-			1284.3	
2	27	Mongolian tomb	-	-	-			1282.7	
2	28	Mongolian tomb	-	-	-			1282.2	
2	29	Mongolian tomb	-	-	-			1284.8	
2	30	Mongolian tomb	-	-	-			1286	
2	31	Mongolian tomb	-	-	-			1285.7	
2	32	Mongol ian tomb	-	-	-	47° 06′ 08.4″	108° 49′ 40.0″	1276.8	
2	33	Uncertain	-	-	-			-	
2	34	Uncertain	-	-	-			-	
2	35	Uncertain	-	-	-			-	
2	36	Uncertain	-	-	-			-	
2	37	Stone-slab grave						1293	
2	38	Unknown	-	-	-			1288.2	
2	39	Stone-slab grave	5	3.5	○			1285	
2	40	Stone-slab grave	4	4	○			1283.8	
2	41	Stone-slab grave	5	4	Excavated			1290.5	
2	42	Stone-slab grave	4.5	3.5	○			1284.7	
2	43	Mongolian tomb	-	-	-			1284	
2	44	Stone-slab grave	4.5	3.5	○			1286	
2	45	Mongolian tomb	-	-	-			1284.7	
2	46	Stone-slab grave	4.5	3	○	47° 06′ 02.6″	108° 49′ 36.0″	1267.2	
2	47	Stone-slab grave	4	3	○	47° 06′ 03.0″	108° 49′ 35.1″	1270	
2	48	Mongolian tomb	-	-	-	47° 06′ 02.6″	108° 49′ 33.8″	1270.2	
2	49	Mongolian tomb	-	-	-	47° 06′ 02.5″	108° 49′ 33.2″	1270.3	

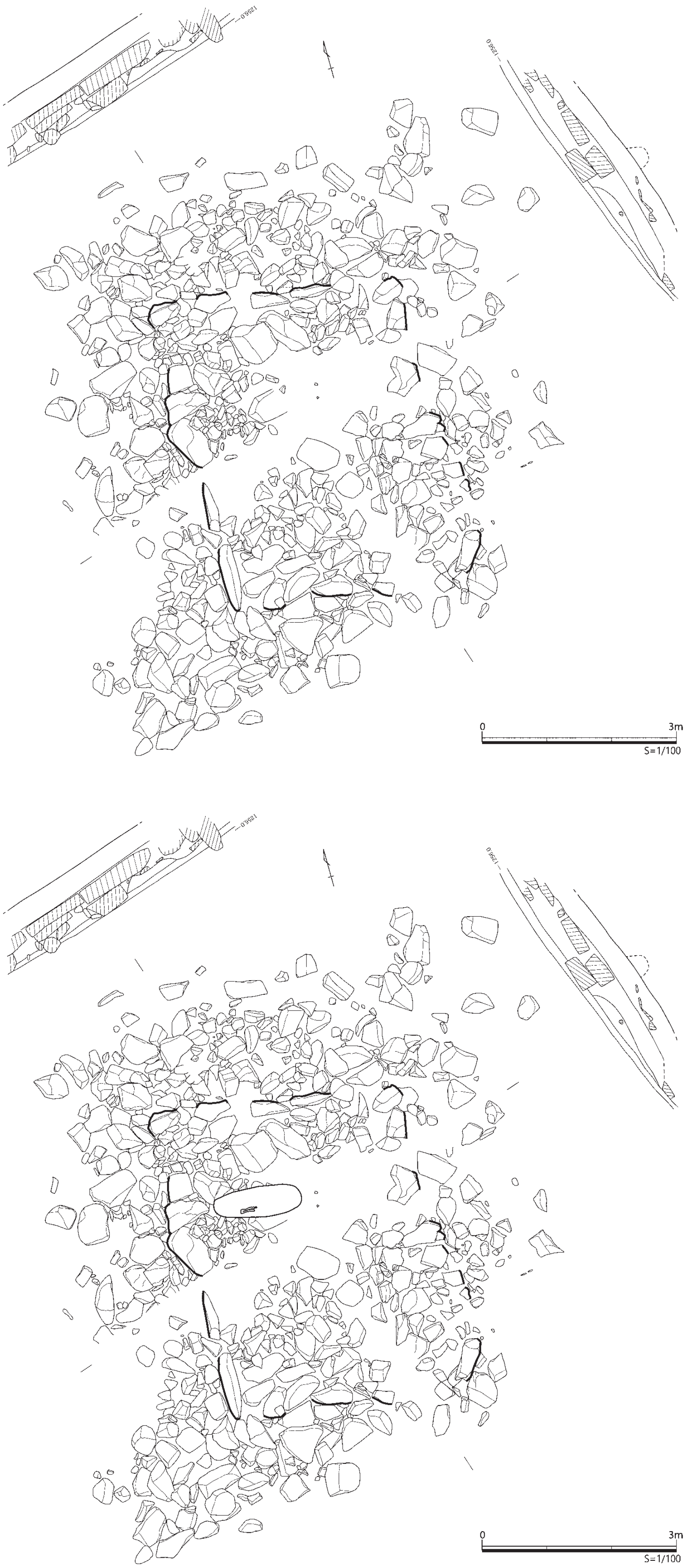


Fig.15 Grave No.9, Location 1 of Daram site

Before Excavation at Tevsh grave No.9

Stone structure of Tevsh grave No. 9

Stone fence of Tevsh grave No.9

Stone fence of Tevsh grave No.9

Pit burial of Tevsh grave No.9

Pit burial of Tevsh grave No.9

Fig.16 Grave No. 9, Location 1 of Daram site

the types. Table 1 and Figure 6-14 show the characteristics and figures for these.

3. Excavation results of archaeological features

Daram Grave No. 9 (Fig. 15, 16)

This grave features a rectangular stone fence that has no erected corner stones, with paved stones outside of the stone fence, of which some sections had already been removed. The rectangular plan of the stone fence is 4.7 meters in length and 3.8 meters in width. It has a pit burial under the stone construction, but no cover stone on the pit burial. The stone construction has been made with relatively thicker stone slabs in the stone fence. Because the pit burial is relatively smaller at 1.3 meters in length and 0.5 meters in width, it is supposed that the individual buried in this pit was an infant or flexed smaller female. The only remains of a sacrificed animal found in the pit burial was the shoulder blade of a horse. The collagen taken from this horse bone dates to 896 - 806 cal. BC. Therefore, this grave is believed to date to the 9th century BC. This grave is one of earliest graves in Daram Cemetery.

Daram Grave No. 2 (Fig. 17, 18)

The rectangular plan of the stone fence is 4.0 meters in length and 2.5 meters in width. Some stones out of the rectangular stone fence were paved to support the stone fence. The stone construction consisted of stones piled inside of the enclosure, but it was looted inside of the stone fence. The cover stone on the pit burial under the stone construction was also disturbed. The pit burial is 1.9 meters in length and 1.0 meter in width. A few small fragments of human bones were found in the pit burial. The interred individual is believed to have been an adult due to the scale of the pit burial.

Daram Grave No. 4 (Fig. 19-26)

The rectangular plan of the stone fence is 8.5 meters in length, 7.7 - 6.5 meters in width and 0.3 - 0.7 meters in height, with four erected corner stones (Fig. 19). The stone structure consisted of piled stones inside the stone fence, but no stones outside the stone fence. A whetstone and horse teeth were found in the stone structure (Fig. 23, 26). A looted pit was found in the center of the rectangular stone fence, but fortunately the looters did not reach the artifacts under the cover stone, which prevented against looting.

The upper pit burial, which is 2.1 meters in length and 2.0 meters in width under the stone construction, existed in the center. A huge stone measuring 1.8 meters in length, 1.3 meters in width and 0.5 meters in height was placed in the southern part of the pit burial. Also, human bones (Human Bones A) were found along the northern edge of the pit burial. The skull had already been stolen by looters, but other bones from the shoulder downward had been preserved in a relatively good state. This individual had flexed feet and was oriented in an easterly direction. This individual represents the second such burial, and 392 stone beads and 8 red stone beads ware found in close proximity to this individual. We can surmise that these beads had originally been sown to some kind of woven item when placed on the huge cover stone.

A pit burial measuring 1.7 meters in length, 0.9 meters in width and 0.7 meters in depth was found under the cover stone. This grave also has the same kind of double pit burial as that of Grave No.1, but the lower pit burial is much deeper than that of Grave No. 1. Human bones were found at the bottom of the lower pit burial. The skull was no longer present, but the foot bones were still preserved. This is the first interred individual (Human Bones B). This individual had been stretched out in a different position to the second individual. This individual was orientated in an easterly direction, the same as the second individual. 587 stone beads and 3 red stones were found in the lower pit burial. The beads were found throughout the lower pit burial, from top to bottom (Fig. 24, 25). We can surmise that these beads had originally been sown to some kind of woven item or the clothes of the deceased individual. In addition, two bronze buttons were found at the middle level on the edge of the lower pit burial near to the buried individual's feet. We have another bronze button of unknown origin which may have been accompanied by other two bronze buttons (Fig.22, 23). These bronze buttons are also thought to have been sown into a woven item.

A stone-like human head was found separately at the foot side and head side of the individual buried in the lower pit. Two stones were found in the middle or a higher level in the lower pit burial. The location of these stones suggests that they were placed there for some purpose. It is supposed that these stones were placed on the wooden coffin or the body, which was wrapped in woven garments or clothes, as a sinker on the east and west side of the body, and that the individual was buried with sand. This is because white sand was found buried in the lower pit burial.

The first buried individual (Human Bones B) is a mature female, and the second (Human Bone A) an elderly female. According to the dating of the human

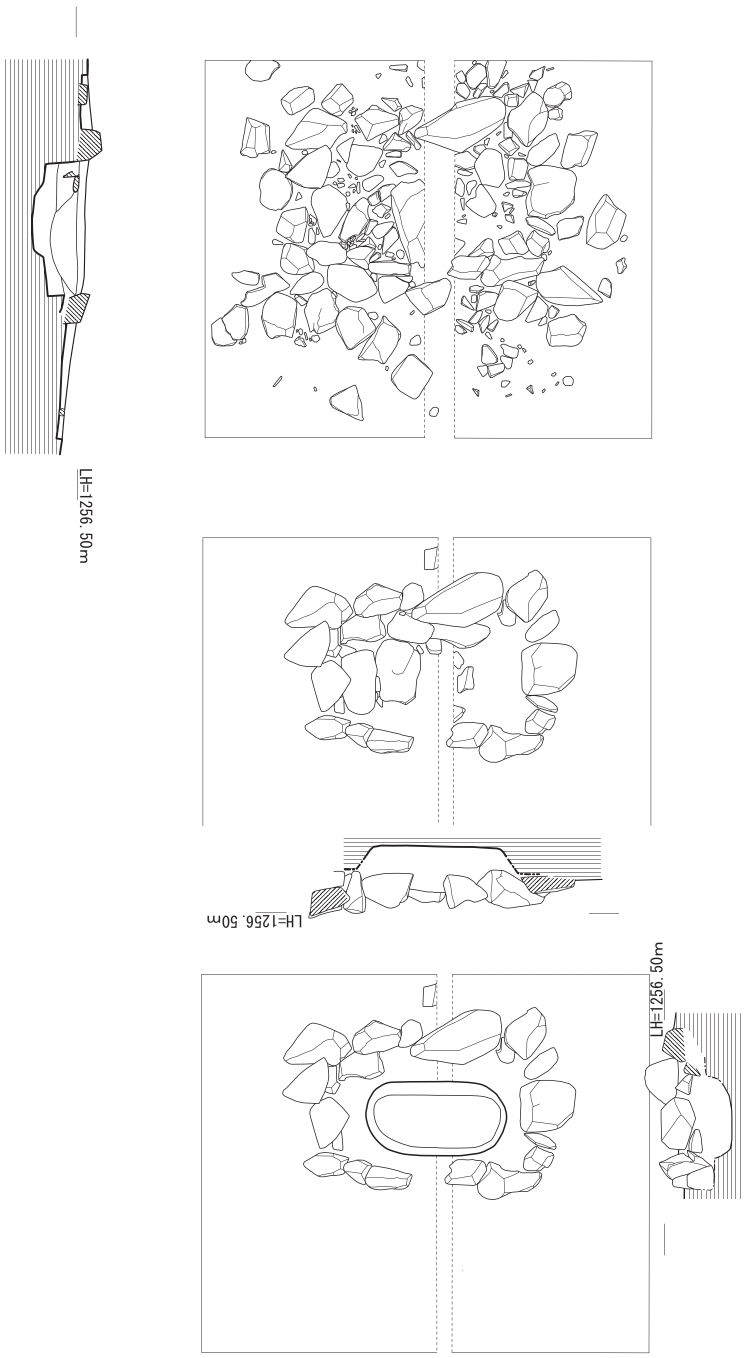
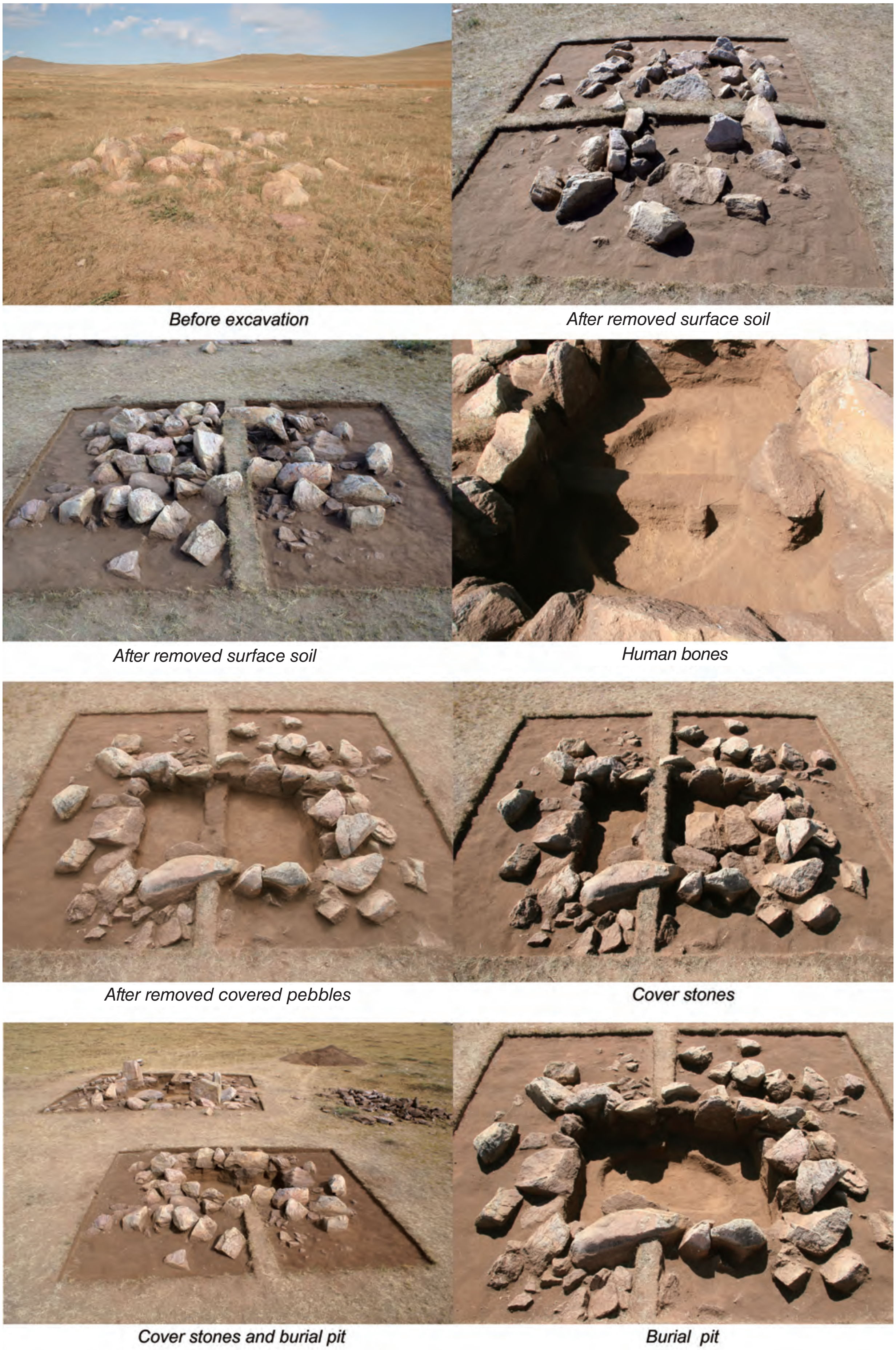


Fig.17 Grave No.2, location 1 of Daram site



Before excavation | *After removed surface soil*

After removed surface soil | *Human bones*

After removed covered pebbles | *Cover stones*

Cover stones and burial pit | *Burial pit*

Fig.18 Grave No.2, location 1 of Daram site

bones, the first individual lived sometime during the 8^{th} or 7^{th} centuries BC, and the second sometime during the 4^{th} or 3^{rd} centuries BC. The time difference between the first and second individuals is almost three hundred years, meaning that they are different burials. After construction of Grave No. 4, the second individual was, for some reason, buried by re-using Grave No.4. This grave was then looted and the contents lost along with the head of the second individual. This grave also contained larger quantities of beads, much more than in other graves. This suggests that stone-slab graves are individual graves which contain grave goods as symbols of wealth.

Daram Grave No. 8 (Fig. 28 - 30)

The rectangular enclosure is 4.2 meters in length, 3.0 meters in width and 0.3 - 0.8 meters in height, with four erected corner stones. Many stones were distributed around the enclosure. The rectangular enclosure consists of standing flat slab stones which form walls and erected stones in each corner. In the western of the enclosure, there are many pebbles, but very few pebbles are found in the eastern half. Under these pebbles are two heavy slab stones covering half of the burial pit, which had been looted. The burial pit has an irregular triangular plan in which the longest side is about 1 m in length with a depth of 20 cm. On one of the cover stones, we found a horse's tooth. One fragment of the rim of a vessel, two fragments of the body of a vessel and a bead made from turquoise were discovered while sieving the soil from burial pit. The vessel's surface had been smoothed with tools, streaks from which are still evident. Two lines of punctuated holes can be observed on the rim surface. The turquoise bead is 5 mm in diameter and 2.5 mm in thickness. Pottery fragments were also found in the burial pit (Fig. 30). No human bones were discovered.

Daram Grave No. 41 (Fig. 31 - 34)

This grave is one of the graves located on the mountainside near the summit of Mt. Daram (Location 2). The rectangular enclosure is 4.6 meters in length, 3.6 meters in width and 0.4 - 0.8 meters in height, with the four erected corner stones. Many stones were distributed around the enclosure. Three sides consisted of a few standing flat slab stones, which form walls, while the south side has been partly destroyed. Inside the enclosure of stones, there are many compacted pebbles, especially in the eastern part. After removing these pebbles, we found a rectangular burial pit covered by five huge slab stones. The bed of the grave is slightly inclined toward the foot of the mountain. The size of the burial pit is 1.1 m in length, 0.7 m in width and 0.3 m in depth. We have found no evidence that the cover stones had been removed. However, there were no human bones or grave goods in the burial pit. The only one discovery accompanying the grave was the left jawbone of a horse that was found in the northwestern corner of the enclosure on the bed (Fig. 31). While sieving the soil on the bed, we found a fragment of a vessel body and a micro-blade made of flint (Fig. 33). It is not certain whether these artifacts accompanied the grave.

Daram Grave No. 1 (Fig. 35 - 39)

The rectangular stone fence with four erected corner stones consists of relatively bigger stone cists measuring 1.0 to 1.4 meters in height. The rectangular plan of the stone fence is relatively bigger, measuring 4.3 meters in length and 4.3 meters in width. The inside of the rectangular stone fence is covered with piled stones, and the outside of the stone fence is paved with stones. Three cover stones had been placed in a cross along the longitudinal axis of the pit burial under the piled stones inside of the rectangular stone fence. However, one of these had been pushed aside in an easterly direction from the original position by looters. Some sherds of pottery were found near to the disturbed pit dug up by looters (Fig. 37, 38). These pottery fragments, which originally consisted of a piece of pottery, were broken by looters and cast aside east of the looter's pit. The pit burial was 2.7 meters long and 2.1 meters wide under the cover stones. It is a doubled pit burial with a pit shaped like a wooden coffin measuring 2.0 meters in length, 1.0 - 0.6 meters in width and 0.3 meters in depth in the center of the pit burial. The pit burial shaped like a wooden coffin is half round on the profile. If this represents traces of a wooden coffin, it is probably supposed to be curved in the log. The pit like a wooden coffin is wider in the eastward portion and therefore it is thought that the individual was buried in an easterly orientation. Animal bones like horse teeth were found mainly in the eastern section of the pit burial (Fig. 39). Animal sacrifices would have been held near to the head of the deceased individual during the funeral ceremony. In addition, a cattle horn was found in the looter's pit. This suggests that the looters conducted a ritual ceremony when it was looted.

4. Dating of Daram Cemetery

According to the classification of stone-slab graves (Миямото 2013), the graves uncovered during our excavations at Daram Cemetery site consist of Type 1b: square grave; Type 2a, Type 2b and Type 2c:

Fig.19 Grave No.4, Location 1 of Daram site

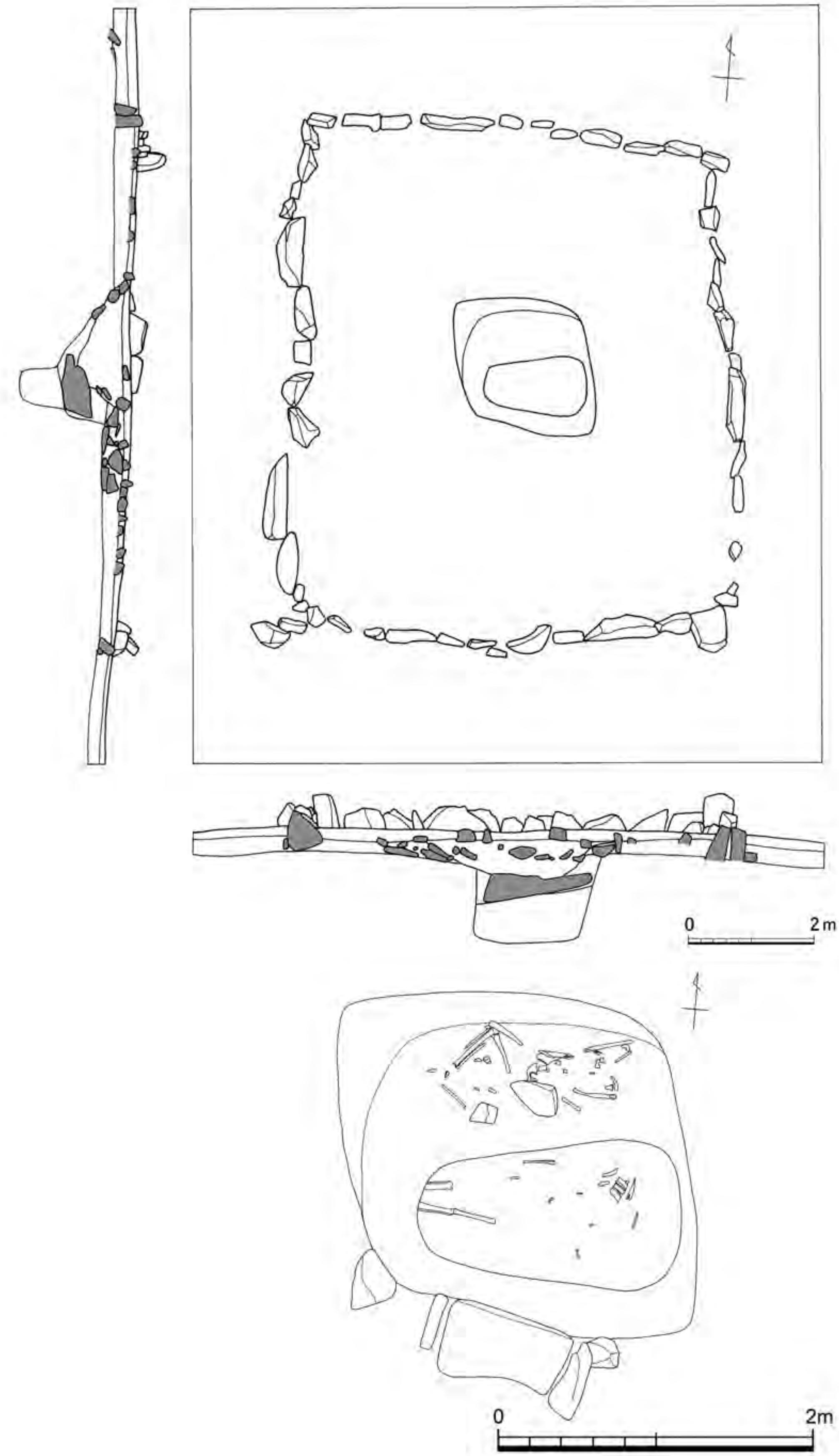
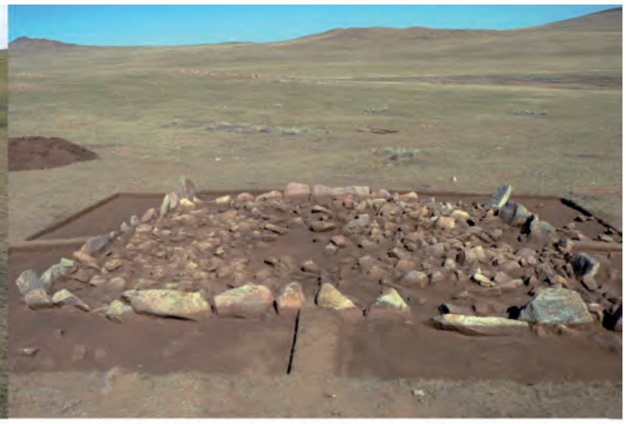


Fig.20 Grave No.4, Location 1 of Daram site

Before excavation



After removed surface soil

After removed surface soil

After removed surface soil

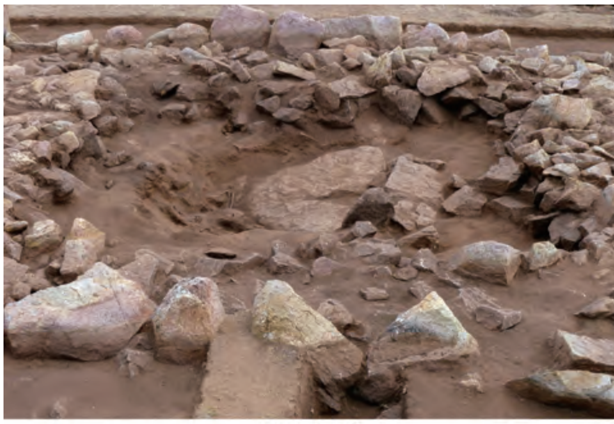
After removed covered pebbles

Cow horn

Cylinder bead in burial pit

Burial pit

Fig.21 Grave No.4, Location 1 of Daram site

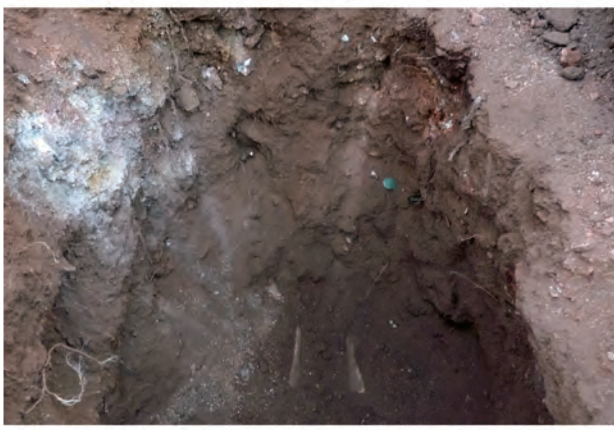


Burial pit

Human remains A

Human remains A

Human remains B



Legs of human remains B and bronze ornaments

Bronze ornaments with human remains B

Human remains B

Main burial pit with human remains B

Fig.22 Grave No.4, Location 1 of Daram site

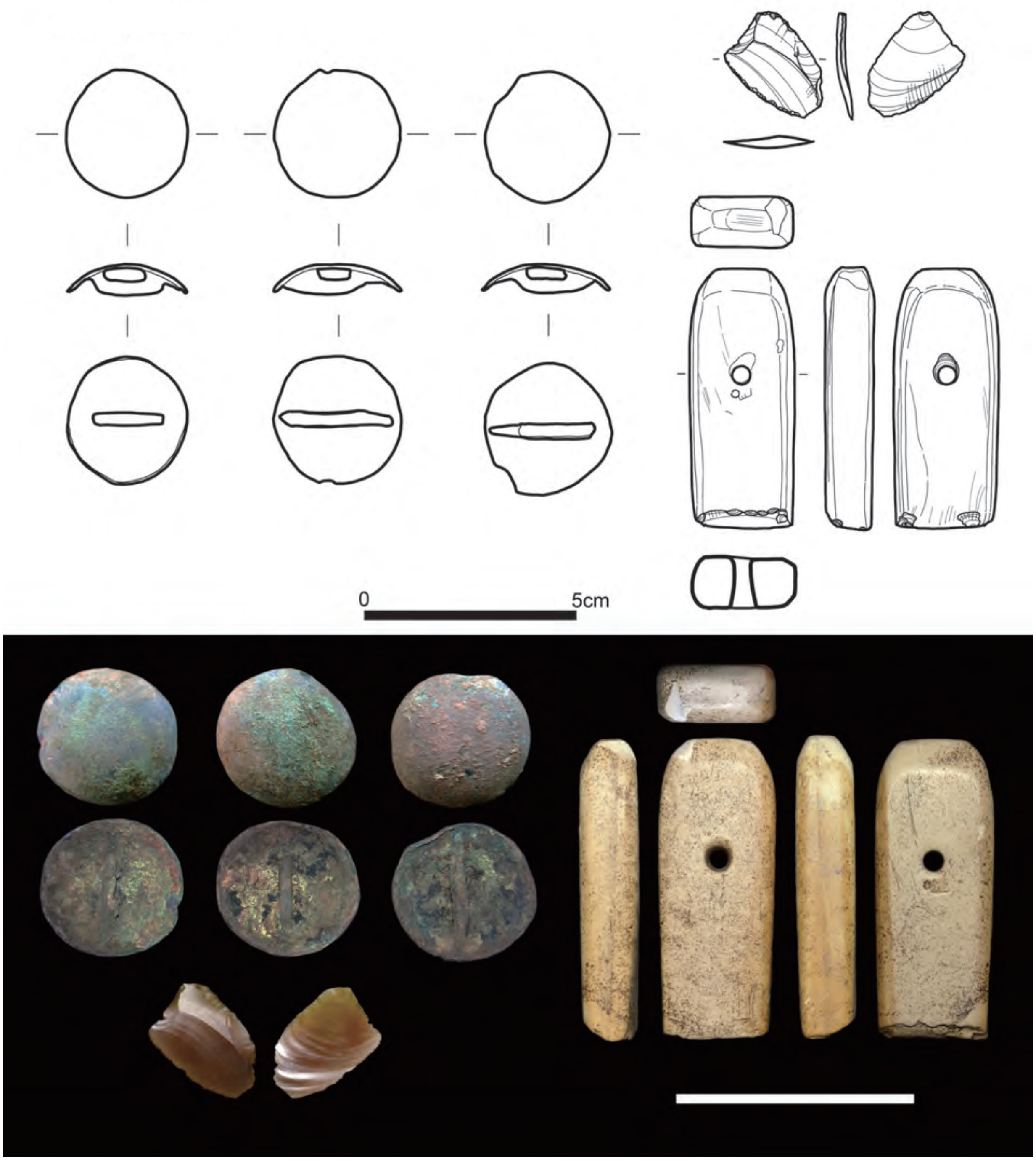


Fig.23 Artifacts found at Grave No.4, Location 1 of Daram site

stone-slab grave. There are Type 1b: Grave No. 9 and Grave No. 2; Type 2a: Grave No. 4; Type 2b: Grave No. 8 and grave No.41; and Type 2c: Grave No. 1.

The animal and human bones in Daram Cemetery have been dated to after the 8th century BC. The dating is shown in the Figure (reference to Chapter 4). Calibration dating covers a relatively wide timespan, as is mentioned as a problem of 2,400 years. Among these data, a relatively small covering can be shown in Grave No. 1 of Daram Cemetery dating to 5th - 4th centuries BC. Although the calibration dating is quite wide, the distribution of the covering in Grave No. 2 and Grave No. 4 of Daram Cemetery is mainly shown in the left wing in the 8th - 7th centuries BC. Therefore, Grave No. 4 of Daram Cemetery is believed to date to the 8th - 7th centuries BC. On the other hand, from the horse bone in the pit burial, we can say that Grave No.9 of Daram Cemetery dates to 896 - 806 cal. BC: 9th century BC.

According to the results of AMS dating of human bones and sacrificed animals, we can determine the dating of square graves and stone-slab graves. Type 1b dates to the 9th - 7th centuries BC; Type 2a dates to the 8th - 6th centuries BC; and Types 2b and 2c date to

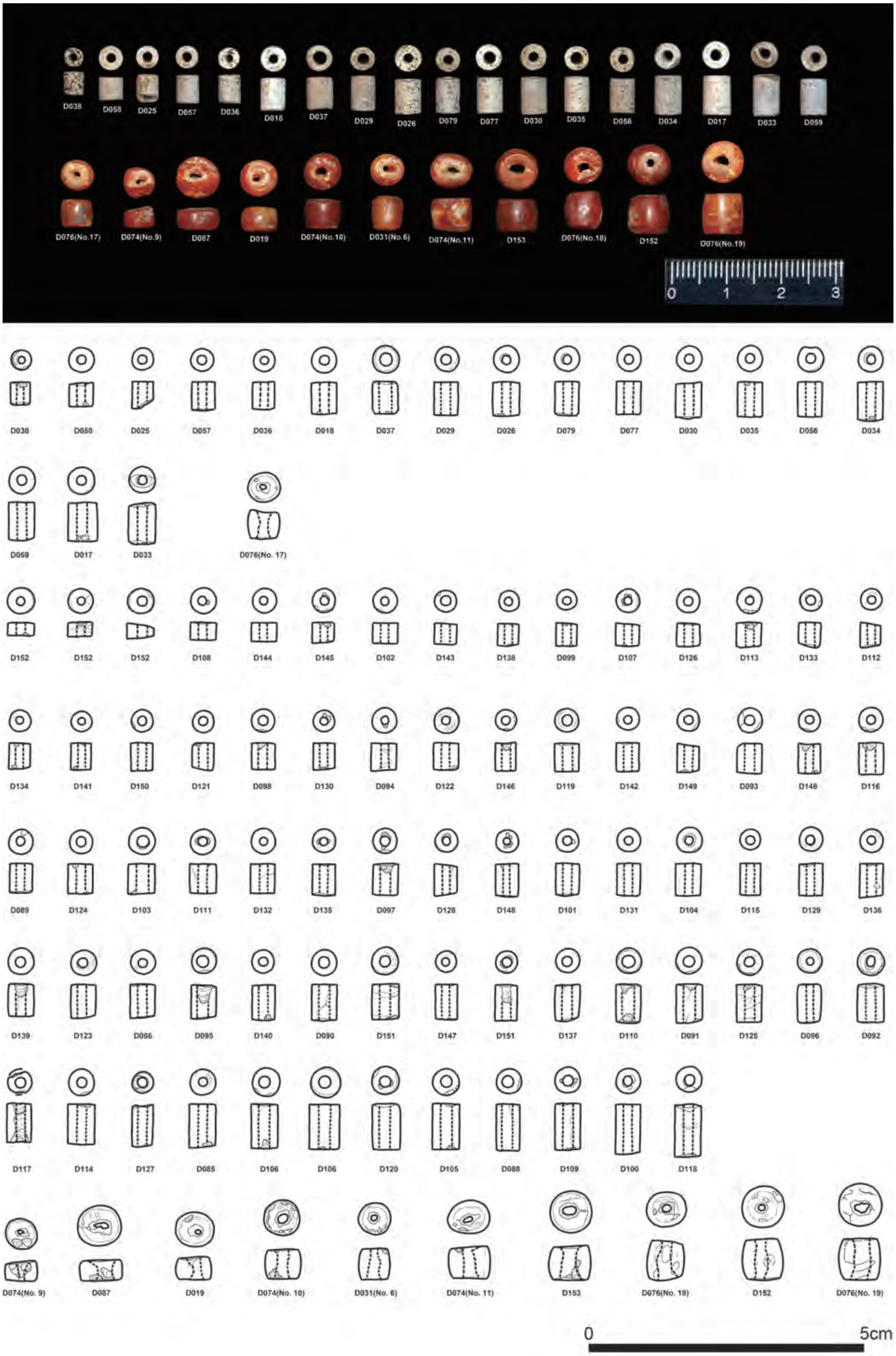


Fig.24 Stone beads found at Grave No.4, Location 1 of Daram site

Fig.25 Stone beads found at Grave No.4, Location 1 of Daram site

Fig.26 Horse teeth found at Grave No.4, Location 1 of Daram site

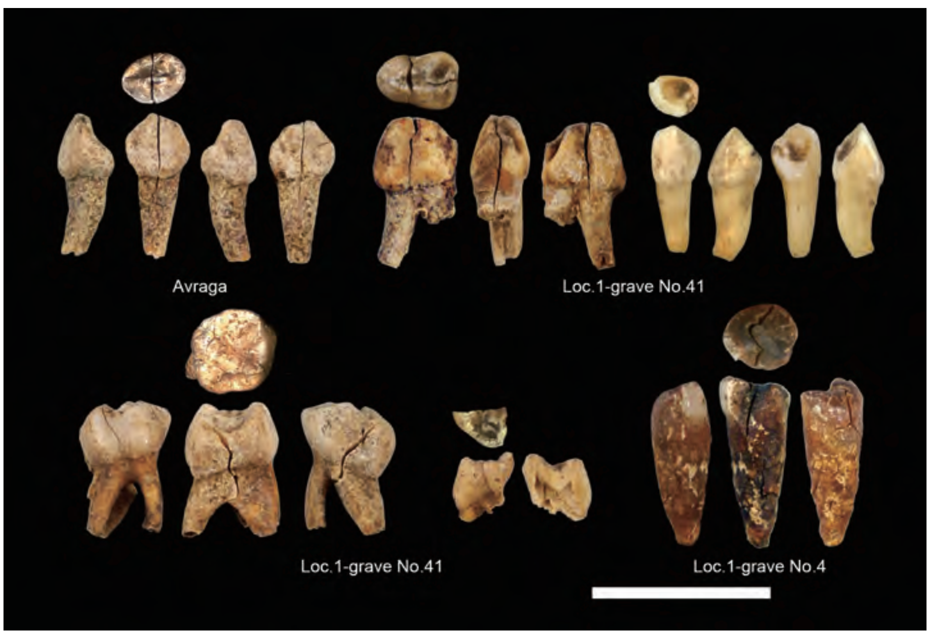


Fig.27 Human teeth found in the excavations in Outer Mongolia

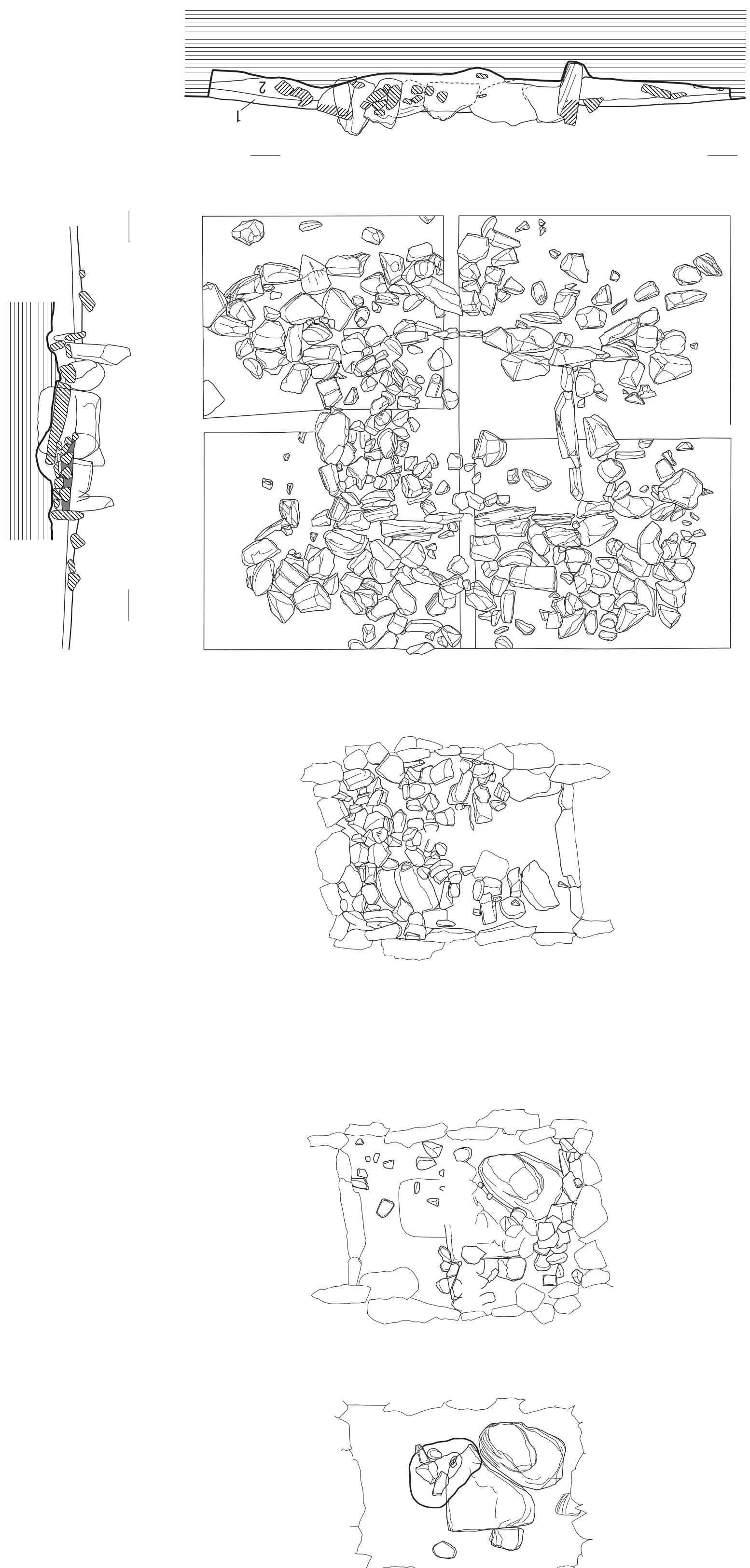


Fig.28 Grave No.8, Location 1 of Daram site

Before excavation

After removed surface soil

Cover pebbles

Horse lower jawbone

After removed covered pebbles

Cover stones

Cover stones and burial pit

Burial pit

Fig.29 Grave No.8, Location 1 of Daram site

Fig.30 Artifacts found at Grave No.8, Location 1 of Daram site

Fig.31 Sacrificed horse bones found at Grave No.41, Location 1 of Daram site

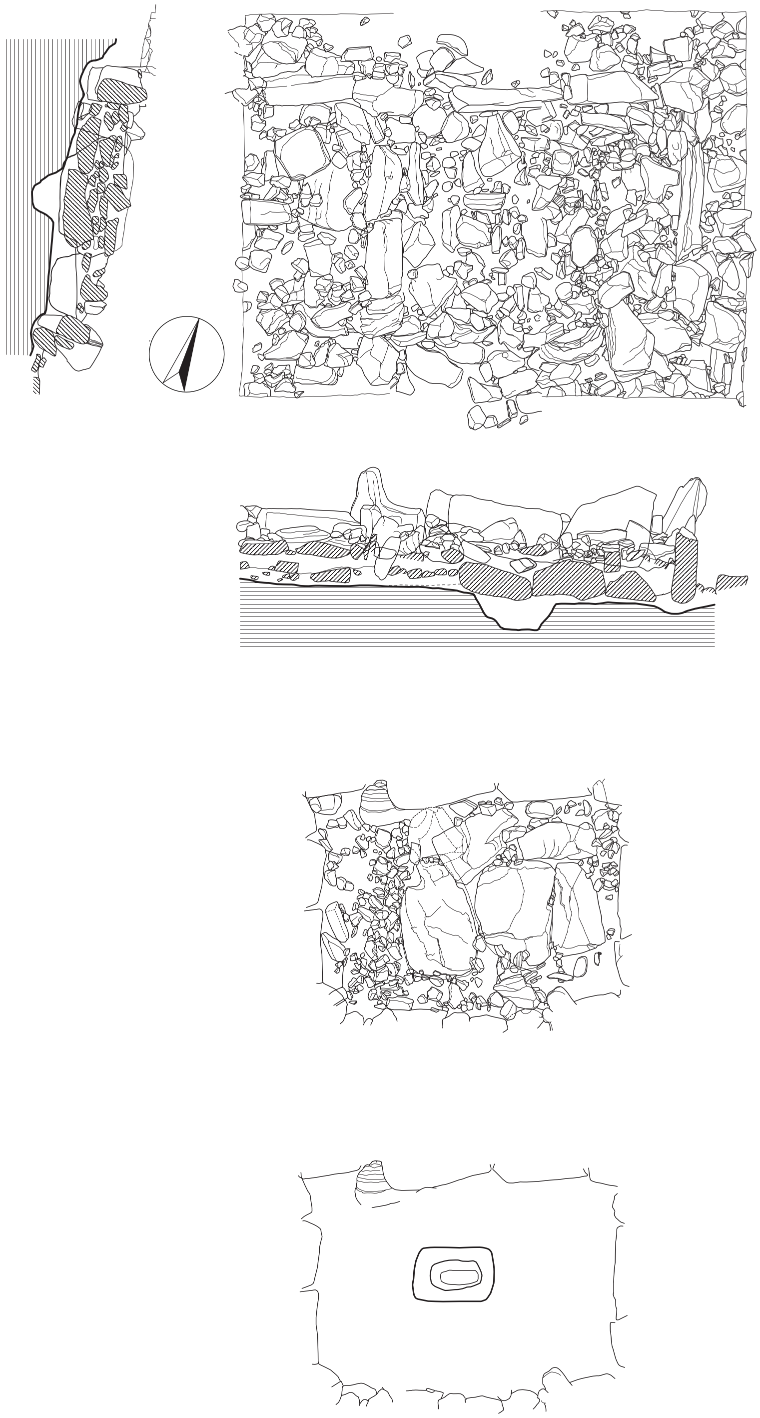


Fig.32 Grave No.41, Location 2 of Daram site

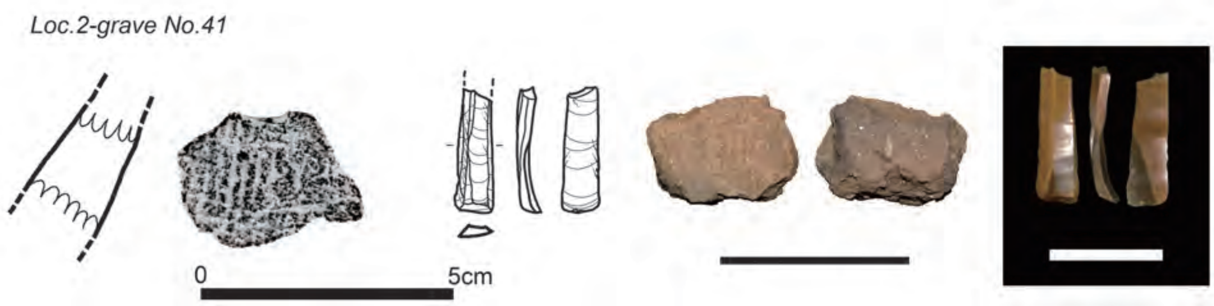


Fig.33 Artifacts found at Grave No.41, Location 2 of Daram site

Before excavation

After removed surface soil

After removed surface soil

After removed covered pebbles

Horse lower jawbone

Cover stones

Cover stones

Burial pit

Fig.34 Grave No.41, Location 2 of Daram site

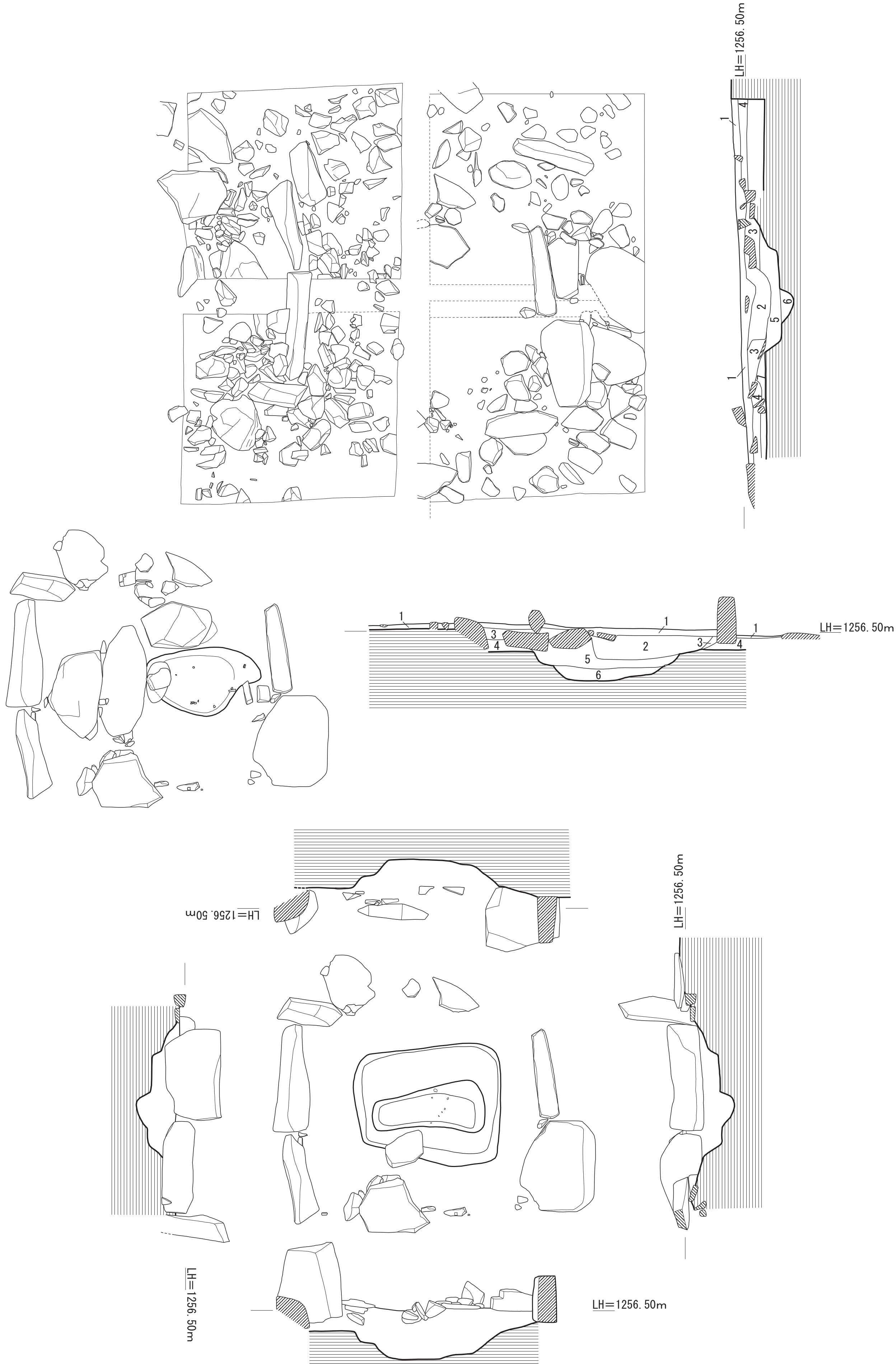


Fig.35 Grave No.1, Location 1 of Daram site

Before excavation

After removed surface soil

After removed cover stones

Burial pit

Burial pit

Cow horn

Burial pit

Burial pit

Fig.36 Grave No.1, Location 1 of Daram site

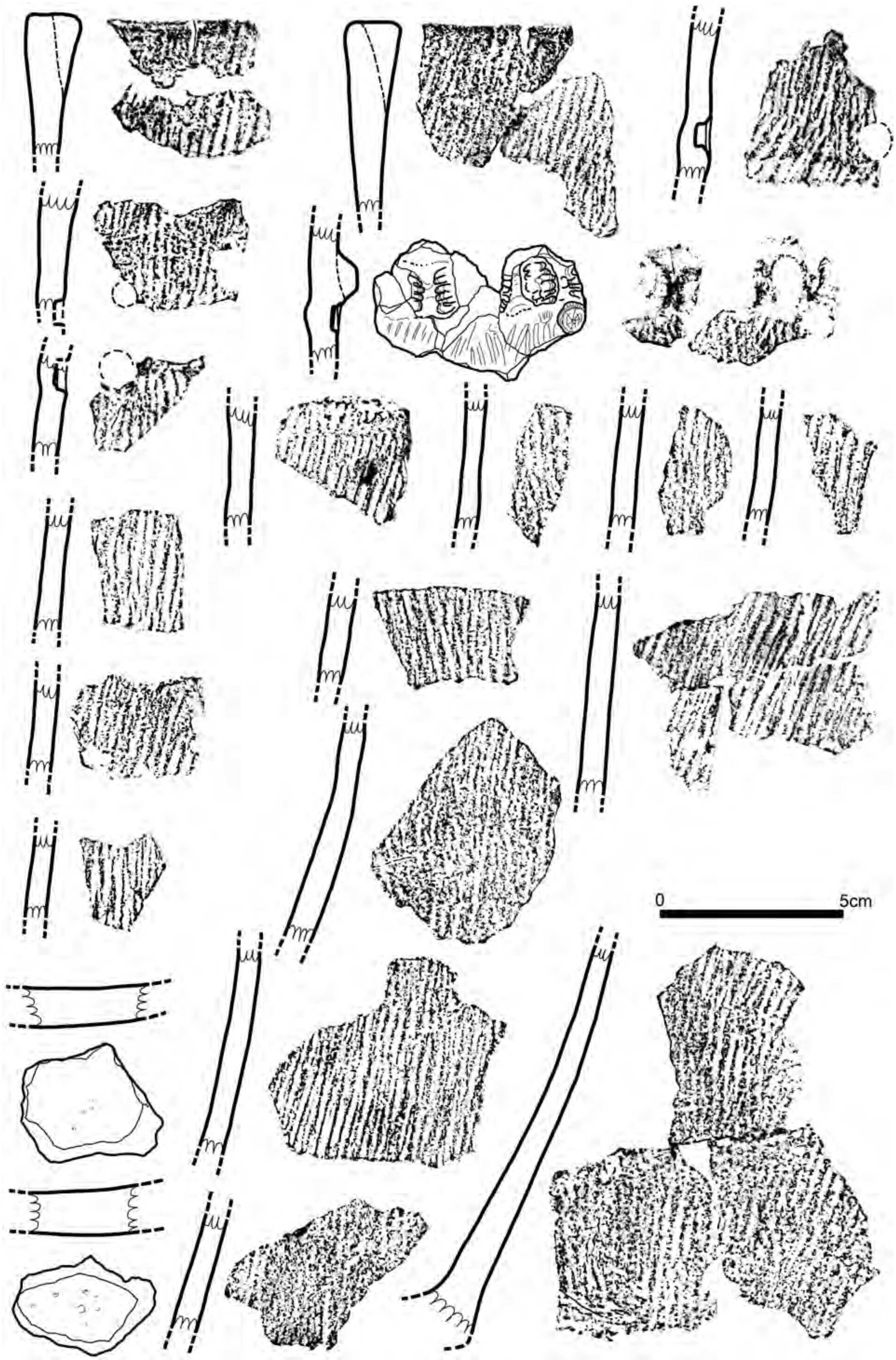


Fig.37 Pottery found at Grave No.1, Location 1 of Daram site

Fig.38 Pottery found at Grave No.1, Location 1 of Daram site

Fig.39 Sacrificed horse bones found at Grave No.1, Location 1 of Daram site

the 5th - 3rd centuries BC. Therefore, Daram Cemetery can be divided into four phases. The first phase is Type 1b stone-slab graves dating to the 9 - 8th centuries; the second phase is Type 2a stone-slab graves dating to the 8th - 6th centuries BC; the third phase is Type 2b and 2c stone-slab graves dating to the 5th - 3rd centuries BC; and the fourth phase is the end of this cemetery dating to the 4th - 3rd centuries BC.

5. Surface finds

During the excavations, we found and collected a number of artifacts around the graves (Fig. 40, 41). There were various kinds of artifacts from various ages. Stone tools consisted of kinds of scrapers, burins and tanged point, which would be from the Paleolithic to Bronze Age. Fragments of vessels are from the Khitan and the Middle Age. Two bronze coins “Kai-yuan-tong-bao” were collected. The age of fragments of iron pans is uncertain.

6. Conclusion

Daram Cemetery started in the 9th century BC as Type 1b stone-slab graves: Grave No. 9 and Grave No. 2, such as square graves located in the first cemetery area on the lower slope of Daram Hill. This is the first stage of the Daram Cemetery site. The second phase of Daram Cemetery consisted of Type 2a of stone-slab graves: Grave No.4 was also located in the first

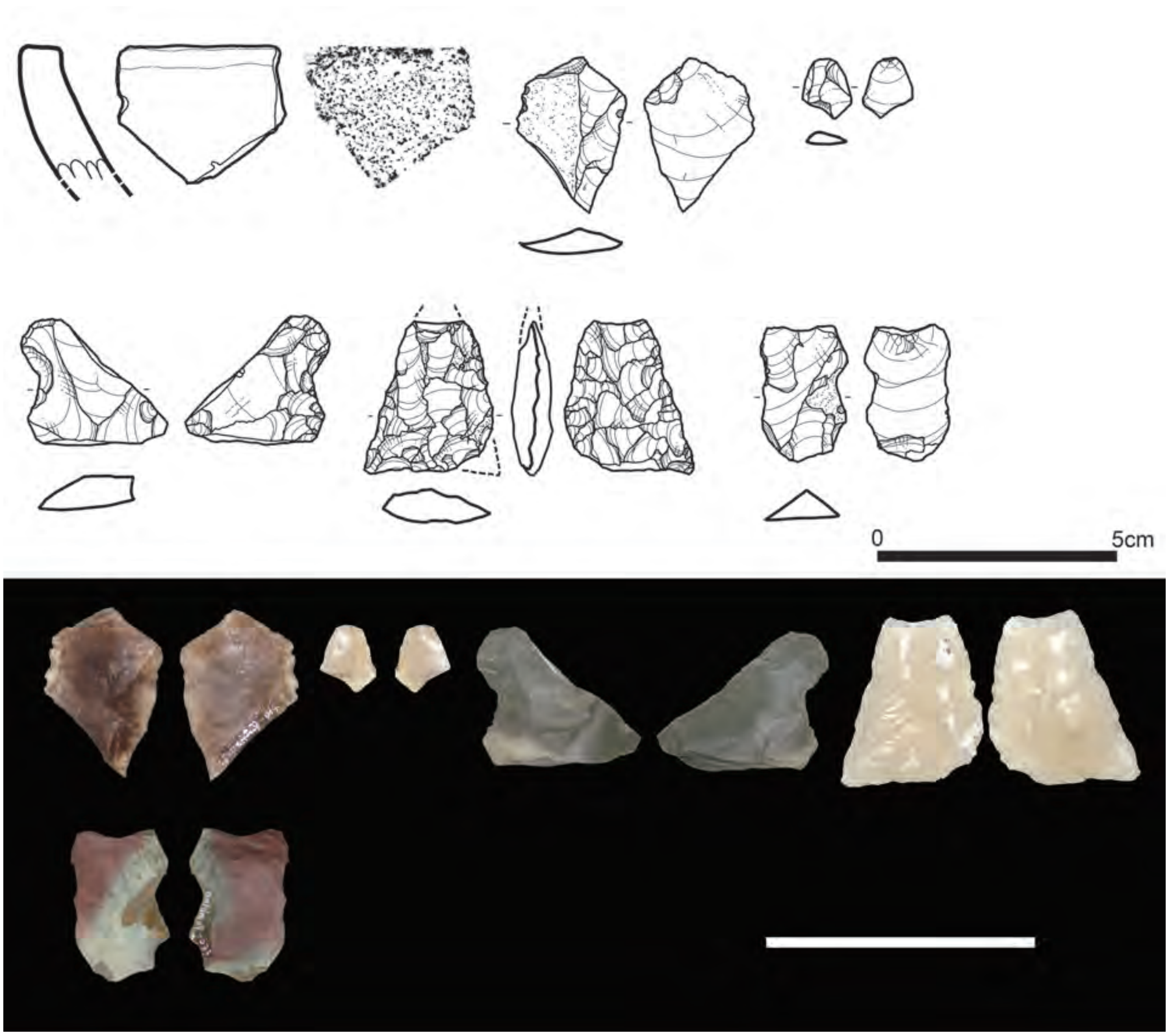


Fig.40 Artifacts found at Daram site

cemetery area. During the 3rd phase of the Daram Cemetery site, the cemetery area developed and separated into two areas; the first area which is located on the lower slope of Daram Hill, and the second area which is located higher up the slope near to the top of Daram Hill. This development of different cemetery areas indicates the formation of social groups. The second cemetery area would have been for extended family members from the social groups of the first cemetery area. The second cemetery area is for people of relatively lower status than those of the first cemetery area based on differences in the grave goods and grave structure. Such a process of change at Daram Cemetery site means the social development of herding society. During the fourth phase, around the 4th - 3rd centuries BC, this cemetery went into disuse, which is when the Xiongnu started to establish herding states.

Fig.41 Artifacts found at Daram site

2 Excavations at Tevsh Site

1. Background and purposes of excavations

Having finished excavations at Daram Site, we proposed the following title to Kyushu University Interdisciplinary Programs in Education and Projects in Research Development: "Interdisciplinary Research on immigration and reforms to grouping by ancient nomads on the Mongolian Plateau." For this project, the Department of Archeology in the Faculty of Humanities, Kyushu University, and the Archeological Institute of Academia Scinica in Mongolia entered into an agreement to conduct research entitled"Mongolian Khun Project: The Physical Anthropological Study of Prehistoric Mongolian Populations, Joint Mongolian-Japanese Research Project". We conducted joint Mongolian and Japanese excavations at Tevsh Site, Bogud sum of Uvurkhangai aimag in August, 2012.

We carried out general surveys in Tuvu Aimag, Uvurkhangai Aimag and Arkhangai aimag before starting the excavations at Tevsh Site (Fig. 42). While carrying out these surveys, I became interested in a figured grave that had not been clearly located in the chronology. Figured graves are called Фигурные Могилы in Russian, and шоргоолжин булш in Mongolian. These figured graves are classified as type 3 by Dr. Sosnovski (Цыбиктаров 1998).

Toward the end of these general surveys, we found many figured graves and khirigsuur at Tevsh Site. The distribution of graves is concentrated in three groups: an eastern area group, a middle area group and a western area group on the southern slope of the Tevsh mountain area, near Bogdo sum, Uvulhangai aimag. Two of the groups - the eastern group and western group - each have rock art with different motifs located in the center of each group (Fig. 43- 1). The figured graves are located in the eastern area group (Fig. 43- 3). The stone enclosure of khirigsuur has two kinds of plan: a square enclosure plan and a round enclosure plan. The square enclosure plan is concentrated in the western area

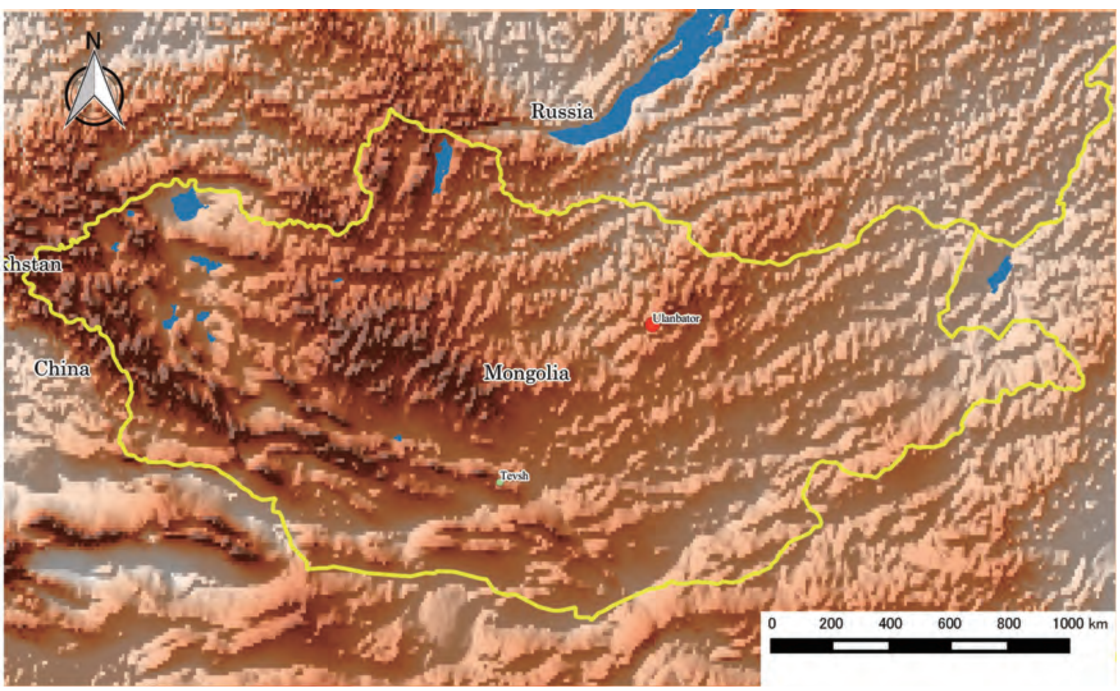
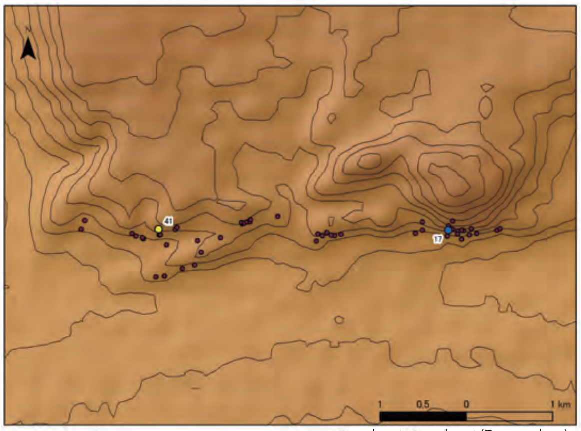
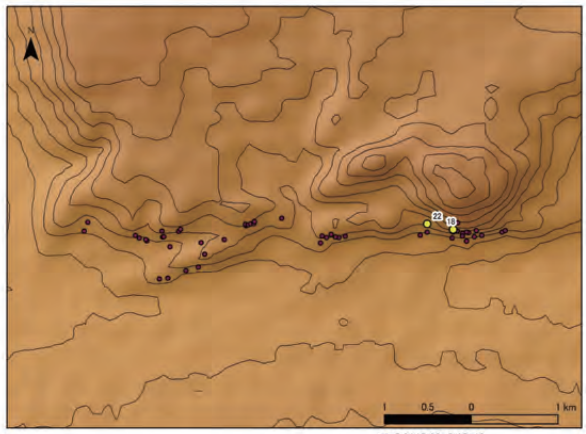


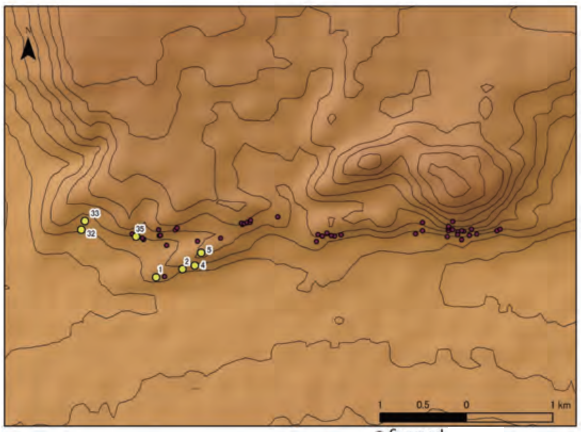
Fig.42 Locations of Tevsh site



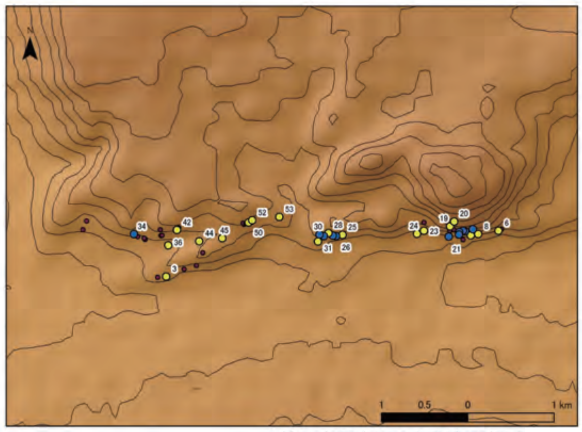
1 Location of rock art



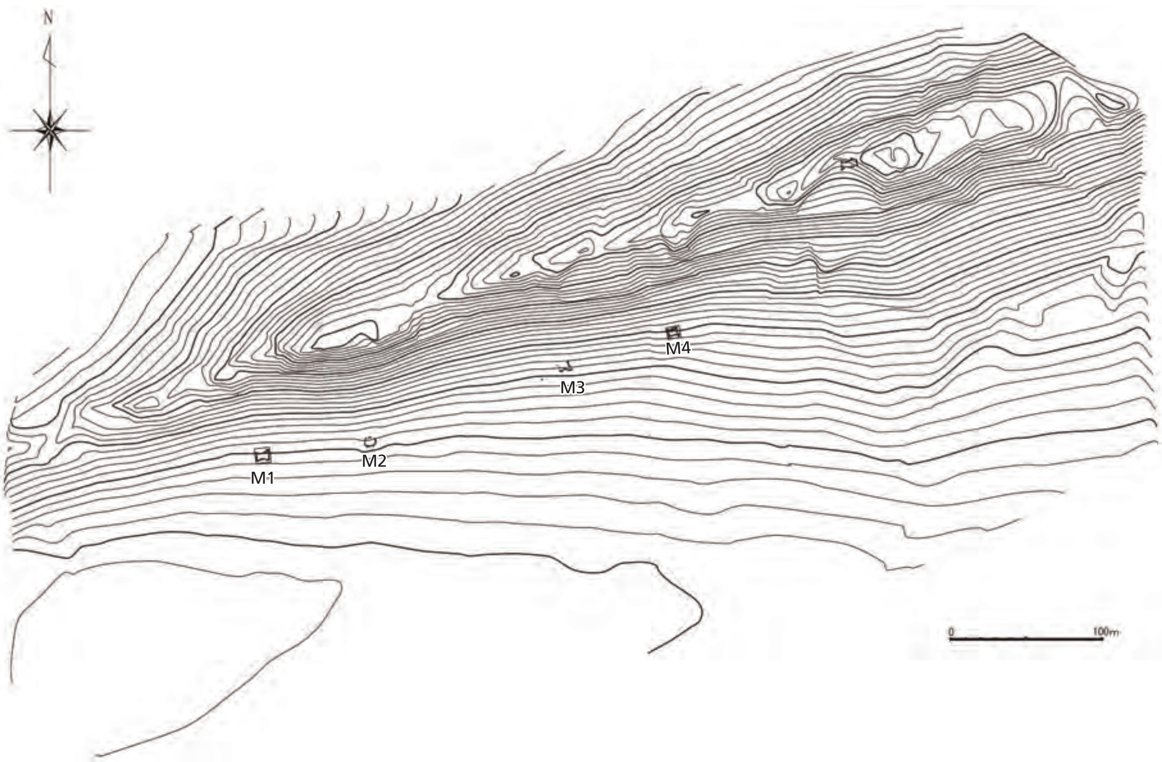
2 Distribution of square graves



3 Distribution of figured graves



4 Distribution of khirigsuur



5 Location of figured graves

Fig.43 Distribution of figured graves and the morphology of Tevsh Site

group, and the round enclosure plan is concentrated in the middle and western area group (Fig. 43- 4). The adoption of these two different types of stone enclosure in khirigsuur may be accorded to the dating or differences in social group.

Some figured graves at Tevsh Site had already been excavated by Russian scholars. Two figured graves were excavated by Dr. Volkov in 1964 (Волков 1967). Both graves contained human bones but no grave goods. The location of one of these was recorded as being on the eastern slope of Mount Tevsh. However, we were unable to locate these figured graves on the eastern slope during our surveys, although figured graves may have existed in this area in the past. Dr. Volkov subsequently excavated three other figured graves in the eastern area of Tvsh Site in 1971(Волков 1972), but we were again unable to identify these graves. A golden earing was found at one of these figured graves. Because the deer head depicted on this earing is similar to iconography on the deer head handle of Karasku daggers and swords, the earing is also believed to date to the Karasku culture period. Another figured grave had many beads and pottery shards as grave goods. Figures for the grave structure and grave goods have not been published; furthermore, the location of this grave is unknown. Taken together, these facts make it difficult to interpret figured graves.

The figured graves based on which Kovalev and Erdenebaatar named the Tevsh Culture were excavated by Kovalev and Erdenebaatar themselves (Kovalev & Erdenebaatar 2009). The figured graves at Tevsh Culture were excavated by a joint Russian-Mongolian excavation team in 2005-2007. These excavations covered Bapuun Gylaat Grave No. 1 and Bapuun Gylaat Grave No. 2 in Baiamlig sum of Bainkhongor aimag. The former grave is a modified figured grave, and the latter grave is a stylistic figured grave (Kovalev & Erdenebaatar 2009). While these graves do not contain grave goods, they do contain human bones. Analysis of these human bones shows that Bapuun Gylaat Grave No. 2 dates to 1270-970BC or 960-930BC, and Bapuun Gylaat Grave No. 1 dates to 1020-760BC. These dates are similar to the dating of the Karasku culture period. But the structure of the graves and the analysis of human bones are not mentioned in the preliminary excavation report.

As already mentioned, the figured graves at Tevsh Site had already been excavated, but there are no substantial excavation reports detailing these excavations. Given this lack of information on the figured graves, we attempted to excavate the figured graves at Tevsh Site. We conducted our excavations at a different location to the joint Russian-Mongolian excavation team. Figured graves distributed in a straight line are found on the southern slope of a hill in the western area (Fig. 43- 5). It is interesting that the location of the figured graves is limited to the western edge of the western area group, although the cemetery of khirigsuur is divided into three area groups (Fig. 43- 4). Therefore, the distribution of the figured graves is different to that of khirigsuur.

We selected two graves to excavate from among the four figured graves distributed in a straight line. One is Grave No. 1, a relatively large figured grave; the other is No. 3, a relatively small figured grave. Our excavations were conducted from August 15th to 25th, 2012.

2. Grave No. 1, Tevsh site (Fig.44, 45)

The stone structure of Grave No. 1, a relatively big stone slab grave, is 8.5 meters in the length and 7.0 meters in width. At the beginning of the excavation, we removed stones from outside the stone fence, which had dropped down outward from the inside of the stone structure, and found a clear outline of the stone structure (Fig.44). This stone fence forms figured lines and extends to four corners (Fig.44). This figured plan is a characteristic of figured graves.

The skeletal remains of the interred individual were found in a stone cist on the surface. The body had been laid out in an orientation facing west. No pit grave is present (Fig.44). Figured graves usually feature a pit grave under the ground in which the dead were buried. On the contrary, khirigsuur have a stone cist or stone coffin in which the dead were buried by being covered with a pile of stones in the kurugan. In this respect, the burial system of Grave No. 1 is similar to that of khirigsuur. The fact that Grave No. 1 contains no grave goods means that figured graves are relatively early among stone-slab graves. The skeleton was discovered largely intact and was identified as an adult female. These human bones date to 1392-1264cal BC (95.4%).

3. Graves No. 3 and No. 5, Tevsh Site (Fig.46, 47)

We removed stones from outside the stone fence, which had dropped down outward from the inside of the stone structure, and found a clear outline of the stone structure at Grave No. 3, Tevsh Site (Fig.46). The stone structure of Grave No. 3 is 6.5 meters in length and 6.0 meters in width. It is relatively small compared with Grave No. 1, and it is set out in a square plan (Fig.46). The extent of the four corners is

Fig.44 Grave No.1, Tevsh site

not as developed as that of Grave No. 1. A pit burial was found under the stone construction.

The fact that large stones had fallen into the pit burial suggests that it originally existed in a vacant portion of the pit burial, and that soil and rocks fell down in this vacant portion of the pit burial (Fig.47). The vacant portion of the pit burial should be the wooden coffin otherwise weaves wired with the dead. This organic matter perished over time, and clay and rock subsequently fell down into the perished vacant portions of the pit burial. Human bones were found at the rear of the pit burial in Grave No. 3, and burial styles such as this can often be seen in figured graves (Fig.46, 47). The easterly orientation of the interred individual and the pit burial under the surface is also seen in typical stone-slab graves like Daram cemetery, but the back head style of burial is unique to figured graves. The individual buried in Grave No. 3 has been identified as a matured male. The human bones in Grave No. 3 date to 1392-1264calBC (95.4%).

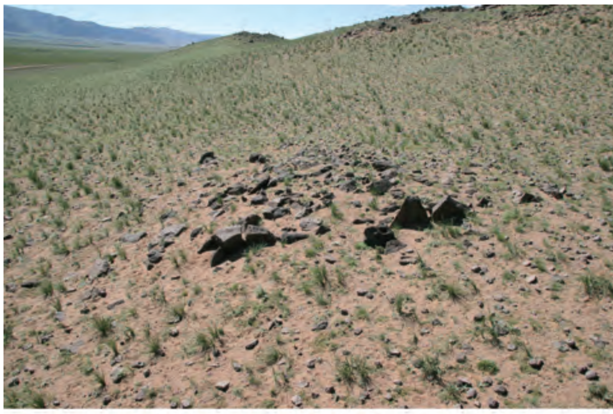
In addition, another grave was constructed on the southern edge of Grave No. 3, extending out from this grave (Fig.46). We call this grave Gave No. 5. Of the human bones, only the foot bones remain, and the body had been laid out in an orientation facing east, the same as that of Grave No. 3 (Fig. 46, 47). The human bones date to 1324-1209calBC (76.8%), and this dating is not in contradiction with the relationship between Grave No. 3 and No. 5. It is believed that Grave No. 5 is an additional burial that is connected in some way with Grave No. 3.

4. Artifacts

All stone artifacts were collected on the surface at Tevsh Site. None were found in the excavated graves during these surveys. Therefore, these artifacts are not connected with the figured graves or the khirigsuur. There are three micro-lithic blades (Fig.48- 1, 2, 3) and two micro-lithic cores (Fig.48- 4, 5). Both micro-lithic cores are of the cuneiform type. These stone artifacts belong to the end of Paleolithic to the earlier Neolithic period.

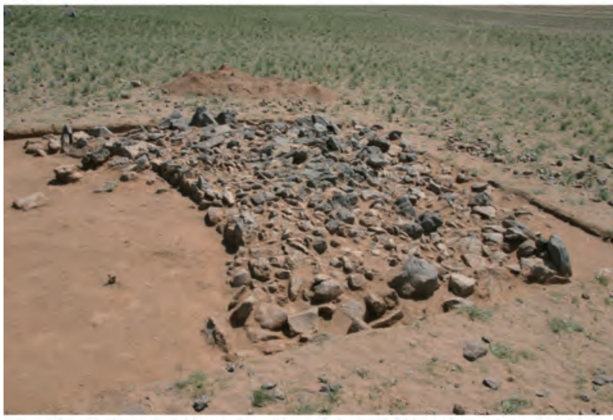
5. Conclusion

The figured graves at Tevsh Site date to between the 14th and 10th centuries BC. This dating places them at around the same time as those of the Bapuun Gylaat Grave No. 1 and No. 2 in Baiankhongor aimag, which a Russian and Mongolian joint research group excavated (Kovalev & Erdenebaatar 2009). The figured graves are earlier than the traditional stone-slab grave that Dr. Sosnovski classified as Type 2



Before excavtion at Tevsh grave No.1

Stone strucutre of Tevsh grave No.1



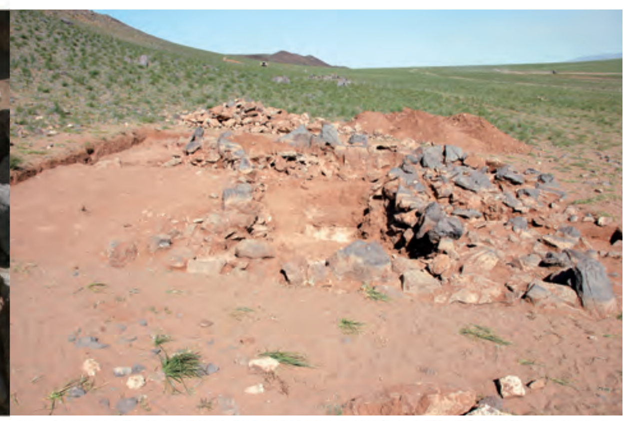
Stone fence of stone structure at Tevsh grave No.1

Stone fence of stone structure at Tevsh grave No.1

Human bones of Tevsh grave No.1

Human skull of Tevsh grave No.1

Stone cist of Tevsh grave No.1



After excavation at Tevsh grave No.1

Fig.45 Grave No.1, Tevsh site

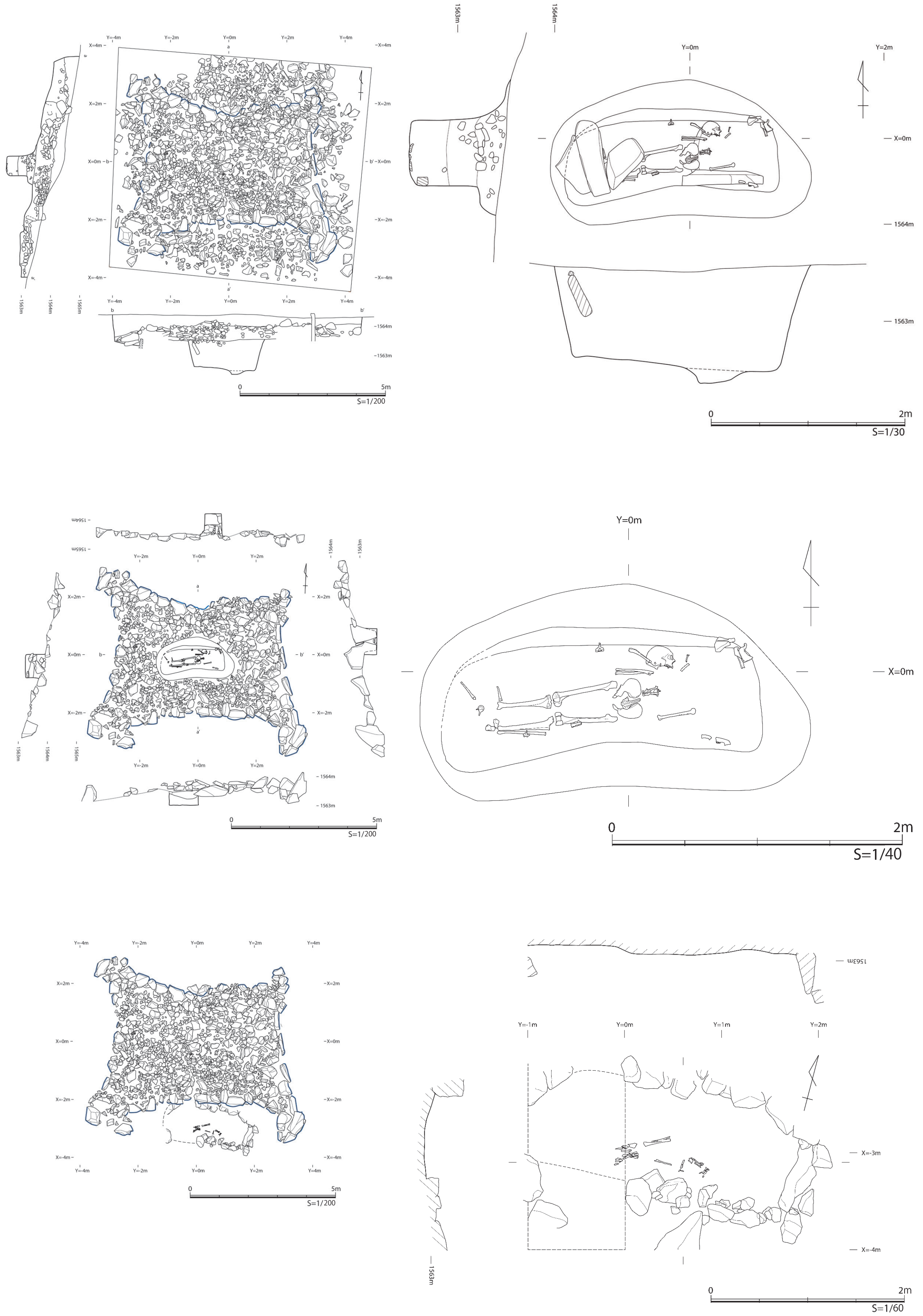


Fig.46 Grave No.3 and Grave No.5, Tevsh site

Before excavation at Tevsh grave No.3

Stone structure of Tevsh grave No.3

Stone fence of Tevsh grave No.3

Burial pit of Tevsh grave No.3

Human bones of Tevsh grave No.3

Human skull of Tevsh grave No.3

Tevsh grave No.3 and No.5

Human bones of Tevsh grave No.5

Fig.47 Grave No.3 and Grave No.5, Tevsh site

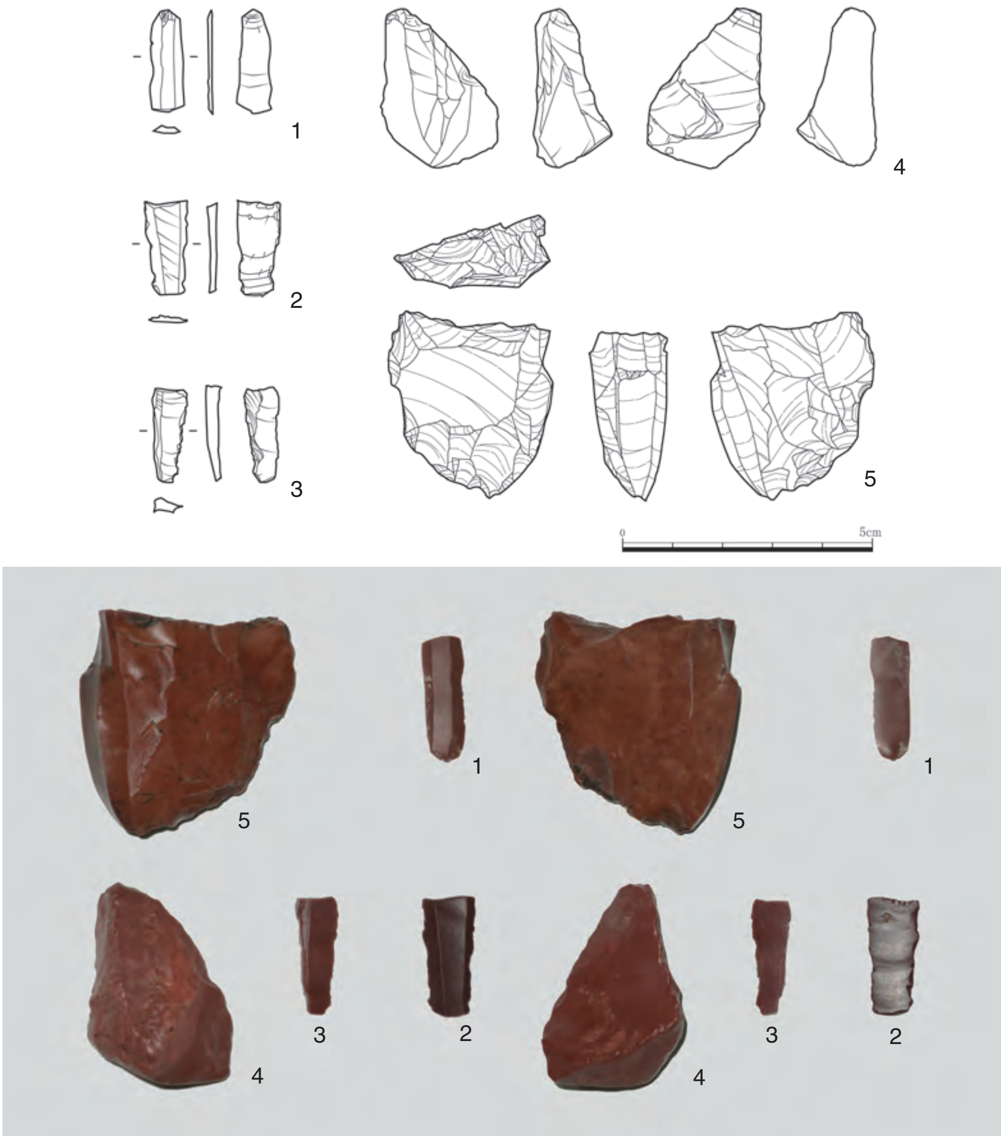


Fig.48 Stone artifacts, Tevsh site

(Цыбиктаров 1998). The figured graves are classified as Type 3 by Dr. Sosnovsky. Through these excavations at Tevsh Site, we can further classify Type 3 into two subtypes. Type 3a is Grave No. 3 at Tevsh Site, of which the plan is a near square plan for the stone structure, which does not extend to the four corners. Type 3b is Grave No. 1 at Tevsh Site, of which the plan is rectangular with developed four corners. The Bapuun Gylaat Grave No. 2 is also Type 3b, which is a rectangular plan. This grave dates to 1270-970, 960-930 cal. BC. Therefore, this grave is also later than the Tevsh Grave No. 3, which is Type 3a. This dating proves that Type 3a changed to Type 3b in the figured graves.

3 The analysis on the human skeletal remains of the Bronze Age unearthed from the both sites of Daram in the Khentii province and Tevsh in the southern Khangai, Mongol

1. Introduction

Human population movements and diffusions at the prehistoric and historic time in East Asia often originated from Mongolian Plateau. The people of Mongolian Plateau triggered the diffusions southward of Neolithic agricultural groups, and the territorial expansions of the Xiongnu and Mongol empires. Therefore, knowing about the prehistoric and historic Mongolian people, especially their physical traits, is significantly needed to dissolve the problems related to the human population history in East Asia. In 2009-2012, Mongolian (the Mongolian Academy of Sciences) Japanese (Kyushu University and Kumamoto University) joint team excavated the Daram site at Khentii province and the Tevsh site at the southern Khangai province, and found the human skeletal remains of the Bronze Age. We report on these human skeletal remains in this chapter.

2. Methods

The age and sex of each individual were primarily determined on the basis of the standards arranged by Buikstra and Ubelaker (1994). In sexing, as far as the preservation condition of material perimits, we used a dominant sexing method using bones such as a hip bone (Phenice, 1969) and followed the method in Nakahashi and Nagai (1986) for poorly preserved material. Adult age was estimated based on age-related changes of the morphology of pubic symphysis and auricular surfaces (Todd, 1920; Lovejoy et al., 1985).

We primarily followed the measurement method of Martin (Baba, 1991). The methods employed by Hawkey and Merbs (1995) for characterizing muscle markers were used. Cranial measurements were done by K.O., limbs measurements by T.N. and K.O., musculo stress markers observations by S.Y., paleopathological observations was by T.N. and K.O..

3. Preservation, Sex, and Age

A. Daram site

One skeletal individual was unearthed on the cover stone of the grave, and the other skeletal individual was inside the grave. The first one was named Daram M4A, the latter one Daram M4B. See the chapter 2 of this book on the state of affairs when these skeletal remains were just unearthed (e.g., burial positions, grave goods).

Burial individual No. 4A

Preservation: the cranium and thorax are lacked (Fig.49-1). Only lower right molar (M1 or M2), lumber vertebrae and sacrum were confirmed among the trunk. The long limb bones are relatively good preserved except right tibia, although the most of their epiphyses were broken. The preauricular groove of hip bone is relatively deep.

Sex: the morphological traits of pubic bones indicate that the biological sex is female.

Age: the condition of the pubic symphysis is assigned to the ninth or tenth stage according to the standard of Todd (1920). These stages range over 50 years.

Burial individual No. 4B

Preservation: the most of cranium and trunk are lost (Fig.49-2). Only left ulna is preserved among the upper limb bones. The lower limb bones are good preserved except right femur.

Sex: The total size of limb bones suggest that the biological sex could be female.

Age: The detail age at the death is unknown since the both of hip bone and cranium, which are effective to estimate the age, are lacked. The formation of bony lipping on the knee joint suggests that she is probably middle adult (35-50 years).

B. Tevsh site

One individual was respectively unearthed in the grave No.1, grave No.3, and grave No.5, which was

1 The whole skeletal body of the Daram M4A female

2 The whole skeletal body of the Daram M4B female

3 The whole skeletal body of the Tevsh M1 female

4 The crania of the Tevsh M1 female (the front view)

Fig.49 Humane bones, Daram and Tevsh Sites

attached to the grave No. 3. See the chapter 2 of this book on the state of affairs when these skeletal remains were just unearthed.

Burial individual No. 1

Preservation: the most parts of body were observable (Fig.49-3). The face bones were good preserved while the calvarium was significantly broken (Fig.49-4, 50-1). The left clavicle and right ilium were lacked. The metopic suture remains.

Sex: the shape of the pubic bones shows that the biological sex is female.

Age: the condition of the pubic symphysis is assigned to the eighth stage according to the standard of Todd. This stages range the first half of forties.

Burial individual No. 3

Preservation: the most of parts of body were good preserved (Fig.50-2), especially in skull (Fig.50-3, 4, 51-1, 2). The parts of body lacked postmortem are right clavicle, right antebrachia, left humerus, and pubis. The mild mandibular torus is recognized.

Sex: the curve of the greater sciatic notch of hip bone indicates that the biological sex is male.

Age: the condition of the auricular surface of the hip bones belongs to the fifth stage according to the standard of Lovejoy et al. (1985). This stage ranges the first half of forties.

1 The crania of the Tevsh M1 female (the obliquely front view)

2 The whole skeletal body of the Tevsh M3 male.

3 The crania of the Tevsh M3 male (the front view)

4 The crania of the Tevsh M3 male (the obliquely front view)

Fig.50 Human bones, Tevsh Site

Burial individual No. 5

Preservation: the most parts of body were lacked. The parts of diaphysis of long bones were preserved with bad condition. The following parts were confirmed, right humerus, right radius, right ulna, right and left femora, right and left tibias.

Sex: the total size of the limb bones suggests that the biological sex is male.

Age: these limb bones indicate that the age at the death is over 20 years, but the detailed age is unknown.

4. Morphological traits

Table 2-4 shows the measurements of cranium, upper limb bones, and lower limb bones, respectively. The comparisons of the Daram and Tevsh individuals with the other assemblages were done in the following, which stemmed from China (the groups from the northern Great Wall region, the Central Plains, Qinghai province, Sichuan province) and Siberia of the Bronze Age or the early Iron Age.

A. Cranium

Table 5 showed that the Tevsh M3 male had the much greatest values among the comparison

1 The crania of the Tevsh M3 male (the side view)

2 The crania of the Tevsh M3 male (the top view)

3 The healed fracture in left middle-leveled rib of the Tevsh M1 female

4 The healed fracture in the nasal bones of the Tevsh M3 male.

5 The possible healed fracture in the left femur of the Tevsh M3 male (the front view, the left side of the photo is superior)

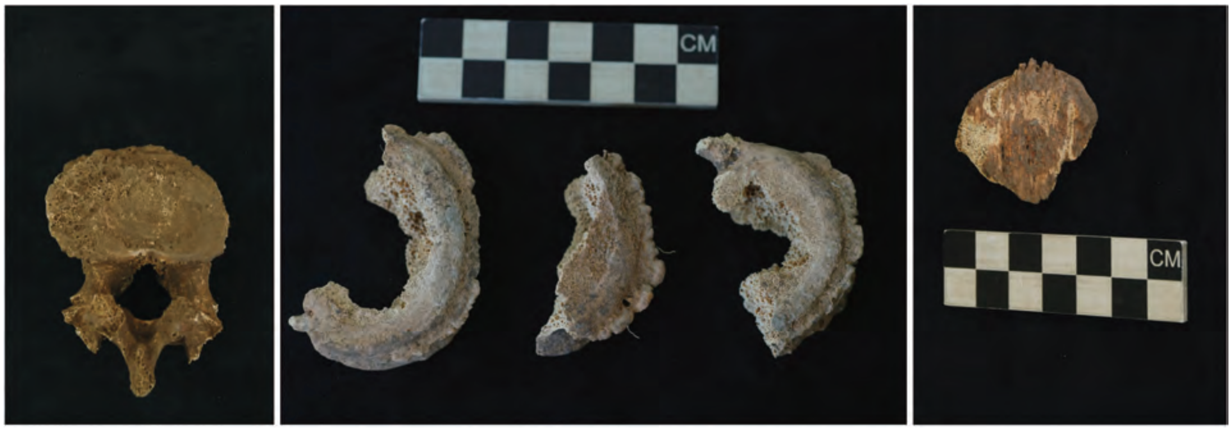
6 The compression fracture in the lower thoracic vertebrae of the Tevsh M3 male

Fig.51 Humane bones, Tevsh Site

assemblages in maximum cranial length, maximum cranial breadth, bizygomatic breadth, upper facial height, and nasal height, although the difference of maximum cranial length between the Tevsh M3 male and the Siberia Bronze Age assemblage was little. The Tevsh M1 female also had the greatest values among the comparison assemblages in upper facial height and nasal height (Table 6).

B. Humerus

Table 7 indicated that the Tevsh M3 male had the greatest value among the comparison assemblages in the lengths, diameters, and circumference. This individual showed that *teres major* and *latissimus*



1 The lippings in the lumber vertebra of the Daram M4A female

2 The lippings in the lumber vertebra of the Tevsh M3 male

3 The lippings in the left patella of the Daram M4B female

Fig.52 The lippings of Daram and Tevsh Sites

dorsi, pectoralis major and *deltoideus* of right humerus remained among the most utilized muscle. All these musculo skeletal marker (MSM) scores were 3. The Tevsh M1 female also had the greatest value among the comparison assemblages in the diameters and circumference, while the Daram M4A female did not show such a tendency (Table 8). The M4A female was able to observe the left *pectoralis major, teres major* and *latissimus dorsi* and *deltoideus* muscle attachment site, but these scores were 2, and the moderate development was confirmed.

C. Radius

Table 9 showed that the Tevsh M3 male had the greatest value among the comparison assemblages in the lengths and diameters, and circumference, and the most flatness in the shaft index. In this individual, MSMs scores in left *biceps brachii* and left *pronator teres* were 3, respectively. The Daram M4A female had the greatest value among the comparison assemblages in minimal circumference of the distal shaft and maximum transverse shaft diameter, and the most flatness in the shaft index (Table 10). The Tevsh M1 female had the greatest value among the comparison assemblages in the all measurements and indices.

D. Ulna

Table 11 showed that the Tevsh M3 male had the greatest value among the comparison assemblages in lengths, circumference, dorso-volar shaft diameter, and the second greatest in transverse shaft diameter and shaft index. M3 male showed MSMs score 3 in left *pronator quadratus* and *supinator*. The Daram M4A female had the greatest value among the comparison assemblages in transverse shaft diameter, and the second flatness in shaft index (Table 12). The Daram M4B female also had the greatest value among the comparison assemblages in transverse shaft diameter, and the most flatness in shaft index. The Tevsh M1 female had the greatest value among the comparison assemblages in physiological length, least circumference of the shaft, dorso-volar shaft diameter, length-circumference index, and shaft index. The maximum length of the Tevsh M1 female was the second greatest after the Kashahu Bronze Age assemblage. This female showed moderate development of *pronator quadratus* muscle and *supinator* muscle attachment sites on right and left ulna, that is MSMs score 2.

E. Femur

The table 13 showed that the both individuals of the Tevsh M3 and M5 males had the greatest value among the comparison assemblages in the almost of lengths, diameters, and indices. In length-circumference index, the Tevsh M3 male had the third greatest value among the comparison assemblages. The attachment sites of muscles in *linea aspera* and *lliacus* of right femur showed high score in this individual. The Daram M4A female had the greatest value among the comparison assemblages in transverse diameter of the mid-shaft, circumference of the mid-shaft, and transverse subtrochanteric diameter, and the most pilastric and platymeric (Table 14). The Daram M4B female had the greatest circumference of the mid-shaft among the comparison assemblages. The Tevsh M1 female had the greatest value among the comparison assemblages in diameters and circumference of the mid-shaft, and transverse subtrochanteric diameter, and the second most platymeric. The attachment sites of muscles in *linea aspera* of right and left femur showed score 3 in this individual.

F. Tibia

Table 15 indicated that the Tevsh M3 male had the greatest value among the comparison assemblages in the all lengths, diameter, and circumferences. This individual showed that the attachment sites of soleus in both side were MSMs score 3, but the attachment sites of tibialis posterior and flexor digitorum longus in both side were MSMs score 1. The Tevsh M5 male had the greatest value among the comparison assemblage in maximum diameter of the mid-shaft and circumference of the mid-shaft, and the second most flatness in mid-shaft index. The Daram M4A female had the greatest value among the comparison assemblages in the all diameters and circumference, and the second most flatness in mid-shaft index after the Tsukumo Jomon assemblage (Table 16). The Daram M4B female had the second smallest circumference of the mid-shaft, and the second least flatness in mid-shaft index after the Kyushu Modern assemblage. The Tevsh M1 female had the greatest value among the comparison assemblages in the almost of lengths, diameters, and circumferences, and the second most flatness in the mid-shaft index after the Tsukumo Jomon assemblage.

G. Fibula

Table 17 showed that the Tevsh M3 male had the second greatest least circumference of the shaft among the comparison assemblages after the Dinggong Longshan assemblage. The Daram M4A female had the greatest value among the comparison assemblages in the both circumferences and mid-shaft index (Table 18). The Daram M4B female had the greatest value among the comparison assemblages in the almost of diameters, circumferences, and length-circumference index, and the most flatness in mid-shaft index. The Tevsh M1 female had the greatest value among the comparison assemblages in the almost of lengths, diameters, circumferences, and indices.

H. Limb proportions

Table 19 showed that the Tevsh M3 male had the smallest value among the comparison assemblages in crural index (maximum length of tibia/maximum length of femur), and the second smallest in humerus-femur circumference index (least circumference of the shaft of humerus/circumference of the mid-shaft of femur), and the smallest in fibula-tibia circumference index (circumference of the mid-shaft of fibula/circumference of the mid-shaft of tibia). Table 20 indicated that the Daram M4A female had the smallest value among the comparison assemblages in humerus-femur circumference index. The Daram M4B female had the greatest value among the comparison assemblages in fibula-tibia circumference index. The Tevsh M1 female had the second greatest value among the comparison assemblages in humerus-femur circumference index, and the greatest value in fibula-tibia circumference index.

I. Estimated height

The table 21 indicated that the Tevsh M3 male had the much greatest height among the comparison assemblages, which was 171.5 cm calculated by the maximum femur length according to the method of Pearson.

5. Paleopathology

A. Fracture

The Tevsh M1 female had a healed fracture in left middle-leveled rib (Fig.51-3). The curve of the rib body was unnaturally bent in the medial direction. The Tevsh M3 male had three healed fractures in nasal bones, left femur, and the lower-leveled thoracic vertebrae. The inferior margin of the nasal bones was flatly pressed in the dorsal direction (Fig.51-4), which suggested that his face had some physical shock from the front. An irregular ridge was formed on the lateral side of the diaphysis of the left femur from superior to inferior and slightly posterior (Fig.51-5). It could be a healed twisting or bending fracture although the X-ray examination was needed for the diagnosis. The two of the lower thoracic vertebrae, which deformed into a wedge shape, were fused together (Fig.51-6). The both vertebra bodies could have compression fracture.

B. Osteoarthritis

Mild lipping was observed on the epiphysis of the lumber vertebra body in the Daram M4A female (Fig.52-1), Tevsh M1 female, and Tevsh M3 (Fig.52-2) male. The osteoarthritis was appeared on the knee in the Daram M4A female and Daram M4B female. Some mild lipping was formed on the patellar surface of the left femur of the Daram M4A female and on the superior margin of the left patella of the Daram M4B female (Fig.52-3). The Tevsh M3 male had a erosion of the compact bone of the mandibular fossa of temporal bone, which suggested the temporomandibular joint disorder.

C. Stress marker

The Tevsh M1 male had mild healed cribra orbitalia and the linear enamel hypoplasia of right lower canine. The Tevsh M3 male had mild healed cribra cranii and the linear enamel hypoplasia of right lower canine.

D. Oral diseases

Mild and moderate alveolar resorption was appeared in the premolars and molars section of the maxillary of the Tevsh M1 female, and in the premolars and molars section of the mandible of the Tevsh M3 male. The Tevsh M3 male had a abscess in the right second premolar section of mandible.

6. Conclusion

The results of the examination on the human skeletal remains excavated from the Daram and Tevsh sites were summarized as followings. The Daram M4A individual was an old adult (over 50 years) female. The Daram M4B individual was a middle adult (35-50 years) female. The Tevsh M1 individual was a middle adult (the first half of forties) female. The Tevsh M3 individual was middle adult (the first half of forties) male. The Tevsh M5 individual was adult (over 20 years) male.

In the metrical data, the cranium of the both of the Tevsh M1 female and the Tevsh M3 male totally had a much greater size compared to the Bronze Age or the Early Iron Age assemblages in China and Japan. The other individuals lacked their cranium postmortem. The limb bones of the Daram and Tevsh males and females also had greater lengths, diameters, and circumferences compared to the Bronze Age or the Early Iron Age assemblages in China and Japan. In particular, the femur of the Tevsh M3 male was extraordinary large-sized, and the muscle attachment sites were also relatively prominent. Thus, the height of the Tevsh M3 male was significantly tall (171.5 cm) among prehistoric and historic societies. The crural index of the Tevsh M3 male was the smallest among the comparison assemblages, which could be regarded as the result of the adaptation to cold climate. It should be needed that we collect metrical data of the prehistoric and historic Mongolian assemblages, and understand the changes with time period and the regional differences.

Finally, the Tevsh individuals showed relatively high prevalence in fracture premortem. The Tevsh M3 male had three healed fractures, and the Tevsh M1 female did one. The osteoarthritis in lumbar vertebra was also widespread. The moderate lipping along the epiphysis of lumber vertebral body was observed in the Daram M4A female, the Tevsh M1 female, and the Tevsh M3 male.

Table 2. Measurements in cranium

Site	Tevsh	
Sample No.	M1	M3
Sex	F	M
1. Maximum cranial length	-	190
5. Basal length	-	98
8. Maximum cranial breadth	-	167
9. Minimum frontal breadth	91.5	84.5
17. Basi-bregmatic height	-	126
23. Horizondal circumference	-	560
24. Transverse arc	-	338
25. Total sagittal arc	-	380
40. Facial profile length	-	98
45. Bizygomatic breadth	-	148
46. Bimaxillary breadth	100	112
47. Total facial height	117	137
48. Upper facial height (sd)	72	83.5
50. Anterior interorbital breadth	17.4	19.2
IA. Anterior interorbital arc	-	22.5
51. Orbital breadth	43	42.3
52. Orbital height	33.5	35.5
54. Nasal breadth	26	27.5
55. Nasal height	55	63
57. Least nasal breadth	-	7.9
FC. Frontal chord	98.6	96.4
FS. Frontal subtense	-	12.1
SC. Simotic chord	-	7.9
SS. Simotic subtense	-	2.5
ZC. Zygomaxillary chord	97.4	113.5
ZS. Zygomaxillary subtense	21.3	23.8
72. Facial profile angle	-	87
73. Middle facial profile angle	-	94
74. Alveolar profle angle	-	71
8:1 Cranial length-breadth index	-	87.9
17:1 Cranial length-height index	-	66.3
17:8 Cranial breadth-height index	-	75.4
47:45 Kollmann's total facial index	-	92.6
48:45 Kollmann's upper facial index	-	56.4
47:46 Virchow's total facial index	117	122.3
48:46 Virchow's upper facial index	72	74.6
50:IA Prominence index of nasal root	-	85.3
52:51 Orbital index	77.9	84.0
54:55 Nasal index	47.3	43.7
FS:FC Frontal index of flatness	-	12.6
SS:SC Simotic index of flatness	-	31.1
ZS:ZC Zygomaxillary index of flatness	21.9	21.0
69. Mandibular symphysis height	34	41

Table 3. Summary of measurements of the upper limbs

	Site	Daram		Tevsh	
	ID	M4A	M4B	M1	M3
	Sex	Female	Female	Female	Male
Clavicle					
1. Maximum length	L	-	-	-	161
	R	-	-	-	-
4. Vertical diameter of the mid-shaft	L	-	-	-	12
	R	-	-	-	-
5. Sagittal diameter of the mid-shaft	L	-	-	-	11.5
	R	-	-	-	-
6. Circumference of the mid-shaft	L	-	-	-	39
	R	-	-	-	-
4:5 Mid-shaft index	L	-	-	-	104.3
	R	-	-	-	-
6:1 Length-circumference index	L	-	-	-	24.2
	R	-	-	-	-
Humerus					
1. Maximum length	L	-	-	-	-
	R	-	-	-	332
2. Total length	L	-	-	-	-
	R	-	-	-	330
5. Maximum diameter of the mid-shaft	L	20	-	23	-
	R	-	-	23	27
6. Minimum diameter of the mid-shaft	L	15	-	18	-
	R	-	-	19	20
7. Least circumference of the shaft	L	55	-	63	-
	R	-	-	61	72
7a. Circumference of the mid-shaft	L	59	-	67	-
	R	-	-	68	76
6:5 Mid-shaft index	L	75.0	-	78.3	-
	R	-	-	82.6	74.1
7:1 Index of robustness	L	-	-	-	-
	R	-	-	-	21.7
Radius					
1. Maximum length	L	-	-	230	258
	R	-	-	235	-
2. Physiological length	L	-	-	216	242
	R	-	-	219	-
3. Minimal circumference of the distal shaft	L	38	-	41	46
	R	-	-	41	-
4. Maximum transverse shaft diameter	L	18	-	16	20
	R	-	-	17	-
4a. Transverse diameter of the mid-shaft	L	-	-	15	17
	R	-	-	16	-
5. Sagittal shaft diameter	L	10	-	12	13
	R	-	-	12	-
5a. Safittal diameter of the mid-shaft	L	-	-	12	13
	R	-	-	11	-
3:2 Length-circumference index	L	-	-	19.0	19.0
	R	-	-	18.7	-
5:4 Shaft index	L	55.6	-	75.0	65.0
	R	-	-	70.6	-
5a:4a Mid-shaft index	L	-	-	80.0	76.5
	R	-	-	68.8	-
Ulna					
1. Maximum length	L	-	-	-	283
	R	-	-	249	-
2. Physiological length	L	-	-	219	247
	R	-	-	223	-
3. Least circumference of the shaft	L	-	-	41	40
	R	-	-	38	-
11. Dorso-Volar shaft diameter	L	12	11	14	16
	R	13	-	14	-
12. Transverse shaft diameter	L	16	17	16	17
	R	16	-	15	-
3:2 Length-circumference index	L	-	-	18.7	16.2
	R	-	-	17.0	-
11:12 Shaft index	L	75.0	64.7	87.5	94.1
	R	81.3	-	93.3	-

Abbreviations: L, left; R, right.

Table 4. Summary of measurements of the lower limbs

	Site	Daram		Tevsh		
	ID	M4A	M4B	M1	M3	M5
	Sex	Female	Female	Female	Male	Male
Femur						
1. Maximum length	L	-	-	-	474	-
	R	-	-	-	480	-
2. Oblique length	L	-	-	-	471	-
	R	-	-	-	477	-
6. Sagittal diameter of the mid-shaft	L	25	27	27	36	33
	R	26	-	26	35	-
7. Transverse diameter of the mid-shaft	L	31	26	27	31	29
	R	31	-	26	29	-
8. Circumference of the mid-shaft	L	86	82	86	105	95
	R	88	-	83	100	-
9. Transverse subtrochanteric diameter	L	34	-	34	32	-
	R	37	-	33	35	-
10. Sagittal subtrochanteric diameter	L	23	-	23	30	-
	R	22	-	23	31	-
8:2 Length-circumference index	L	-	-	-	22.3	-
	R	-	-	-	21.0	-
6:7 Pilastric index	L	82.0	103.8	100.0	116.1	113.8
	R	83.9	-	100.0	120.7	-
10:9 Platymeric index	L	67.6	-	67.6	93.8	-
	R	59.5	-	69.7	88.6	-
Tibia						
1. Total length	L	-	-	331	372	-
	R	-	-	-	374	-
1a. Maximum length	L	-	-	338	381	-
	R	-	-	-	384	-
8. Maximum diameter of the mid-shaft	L	32	25	30	36	-
	R	-	26	29	37	34
8a. Maximum diameter of the nutrient foramen level	L	34	30	34	40	-
	R	-	29	32	41	-
9. Transverse diameter of the mid-shaft	L	22	19	20	25	-
	R	-	19	20	24	22
9a. Transverse diameter of the nutrient foramen level	L	24	20	23	27	-
	R	-	20	23	26	-
10. Circumference of the mid-shaft	L	-	71	78	96	-
	R	-	71	79	96	87
10b. Minimum circumference of the shaft	L	75	67	69	81	-
	R	-	66	70	82	-
9:8 Mid-shaft index	L	68.8	76.0	66.7	69.4	-
	R	-	-	69.0	64.9	64.7
9a:8a Cnemic index	L	70.6	66.7	67.6	67.5	-
	R	-	-	71.9	63.4	-
10b:1Length-circumference index	L	-	-	20.8	21.8	-
	R	-	-	-	21.9	-
Fibula						
1. Maximum length	L	-	319	329	-	-
	R	-	-	331	-	-
2. Maximum diameter of the mid-shaft	L	14	16	15	16	-
	R	15	15	15	16	-
3. Minimum diameter of the mid-shaft	L	12	10	12	12	-
	R	12	11	13	12	-
4. Circumference of the mid-shaft	L	44	44	46	46	-
	R	45	44	46	46	-
4a. Least circumference of the shaft	L	39	37	40	41	-
	R	38	41	39	38	-
3:2 Mid-shaft index	L	85.7	62.5	80.0	75.0	-
	R	80.0	73.3	86.7	75.0	-
4a:1 Length-circumference index	L	-	11.6	12.2	-	-
	R	-	-	11.8	-	-

Table 5. Comparison of measurements in cranium (male)

Site/Group	Tevsh	Zhukaigou[1]	Anyang[2]	Xinghong[3]	Xicun[4]	Lijiashan[5]	Chuanxi[6]	
Region	Outer Mongolia	Inner Mongolia	Henan	Henan	Shanxi	Qinghai	Sichuan	Siberia[7]
Period	Bronze Age	Bronze Age	Bronze Age	Eastern Zhou	Bronze Age	Bronze Age	Bronze Age	Bronze Age
Sample No.	M3	Ave	Ave	Ave	Ave	Ave	Ave	Ave
1. Maximum cranial length	190	175.8	184.5	181.3	180.6	182.2	185.5	191.7
8. Maximum cranial breadth	167	142.3	140.5	144.4	136.8	140.0	138.0	145.2
17. Basi-bregmatic height	126	138.4	139.5	142.0	139.3	136.5	134.3	131.8
5. Basal length	98	99.1	102.3	101.4	103.0	101.2	103.8	104.7
9. Minimum frontal breadth	84.5	90.8	91.0	94.4	93.3	91.2	95.6	94.9
40. Facial profile length	98	96.5	99.2	100.3	99.2	94.7	100.3	102.8
45. Bizygomatic breadth	148	135.2	135.4	137.0	131.5	138.6	135.5	142.4
48. Upper facial height (sd)	83.5	71.8	74.0	73.7	72.6	77.3	74.3	74.9
51. Orbital breadth	42.3	43.9	42.4	42.6	42.0	42.8	40.9	42.5
52. Orbital height	35.5	33.5	33.8	33.9	34.0	35.0	45.0	34.5
54. Nasal breadth	27.5	27.0	27.3	26.7	27.7	26.7	26.1	26.2
55. Nasal height	63	52.4	53.8	52.5	51.6	57.0	52.1	55.6
57. Least nasal breadth	7.9	-	7.3	7.4	7.3	-	8.2	7.5

1) Pan 2000, 2) Han and Pan 1985, 3) Nakahashi 2014, 4) Han et al. 1985, 5) Zhang 1993, 6) Nakahashi et al. 2013, 7) Alekseev and Gochman, 1983
Abbreviation: Ave, average

Table 6. Comparison of measurements in cranium (female)

Site/Group	Tevsh	Zhukaigou	Anyang	Xinghong	Xicun	Lijiashan	Chuanxi	
Region	Outer Mongolia	Inner Mongolia	Henan	Henan	Shanxi	Qinghai	Sichuan	Siberia
Period	Bronze Age	Bronze Age	Bronze Age	Eastern Zhou	Bronze Age	Bronze Age	Bronze Age	Bronze Age
Sample No.	M1	Ave	Ave	Ave	Ave	Ave	Ave	Ave
9. Minimum frontal breadth	91.5	90.6	90.2	90.9	86.3	89.2	92.2	92.7
48. Upper facial height (sd)	72	70.6	68.4	70.9	69.9	72.1	64.8	71.1
51. Orbital breadth	43	44.1	41.7	41.2	39.6	40.5	40.2	41.1
52. Orbital height	33.5	34.1	32.9	33.6	31.4	34.8	32.9	33.9
54. Nasal breadth	26	26.8	26.6	26.5	25.2	26.8	26.1	24.7
55. Nasal height	55	51.7	49.5	50.9	50.3	52.4	47.8	51.5

Table 7. Comparison of the measurements in humerus (male)

Site/Group	Tevsh	Xinghong[1]		Zhouzhuang[1]		Tuchengzi[2]		Kashahu[3]		Beiqian[4]		Dinggong[5]		Weidun[6]		Tsukumo[7]		NK-Y[8]		Kyushu[9]	
Region	Outer Mongolia	Henan		Henan		Inner Mongolia		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Eatern Zhou		Eatern Zhou		Eastern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	332	18	311.3	6	315.5	32	311.9	1	286.0	15	314.5	5	304.0	9	313.8	36	284.3	51	304.1	106	295.3
2. Total length	330	18	307.3	6	309.7	33	307.2	1	284.0	15	310.1	5	301.8	10	309.4	35	280.6	40	298.7	106	290.6
5. Maximum diameter of the mid-shaft	27	23	22.7	10	22.4	33	22.2	1	19.3	30	22.1	9	23.2	11	21.9	50	24.1	137	23.2	106	21.9
6. Minimum diameter of the mid-shaft	20	23	16.7	10	17.6	33	18.1	1	15.6	30	16.5	9	16.9	11	17.4	50	17.8	137	17.5	106	16.9
7. Least circumference of the shaft	72	25	61.8	15	63.2	33	68.3	1	53.0	34	58.4	7	60.7	11	60.5	50	64.0	147	63.8	106	61.8
6:5 Mid-shaft index	74.1	23	73.6	10	78.6	33	81.8	1	80.8	30	74.9	9	73.1	11	79.3	50	73.9	137	75.6	106	79.1
7:1 Index of robustness	21.7	18	19.8	6	20.0	32	21.9	1	18.5	15	18.5	5	19.9	9	19.4	36	22.7	50	21.0	106	20.9

1) Okazaki 2014, 2) Gu 2010, 3) Nakahashi et al. 2013, 4) Nakahashi et al. 2013, 5) Okazaki and Luan 2008, 6) Wakebe 2002, 7) Ikeda 1988, 8) Nakahashi and Nagai 1989,
9) Abe 1955; Inabe 1955; Sentou 1957; Mizoguchi 1957
Abbreviation: N, number of samples

Table 8. Comparison of the measurements in Humerus (female)

Site/Group	Daram	Tevsh	Xinghong		Zhouzhuang		Tuchengzi		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia	Outer Mongolia	Henan		Henan		Inner Mongolia		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Bronze Age	Eatern Zhou		Eatern Zhou		Eastern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	-	-	31	288.6	1	290.0	13	283.4	5	291.5	8	283.8	6	289.7	7	283.0	21	264.4	42	284.1	36	271.7
2. Total length	-	-	31	284.9	1	290.0	13	279.0	5	238.9	8	281.3	6	287.5	8	280.9	19	259.6	37	280.0	36	268.6
5. Maximum diameter of the mid-shaft	20	23	34	20.4	7	19.6	16	19.7	10	19.9	22	19.8	12	20.5	10	20.1	40	19.7	78	20.7	36	19.8
6. Minimum diameter of the mid-shaft	15	18	34	15.2	7	14.3	16	15.4	10	14.9	22	15.3	12	14.8	10	15.2	41	14.0	79	15.4	36	14.8
7. Least circumference of the shaft	55	63	38	55.2	7	54.1	16	60.4	7	54.7	22	52.0	11	54.7	10	54.7	42	53.9	96	56.5	36	54.8
6:5 Mid-shaft index	75.0	78.3	34	74.9	7	72.8	16	78.5	10	74.8	20	76.9	12	72.3	10	75.7	40	71.3	78	74.7	36	75.3
7:1 Index of robustness	-	-	31	19.2	1	18.6	13	21.2	5	18.8	7	17.2	6	19.2	7	19.0	21	20.4	42	19.6	36	20.2

Table 9. Comparison of the measurements in radius (male)

Site/Group	Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	258	13	244.3	3	243.0	2	242.0	11	241.5	3	241.0	3	253.7	27	230.6	64	236.7	64	219.9
2. Physiological length	242	13	229.6	3	228.0	2	228.5	12	229.8	3	225.0	3	239.0	28	217.4	52	221.1	64	208.2
3. Minimal circumference of the distal shaft	46	16	41.5	8	42.1	2	39.3	16	38.1	3	42.3	4	40.0	38	44.0	129	42.9	63	40.1
4. Maximum transverse shaft diameter	20	22	16.9	9	16.6	2	16.0	23	16.4	5	16.8	4	16.3	42	17.1	130	17.3	63	16.0
5. Sagittal shaft diameter	13	22	12.1	9	11.7	2	11.7	23	11.5	5	11.4	4	11.5	42	12.0	130	12.3	63	11.7
3:2 Length-circumference index	19.0	11	18.0	3	19.1	2	17.2	10	16.7	3	18.8	3	17.0	27	20.5	52	19.6	61	20.4
5:4 Shaft index	65.0	22	71.8	9	71.3	2	72.8	21	69.5	5	68.0	4	71.2	42	70.2	130	71.4	60	71.4

Table 10. Comparison of the measurements in radius (female)

Site/Group	Daram	Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia	Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	-	230	18	220.8	1	223.0	3	230.0	5	225.6	5	224.8	2	222.0	24	208.2	38	217.3	12	199.9
2. Physiological length	-	216	17	207.8	1	212.0	4	214.3	5	215.6	5	211.2	4	210.0	26	196.4	31	206.8	12	187.0
3. Minimal circumference of the distal shaft	38	41	28	36.9	3	36.0	4	37.4	9	35.9	9	37.2	3	35.0	30	36.4	88	37.7	12	34.7
4. Maximum transverse shaft diameter	18	16	28	15.9	6	14.3	4	15.3	14	14.6	13	15.7	2	15.5	34	14.6	95	15.6	12	14.5
5. Sagittal shaft diameter	10	12	28	10.7	6	10.1	4	10.9	14	10.2	13	10.6	2	11.0	34	9.8	95	10.7	12	9.7
3:2 Length-circumference index	-	19.0	17	18.0	1	17.5	4	17.4	5	16.3	5	17.8	2	17.4	25	18.2	30	17.8	11	18.1
5:4 Shaft index	55.6	75.0	28	67.6	6	70.5	4	71.3	14	70.6	13	67.5	2	71.7	34	67.5	95	68.8	10	68.3

Table 11. Comparison of the measurements in ulna (male)

Site/Group	Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	283	9	266.3	2	265.5	1	255.0	8	268.1	3	258.7	2	263.5	19	249.1	38	256.8	62	236.2
2. Physiological length	247	13	235.3	2	232.0	1	230.0	10	240.4	4	231.5	2	236.0	25	219.7	36	225.6	64	209.2
3. Least circumference of the shaft	40	11	35.8	2	39.0	1	35.0	16	35.7	4	37.9	4	33.5	34	37.7	98	37.7	65	35.8
11. Dorso-Volar shaft diameter	16	22	13.2	13	13.5	1	13.6	25	13.6	5	13.5	4	13.0	50	14.3	149	13.2	63	12.8
12. Transverse shaft diameter	17	22	15.7	13	16.5	1	14.4	25	16.0	5	15.0	4	15.5	50	16.3	149	17.5	64	16.5
3:2 Length-circumference index	16.2	11	15.3	2	16.8	1	15.2	10	15.0	4	16.4	2	13.6	25	17.4	36	17.0	63	17.0
11:12 Shaft index	94.1	22	84.0	13	81.5	1	94.4	25	85.3	5	90.4	4	84.4	50	88.5	149	76.0	63	74.9

Table 12. Comparison of the measurements in ulna (female)

Site/Group	Daram		Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M4B	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	-	-	249	14	241.9	1	243.0	3	251.0	3	230.0	3	239.0	1	239	12	227.2	30	236.8	12	215.0
2. Physiological length	-	-	223	18	214.1	2	215.5	4	219.0	4	212.5	4	211.0	1	211	12	198.6	33	207.9	12	189.2
3. Least circumference of the shaft	-	-	38	20	32.5	2	32.5	4	33.0	8	32.3	5	33.8	1	33	24	32.8	64	34.3	12	32.1
11. Dorso-Volar shaft diameter	12	11	14	36	11.3	5	11.0	4	13.5	15	11.8	13	11.4	1	12	37	11.3	95	11.3	12	10.9
12. Transverse shaft diameter	16	17	15	36	14.6	5	13.0	4	15.1	14	13.9	13	13.7	1	14	37	13.6	95	15.8	12	13.9
3:2 Length-circumference index	-	-	17	18	15.2	2	15.1	4	15.0	3	15.4	4	16.4	1	15.6	12	16.4	32	16.4	12	16.8
11:12 Shaft index	75.0	64.7	93.3	36	78.5	5	85.7	4	89.9	14	85.2	13	84.7	1	85.7	37	83.5	95	71.7	12	77.5

Table 13. Comparison of the measurements in femur (male)

Site/Group	Tevsh		Xinghong		Zhouzhuang		Tuchengzi		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Henan		Henan		Inner Mongolia		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Eatern Zhou		Eatern Zhou		Eastern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	M5	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	480	-	24	439.9	16	442.1	40	434.3	6	428.1	23	447.5	9	447.7	12	439.5	19	414.1	97	432.2	59	406.5
2. Oblique length	477	-	22	437.3	16	439.1	39	429.9	6	425.3	21	440.7	8	443.5	12	436.2	19	411.0	44	430.7	59	403.2
6. Sagittal diameter of the mid-shaft	35	33	27	29.4	47	29.5	44	29.4	15	28.0	50	29.1	9	27.9	19	29.9	47	29.0	234	29.5	59	26.5
7. Transverse diameter of the mid-shaft	29	29	27	27.9	47	27.8	44	27.7	15	27.6	50	26.5	9	26.6	19	26.8	47	26.0	238	27.8	59	25.6
8. Circumference of the mid-shaft	100	95	27	89.7	46	89.9	44	91.2	15	87.1	49	87.6	9	86.3	19	89.5	47	87.4	233	90.2	59	82.4
9. Transverse subtrochanteric diameter	35	-	22	32.3	25	32.4	44	32.8	6	33.8	41	30.8	9	30.6	18	31.1	43	30.7	189	32.6	59	29.4
9′. Maximum subtrochanteric diameter	-	-	25	33.2	36	32.9	-	-	14	34.7	-	-	9	31.3	-	-	50	31.7	-	-	-	-
10. Sagittal subtrochanteric diameter	31	-	22	25.5	25	26.0	44	25.4	6	23.5	42	26.2	9	24.9	18	26.1	43	25.5	189	26.1	59	24.3
10′. Minimum subtrochanteric diameter	-	-	25	24.9	36	25.0	-	-	14	22.6	-	-	9	24.0	-	-	49	24.3	-	-	-	-
8:2 Length-circumference index	21.0	-	20	20.3	14	20.7	39	-	6	20.3	20	19.6	8	19.7	12	21.2	19	21.2	44	20.9	59	20.4
6:7 Pilastric index	120.7	113.8	27	105.6	47	106.7	44	105.7	15	101.8	50	109.9	9	105.3	19	112.3	47	111.8	234	106.8	59	103.8
10:9 Platymeric index	88.6	-	22	79.3	25	80.4	44	77.8	6	69.5	41	85.0	9	81.4	18	84.2	43	83.1	189	80.3	58	82.8
10′:9′ Platymeric index	-	-	25	75.4	36	76.3	-	-	14	65.3	-	-	9	76.7	-	-	49	76.7	-	-	-	-

Table 14. Comparison of the measurements in femur (female)

Site/Group	Daram		Tevsh	Xinghong		Zhouzhuang		Tuchengzi		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Outer Mongolia	Henan		Henan		Inner Mongolia		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Bronze Age	Eatern Zhou		Eatern Zhou		Eastern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M4B	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	-	-	-	28	412.5	4	407.5	20	400.0	13	409.5	10	421.5	9	417.2	10	403.2	22	388.2	64	404.7	13	380.1
2. Oblique length	-	-	-	28	406.9	4	402.5	20	394.8	13	405.8	10	416.2	9	411.9	10	399.4	22	381.7	37	400.5	13	375.9
6. Sagittal diameter of the mid-shaft	25	27	27	43	25.1	24	25.0	20	25.1	25	24.7	25	25.9	15	24.9	13	25.0	45	25.2	162	25.7	13	23.6
7. Transverse diameter of the mid-shaft	31	26	27	43	26.7	24	26.5	20	25.3	25	26.3	25	24.0	15	26.7	13	25.2	45	24.2	162	26.3	13	23.2
8. Circumference of the mid-shaft	86	82	86	43	80.9	24	80.7	20	80.9	25	79.6	25	75.5	15	81.3	13	77.9	45	78.0	161	81.3	13	74.2
9. Transverse subtrochanteric diameter	34	-	34	38	30.3	13	30.5	20	29.3	15	31.9	23	27.6	13	30.2	12	28.3	42	28.4	136	30.7	13	27.5
9′. Maximum subtrochanteric diameter	-	-	-	42	30.7	20	29.8	-	-	22	33.5	-	-	14	31.0	-	-	48	29.4	-	-	-	-
10. Sagittal subtrochanteric diameter	23	-	23	38	22.8	12	22.0	20	21.8	15	21.3	23	23.1	13	22.7	12	23.3	42	22.2	136	23.2	13	21.3
10′. Minimum subtrochanteric diameter	-	-	-	42	22.1	19	21.6	-	-	22	20.2	-	-	14	21.8	-	-	47	21.5	-	-	-	-
8:2 Length-circumference index	-	-	-	28	20.0	4	19.8	-	-	13	19.6	10	18.3	9	20.0	10	19.6	21	20.3	37	20.3	13	19.8
6:7 Pilastric index	82.0	103.8	100.0	43	94.6	24	94.7	20	99.8	25	94.1	25	108.1	15	93.5	13	99.7	45	104.5	162	98.0	13	102.0
10:9 Platymeric index	67.6	-	67.6	38	75.6	12	72.6	20	74.4	15	66.8	23	83.9	13	75.3	12	82.5	42	78.2	136	75.7	13	77.1
10′:9′ Platymeric index	-	-	-	42	72.0	19	71.0	-	-	22	60.6	-	-	14	70.3	-	-	47	73.0	-	-	-	-

Table 15. Comparison of the measurements in tibia (male)

Site/Group	Tevsh		Xinghong		Zhouzhuang		Tuchengzi		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Henan		Henan		Inner Mongolia		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Eatern Zhou		Eatern Zhou		Eastern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	M5	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Total length	372	-	16	359.6	13	358.5	20	336.8	13	350.6	14	358.0	4	364.5	10	353.1	20	340.0	46	347.6	61	320.3
1a. Maximum length	381	-	16	365.1	12	361.4	20	358.3	13	355.8	15	362.0	4	368.5	11	359.1	22	343.6	73	352.3	60	326.9
8. Maximum diameter of the mid-shaft	36	34	20	32.1	27	31.6	21	29.7	15	30.0	43	30.8	6	32.5	14	31.6	46	32.3	110	31.5	61	27.8
8a. Maximum diameter of the nutrient foramen level	40	-	23	36.0	28	36.3	21	34.8	16	34.3	41	34.7	5	35.9	10	35.7	38	35.2	213	36.3	60	30.6
9. Transverse diameter of the mid-shaft	25	22	20	22.0	26	23.1	21	21.7	15	21.8	44	21.3	6	22.3	14	21.5	46	20.4	111	22.7	61	21.1
9a. Transverse diameter of the nutrient foramen level	27	-	24	24.0	27	24.8	21	23.2	16	22.5	41	23.6	5	25.2	11	23.5	38	22.2	212	25.3	61	23.7
10. Circumference of the mid-shaft	96	87	20	85.3	23	85.7	-	-	15	81.5	41	80.5	5	86.9	14	83.3	45	84.5	110	85.6	62	78.4
10b. Minimum circumference of the shaft	81	-	22	77.9	28	76.8	21	80.2	14	75.3	33	72.6	5	79.4	13	75.0	41	76.7	185	77.4	60	71.3
9:8 Mid-shaft index	69.4	64.7	20	68.8	26	73.6	21	73.4	15	72.6	34	69.4	6	68.8	14	68.3	46	63.3	110	72.5	61	76.1
9a:8a Cnemic index	67.5	-	23	67.1	27	68.5	-	-	16	65.5	32	68.2	5	70.2	10	66.0	38	63.0	211	69.7	60	77.5
10b:1Length-circumference index	21.8	-	14	21.5	12	21.7	-	-	13	21.3	11	20.4	4	21.8	10	21.1	20	22.9	45	22.2	60	22.4

Table 16. Comparison of the measurements in tibia (female)

Site/Group	Daram		Tevsh	Xinghong		Zhouzhuang		Tuchengzi		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Outer Mongolia	Henan		Henan		Inner Mongolia		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Bronze Age	Eatern Zhou		Eatern Zhou		Eastern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M4B	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Total length	-	-	331	26	332.9	4	321.0	12	306.7	16	327.6	3	328.3	10	334.1	9	327.2	17	319.8	40	325.6	14	301.0
1a. Maximum length	-	-	338	26	337.3	4	324.5	12	325.8	16	332.3	4	329.5	10	337.7	9	330.4	17	324.4	53	330.0	14	306.6
8. Maximum diameter of the mid-shaft	32	25	30	29	28.0	8	27.2	12	25.7	26	27.1	20	27.2	13	27.9	10	26.1	42	27.3	77	26.9	14	24.7
8a. Maximum diameter of the nutrient foramen level	34	30	34	36	30.7	8	30.1	12	29.8	24	30.4	18	29.6	12	31.4	10	30.2	37	30.5	139	30.7	14	28.1
9. Transverse diameter of the mid-shaft	22	19	20	29	19.2	8	19.7	12	18.4	26	19.2	20	19.4	13	19.5	10	18.8	42	17.9	77	19.8	14	18.8
9a. Transverse diameter of the nutrient foramen level	24	20	23	36	21.3	8	21.5	12	20.3	25	19.9	18	20.3	12	22.5	10	21.0	36	19.4	140	22.1	14	21.1
10. Circumference of the mid-shaft	-	71	78	29	74.2	7	75.0	-	-	26	72.8	20	71.2	13	74.5	10	72.2	42	73.4	76	73.8	14	70.1
10b. Minimum circumference of the shaft	75	67	69	33	68.3	8	66.0	12	71.0	24	68.3	9	67.1	13	68.3	10	65.2	35	67.6	126	68.2	14	63.6
9:8 Mid-shaft index	68.8	76.0	66.7	29	68.9	8	72.5	11	72.2	26	70.9	14	71.5	13	70.1	10	72.3	42	65.8	77	73.9	14	76.3
9a:8a Cnemic index	70.6	66.7	67.6	36	69.6	8	71.5	-	-	24	66.0	13	67.9	12	71.9	10	69.8	36	63.6	139	72.0	14	74.9
10b:1Length-circumference index	-	-	20.8	23	20.6	3	21.0	-	-	16	20.7	1	19.9	10	20.8	9	19.9	17	21.1	40	20.8	14	21.2

Table 17. Comparison of the measurements in fibula (male)

Site/Group	Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	-	10	356.0	2	378.0	7	340.6	4	358.5	1	360.0	1	364	13	329.5	22	345.2	58	322.9
2. Maximum diameter of the mid-shaft	16	13	15.6	6	17.8	14	14.9	23	16.0	2	17.5	2	15	44	17.8	80	17.0	59	14.5
3. Minimum diameter of the mid-shaft	12	13	11.9	6	11.9	14	11.1	23	11.7	2	11.3	2	13	44	12.2	80	11.5	59	10.0
4. Circumference of the mid-shaft	46	13	45.8	6	48.4	14	42.5	22	44.5	2	48.0	2	45	44	51.3	81	47.2	59	41.5
4a. Least circumference of the shaft	41	14	36.1	4	40.3	8	33.6	12	40.2	1	44.0	3	36	29	39.2	49	39.9	59	35.6
3:2 Mid-shaft index	75.0	13	76.3	6	67.7	14	74.5	18	75.2	2	64.5	2	86.5	44	68.6	80	68.1	59	69.5
4a:1 Length-circumference index	-	10	10.3	2	11.5	7	9.8	4	10.7	1	12.2	1	10.4	13	12.0	21	11.5	58	11.1

Table 18. Comparison of the measurements in fibula (female)

Site/Group	Daram		Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M4B	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
1. Maximum length	-	319	329	20	327.8	1	313.0	2	312.0	1	312	2	325.5	3	322.7	8	316.9	19	324.4	14	300.6
2. Maximum diameter of the mid-shaft	14	16	15	24	14.0	2	13.5	16	14.2	3	13.7	10	15.4	4	13.8	32	14.7	63	14.7	14	12.9
3. Minimum diameter of the mid-shaft	12	10	12	24	10.4	2	8.8	16	10.1	3	9.7	10	10.2	4	9.3	32	10.0	63	9.7	14	8.6
4. Circumference of the mid-shaft	44	44	46	23	40.3	2	37.3	16	39.9	3	37.7	10	43.0	4	38.3	32	42.8	62	40.9	14	36.8
4a. Least circumference of the shaft	39	37	40	20	33.4	1	31.0	3	30.7	3	33.3	4	36.5	3	33.7	20	34.0	29	36.9	14	32.3
3:2 Mid-shaft index	85.7	62.5	80.0	24	75.1	2	64.8	16	72.0	3	71.1	10	66.8	4	67.3	32	68.3	63	66.3	14	67.6
4a:1 Length-circumference index	-	11.6	12.2	20	10.2	1	9.9	2	10.0	1	10.9	2	11.2	3	10.4	8	11.0	19	11.5	10	10.8

Table 19. Comparison of the limb proportions (male)

Site/Group	Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M3	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
Brachial index	77.7	9	76.3	2	78.1	1	82.9	5	77.9	1	78.1	3.0	81.5	32	81.1	58	77.8	64	74.5
Crural index	80.0	14	82.6	10	81.2	4	80.7	9	81.4	4	81.4	8.0	81.9	21	83.0	85	81.5	59	80.4
Humerus-femur circumference index	68.6	24	69.0	11	70.9	1	71.1	30	67.1	1	69.3	9.0	68.8	49	73.2	190	70.7	59	75.0
Fibula-tibia circumference index	47.9	13	54.2	6	54.5	12	51.9	18	52.4	2	56.6	1.0	52.4	45	60.7	96	55.1	59	52.9

Table 20. Comparison of the limb proportions (female)

Site/Group	Daram		Tevsh	Xinghong		Zhouzhuang		Kashahu		Beiqian		Dinggong		Weidun		Tsukumo		NK-Y		Kyushu	
Region	Outer Mongolia		Outer Mongolia	Henan		Henan		Sichuan		Shandong		Shandong		Jiangsu		Japan		Japan		Japan	
Period	Bronze Age		Bronze Age	Eatern Zhou		Eatern Zhou		Bronze Age		Dawenkou		Longshan		Majiabin		Jomon		Yayoi		Modern	
Sample No.	M4A	M4B	M1	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave	N	Ave
Brachial index	-	-	-	16	77.0	1	76.9	2	75.9	1	81.6	3	75.4	2	79.1	23	78.7	40	76.5	12	73.6
Crural index	-	-	-	22	81.7	3	80.4	8	81.4	3	79.4	9	80.9	7	81.7	20	83.6	59	81.5	13	80.7
Humerus-femur circumference index	64.0	-	73.3	37	68.3	4	68.8	5	66.5	14	67.1	6	66.4	9	71.1	44	69.1	129	69.5	13	73.9
Fibula-tibia circumference index	-	62.0	59.0	21	54.1	2	54.0	15	54.2	3	54.7	9	58.6	3	53.1	37	58.3	69	55.4	14	52.5

Table 21. Comparison of the statures calculated by the maximum length of femur (male)

Site	Region	Period	Sample No.	N	M (cm)
Tevsh	Outer Mongolia	Bronze Age	M3	1	171.5
Xinghong[1)]	Henan	Eatern Zhou	Ave	24	164.0
Zhouzhuang[1)]	Henan	Eatern Zhou	Ave	16	164.4
Tuchengzi[2)]	Inner Mongolia	Eastern Zhou	Ave	40	163.0
Kashahu[3)]	Sichuan	Bronze Age	Ave	6	161.8
Beiqian[4)]	Shandong	Dawenkou	Ave	23	165.4
Dinggong[5)]	Shandong	Longshan	Ave	9	165.5
Weidun[6)]	Jiangsu	Majiabin	Ave	12	163.9
Tsukumo[7)]	Japan	Jomon	Ave	19	159.2
NK-Y[8)]	Japan	Yayoi	Ave	97	162.6
Kyushu[9)]	Japan	Modern	Ave	59	157.7

4 Carbon and nitrogen stable isotope ratios and radiocarbon ages on the skeletal remains from Daram and Tevsh Sites of the Bronze Age, Mongolia

1. Introduction

In order to determine the chronology of burial customs in the Bronze age of Mongolia, we have directly investigated a series of bone remains at the Daram and Tevsh sites. In general most bone have kept collagen in good preservation status and produced reliable data on stable carbon and nitrogen isotope ratios (δ^{13}C and δ^{15}N values, respectively) and radiocarbon (^{14}C) ages.

2. Materials and Methods

Ten bone samples from Daram Site and four bone samples from Tevsh Site were analyzed for extracting collagen and measurement stable carbon and nitrogen isotope ratios and radiocarbon ages. The collagen extraction was conducted by the following manner.

Collagen Extraction

We have conducted gelatinization to extract collagen (Longin et al. 1971; Yoneda et al. 2002).

1) Sandblasting and utrasonication in pure water for 10 min,
2) Removal of attached organic matters with 0.2 M NaOH soaking overnight,
3) Soaking with pure water overnight to remove acid,
4) After lyophilisation, sample was crashed into fine powder by a mortar and pestle,
5) Powder was sealed in cellulose tube and demineralized with 1.2 M HCL overnight at the temperature of 4°C,
6) Neutralization with pure water overnight at the temperature of 4°C,
7) Remaining organic matter was recovered by centrifugation and freeze-dried to weigh,
8) Organic matter was heated at 90°C in pure water overnight to extract gelatin,
9) Dissolved gelatin was purified by Watman GF/F filter and lyophilized.
10) The weight of extracted gelatin was recorded and fraction was applied for the following analyses.

Elemental and isotopic analyses

The concentration of carbon and nitrogen in gelatin was measured by Flash 2000 Elemental Analyzer and produced gases were introduced to a ConFloIII interface and measured for stable isotope ratios in carbon and nitrogen simultaneously using a Delta V isotope ratio mass spectrometer (Thermo Fisher Scientific, Germany). A half milligram of gelatin was weighed in a tin cup and measured with laboratory standards (e.g. alanine) which can be traced back to international standards (PDB for carbon and AIR for nitrogen). Typical uncertainties with carbon and nitrogen isotopic ratios were 0.1‰ in δ^{13}C and δ^{15}N notation.

Graphitization and AMS analysis

After evacuation, 2.5 mg of collagen was sealed in a dual quartz tube with CuO and Surfix and heated at 850°C for 3 hours to produce CO_2 (Minagawa et al. 1984). The CO_2 was cryogenically purified in a vacuum line and reacted at the temperature of 450°C for 8 hours with an excess amount (2.2 times of CO_2) of H2 with 2mg of iron powder catalysis in an isolated grass vessel with a stop cock (Kitagawa et al. 1993).

Produced graphite was pressed in Al holder for accelerator mass spectrometry (AMS) by Paleo Labo Co. Ltd. (Kobayashi et al. 2007). Some international standards were measured at the same time and δ^{13}C measured by AMS was applied to calculate the conventional radiocarbon date (Stuiver and Polach 1977).

3. Results

The extraction of gelatin which biologically consisted of collagen was conducted on 14 samples and we can obtain enough amount of gelatin. One

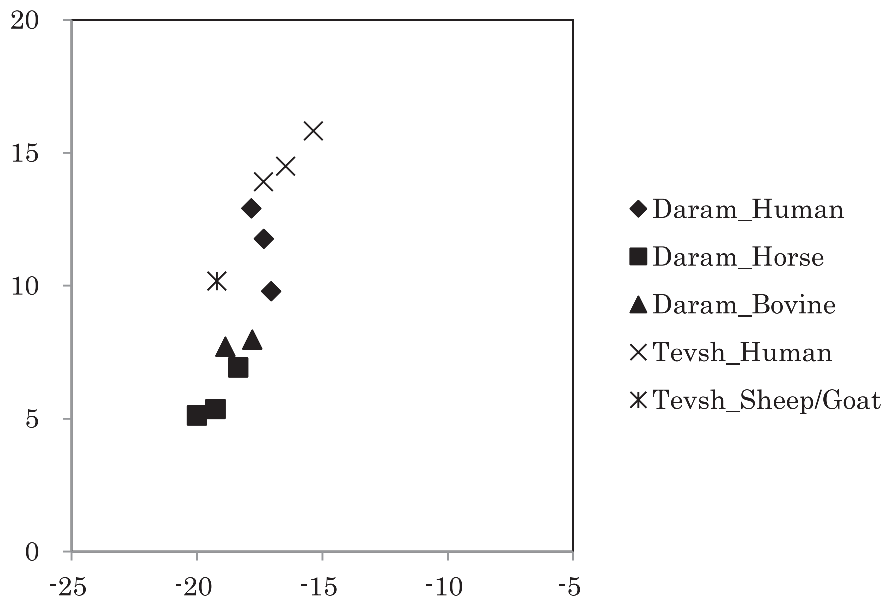


Fig.53 Stable carbon and nitrogen isotope ratios in human and animal from Mongolian Bronze age sites at Daram uul and Tevsh uul

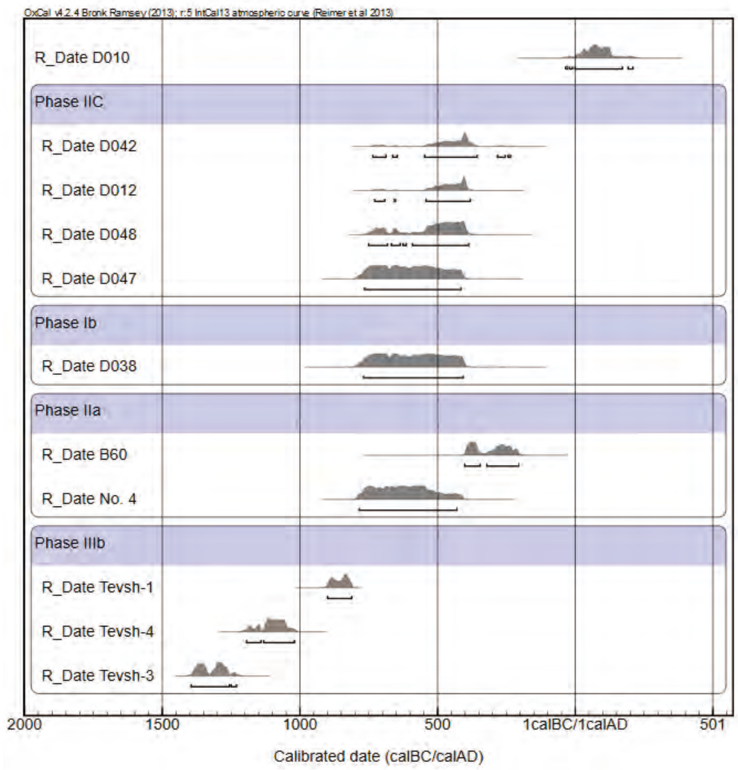


Fig.54 Calibrated radiocarbon ages for Daram uul and Tevsh uul sites

sample from Daram site (D023) did not produce enough gelatin for further analyses.

In general, the gelatin yield less than 1% empirically suggest the degradation of collagen (van Klinken 1999). The carbon concentration more than 13%, nitrogen concentration more than 4.8% and atomic C/N ratio between 2.9 and 3.6 were used as criteria for good preservation of collagen in gelatin (DeNiro 1985; van Klinken 1999). The elemental concentration and atomic C/N ratios show that all samples excepted for D021 from Daram site showed good results in relation to collagen preservation (Table 22). Hence, we analyzed 12 samples for stable isotopes and radiocarbon ages.

Stable carbon and nitrogen isotope ratios in collagen reflecting animals' protein sources were measured (Table 23). Figure 53 illustrated the general agreement with $\delta^{13}C$ values in cattle, horse and sheep/goat to C_3 consumer (around -22‰). Although human from both Daram and Tevsh Sites show similar to C_3 consuming animals in $\delta^{13}C$, their $\delta^{15}N$ values are higher than those of animals, suggesting they consumed substantial amount of animal meat as their protein source. Tevsh human show higher $\delta^{15}N$ than Daram human but we cannot discuss the difference in their meat consumption because a sheep/goat from Tevsh Site also showed relatively higher $\delta^{15}N$ value. We have to compare both two sites with more animal data in order to compare the difference in ancient human diet and ancient ecosystem themselves.

The conventional radiocarbon age (in year BP unit) on human and animals were shown Table 22 with one standard deviation error and calibrated into cal BP years with IntCal13 data set (Reimer et al. 2013) using a calibration software, OxCal4.1 (Bronk Ramsey 2009)(Table 23). The calibrated data shown in Figure 54 can be analyzed in light of Bayesian statistics with archaeological context in the future studies.

Table.22 Sample prepared and preservation status

Sample	Species		Site	Location	Yield (%)	%C	%N	C/N
D048	cattle	tooth	Daram uul	M1	6.0	45.8	16.4	3.3
B60	human	rib	Daram uul	M4 Burrial-A	2.3	45.9	16.2	3.3
D021	cattle	tooth	Daram uul	M41	0.9	45.4	14.3	3.7
No. 4	human	rib	Daram uul	M4 Burial-B	1.7	42.5	13.8	3.6
D010	cattle	horn core	Daram uul	-	3.4	55.2	17.3	3.2
D012	horse	molar	Daram uul	M1	3.7	55.2	15.5	3.6
D023	horse		Daram uul	M1	0.0	ND	ND	ND
D038	human?	unknown	Daram uul	M2	1.2	55.0	16.0	3.4
D042	horse	femur	Daram uul	M1cofine	1.9	54.9	16.2	3.4
D047	horse	incisor	Daram uul	M1cofine	7.9	54.8	17.3	3.2
No. 1	human	rib	Tevsh uul	Figured Grave 1	8.1	44.4	16.6	3.1
No. 2	sheep/goat	rib	Tevsh uul	Figured Grave 1 Layer 3	8.5	46.4	17.3	3.1
No. 3	human	rib	Tevsh uul	Figured Grave 1 Layer 3	7.4	43.5	16.4	3.1
No. 4	human	tibia	Tevsh uul	Figured Grave 5	0.6	42.3	14.5	3.4

Table.23 Result of isotope analyses and radiocarbon dating (uncalibrated)

Sample	Species	C/N	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	CRA (BP)	$\delta^{13}C$ w/AMS	Lab ID
D048	cattle	3.3	-17.8	8.0	2395 ± 50	(IRMS)	MTC-16081
B60	human	3.3	-17.3	11.8	2277 ± 43	(IRMS)	MTC-16082
D021	cattle	3.7	-16.5	7.5	2278 ± 42	(IRMS)	MTC-16083
No. 4	human	3.6	-17.8	12.9	2487 ± 50	(IRMS)	MTC-16084
D010	cattle	3.2	-18.9	7.7	1924 ± 41	(IRMS)	MTC-14191
D012	horse	3.6	-19.3	5.4	2368 ± 37	(IRMS)	MTC-14192
D023	horse	ND	ND	ND	ND		
D038	human?	3.4	-17	9.8	2455 ± 66	(IRMS)	MTC-14193
D042	horse	3.4	-20	5.1	2350 ± 46	(IRMS)	MTC-14194
D047	horse	3.2	-18.4	6.9	2465 ± 54	(IRMS)	MTC-14195
No. 1	human	3.1	-17.3	13.9	2706 ± 20	-18.1	PLD-23379
No. 2	sheep/goat	3.1	-19.2	10.2	348 ± 17	-20.1	PLD-23380
No. 3	human	3.1	-16.5	14.5	3050 ± 20	-17.2	PLD-23381
No. 4	human	3.4	-15.4	15.8	2912 ± 20	-16.7	PLD-23382

Table.24 Calibrated radiocarbon ages of graves

Sample	Species	C/N	Conventional ^{14}C age (BP)	Calibrated ^{14}C age (calBP; 1s=68.2%)	Calibrated ^{14}C age (calBP; 2s=95.4%)
D048	cattle	3.3	2395 ± 50	2652 (2.1%) 2645	2701 (15.3%) 2631
				2490 (66.1%) 2349	2618 (5.7%) 2585
					2576 (1.2%) 2563
					2541 (73.3%) 2339
B60	human	3.3	2277 ± 43	2348 (37.8%) 2304	2354 (44.2%) 2295
				2235 (30.4%) 2184	2270 (51.2%) 2155
No. 4	human	3.6	2485 ± 50	2716 (12.9%) 2676	2736 (95.4%) 2379
				2668 (4.1%) 2654	
				2644 (51.3%) 2490	
D010	cattle	3.5	1924 ± 41	1921 (5.7%) 1912	1985 (0.7%) 1979
				1900 (62.5%) 1824	1971 (1.5%) 1960
					1951 (91.0%) 1778
					1758 (2.3%) 1740
D012	horse	3.6	2368 ± 37	2436 (68.2%a) 2344	2678 (4.3%) 2642
					2607 (0.4%) 2603
					2492 (90.7%) 2331
D038	human?	3.5	2455 ± 66	2700 (19.9%) 2632	2719 (95.4%) 2357
				2617 (9.0%) 2585	
				2575 (2.8%) 2564	
				2540 (31.9%) 2424	
				2409 (1.1%) 2405	
				2394 (3.5%) 2380	
D042	horse	3.5	2350 ± 46	2456 (1.8%) 2451	2685 (5.1%) 2637
				2439 (66.4%) 2330	2613 (1.3%) 2596
					2497 (86.6%) 2306
					2232 (1.9%) 2204
					2194 (0.4%) 2185
D047	horse	3.4	2465 ± 54	2705 (23.3%) 2629	2715 (95.4%) 2365
				2620 (18.8%) 2555	
				2546 (25.5%) 2458	
				2446 (0.6%) 2444	
No. 1	human	3.1	2706 ± 20	2843 (25.9%) 2820	2849 (95.4%) 2762
				2800 (42.3%) 2768	
No. 2	sheep/goat	3.1	348 ± 17	462 (30.8%) 429	482 (41.3%) 423
				375 (37.4%) 325	396 (54.1%) 317
No. 3	human	3.1	3050 ± 20	3329 (32.0%) 3292	3345 (91.2%) 3206
				3255 (36.2%) 3215	3200 (4.2%) 3180
No. 4	human	3.4	2912 ± 20	3076 (68.2%) 3000	3144 (18.6%) 3091
					3082 (76.8%) 2969

5 Mitochondrial DNA analysis of the teeth samples excavated from Daram Site

Recent advances in molecular biological techniques have facilitated the recovery and analysis of DNA from ancient materials, thereby enabling an objective approach to studying the genetic composition of past populations. To understand the origin of past population, DNA analysis of ancient human remains is effective because it provides the genetic characteristics of these people. Also, they can help shed light on the relationships between these people and the present population. To clarify the genetic characteristics of Daram Site in Mongol, ancient DNA analysis was conducted on human skeletal remains excavated by the Kyushu University archaeological teams.

Materials and methods

Tooth enamel forms a natural barrier to exogenous DNA contamination. Furthermore, the DNA recovered from teeth appears to lack most of the inhibitors of the enzymatic amplification of ancient DNA. Therefore, two teeth samples (A and B) that excavated from grave No. 41 (fig. 27) were used in the present analysis.

DNA analyses were performed at the National Museum of Nature and Science, which are dedicated to ancient DNA analysis. We employed standard precautions to avoid contamination and negative extraction and PCR controls (Shinoda et al., 2006).

The tooth samples were dipped in a contamination removal solution for 5 min, rinsed several times with DNase-/RNase-free distilled water, and allowed to air dry. When the samples were completely dry, they were pulverized in a mill (Multi-beads Shocker MB400U; Yasui Kikai, Osaka, Japan).

DNA was extracted in 2 steps using a DNA extraction kit (Mo Bio Co.). The pulverized tooth powder (0.3 g) was placed in a 15-ml conical tube, and demineralized in 5 ml of EDTA 0.5M solutions. The samples were rotated and incubated at 37°C for 12-15 h. After the protainase K digestion (0.5mg/ml), remaining pellet was used for DNA extraction with the kit. Approximately 50 μl of the extracted DNA solution was obtained. The eluted DNA was amplified by PCR without further processing.

A segment of hypervariable region (HVR) 1 (nucleotide positions 16121 to 16238 and 16209 to 16402, relative to the revised Cambridge reference sequence; Andrews et al., 1999) were sequenced both samples. Two-microliter aliquots of the extracts were used as the templates for PCR. Amplifications were carried out in a total reaction volume of 25 μl containing one unit of Taq DNA polymerase (HotStarTaqTM DNA polymerase; QIAGEN), 0.1 μM of each primer, and 100 μM of dNTPs in 1× PCR buffer provided by the manufacture. The conditions for PCR were as follows: incubation at 95°C for 15 min; 40 cycles at 94°C for 20 s, 50°C -56°C for 20 s, 72°C for 15 sec; and final extension at 72°C for 1 min.

The primers used to amplify the regions described above are same as Shinoda et al. 2008. The PCR products were recovered from 1.5% agarose gel using a QIAEX II Agarose Gel Extraction kit (Qiagen, Germany), and the aliquot were prepared for sequencing using forward and reverse primers and a BigDye Cycle Sequencing Kit (Applied Biosystems, Foster City, CA, USA). The same primers used for generating the PCR product were also used in the sequencing reaction. Sequencing was done in both directions so as to make it possible to check for polymorphisms or ambiguous bases detected with one primer. All sequencing reactions were analyzed using a model 3130 DNA Sequencer with SeqEd software.

Results and discussion

Among the two samples considered in this study, ancient DNA was successfully amplified from sample A. It has mutation sites of 16223,16290, 16319 and 16362 (Table 25).Sample B failed to yield a product on amplification. Haplogroup of the sample A were decided according to variations in HVR1 sequences of mtDNA. This sample belongs to haplogroup A.

Haplogroup distribution of mtDNA often shows the spatial frequency patterns (Forster 2004). In modern Asian populations, haplogroup A,C,D,G,Y and Z have high frequencies in northeast populations, whereas in southeast Asians C,Y or Z have rarely been found, but instead haplogroup B and F are predominant (Kivisild et al. 2002). It is said that only a restricted number of major subhaplogroups of M and N, (namely, G, M8, M9, A, and N9) may be of central or northern Asia provenance. Among these, haplogroup A is one of the most common haplogroup observed in the present-day Mongolia and Siberian populations. So, it is safety said that the buried people was originated not from Southeast Asia but northeast Asia.

Table.25 D-loop sequences of the Durham A sample

	16121	tattgtacgg	taccataaat	acttgaccac	ctgtagtaca	taaaaaccca
A		....	....	....	....	....
	16171	atccacatca	aaaccccctc	cccatgctta	caagcaagta	cagcaatcaa
A		....	....	....	....	....
	16221	ccctcaacta	tcacacatca	actgcaactc	caaagccacc	cctcacccac
A		..t.......	....	....	....	....
	16271	taggatacca	acaaacctac	ccacccttaa	cagtacatag	tacataaagc
A		....	.........t	....	....	........a.
	16321	catttaccgt	acatagcaca	ttacagtcaa	atcccttctc	gtccccatgg
A		....	....	....	....	....
	16371	atgaccccc	tcagataggg	gtcccttgac		
A		....	c.........	....		

Numbers indicates the revised Cambridge reference sequence (CRS)
"." indicates identical to the revised Cambridge reference sequence.

6 The Strontium analysis on the human skeletal remains of the Bronze Age from Tevsh Site in the southern Khangai, Mongol

Introduction

Recently, strontium (hereafter Sr) isotope analysis in archaeological skeleton has been established as one of the most effective method to examine prehistoric human mobility (e.g. Bently et al. 2004; Bently 2006). Ericson (1985) first introduced the method that could measure Sr isotopes in the teeth and bones of archaeological human skeletons.

The theoretical basis is that the Sr isotope ratios (hereafter $^{87}Sr/^{86}Sr$) are conveyed from weathering rocks, through the soil and water, into food chain. Animals that eat the plants growing in those soils and drink water acquire the $^{87}Sr/^{86}Sr$ ratio peculiar to the rock. As a result, humans that eat animals and plants and drink water acquire $^{87}Sr/^{86}Sr$ ratio of local. Because Sr is a high-mass element, the mass difference between the two isotopes is relatively small, and fractionation in $^{87}Sr/^{86}Sr$ ratio can be ignored (Blum et al., 2000). In human, tooth enamel is formed without remodeling in one's childhood. The $^{87}Sr/^{86}Sr$ ratio in tooth enamel is a signature of Sr from a person's childhood habitat. Therefore, the $^{87}Sr/^{86}Sr$ ratios in tooth enamel reflect the geographical origin.

Sr isotope analysis has usually been performed using thermal ionization mass spectrometry (TIMS) which is applicable for solution of the samples. All samples were dissolved to analyze it. The third molar was used for these analyses, because there was little influence on morphological researches. The advent of laser-ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) provides the possibility to measure Sr isotope variations with less damage to the samples than TIMS (Porhaska et al. 2002; Horstwood et al. 2008). Due to the character of less damage, LA-MC-ICP-MS enables the analysis of any tooth type, not only the third molar. Particularly, analysis of incisor can examine Sr isotope variations obtained during the lactation period, while the third molar is generally formed from 9 years old to 13 years old (Hillson 1996). The analysis that all age stage during human dental formation (Hillson 1996) is enabled provides more detailed examination to human mobility. The $^{87}Sr/^{86}Sr$ ratio during the lactation period is considered to be less fluctuation of the value with dietary than the value during the weaning. Hence, it is possible that $^{87}Sr/^{86}Sr$ ratios from the incisor more directly reflect Sr isotope ratios from person's childhood geological habitat than those from the third molar.

This document reports the results of Sr isotope analyses about the Tevsh tooth samples using LA-MC-ICP-MS. We examined difference of geographical origin between individuals excavated from the Tevsh sites.

Materials and Method

For this study, we used samples from lateral and central incisors of individuals from Tevsh Site and Chandman Khar Site. Table26 shows the details of individuals analyzed. The morphological analysis on the human skeletal from Tevsh Site is reported by Okazaki et al. in this book. The biological sex in Burial No.1 individual (No.1) is female and age range the first half of forty. The biological sex in Burial No.3 individual (No.3) is male and age range the first half of forty. The morphological characters on the human skeletal remains from Chandman Khar Site are unidentified at present. In this study, the human skeletal remains from Chandman Khar Site were used for comparison. In individuals analyzed from Tevsh Site, the odontogenesis age of the analysis point is regarded as 1-2 years old (Hillson 1996).

We used MC-ICP-MS (Thermo Scientific Neptune Plus) combined with LA system (Photon Machine AnalyteG2 Excimer laser) installed at Kyushu University, Japan. First, the state of analysis part was observed using an optical microscope in order to avoid weathered portion. The surface of teeth was polished from 3mm to 7mm using dental engine to make flat plane and to obtain the stability of the signal. . Second, isotopic analyses were performed using LA-MC- ICP-MS. $^{87}Sr/^{86}Sr$ and $^{43}Ca/^{88}Sr$ ratios were calculated based on data correction protocols described by Horstwood et al. (2008). Finally, the observation of the analysis traces was carried out using scanning electron microscope (SEM, Keyence VHX-D500). The analysis carried out for each individual five times.

Because, main ingredient of teeth is apatite ($Ca_5(PO_4)_3(F,Cl,OH)_2$), the concentration of Ca is approximately constant. By checking $^{43}Ca/^{88}Sr$, content of Sr was measured.

Results

The results and weighted average values are presented in Table26. Figure55 and figure 56 show $^{87}Sr/^{86}Sr$ ratios and $^{43}Ca/^{88}Sr$ ratios, respectively. The analysis No.3 of burial No.1 from Tevsh Site was excluded from this calculation because it was outlier.

The $^{87}Sr/^{86}Sr$ ratios in the Tevsh No.1 is 0.71295±0.00040, varying in the range of 0.71259 - 0.71314. The $^{87}Sr/^{86}Sr$ ratios in the Tevsh No.3 is 0.71140±0.00055, varying in the range of 0.71085 0.71184. As shown in Figure55, there is a difference in $^{87}Sr/^{86}Sr$ values between burial No.1 and No.3 from Tevsh Site. In the case of the Tevsh No.1, the variation of $^{43}Ca/^{88}Sr$ ratio is slightly large (Fig.56). The ^{43}Ca values of all individuals that were analyzed are high. It means that Sr concentration is low. Hence, it is thought that the variation of $^{43}Ca/^{88}Sr$ ratio in the Tevsh No.1 have little influence on $^{87}Sr/^{86}Sr$ ratios.

On the other hand, the $^{87}Sr/^{86}Sr$ ratios of each individual from Chandman Site don’t have the clear difference. The $^{87}Sr/^{86}Sr$ ratios in the Chandman No.6 is 0.71030±0.00075, varying in the range of 0.70979 - 0.71125. The $^{87}Sr/^{86}Sr$ ratios in the Chandman No.10 is 0.71026±0.00053, varying in the range of 0.70922 - 0.71056. The $^{87}Sr/^{86}Sr$ ratios in the Chandman No.12 is 0.71017±0.00058, varying in the range of 0.70956 -0.71079. The $^{87}Sr/^{86}Sr$ ratios in the Chandman No.26 is 0.70928±0.00063, varying in the range of 0.70841 - 0.70980.

Discussions

The results confirm that the difference of $^{87}Sr/^{86}Sr$ ratios between the Tevsh No.1 and No.3 is clear. The difference may mean geological difference. On the otherhand, the differences of $^{87}Sr/^{86}Sr$ ratios among individuals from chandman Site is small. We interpret the result as difference in childhood habitat between No.1 and No.3 from Tevsh Site. On the other hand, the differences of $^{87}Sr/^{86}Sr$ ratios amang individuals from Chandman Site is small. It is difficult to determine where each individual childhood only from strontium isotopes, because the Mongolian geological feature is complicated. As for both individuals, the odontogenesis age estimated by analysis point is regarded as 1-2 years old. Therefore, when they were 1-2 years old each, the places where they were brought up are different, even if it was wherever.

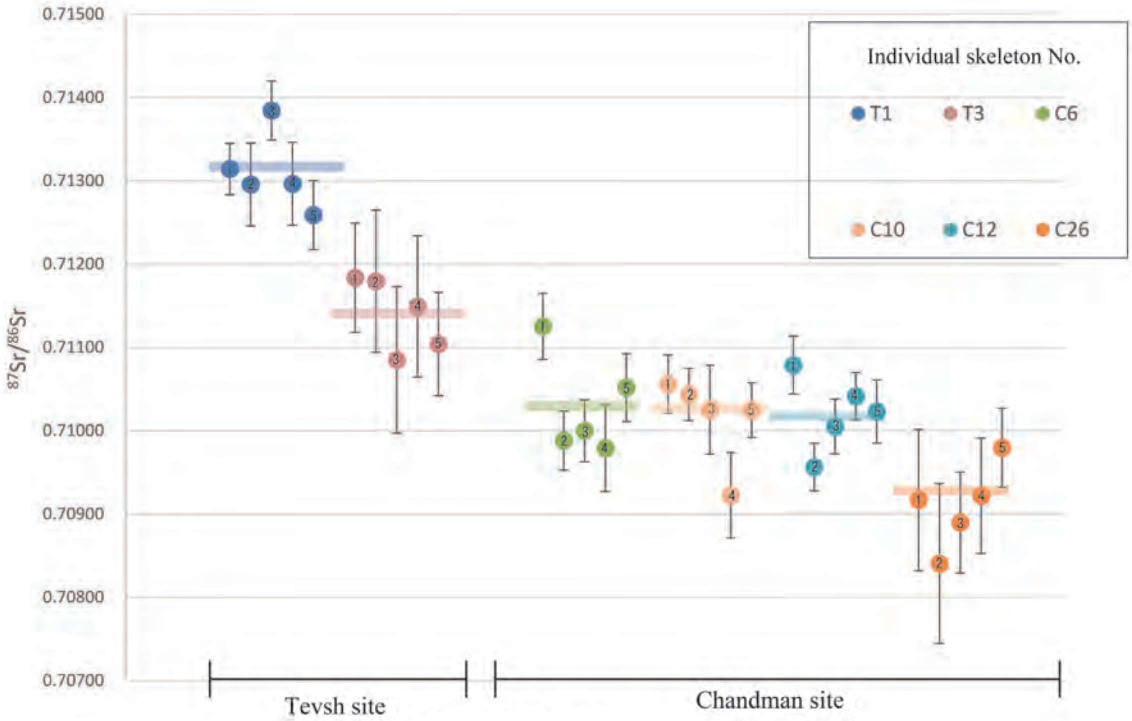
Conclusions

We investigates the possibility of mobility in individuals who were buried in Tevsh Site. The strontium isotopes result indicated that there is a difference in $^{87}Sr/^{86}Sr$ ratios between the Tevsh No.1 and No.3. The results suggested that the geographic origins are difference between the Tevsh No.1 and No.3 who were buried in the same sites. Because the C14 dates when they belong are different, this interpretation will not have the big contradiction.

Table.26 Characters, $^{87}Sr/^{86}Sr$ ratio and $^{43}Ca/^{88}Sr$ ratio of human skeletal remains who were analyzed in this study

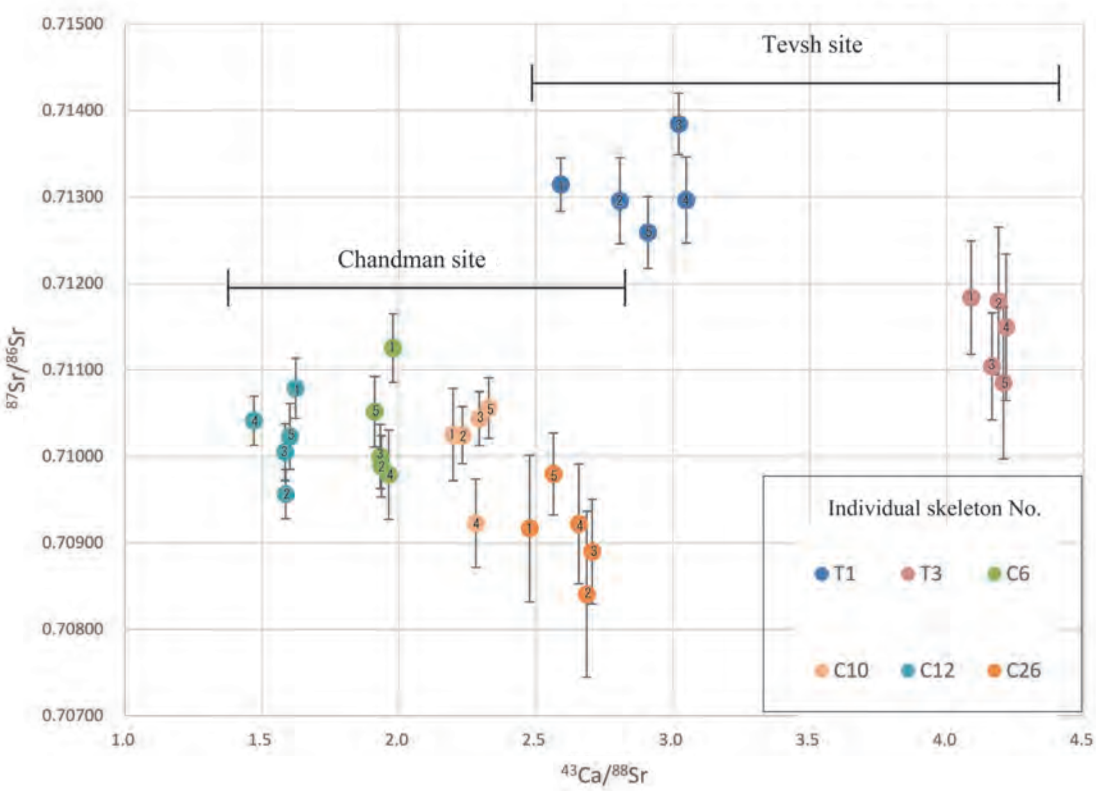
Site name	Burial No.	Individual skeleton No.	Teeth type	Age estimated by Analysis point	Analysis No.	$^{87}Sr/^{86}Sr$	StdErr (2σ)		$^{43}Ca/^{88}Sr$	The weighting mean $^{87}Sr/^{86}Sr$ except th eoutlier	MSWD	Calibrated Date
Tevsh Uul	No.1	T1	LLI_1	1-2years old	1	0.71314	0.00031		2.5910	0.71295± 0.00040	1.5	901BC(95.4%) 812BC
					2	0.71296	0.00050		2.8070			
					3	0.71384	0.00036	*	3.0216			
					4	0.71296	0.00050		3.0495			
					5	0.71259	0.00041		2.9097			
Tevsh Uul	No.3	T3	LLI_1	1-2years old	1	0.71184	0.00066		4.0891	0.71140± 0.00055	1.4	1392BC(95.4%)1264BC
					2	0.71180	0.00085		4.1888			
					3	0.71085	0.00088		4.2074			
					4	0.71149	0.00085		4.2166			
					5	0.71104	0.00062		4.1657			
Chandman	No.6	C6	RUI^1	3-4years old	1	0.71125	0.00040		1.9792	0.71030± 0.00075	9.0	43BC(95.4%)54AD
					2	0.70988	0.00035		1.9360			
					3	0.71000	0.00037		1.9327			
					4	0.70979	0.00052		1.9634			
					5	0.71052	0.00041		1.9116			
Chandman	No.10	C10	RUI^2	4-6years old	1	0.71056	0.00035		2.3285	0.71026± 0.00053	5.2	-
					2	0.71044	0.00031		2.2943			
					3	0.71025	0.00053		2.1983			
					4	0.70922	0.00051		2.2809			
					5	0.71025	0.00033		2.2327			
Chandman	No.12	C12	RUI^1	4-5years old	1	0.71079	0.00035		1.6230	0.71017± 0.00058	8.6	-
					2	0.70956	0.00028		1.5867			
					3	0.71005	0.00033		1.5853			
					4	0.71041	0.00028		1.4713			
					5	0.71023	0.00038		1.6025			
Chandman	No.26	C26	RUI^1	4-5years old	1	0.70917	0.00085		2.4779	0.70928± 0.00063	2.4	1493AD(76.1%)1603AD 1615AD(19.3%)1643AD
					2	0.70841	0.00096		2.6863			
					3	0.70890	0.00061		2.7062			
					4	0.70922	0.00069		2.6572			
					5	0.70980	0.00047		2.5649			

* indicate the outlier value



The numbers in these circles indicate the analysis No in table26. Bold bar indicate the weighted average Sr ratio of each skeleton.

Fig.55 $^{87}Sr/^{86}Sr$ ratio



The numbers in these circles indicate the analysis No in table26.

Fig.56 $^{43}Ca/^{88}Sr$ ratio

7 Substance identification of the beads at the stone-slab grave from Daram Site, Khentii province, Mongolia

1. INTRODUCTION

Substance identification of the archaeological remains reveals their constituent materials, such as rock, mineral, glass and so on, and provides a clue for their places of origin. In this report, we performed several instrumental analyses on the beads at the stone-slab grave from Daram Site, Khentii province and show what kind of materials comprise them.

2. MATERIAL AND METHODS

Tubular bead and round bead, which were excavated at the No. 4 stone-slab grave from the Daram Site, Khentii province, Mongolia, were analyzed in this study.

The tubular bead (Fig. 57a) is 11 mm long and 7 mm in diameter. This sample shows mat whitish color and comprises fine grained materials. The sample was embedded in epoxy resin and was polished using diamond paste in order to expose flat surface. Chemical compositions of this tubular bead were analyzed using scanning electron microscope (SEM, JEOL JSM -5310S) equipped with energy dispersive X-ray spectrometer (EDS, JEOL JED-2100) installed at Kyushu University.

The round bead (Fig. 57b) is 10 mm long and 8 mm in diameter and show glossy reddish color with whitish spots. This sample was analyzed using Raman spectrometer (JASCO NRS-3100) in order to identify the constituent materials of this bead with non-destructive analytical technique.

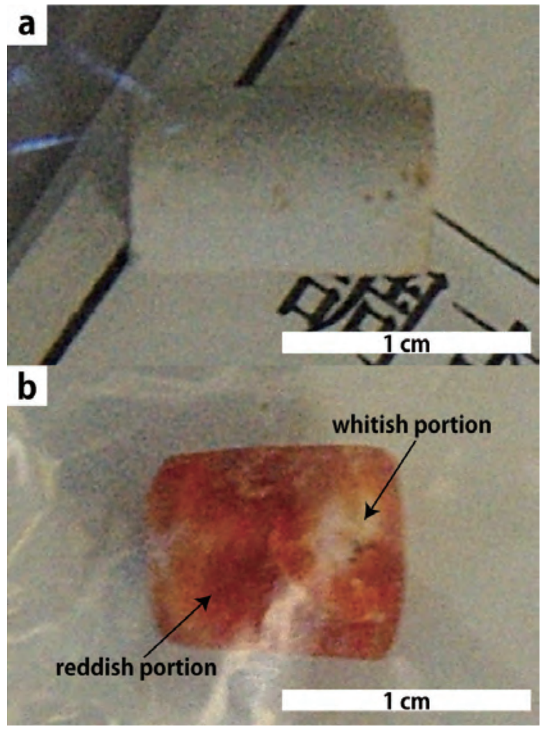


Fig.57 Photos of the beads analyzed in this report. (a) Tubular bead. (b) Round bead

3. RESULT

3-1. Tubular bead

The back scattered electron (BSE) image of the sample (Fig. 58) shows a homogeneous brightness except for small pits or holes. Because a difference of the BSE brightness reflects a difference in average atomic number of the materials, the homogeneous brightness of the sample indicates that it comprises mostly single substance. The chemical compositions obtained from three spots in the tubular bead are consistent with talc ($Mg_6Si_8O_{20}(OH)_4$, Table 27).

3-2. Round bead

This sample shows heterogeneity on the basis of the color. Raman spectra were obtained from reddish portion and whitish portion (Fig. 59).

Spectrum obtained from the reddish portion shows sharp peak at ca. 465 cm^{-1}. Spectrum from the whitish portion also shows peak at ca. 465 cm^{-1} and additional peak at ca. 502 cm^{-1}.

The spectrum with sharp single peak at ca. 465 cm^{-1} is characteristics of quartz (SiO_2, spectrum 3 in Fig. 59), therefore main constitute of the reddish portion is interpreted to be quartz. A sharp peak at ca. 465 cm^{-1} of spectrum from the whitish portion is also interpreted to belong to quartz. An additional small peak at ca. 502 cm^{-1} is consistent with that of moganite (spectrum 1 in Fig. 59). Moganite is a monoclinic

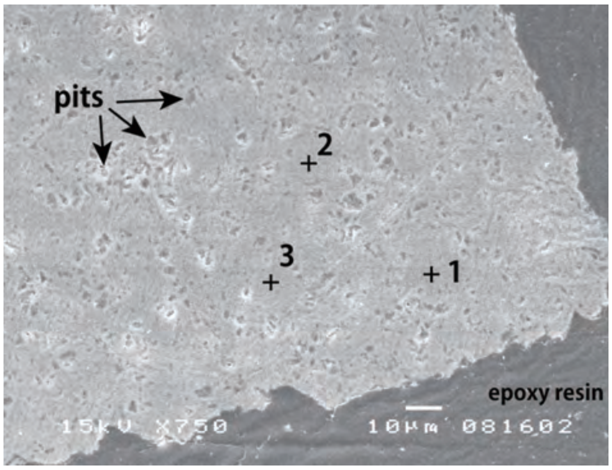


Fig.58 BSE image of the tubular bead. Analyzed points are also shown

Table.27 Chemical compositions obtained from the tubular bead

Point No.	1	2	3
SiO_2	62.69	63.01	63.21
TiO_2	0.00	0.00	0.00
Al_2O_3	0.00	0.18	0.86
Cr_2O_3	0.55	0.55	0.03
FeO	1.01	0.00	0.00
MnO	0.00	0.34	0.26
MgO	30.99	30.44	29.66
CaO	0.00	0.00	0.30
Na_2O	0.00	0.00	0.35
K_2O	0.00	0.16	0.09
total	95.24	94.68	94.76
O	22	22	22
Si	7.98	8.04	8.03
Ti	0.00	0.00	0.00
Al	0.00	0.03	0.13
Cr	0.03	0.03	0.00
Fe	0.11	0.00	0.00
Mn	0.00	0.04	0.03
Mg	5.88	5.78	5.62
Ca	0.00	0.00	0.04
Na	0.00	0.00	0.09
K	0.00	0.03	0.01
cation total	13.99	13.94	13.95

polymorph of SiO_2, i.e., it has same chemical composition as quartz but has a different mineral structure. The intergrowth of microcrystalline quartz and moganite are commonly found in agetes and in other silica phases (e.g., Graetsch et al., 1987; Heaney, 1995; Rogers and Cressey, 2001). Especially the spectrum from the whitish portion of the round bead is quite similar to the spectra from the mixture of moganite and quartz (spectrum 2 in Fig. 59), and it suggests that the round bead is interpreted to be composed of microcrystalline silica phase like agate and chalcedony.

4. Summary

On the basis of instrumental analyses, the tubular bead and the round bead at the stone-slab grave from the Daram Site were identified to be talc and microcrystalline silica phase like agate and chalcedony, respectively. Talc and silica phase are chemically quite simple and are ordinary materials in the crust. Therefore it is difficult to identify their original places only by the methods used in this reports. If several archaeological evidences enable to

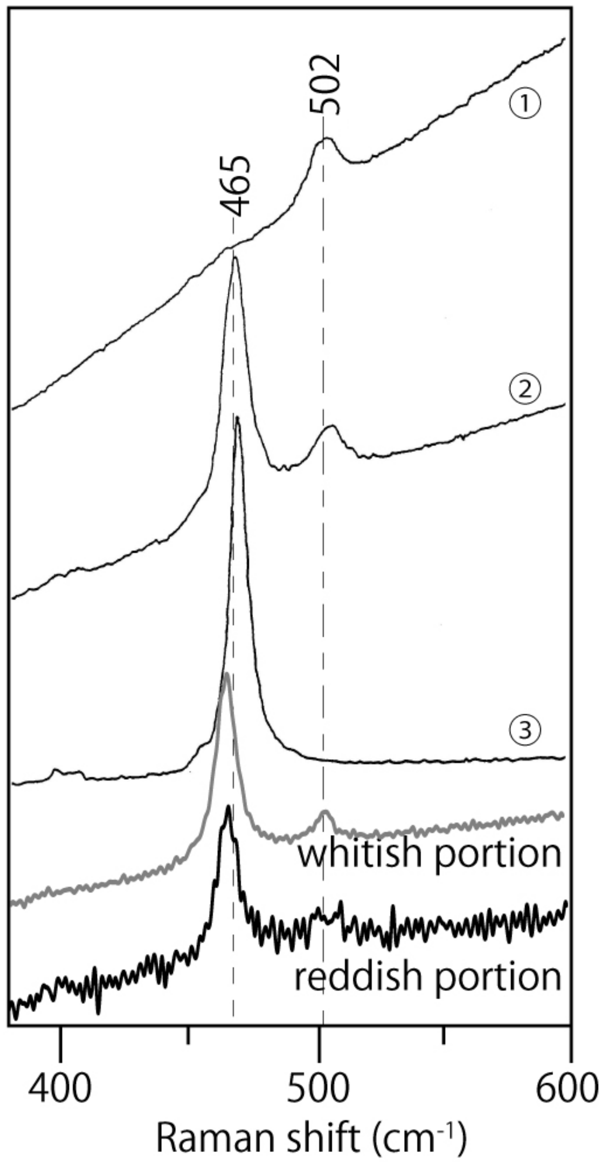


Fig.59 Raman spectra obtained from the round bead. Reference spectra (Götze et al., 1998) are also shown: spectrum 1 from moganite, spectrum 2 from mixture of 50 % of moganite and 50 % of quartz, spectrum 3 from quartz

put constraints on the places with which the ancient people in the Daram Site have interaction, we can judge whether the beads are derived from those places according to comparison of the beads with the natural rocks and minerals collected in the places.

8 Chronology of Stone-slab Graves in Mongolia based on Excavation Results from Daram and Tevsh Sites

Introduction

There are two burial customs in Bronze Age Mongolia: khirigsuur and stone-slab graves. Khirigsuur are distributed in the western part of Mongolia; on the other hand, stone-slab graves are distributed in the eastern part of Mongolia. In central Mongolia, there is a mixed distribution of both burial customs (Цыбиктаров 1998). The dating of khirigsuur is relatively earlier than that of stone-slab graves (Fitzhugh ed. 2005). Khirigsuur do not usually contain grave goods like bronze weapons. There are some sacrificed horse pits under the cairns outside the enclosure of khirigsuur. Khirigsuur do not usually have grave goods. The scale of khirigsuur indicated the scale of social units or of social cohesion (Wright 2014). On the other hand, some stone-slab graves have grave goods such as bronzes, beads and pottery. The kinds of grave goods found in stone-slab graves differ greatly depending on the social status of the individual buried there, much more than with khirigsuur. In this case, it is assumed that much more esteem was given to the personality of the social group in the stone-slab burial culture than that of khirigsuur.

1. Burial structures of the stone-slab burial culture

At the beginning of the 20th century, Sosnovskii divided the burial structures of stone-slab graves into three types (Цыбиктаров 1998). Even now, this classification of stone-slab graves (Fig. 60) is still useful in Mongolian archeology. Type 1 stone-slab graves consist of a square or rectangular stone fence, inside of which is piled with stones (Fig. 60-1). Type 2 stone-slab graves consist of a square or rectangular stone fence with four corner stones, which are higher than other stone fences, inside of which is piled with stones (Fig. 60-2). Type 3 stone-slab graves are figured stone fences, inside of which is piled with stones (Fig. 60-3). Sosnovskii believed that Type 1 dated to the 8th - 5th centuries BC, and Type 2 to the 4th - 2nd centuries BC. Cybiktarov also divided these graves into largely the same three types as Sosnovskii. Cybiktarov's classifications for the burial structures of the stone-slab burial culture consist of stone-slab graves, figured tombs, and Dvortsy-type graves. Cybiktarov divided stone-slab graves into the Chulut stage and the Atsai stage (Цыбиктаров 1998). He believed that the Chulut stage dates to between the 13th and 8th centuries BC, and the Atsai stage to between the 8th and 5th centuries BC. The Chulut stage corresponds to Sosnovskii's Type 1, and the Atsai stage to his Type 2. The Dvortsy-type graves are a special group that consists of oval or rectangular piled stones measuring 6 to 8 meters along a longitudinal axis. Cybiktarov believes that the Dvortsy-type graves are elite graves, as the grave goods of this burial type are richer and more diverse compared with the stone-slab graves (Cybiktarov 2003). However I. I. Kirillov and O. I. Kirillov supposed that the Dvortsy-type graves indicated a kind of local burial particular to the eastern Trans-Baikal regions (Kirillov 1979). In this case, the Dvortsy-type as classified by Cybicktarov would not be discussed in the context of the Mongolian Plateau.

Sosnovskii's Type 1 and Cybiktarov's Chulut stage consist of a stone construction with a square or rectangular stone fence. The Dvortsy-type also would be included in Sosnovskii's Type 1 according to the burial structure. In this case, I would like to name this burial type as square stone construction graves. These square stone construction graves were found at Ulaanzuukh Site in Tuvshinshiree sum, Sukhbaataar Aimag, Mongolia (Tumen et al. 2014). The Bulgiin Ekh in Tuvshinshiree sum, Sukhbaataar Aimag (Tumen et al. 2014, Fig. 64-1) and Grave No. 9 at Daram Site (Fig. 64-2) are also square stone construction graves. These square stone construction graves have pit burials under the square stone construction. Five dated samples of human skeletal remains at Ulaanzuuk Site cover the period 1456 - 1187 cal. BC (Tumen et al. 2014). Therefore, these square stone construction graves date to a relatively early phase in the stone-slab burial culture. And these square stone construction graves have no pile of stones outside the

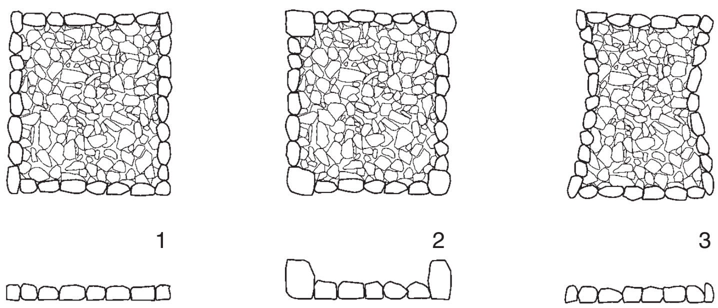


Fig.60 Classification by Sosnovski about the stone-slab graves

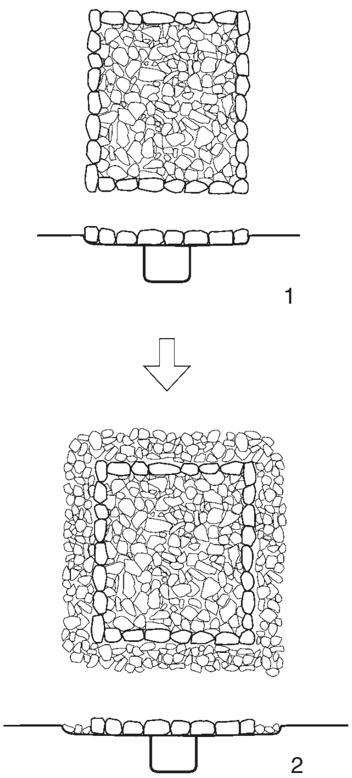


Fig.61 Classification of stone square construction grave (Type 1)

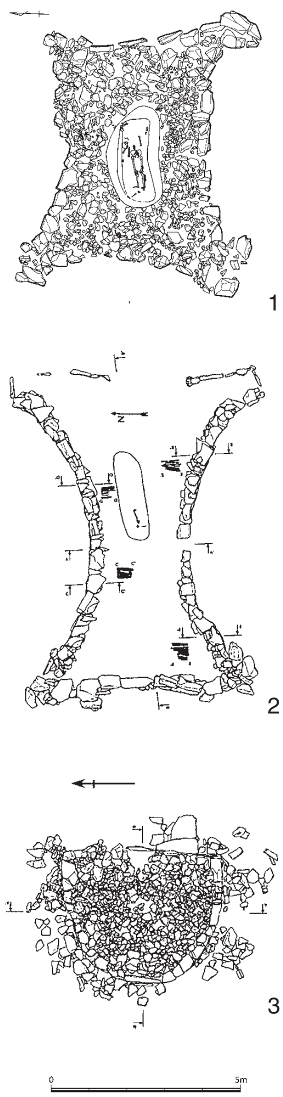


Fig.62 Classification of figured grave (Type 3)

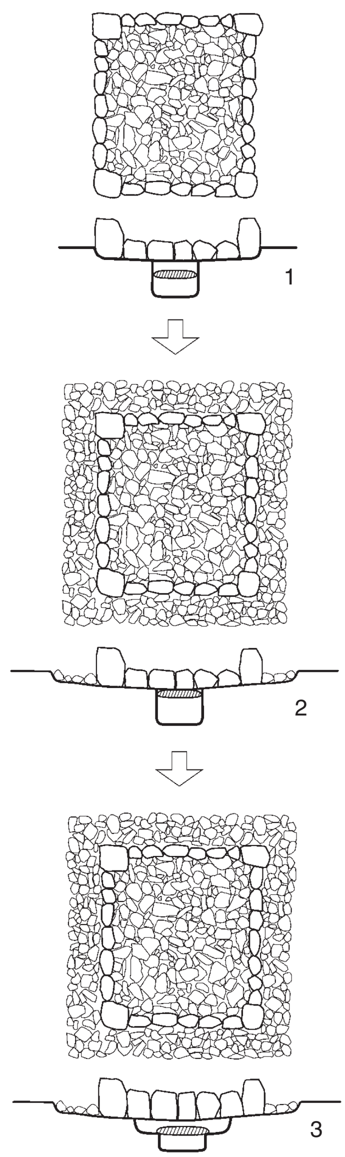


Fig.63 Classification of stone-slab grave (Type 2)

stone fence, which is a typical type of stone construction for Cybiktarov's Chulut stage. In this case, we have to divide them into sub-types based on whether there are piled stones outside the stone fence among these square stone construction graves and the Chulut stage by Cybiktarov. I would like to name the former as Type 1a square stone construction graves (Fig. 64-1) and the latter as Type 1b square stone construction graves (Fig. 64-2). Daram Grave No. 9 has been dated to 896 - 806 cal. BC through analysis of sacrificed horse bones. It is thought that Type 1a square construction graves changed to Type 1b square stone construction graves during this time. In addition, Type 1a square stone construction graves were believed to have originated from southeastern Mongolia according to the distribution of graves (Tumen et al. 2014).

Sosnovskii's Type 3 refers to figured graves. At Tevsh Site, excavated by a Mongolian-Japanese joint research group in 2012 as is reported in this book, figured graves are found at Graves No. 1 and No. 3. Grave No. 3 at Tevsh Site (Fig. 65 - 1) has a figured stone fence which does not have four extended corners. On the other hand, Grave No. 1 at Tevsh Site (Fig. 65 - 2) has a curved stone fence which has four extended corners. According to the dating of human bones in both graves, Grave No. 3 is much earlier than Grave No. 1 at Tevsh Site. Therefore, in the chronology of the figured graves, the figured stone fence which does not have significant extended corners changed to curved stone fences which extend to four corners. However, in Grave No. 1 at Tevsh Site, the dead were buried in a supine position oriented to the west in a stone cist on the surface. On the other hand, in Grave No. 3 at Tevsh Site, the dead were buried in a back-up side position oriented to the east in the pit burial. This latter position is typical of figured graves; the former position, however, is similar to that of khirigsuur. Westerly orientation is usual for khirigsuur. The distribution of figured graves can be seen mainly in the central Mongolian Plateau (Цыбиктаров 1998). We can infer that figured graves are a modified form of square stone construction graves. If this is true, square stone construction graves which originated from the southeastern Mongolian Plateau spread westward to the central Mongolian Plateau, in the process changing into figured graves. However, Tevsh Grave No. 1 was influenced by the burial customs of khirigsuur, which spread eastward from the western Mongolian Plateau.

As is reported in this book, excavations of Daram stone-slab graves conducted by a Mongolian-Japanese joint research group from 2009 to 2011 show that Sosonovski's Type 2, the Atsai stage classified by Cybiktarov, should be divided further by burial structure. Type 2a is a rectangular stone fence with four corner stones, outside of which is not paved with stones. Type 2b is a rectangular stone fence with four corner stones, outside of which is paved with stones. In addition, Type 2b should be further divided into two types. Some of the stone fences in Type 2b are relatively low, while others are relatively high. In this case, the former should be named as Type 2b and the latter as Type 2c. Six stone-slab graves at Daram Site were excavated. At this site, Grave No. 4 (Fig. 66 - 1) is Type 2a; Graves No. 8 (Fig. 66 - 2) and No. 41 (Fig. 66 - 3) are Type 2b; and Grave No. 1 (Fig. 66 - 4) is Type 2c. These stone-slab graves contain human skeletons or sacrificed horses. The dating of these bones indicates that Grave No. 4 dates to between the 8th and 7th centuries BC; that Grave No. 1 dates to between the 5th and 4th centuries BC; and that Graves No. 8 and No. 41 date to between the 5th and 3rd centuries BC. This means that Type 2a stone-slab graves date to a relatively earlier period, and that Type 2b and Type 2c stone-slab graves are later than Type 2a stone-slab graves. It also suggests that Type 2a stone-slab graves gradually developed into Type 2b stone-slab graves, and that these in turn eventually developed into Type 2c stone-slab graves.

2. Classification and chronology of burial structures in the stone-slab burial culture

Through excavations at Daram Site and Tevsh Site, we can re-classify burial structures in the stone-slab burial culture based on the classifications by Sosnovsky and Cybiktarov. There are three categories of burial structure in the stone-slab burial Culture (Table 28): the square stone construction grave (Type 1), the figured grave (Type 2) and the stone-slab grave (Type 3).

Type 1 (Fig. 61) consists of a stone structure with a square or rectangular stone fence, inside of which is piled with stones. Type 1 can be divided into two sub-types depending on whether or not stones have been piled up outside the stone fence: Type 1a (Fig. 61 - 1) and Type 1b (Fig. 61 - 2). In the case of Type 1a, no stones have been piled up outside the stone fence; in the case of Type 1b, however, stones have been piled up outside the stone fence. Because stones have been piled up outside as a means of supporting the stone fence, it is believed that stone fences in Type 1b make stone structures much more easily than those of Type 1a.

Type 3 (Fig. 62) refers to figured graves. Type 3

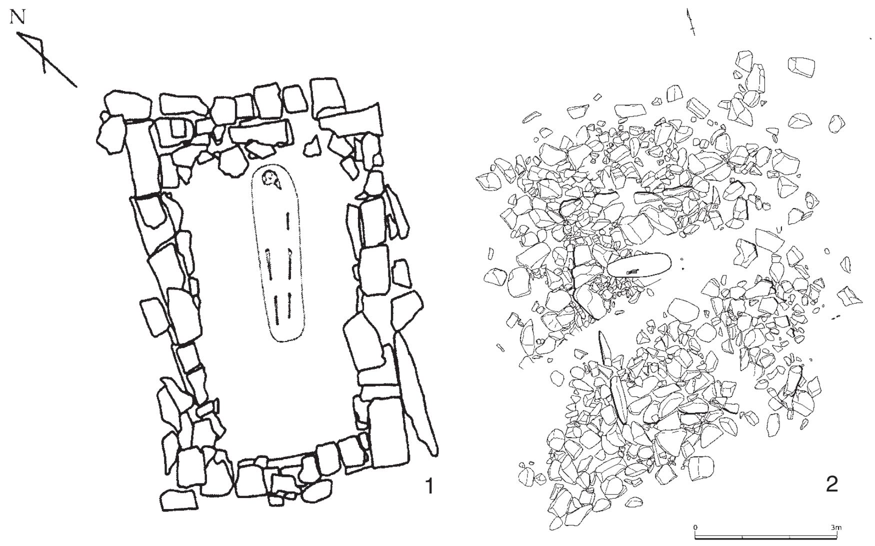


Fig.64 Stone square construction grave (Type 1)

can be divided into three sub-types: Type 3a (Fig. 62 - 1), Type 3b (Fig. 62 - 2) and Type 3c (Fig. 62 - 3). The classification of sub-types is based on the degree of curbing of the stone fence. Type 3a does not exhibit a significant curved line of the stone fence, which does not extend to any significant degree to the corners. Type 3b has a significant curved line of the figured stone fence, which extends to the corners. Type 3a would subsequently change into Type 3b. Type 3c is a stone fence in the shape of a horse's hoof. Type 3c would eventually be modified from Type 3a or Type 3b.

Type 2 (Fig.63) has a rectangular stone fence with four corners. Burial structures such as a stone construction are typical of stone-slab graves. Type 2 can also be divided into three types: Type 2a (Fig. 63 - 1), Type 2b (Fig. 63 - 2) and Type 2c (Fig. 63 - 3). Type 2a has a rectangular stone fence, outside of which is not piled up with stones. Type 2a has a rectangular stone fence, outside of which has been piled up with stones to support stone fence. Type 2c has the same stone structure as that of Type 2b, but the stone fence of Type 2c is much higher than that of Type 2a and Type 2b. The function of the pile of stones outside the stone fence is to allow for a bigger stone fence for Type 2c. Therefore, it is supposed Type 2a gradually changed into Type 2b and then changed into Type 2c. This process of change also indicates the development of stone structures for Type 2.

Additional mention must be made of burial customs. All types of stone-slab burial cultures usually utilized pit burials. However, the location of these pit burials differs among the three types. In the case of Type 1, pit burials are not located in the center of the stone construction; however, those of Type 3 and Type 2 are located in the center. Among these, only Type 2 has cover stones over the pit burials, with a different number of cover stones according to the sub-type of Type 2. Type 2a has also only one cover stone, but Type 2b and Type 2c have multiple cover stones, such as three stones. Only Type 2c has a double pit burial structure, the construction of which would have required much labor; other types have only one pit burial. Type 2c, which has a bigger stone fence and double pit burial, indicates a much higher social status, given the amount of intensive labor required for the construction of the grave.

When discussing these graves, the combination between the classification of the stone construction and that of the pit burial should be made clear in order to constitute the sub-types. Table 28 shows combinations of the classifications of several attributes. Combinations of the attributes clearly indicate the particularity of the sub-types and the typological shifted line. Therefore, we can understand the process of change of the types as follows: from Type1a to Type 1b, from Type 3a to Type 3b, and from Type 2a to Type 2b and then to Type 2c. In addition, it is supposed that Type 1a changed to Type 3a.

The dating of the graves (Table 29) can prove this chronological hypothesis. Table 29 shows the dating of the types based on the AMS data for human bones or sacrificed animal bones. According to this table, the dating of Type 1a covers the period from 1530 - 1187 cal. BC, and is relatively earlier than those of Type 1b, which covers the period from 1440 - 804 cal. BC. And the dating of Type 3a, which covers the period from 1500 - 1110 cal. BC, is also earlier than that of Type 3b and Type 3c, which covers the period from 1270 - 760BC. Based on the dating of Daram Site, we can infer that Type 2a dates to an earlier period than Type 2b and Type 2c. In addition, the square stone

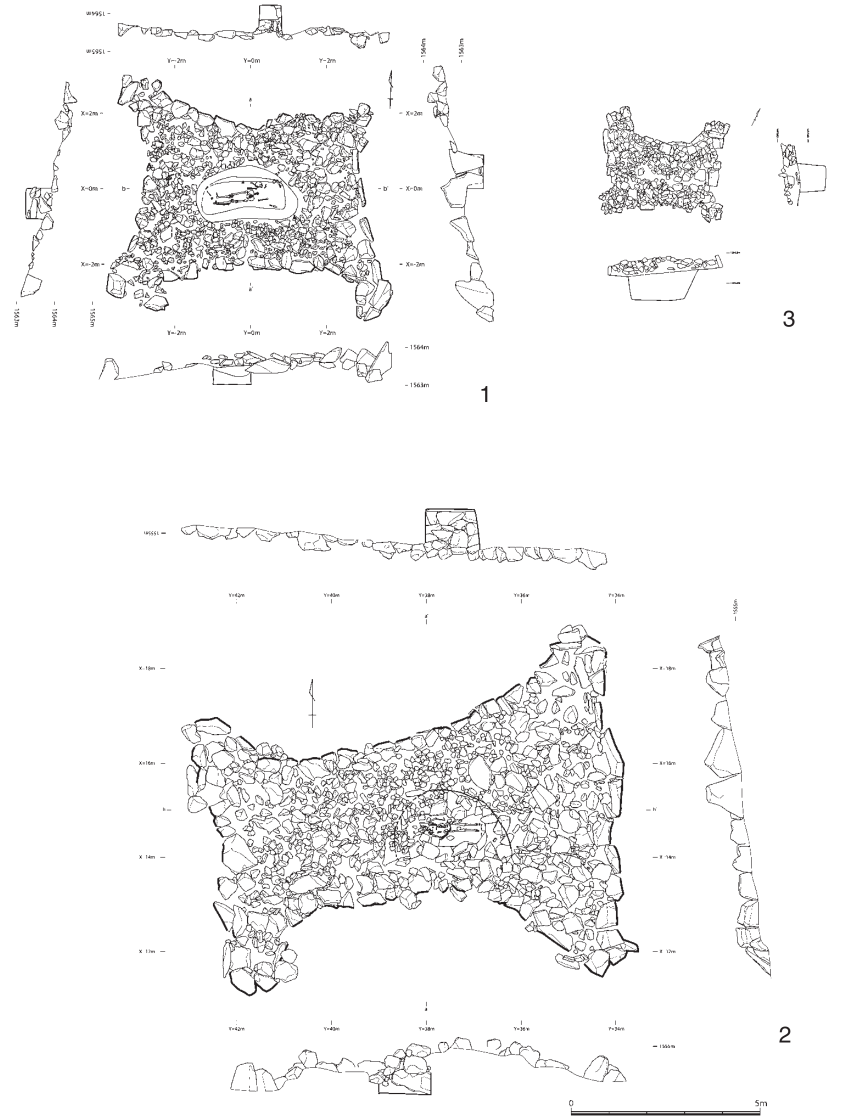


Fig.65 Figured grave (Type 3)

Table.28 Combinations of attributes in the typology

Square stone fence	Figured stone fence	Corner stone	Outer paved stone	Cover stone	Pit burial	Type name
○	×	×	×	×	○	1a
○	×	×	○	×	○	1b
×	○	×	×	×	○	3a
×	○	×	○	×	○	3b
○	×	○	×	single	○	2a
○	×	○	○	double	○	2b
○	×	○	○	double	doubled	2c

construction grave (Type 1) and the figured grave (Type 3) are relatively earlier than the stone-slab grave (Type 2).

Figure 67 shows the chronology of grave structures in the stone-slab burial culture. Based on the distribution and dating of square stone construction graves, it is believed that Type 1a square stone construction graves originated from the southeastern Mongolian Plateau and spread westward to the central Mongolian Plateau, where they changed into Type 1b. Also, Type 1a square stone construction graves changed into Type 3a figured

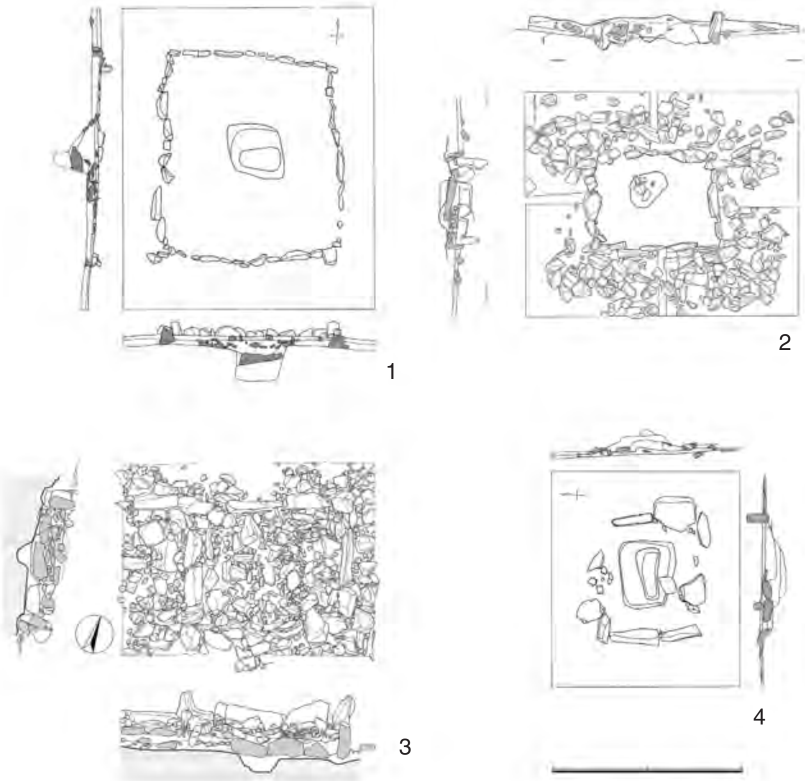


Fig.66 Stone-slab grave (Type 2)

graves in the central Mongolian Plateau. Type 3a then changed into Type 3b and Type 3c in the central Mongolian Plateau. These square stone construction graves and figured graves were distributed in the eastern and central Mongolian plateau from the 15th to 9th centuries BC. On the other hand, stone-slab graves (Type 2) were distributed in this same region from the 8th to 3rd centuries BC. The stone-slab grave replaced the square stone construction grave and figured grave in the eastern and central Mongolian Plateau. This process of change poses questions regarding the origin of Type 2a, as well as why the stone-slab grave came about. We do not know how the four corner stones in Type 2 originated; all we can say is that the square stone construction grave and figured grave do not have these four corner stones. The square stone fence with four corner stones, which is believed to have originated from kherigsuur, was found at Hyauru Hyaraach Site, Gobi Altai Aimag. This grave dates to 1265 - 1108cal. BC (94.2%, 2 sigma), which corresponds to the dating of the square stone construction grave and the figured grave. If this type of khirigsuur is indeed the origin of the stone-slab grave (Type 2), we would name the prototype of the stone-slab grave after this type of khirigsuur. The prototype of the stone-slab grave is found in western Mongolia. The prototype of the stone-slab grave spread from the western Mongolia Plateau to the central Mongolian Plateau in the same way the khirigsuur spread, leading to the supposition that this is the origin of Type 2a stone-slab graves. However, there is insufficient research on the prototype of the stone-slab grave. We hope to have more opportunities to research the prototype of the stone-slab grave in the future.

3. Development process of the stone-slab burial culture

The stone-slab burial culture has three distinct burial customs: the square stone construction grave, the figured grave and the stone-slab grave. The former two burial customs, which date to between the 15th and 9th centuries BC, are of a relatively earlier period than the last one, which dates to between the 8th and 3rd centuries BC. In most cases, as with khirigsuur, graves belonging to the former two burial customs do not contain grave goods. The nature of these burials is suggestive of an egalitarian society. However, Baga Gazaryn Chuluu1, Dundgovi Aimag, a Type 3a figured grave dating to 1390 - 1110 cal. BC, contains relatively large quantities of grave goods. For example, its contents include a Karasuk style bronze knife, bronze arrow heads, a ground stone crucible with handles, and pottery (Nelson et al. 2009). Another figured grave at Tevsh Site, Baiankhongol Aimag, contains a Karasuk style golden earing (Волков 1972). And the square stone construction

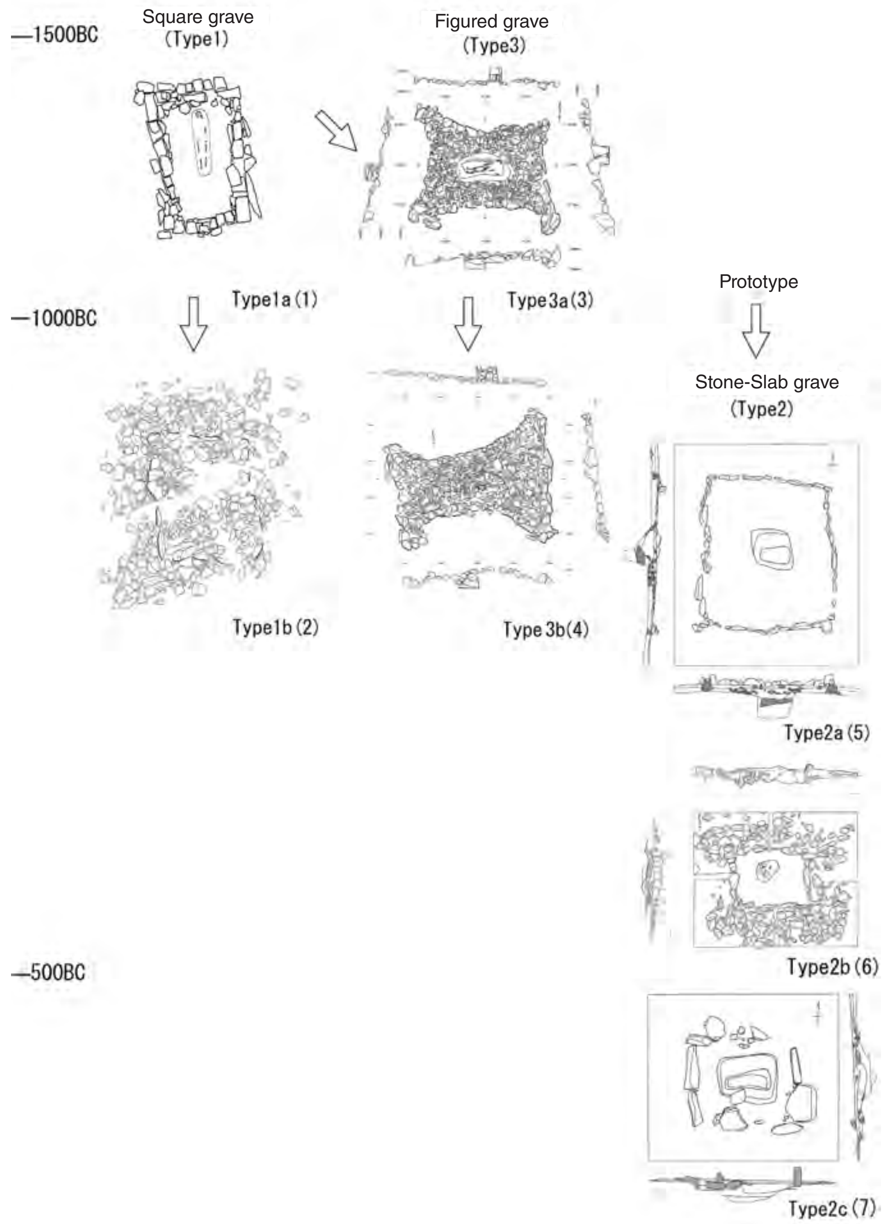


Fig.67 Changes to the grave structure in the stone-slab burial culture

grave at Emgent hoshuu Site, Bulgan Aimag, has bronze helmets (Erdenebaatar 2004). Therefore, several square stone construction graves and figured graves contain fine grave goods like bronze. In addition, the profile on the pit burial at Tevsh Grave No. 3 indicates the likelihood that there was a wooden coffin or body wrapped in textiles or feathers in the burial pit. The presence of pit burial facilities under the stone construction at figured graves means that those graves were invested with special labor. On the basis of this evidence, we believe social classification gradually started as early as the beginning of the stone-slab burial culture.

Such social differences improved during the phase of typical stone-slab graves. Daram Grave No.4, a Type 2a stone-slab grave, has a pit burial with a cover stone under the stone construction. It is probable that there was a wooden coffin or body wrapped in textiles or feathers in the burial pit because of the distribution of grave goods. This stone-slab grave contains many grave goods, such as bronze ornaments and stone beads. Differences in graves goods in terms of quantity and quality show that there were social differences between individuals at that time. It is also very interesting that the individual buried in Daram Grave No. 4 is female. No social differences between the sexes have been confirmed so far, but the social differences between individuals is much more pronounced than those seen in khirigsuur. In addition, Daram Grave No. 1, a Type 2c stone-slab grave, also has a wooden coffin in a burial pit with double pit graves. The wooden coffin in Daram Grave No. 1 was much larger than that of Daram Grave No. 4. Depending on the time period and stage of social

Table.29 Dating of graves by typology in the stone-slab burial culture

grave name	Aimag name	address	Type	Scale	burial way	orientation	cover stone	grave goods	dating (cal BC)	reference
Ulaanzuukh Row 1A (3)	Sukhbaataar	Adgiin Gol	1a	4.1×4.0	pit	NE	0		1423-1288	ТҮмен et al. 2010, Tumen et al. 2014
Ulaanzuukh Row 1D (5)	Sukhbaataar	Adgiin Gol	1a	4.6×3.4	pit	NE	0		1325-1192	ТҮмен et al. 2010, Tumen et al. 2014
Ulaanzuuk Row 2-6	Sukhbaataar	Adgiin Gol	1a						1456-1369	Tumen et al. 2014
Ulaanzuuk Row 2-3	Sukhbaataar	Adgiin Gol	1a						1322-1187	Tumen et al. 2014
Ulaanzuuk Row 2-2	Sukhbaataar	Adgiin Gol	1a						1443-1313	Tumen et al. 2014
Chandomani Khar Uul 2-p	Dornogovi	Delgerekh	1a	4.2×2.8	pit	NE	0		1530-1380	Амартувшин et al. 2015
Chandomani Khar Uul 5-p	Dornogovi	Delgerekh	1a	6.7×5.7	pit	NE	0	motor stone	1440-1250	Амартувшин et al. 2015
Chandomani Khar Uul 33	Dornogovi	Delgerekh	1a	4.3×3.1	pit	NE	0	bead	(1500-1250)	Амартувшин et al. 2015
Bitoogiin Tsagaan 2-p	Bylgan	Xytag-Undur	1a	6.5×6.5	pit,face down		0		(1116-906)	Торбат et et al. 2003
Chandomani Khar Uul 41	Dornogovi	Delgerekh	1b	5.4×4.3	pit	NE	0	tripod	1440-1190	Амартувшин et al. 2015
Chandomani Khar Uul 130	Dornogovi	Delgerekh	1b	3.0×2.1	pit	E	0		1400-1120	Амартувшин et al. 2015
Tavan Khailaast 3-No.1	Henti y	Delgerhaan	1b	3.8×3.2	pit, face up	E	0	bronze ornament18	835-804	Shiraishi ed. 2013
Daram No.9	Henty	Delgerhaan	1b	4.7×3.8	pit	E	0		896-806	Chapter 4
Daram No. 2	Henty	Delgerhaan	1b	4.0×2.5	pit	E	0		769-407	Chapter 4
Orog Hyyp 85-p	Baiankhongol	Bogd	1b	3.2×2.5	pit,face up	NE	0		1220-900	GyhChincuren et al. 2010
Chandomani Khar Uul 31	Dornogovi	Delgerekh	3a	11.5×7.7	pit	E	0		1500-1250	Амартувшин et al. 2015
Baga Gazaryn Chuluu 1	Dundgovi	Adaatsag	3a	4.8×3.2	pit	NE	0	bronze knife, bronze arrow head, polished stone,pottery	1390-1110	Амартувшин & Жаргалан2008, Nelson et al. 2009
Tevsh No. 3	Uvuruhangai	Bogd	3a	6.5×6.0	pit,face down	E	0		1392-1264	Chapter 4
Tevsh No. 1	Uvuruhangai	Bogd	3b	8.5×7.5	stone cist, face up	W	0		901-812	Chapter 4
Baruun Gyalaat 2	Baiankhongol	Baianlig	3b		pit	E	0		1270-970, 960-930	Kovalev & Erdenebaatar 2009
Bor Ovo No.8	Baiankhongol	Bogd	3b		pit	E	0		1112-974	
Ulaanboom 16	Gobi-Altai	Taishir	3b	10×4			0		1270-970	Амартувшин & Адарменх 2010
Baruun Gyalaat 1	Baiankhongol	Baianlig	3c				0		1020-760	Kovlev & Erdenebaatar 2009
Daram No. 4	Henty	Delgerhaan	2a	8.5×7.5	pit	E	1	bronze ornament 3 ,bead1000	786-429	Chapter 4
Daram No. 41	Henty	Delgerhaan	2b		pit		3	pottery sheard	404-205	
Daram No.1	Henty	Delgerhaan	2c	4.3×4.2	pit	E	3	pottery sheard	479-381	Chapter 4

development, not only the stone-slab grave structure itself but also burial facilities like wooden coffins under the stone construction were much bigger. This shows that social complexity based on the individual in social groups was gradually increasing.

Conclusion

Figure 67 shows the changing processes of square stone construction graves, figured graves and stone-slab graves in the stone-slab burial culture of central and eastern Mongolia. Two burial customs, the square stone construction grave and the figures grave, gradually changed along a shifting line in the chronological framework from the 15th to 9th centuries BC. Square stone construction graves originated in southeastern Mongolia and spread to central Mongolia, where they changed into figured graves. Typical stone-slab graves gradually changed from Type 2a to Type 2b and Type 2c in central and eastern Mongolia from the 8th to 3rd centuries BC. This process of change also led to the social development of herding societies in the eastern steppe area. In particular, certain individuals gained esteem within the social stratification. This social particularity is seen in the stone-slab burial culture of central and eastern Mongolia. On the other hand, the khirigsuur in western Mongolia gradually changed in a horizontal space from westward to eastward central Mongolia. The khirigsuur symbolized the social unit or social group rather than a particular individual.

Prof. Honeychurch named the square stone construction graves and figured graves as the Ulannzuukh-Tevsh Culture. He also named the stone-slab grave as Slab Burials (Honeychurch 2015). His location of Ulannzuukh-Tevsh Culture and Slab Burials in the chronological table is similar to our chronology. But he does not explain the relationship among the three types of grave custom in the stone-slab burial culture, nor the minute processes of change on the shifting lines of each burial type.

Closing Remarks

Through excavations at Daram Site and Tevsh Site, we were able to establish a chronology for the stone-slab grave culture. Square stone construction graves emerged in the southeastern Mongolian Plateau and spread westward in the latter half of the second millennium BC. Square stone construction graves changed into figured graves mainly in the middle Mongolian Plateau at the same time. On the other hand, khereksuur were distributed in western Mongolia and spread eastward to the middle Mongolian Plateau in the latter half of the second millennium BC. In the Karask period, there were two separate burial customs in the east and west of the Mongolian Plateau: the stone-slab burial culture and the khereksuur culture. Two separate social groups were a part of the same bronze culture in the Mongolian Plateau. These two social groups are believed to have constituted an egalitarian society due to the presence of very few grave goods.

In the first millennium BC, the typical type of slab-stone grave emerged and became distributed throughout the middle and eastern Mongolian Plateau from the 8th century BC to the third century BC. The stone-slab graves distributed in the eastern part of the Mongolian Plateau belong to one of the social groups of the Tagar culture. These stone-slab graves developed differences in the number and kinds of grave goods, indicating social stratification among the buried individuals. The societies of those who adopted stone-slab graves were much more developed than those of square stone construction graves and figured graves. Social stratification among stone-slab graves was also developing. The stone-slab burial culture should be seen as a direct continuation to the Xionnu Culture in terms of both the burial chronology and historical content.

According to physical anthropological research, the peoples of the Daram and Tevsh Sites are taller in height compared with other prehistoric peoples in East Asia. They sustained far more injuries than other hunter-gatherers or farmers as a result of accidents related to riding horses.

Herding societies would have been based on a more nomadic lifestyle than other peoples. Strontium analysis on teeth at Tevsh Site indicates that one of two figured graves would be different home land of the dead. These results also indicate the probability that the people of the stone-slab burial culture were are herding society. We attempted DNA analysis on teeth from Daram Site based on the same hypothesis. However, the results were inconclusive due to insufficient specimens.

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