Excavations at Bor Ovoo and Khyar Kharaach Sites : The second Report on Joint Mongolian-Japanese Excavations in Outer Mongolia

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https://doi.org/10.15017/1812330

出版情報：pp.1-80, 2017-07. Department of Archaeology, Faculty of Humanities, Kyushu University
バージョン：
権利関係：

812-8581
6-19-1 Hakozaki, Higashi-ku, Fukuoka, Japan
Department of Archaeology
Faculty of Humanities
KYUSHU UNIVERSITY

Printed in: KYUSHU COMPUTER PRINTING
LIMITED COMPANY
815-0035
1-19-1 Mukaino, Fukuoka Minami-ku,
Fukuoka, Japan

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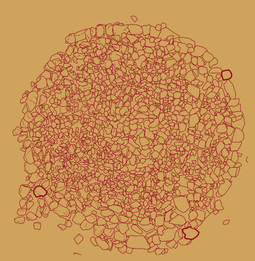

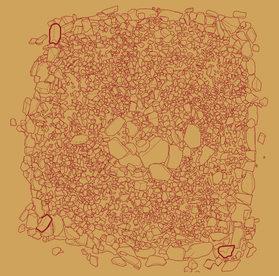

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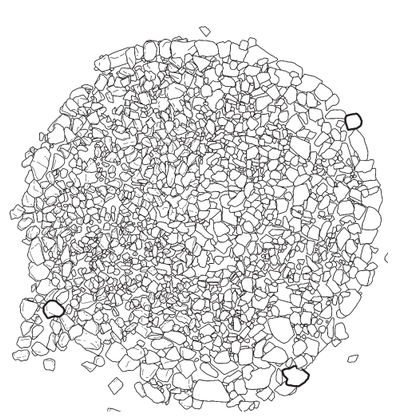

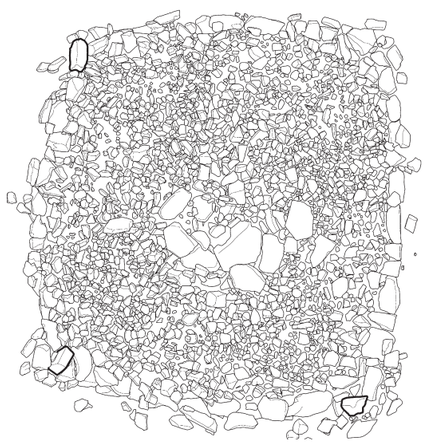

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Edited by Kazuo MIYAMOTO

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July 2017

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Preface

Kazuo Miyamoto

These reports present the results of comprehensive excavations at Bor Ovoo Site in Bayanhongol Aimag, and at Khyar Kharaach Site, Gobi Altai Aimag, Mongolia (Fig. 1). The excavations at Bor Ovoo Site were carried out as part of Kyushu University Interdisciplinary Programs in Education and Projects in Research Development (P&P). The excavations at Khyar Kharaach Site were carried out under a program of the Japan Society for the Promotion of Science (JSPS).

The excavations at Bor Ovoo Site (Fig. 2) were held in 2013 as part of 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 Mongolian Academy of Science entered into an agreement to conduct research entitled "MONGOL KHUN PROJECT: The Physical Anthropological Study of Prehistoric Mongolian Populations, Joint Mongolian-Japanese Research Project." The excavations at Bor Ovoo Site were conducted in August, 2013. Three round graves and a stone-slab grave were excavated on this occasion.

Having finished excavations at Bor Ovoo Site, the following title was proposed for a JSPS research project running from 2015 to 2018 called "Interdisciplinary Research on the Formation Process of Herding Societies in the Eastern Eurasian Grasslands," of which Prof. Kazuo Miyamoto (The Faculty of Humanities, Kyushu University) is representative. A research project group was established under a project entitled "ANCIENT MONGOL KHUN PROJECT, 2015 - 2018," which was initiated under the Joint Mongolian-Japanese Research Project. This research group consisted of members of the Kyushu University Advanced Asian Archeological Center and the Institute of History and Archaeology in Mongolian Academy of Science. As part of this project, we excavated at Khyar Kharaach Site in August 2015 (Fig. 3). Two graves and two ritual stone structures belonging to the Bronze Age were excavated at this site.

These research projects were interdisciplinary in nature, covering not only archaeology but also physical anthropology and chemical archaeology. One of the goals of the research was to investigate the mobility of Bronze Age herding peoples in Mongolia. As such, Strontium analysis on human skeletal remains from Khyar Kharaach Site was conducted. Physical anthropological analysis and radiocarbon dating on the skeletal remains were also conducted. This interdisciplinary research was carried out with the goal of shedding light on the movement and reformation of groups of herding peoples in Bronze Age Mongolia, as well as establishing a burial chronology for the Bronze Age in the Mongolian Plateau, including for round graves and figured graves.

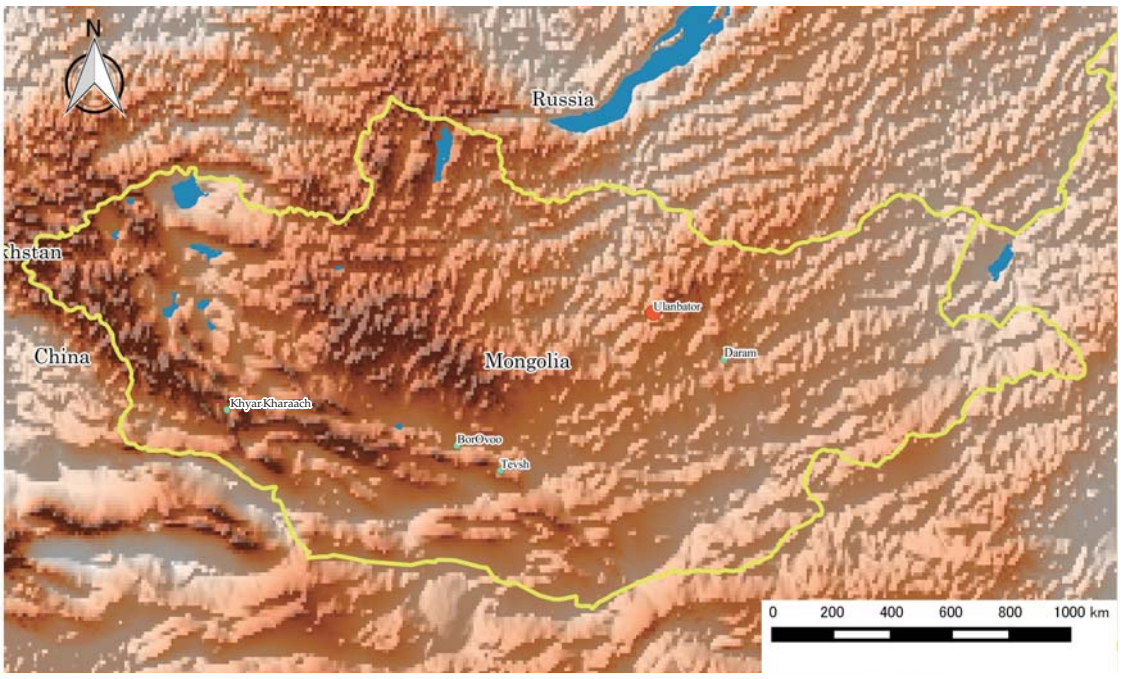


Fig.1 Location of excavations by Mongolian and Japanese joint research group

Fig.2 Cemetery Unit No. 1 of Bor Ovoo Site

Fig.3 Cemetery Unit No. 2 of Khyar Kharaach Site

1 Excavations at Bor Ovoo Site

Kazuo Miyamoto, Tend Amgalantugus and Lhagvadorj Delgermaa

1. Background and purposes behind the excavations at Bor Ovoo Site

An agreement entitled "MONGOL KHUN PROJECT: The Physical Anthropological Study of Prehistoric Mongolian Populations, Joint Mongolian-Japanese Research Project" was exchanged between the Department of Archaeology, the Faculty of Humanities, Kyushu University and the Archeological Institute of Mongolian Academy of Science. We conducted excavations at Bor Ovoo Site under a Program of Kyushu University in the 2013 academic year.

We conducted surveys around Lake Orog nuur, Bayanhongor Aimag in August in 2013, and decided to excavate at Bor Ovoo Site, which until then had been unexcavated (Fig. 4). Prior excavations at Daram Site, Henty Aimag had given us an understanding of the chronology of the typical stone-slab burial culture, and we were able to clarify the processes of change behind figured graves through excavations at Tevsh Site (Миямото2013, Miyamoto, 2016). As such, we decided to conduct excavations at Bor Ovoo Site in order to make clear the relationship between Khirigsuur and the stone-slab burial culture, of which figured graves are a key feature.

Our joint excavations between Japan and Mongolia were conducted from 14th to 26th August in 2013. Professor Kazuo Miyamoto, Dr. Keita Matsumoto, Mr. Shota Fujimoto, Mr. Masahiro Fukunaga and Mr. Purvee Khatanbaatar from Kyushu

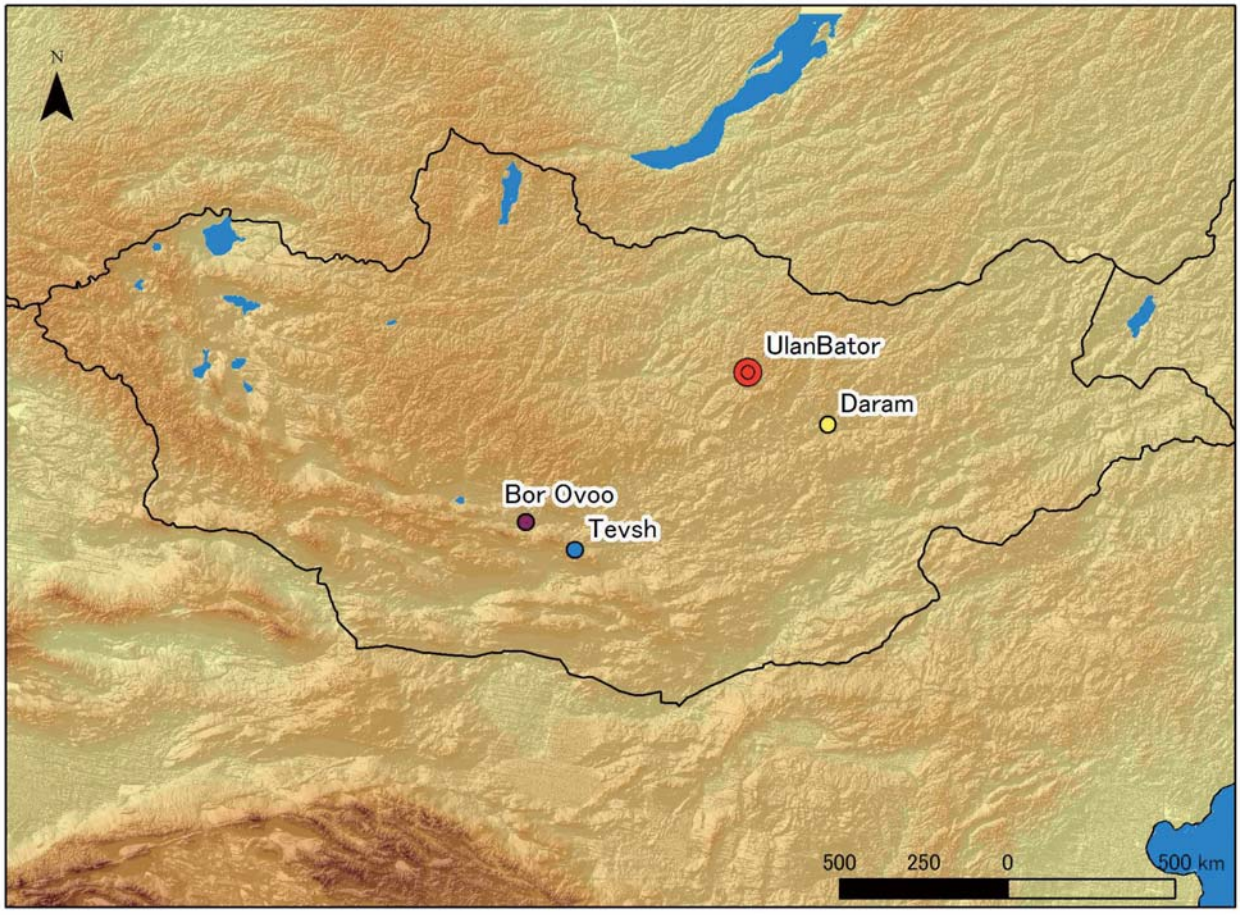


Fig.4 Location of Bor Ovoo Site

University, and Mr. Tsend Amgalantugus and Ms. Lhagvadorj Delgermaa from the Archeological Institute of Mongolian Academy of Science participated in excavations at this site.

2. Location of Bor Ovoo Site and its grave contents

Bor Ovoo Site is located on the northern coast of Lake Orog Nuur, Bayanhongor in central Mongolia, which is situated in the northern range of the Altai Mountains (Fig.5). Although graves on the southern coast of Lake Orog Nuur are located on flat slopes, graves on the northern coast of the lake are located in mountainous areas (Fig. 10). Cemetery Unit No. 1, excavated by our team in a mountainous area, consisted of 29 graves, including Khirigsuur, round graves and figured graves (Fig. 6). In addition, Cemetery Unit No. 2, extending through the eastern mountains across the valley from Unit No. 1, also comprises of Khirigsuur and figured graves, including stone-slab graves (Fig. 7). It is interesting to note that the center of each cemetery has rock art which acts as a symbol for the cemetery (Fig. 8, Fig. 9). It is likely that other cemetery units exist eastward from Unit No. 2 (Fig. 5), but time constraints on this occasion meant that we did not have the opportunity to conduct surveys in this area.

Cemetery Unit No. 1, which we endeavored to excavate, consists of 29 graves and 4 ritual stone structures (Fig. 11, 12). The Khirigsuur in this cemetery are divided into two types of enclosures: 4 square types and 1 round type. The square type consists of Khirigsuur No. 6, No. 7, No. 21 and No. 23, but the round type consists solely of Khrigsuur No. 4 (Fig. 12).

The stone-slab graves consisted of figured graves corresponding to Dr. Sovnoski's Type 3 (Miyamoto, 2016). Archaeological evidence showing that construction of one of the figured graves destroyed a Khirigsuur indicates that figured graves date later than Khirigsuur in the chronology of grave systems (Fig. 12, Fig. 13). Graves No. 25 and No. 26 are recorded as stone-slab graves (Fig. 12), but it would be more appropriate to classify them as figured graves because of the grave distribution on the line with grave No. 8. Such a location of figured graves on the line is a particular arrangement for figured graves. A location on the line like Graves No. 8, No. 25 and No. 26 is also found at the Tevsh Site (Miyamoto & Obata ed. 2016). Although Khirigsuur have an enclosure made of stone mounds, a large number of graves have

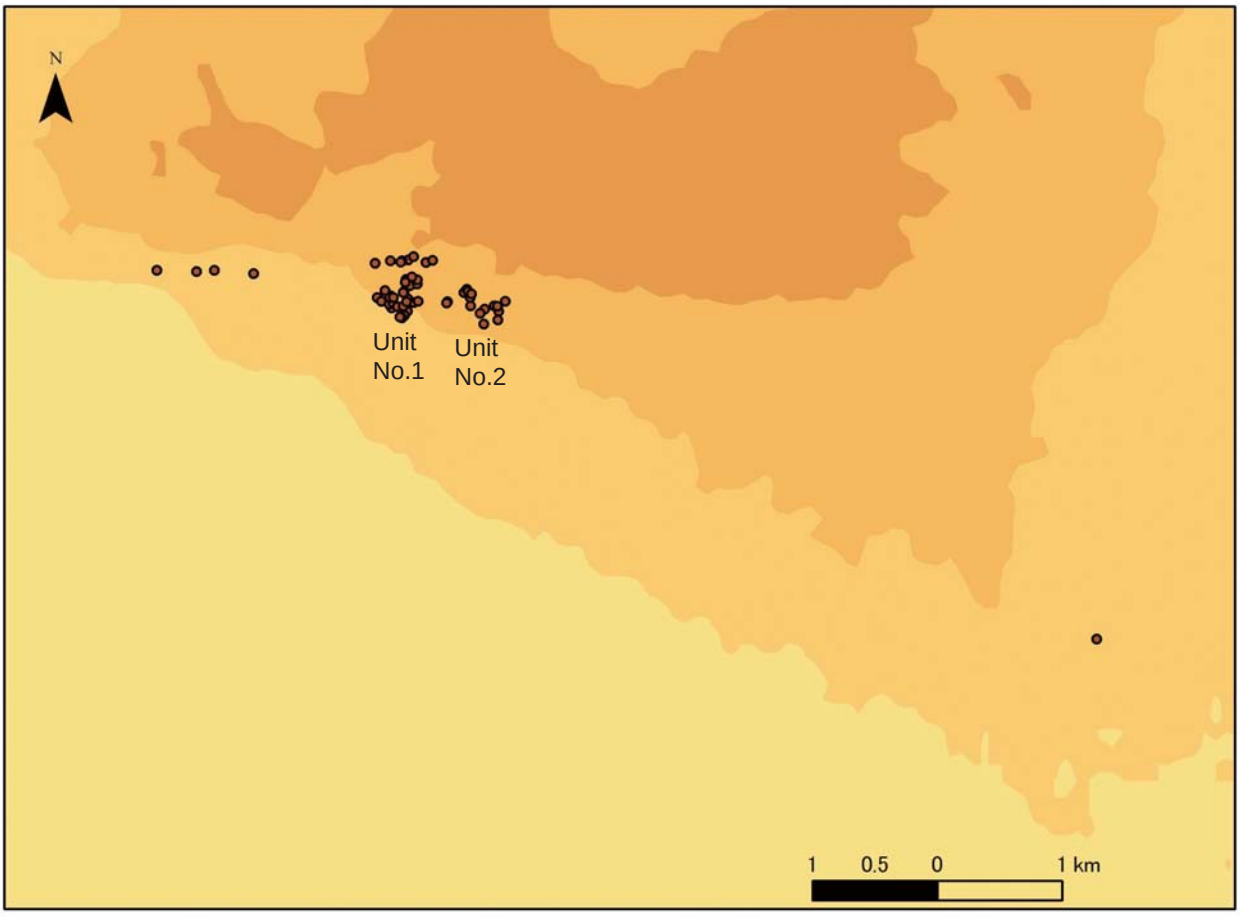


Fig.5 Distribution of graves at Bor Ovoo Site

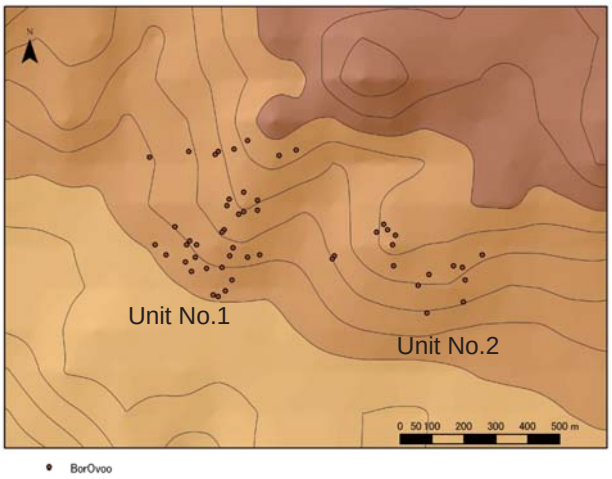


Fig.6 Cemeteries of Bor Ovoo Site

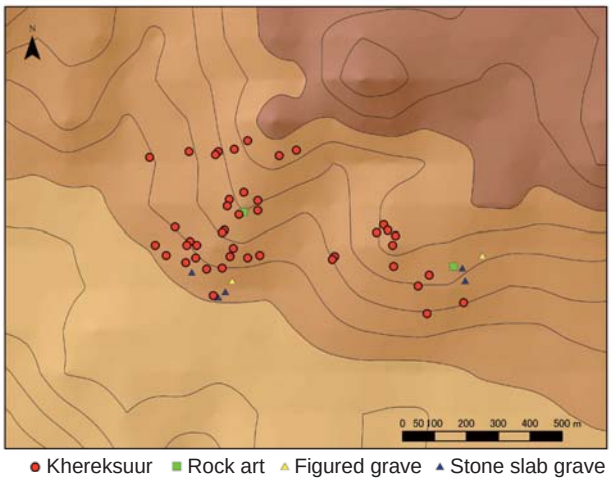


Fig.7 Distribution of grave types in Bor Ovoo Site

Fig.8 Rock art of Cemetery Unit No. 1

Fig.9 Rock art of Cemetery Unit No. 2

Fig.10 View of Mt. Bor Ovoo

Fig.11 Cemetery Unit No. 1 of Bor Ovoo Site

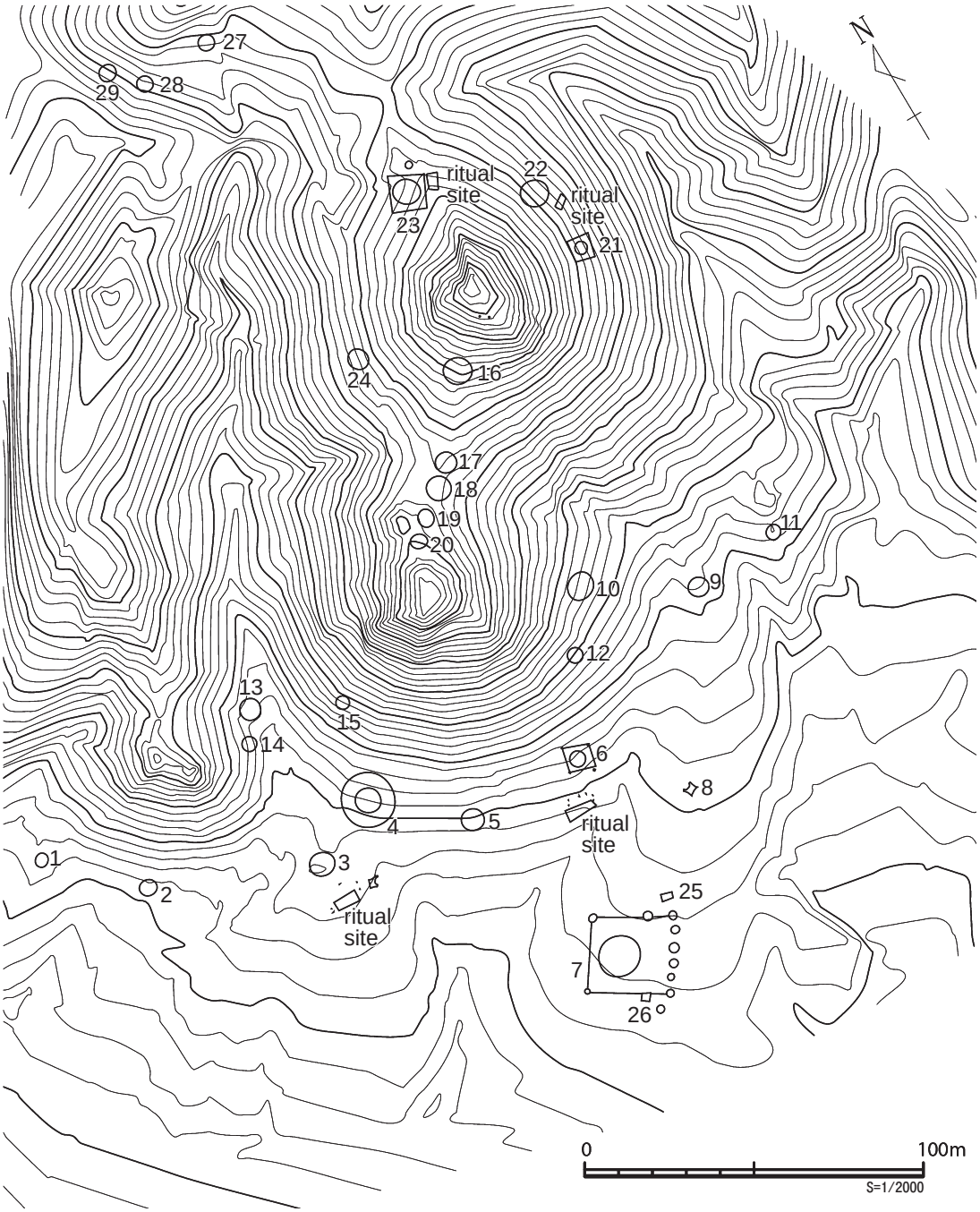


Fig.12 Distribution of graves at Cemetery Unit No. 1 of Bor Ovoo Site

only stone mounds and lack an enclosure. This grave structure could be called a round grave.

The round graves in Cemetery Unit No. 1 consist of 21 graves, which are the main type of grave. Round Graves No. 1, No. 2 and No. 11, and Figured Grave No. 8 were excavated on this occasion (Fig. 13). Round Graves No. 1 and No. 2 are located relatively close in the south-eastern area of this cemetery (Fig. 14). On the other hand, Round Grave No. 11 and Figured Grave No. 8 are located in the south-eastern part of the cemetery (Fig. 37). The figured graves are concentrated in the south-eastern part of the cemetery and three figured graves are arranged in a line (Fig. 12). Evidence that construction of Grave No. 26 destroyed Khirigsuur No. 7 (Fig. 12) indicates that figured graves are at least later than Khirigsuur in the chronology. Archaeological evidence from Bor Ovoo Site indicates that figured graves spread from eastern Mongolia to central Mongolia, although Khirigsuur and round graves spread from western Mongolia to central Mongolia.

In addition to graves, this cemetery has four rectangular stone constructions with paved stones and erected stones around them (Fig. 13). These are conjectured to be ritual stone structures of the same kind found at Khyar Kharaach Site. This suggests that there was some kind of relationship between Khrigsuur and the ritual stone structures, as both

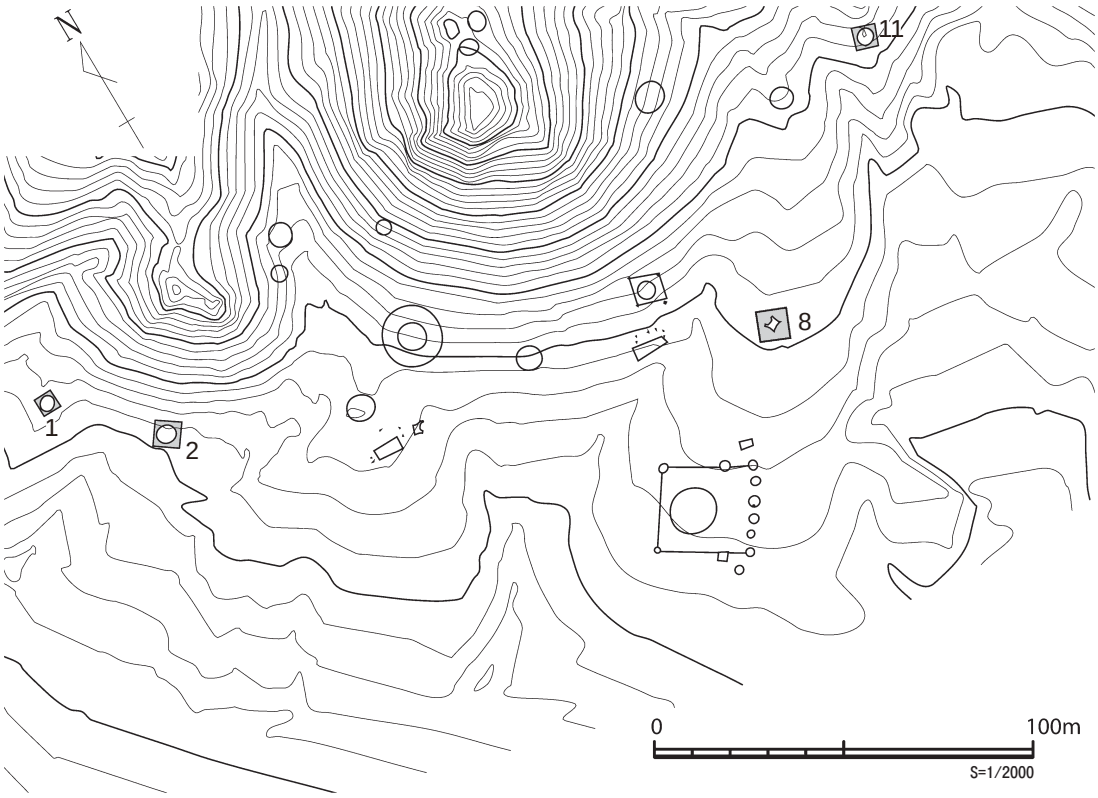


Fig.13 Excavation location of Cemetery Unit No. 1 of Bor Ovoo Site

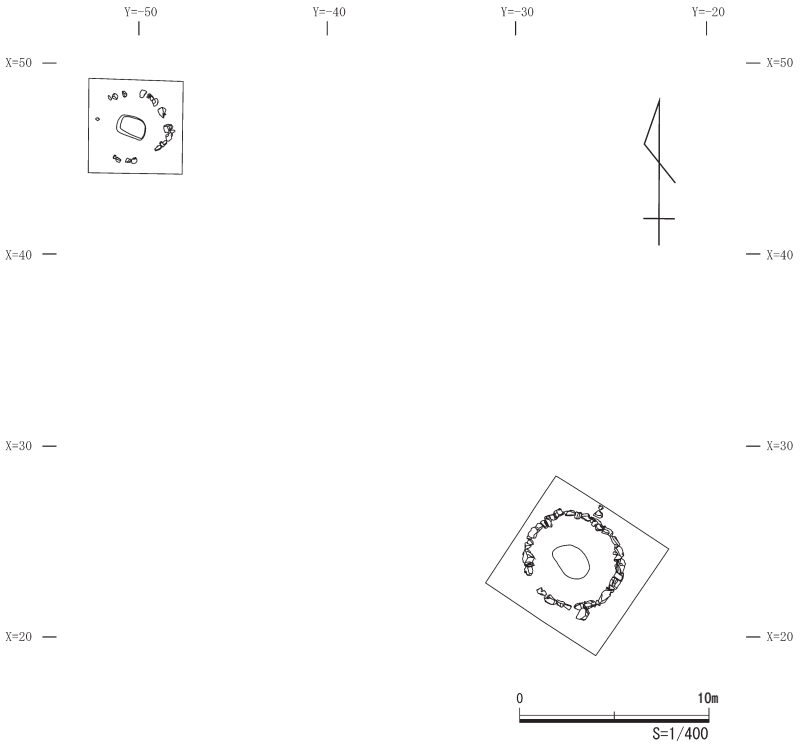


Fig.14 Grave No. 1 and Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

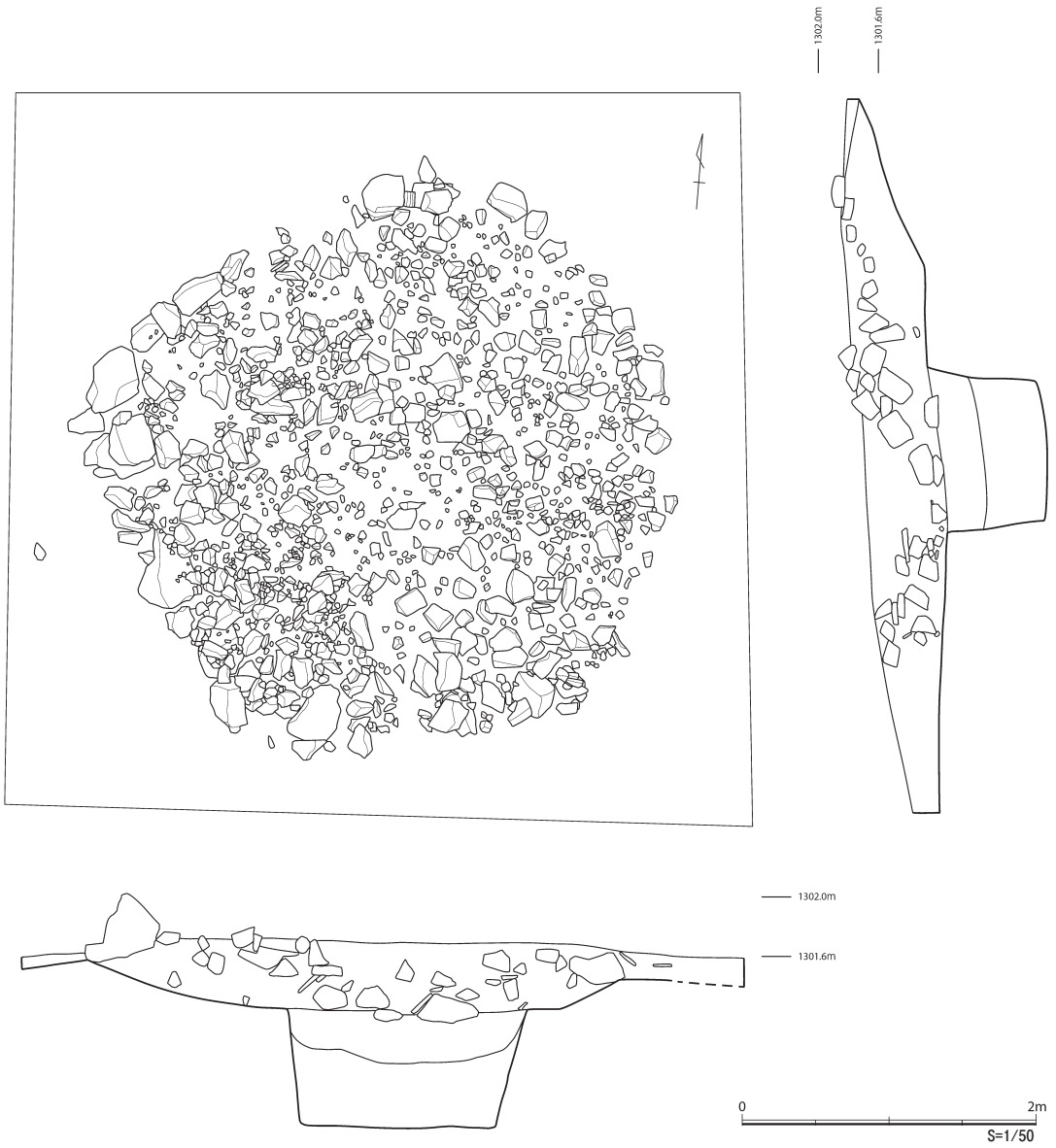


Fig.15 Grave No. 1 at Cemetery Unit No. 1 of Bor Ovoo Site

1 Before excavation *2 After removal of surface soils*

Fig.16 Grave No. 1 at Cemetery Unit No. 1 of Bor Ovoo Site

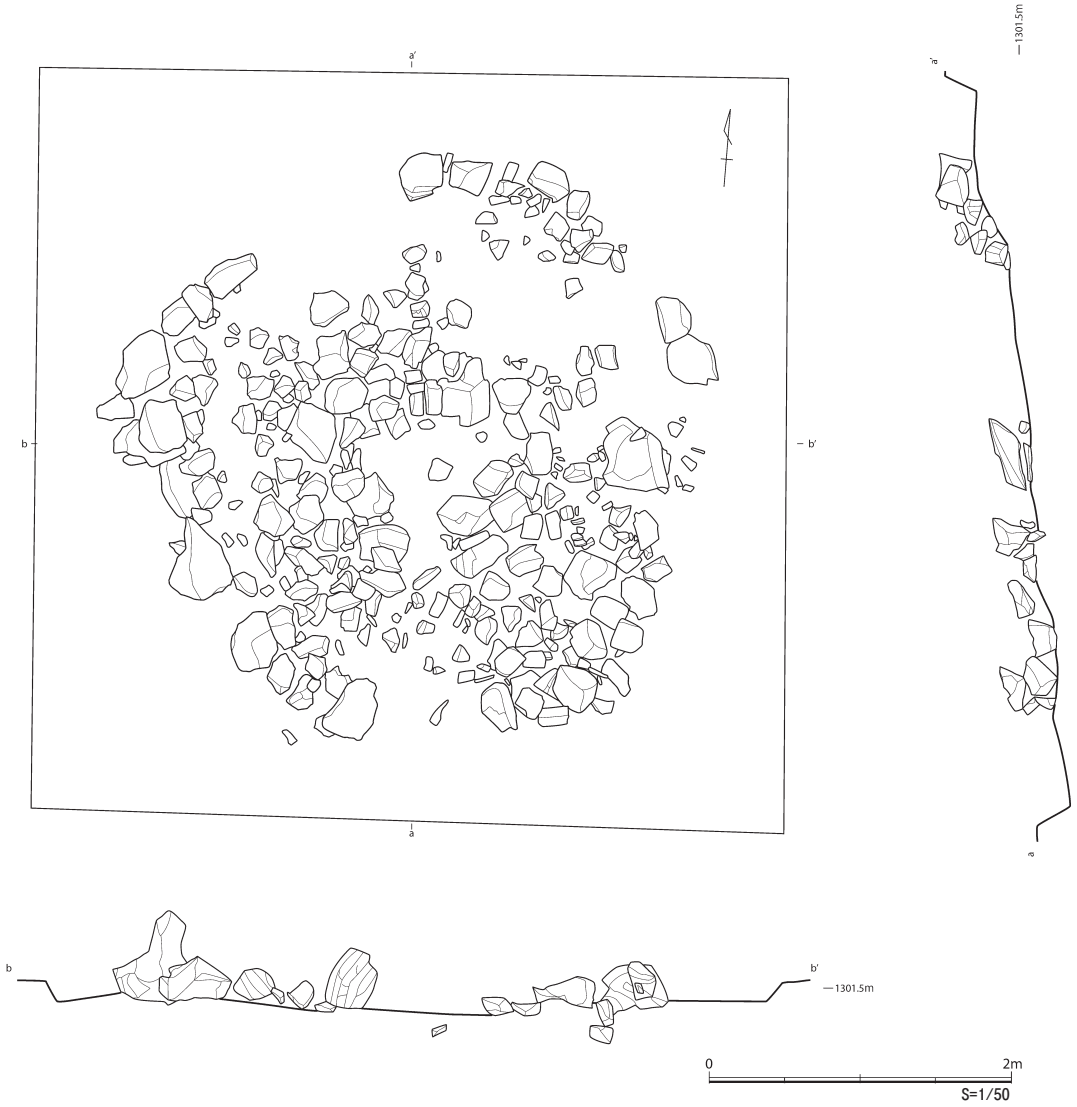


Fig.17 Grave No. 1 at Cemetery Unit No. 1 of Bor Ovoo Site

1 After removal of paved stones *2 Burial pit and stone fence*

Fig.18 Grave No. 1 at Cemetery Unit No. 1 of Bor Ovoo Site

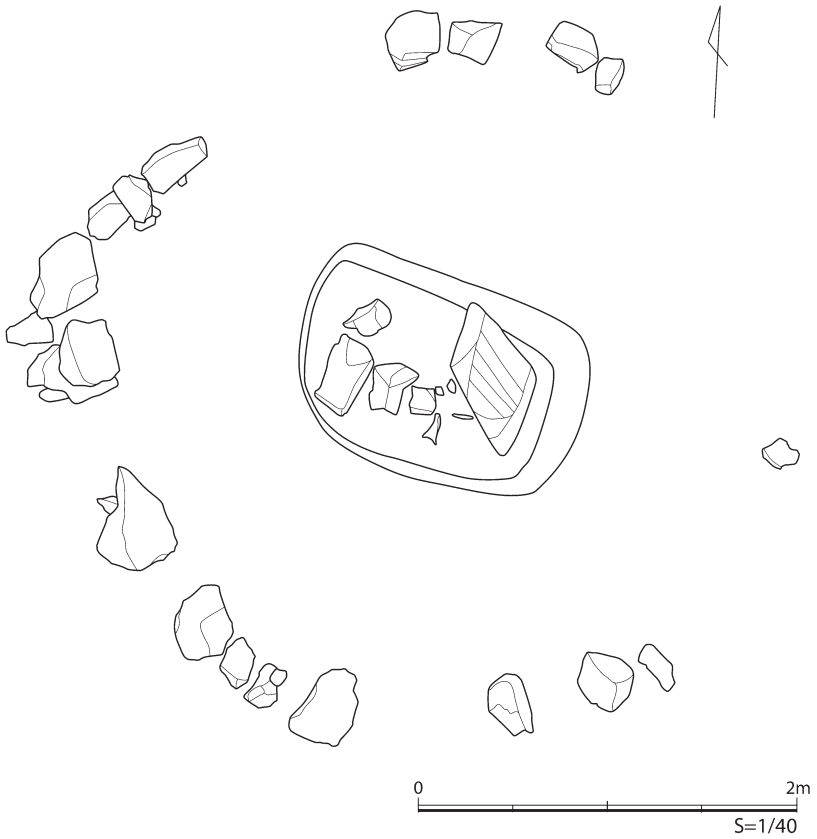


Fig.19 Grave No. 1 at Cemetery Unit No. 1 of Bor Ovoo Site

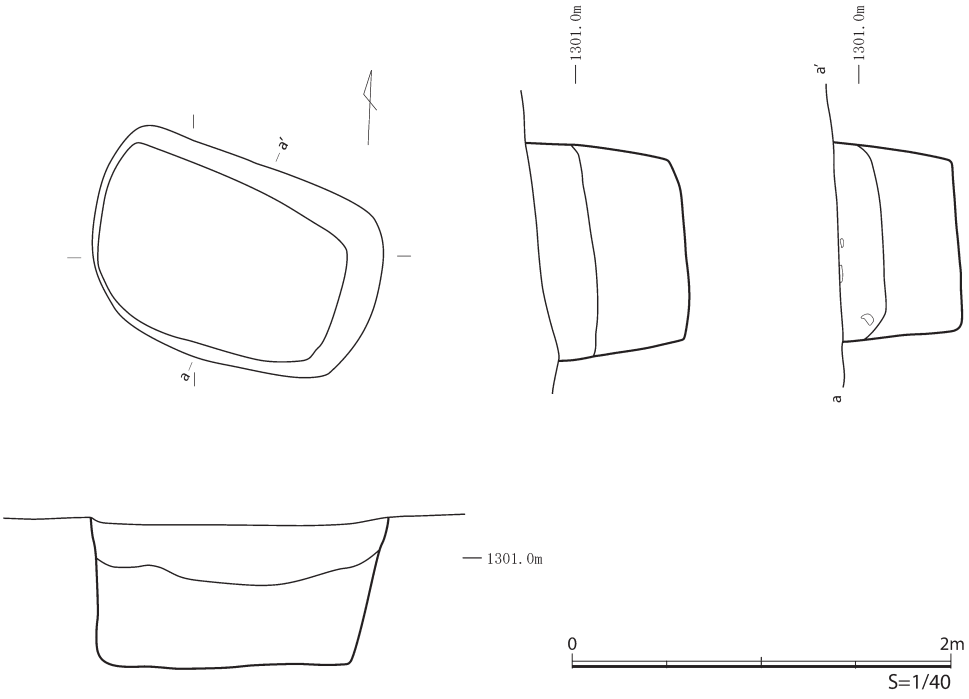


Fig.20 Burial pit of grave at Cemetery Unit No. 1 of Bor Ovoo Site

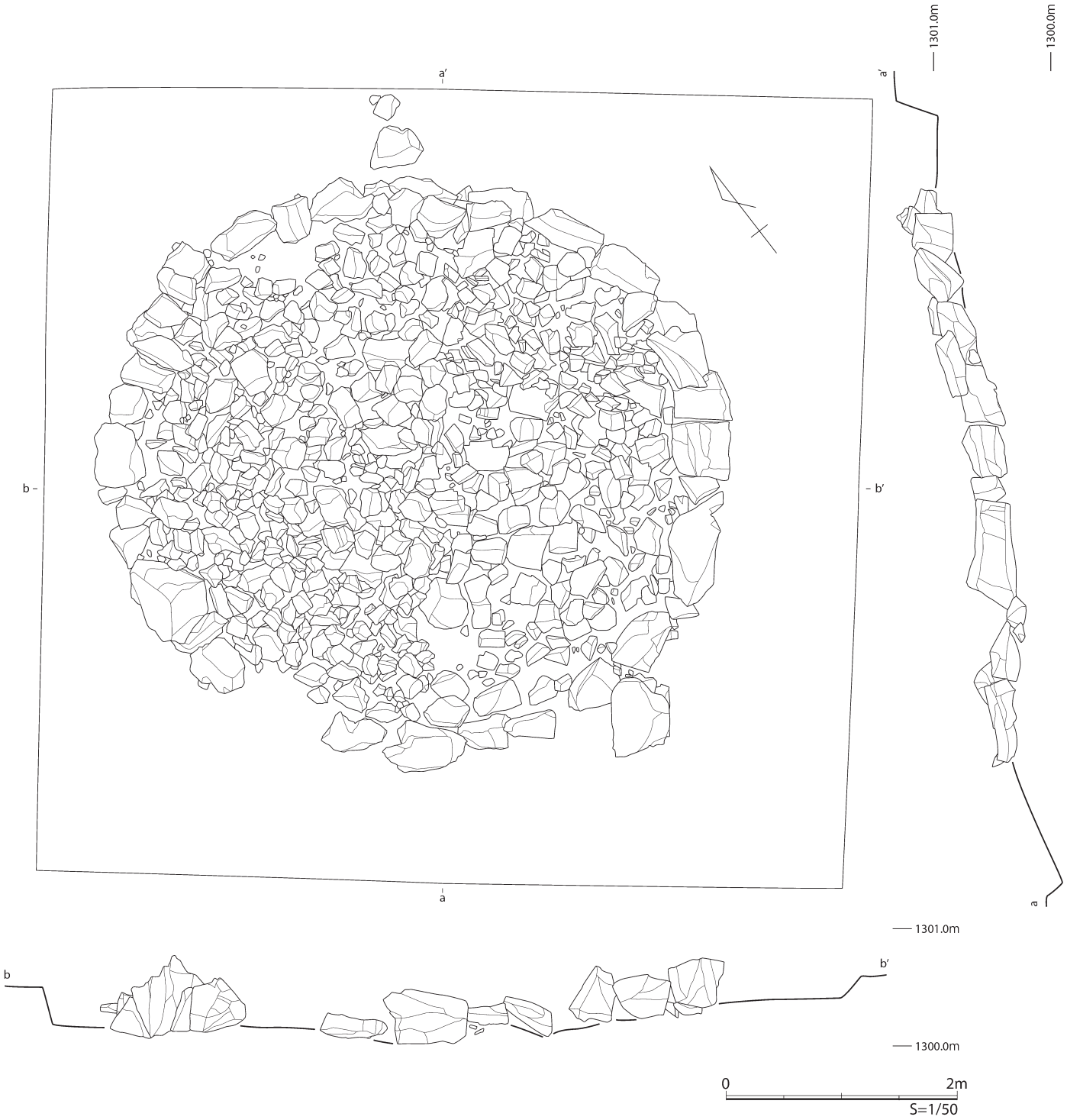


Fig.21 Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

archaeological features are usually located in close proximity at these sites.

3. Round graves

Bor Ovoo Grave No. 1 (Fig. 15 – Fig. 20)

Graves No. 1 and No. 2 are located at the western edge of the cemetery (Fig. 13, Fig. 14). They are not well preserved and lack stone mounds (Fig. 16-1). For this reason, we tried to excavate these graves. Grave No. 1 is a small round grave with a diameter of 3.8 m. (Fig. 15). Although it is thought to be a stone mound piled with stones, a round stone fence is the only well-preserved feature of this grave (Fig. 16-2). The burial pit was found in the center of the round grave and a few of the stones from the stone mound had dropped into the burial pit (Fig. 18-1, Fig. 19). The burial pit has a rectangular plan and is 1.6 m. in length, 1.1 m. in width and 60 cm. in depth (Fig. 18-2, Fig. 20). The burial pit did not contain any artifacts or human bones.

Grave No. 1 is the same kind of round grave as

Fig.22 Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

1 Before excavation *2 After removal of surface soils*

Fig.23 Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

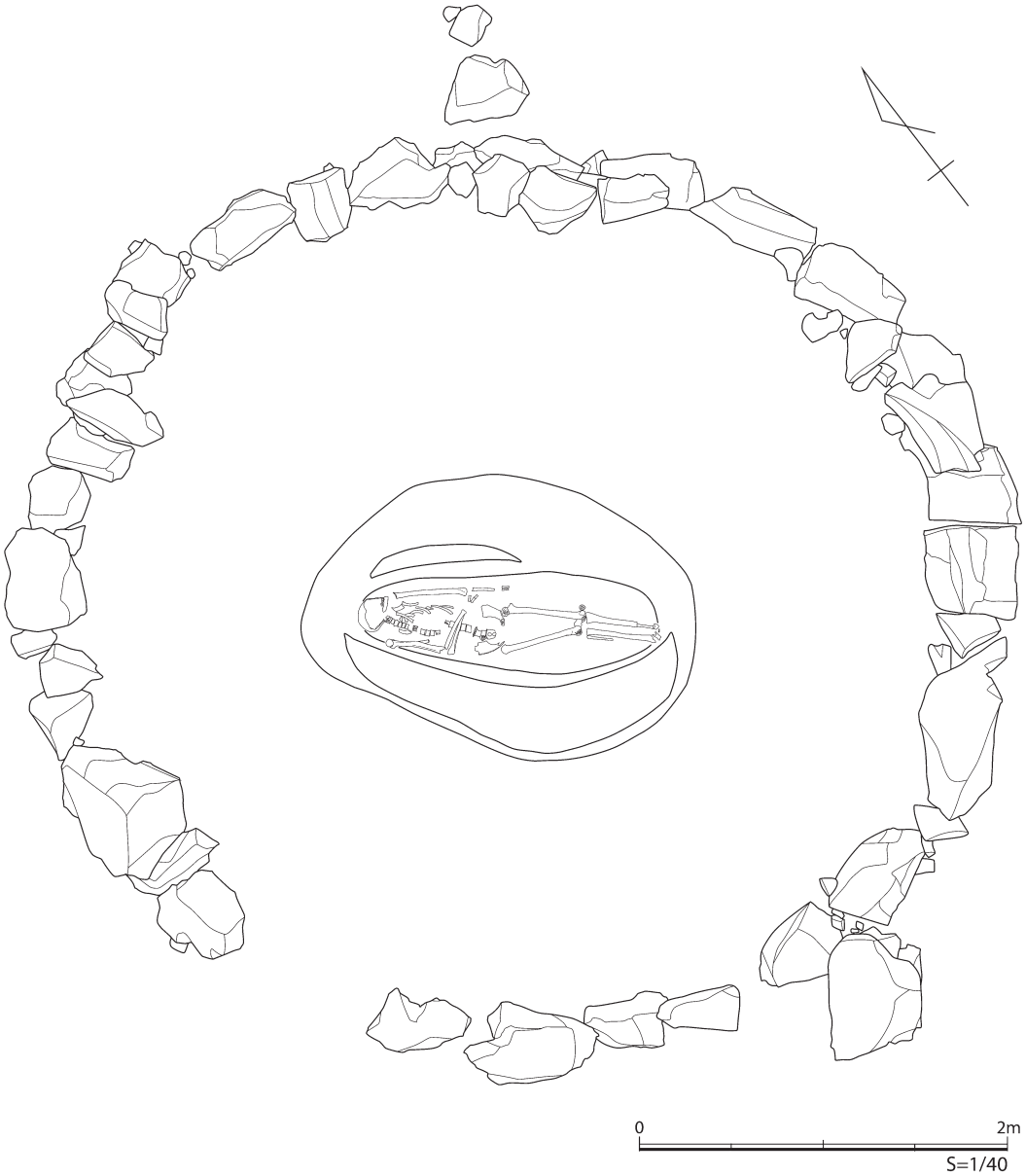


Fig.24 Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

1 After removal of paved stones *2 Cover stones*

Fig.25 Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

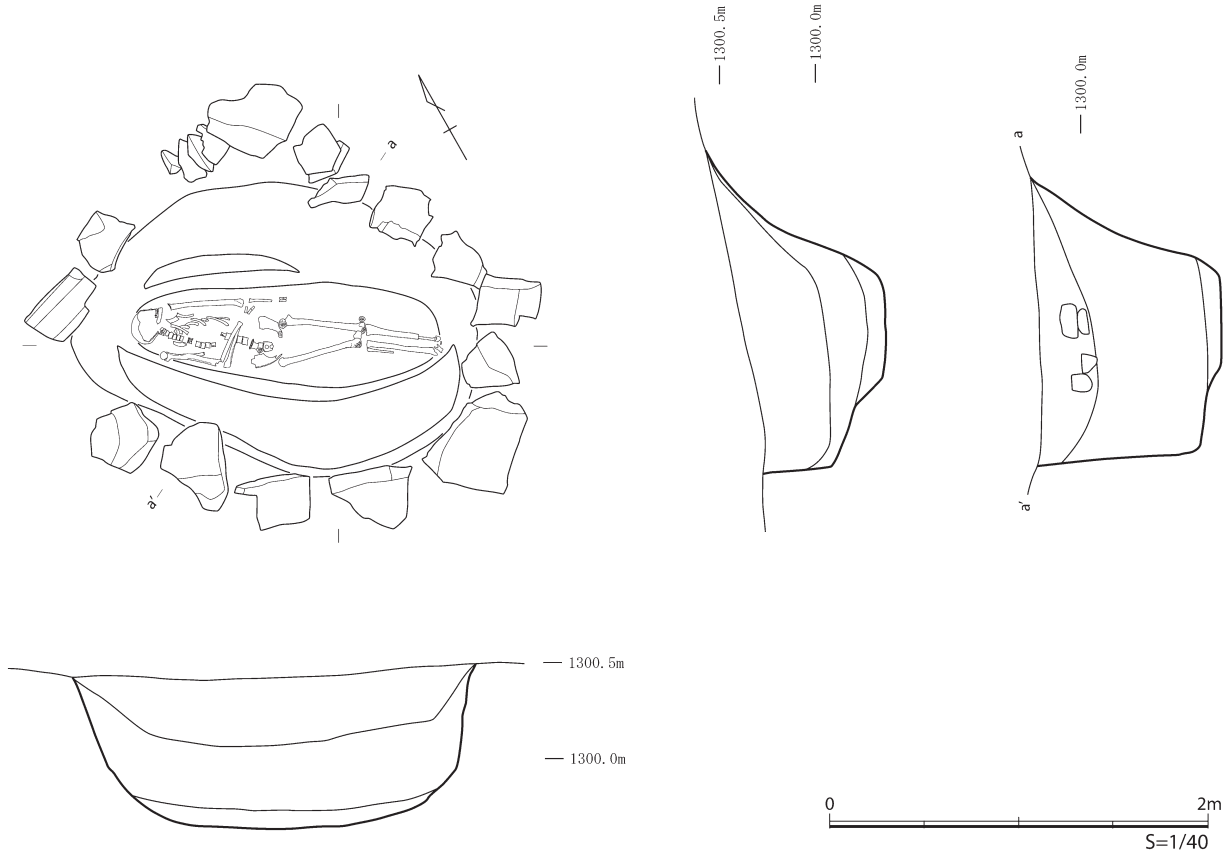


Fig.26 Burial pit of Grave No. 2 at Cemetery Unit No. 1 of Bor Ovoo Site

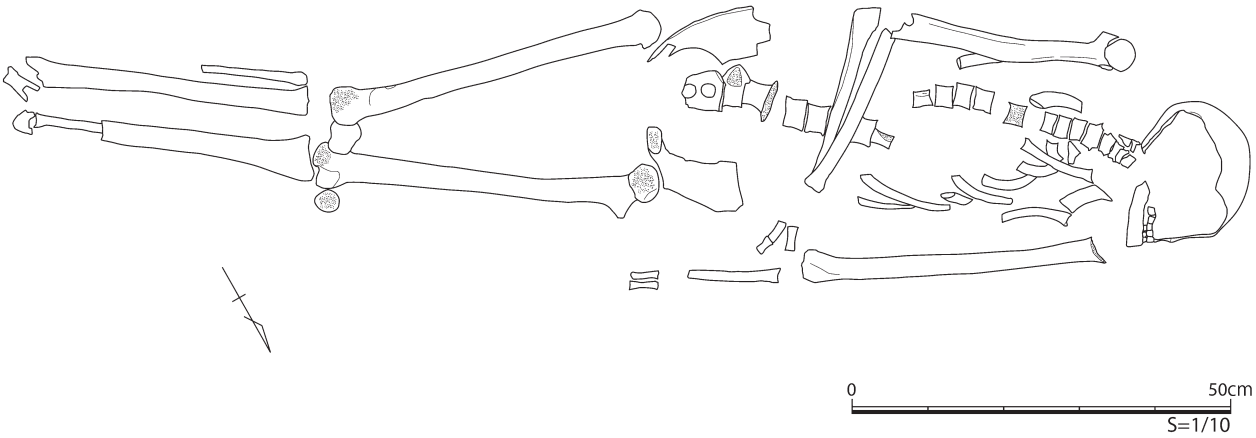


Fig.27 Human skeletons from Grave No. 2 at Unit No. 1 of Bor Ovoo Site

Fig.28 Human skeletons from Grave No. 2 at Unit No. 1 of Bor Ovoo Site

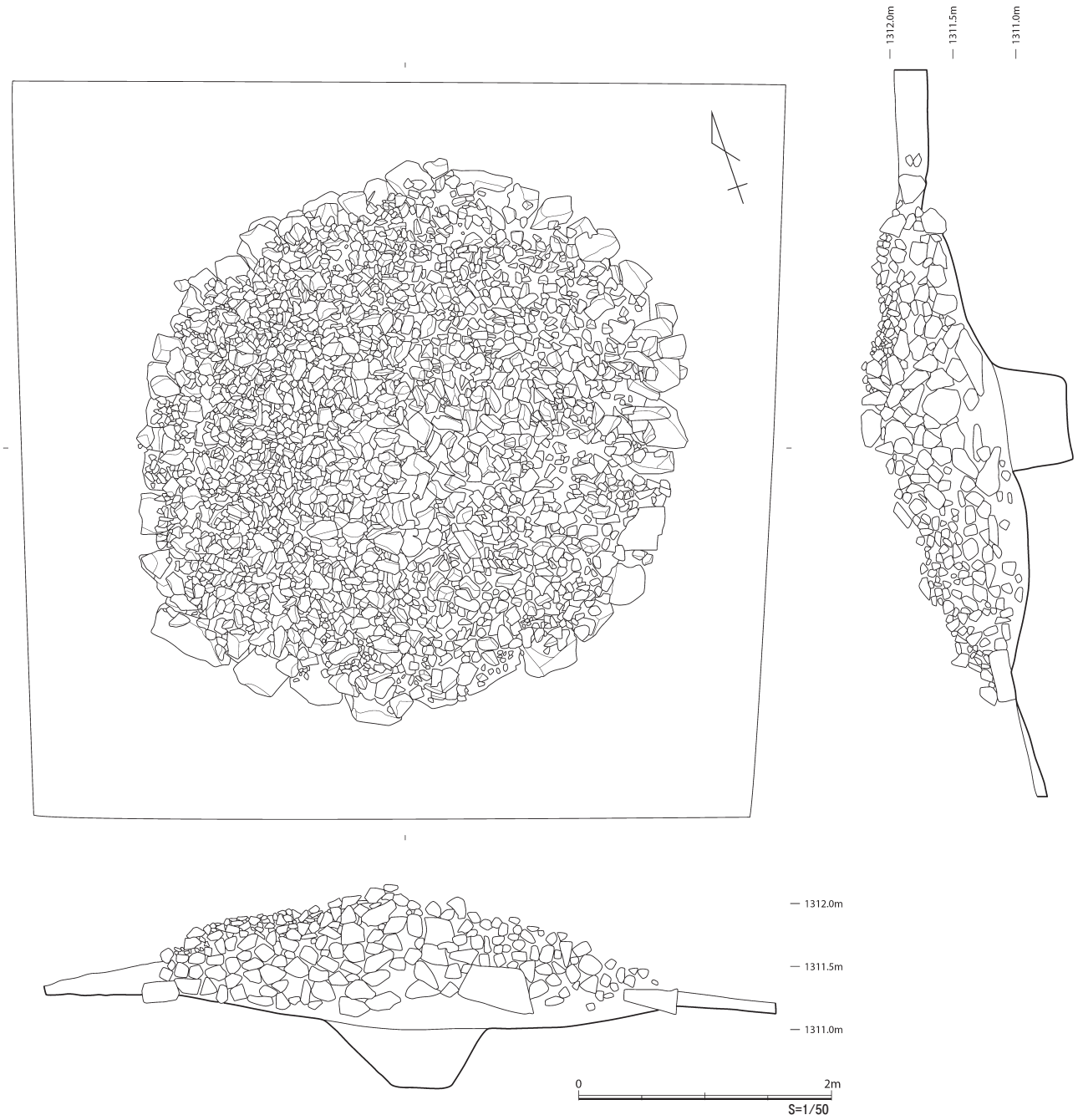


Fig.29 Grave No. 11 at Cemetery Unit No. 1 of Bor Ovoo Site

that of Grave No. 2. It is thought that, during the burial process, the pit was first dug from the surface, and that the deceased individual was then placed in the pit and buried. Then, a round stone fence was constructed around the pit to enable people to determine the burial location, after which a stone mound was constructed and stones were piled up inside the stone fence. The individual buried in Grave No. 1 is conjectured to be a female or a child, because the size of the burial pit of Grave No. 1 is much smaller than that of Grave No.2, which contained an adult individual.

Bor Ovoo Grave No. 2 (Fig. 21 – Fig. 28)

Grave No. 2 is a round grave and consists of a stone mound 5.0 to 5.5 m. in diameter (Fig. 21, Fig. 23-1). At the time of our excavation work, the center portion of the stone mound had already been lost, but the round stone fence of the round grave was well preserved. A stone fence which is composed of relatively large rectangular stones was put in the circle and stones were piled up inside the round stone fence (Fig. 21, 22). The burial pit is located in the center of the stone mound, in which human skeletons were found (Fig. 24). The burial pit is 2.1 m. in length, 1.5 m. in width and 80 cm. in depth, and comprises of a double burial pit. The human bones were placed on the bottom of the double burial pit, a fact which indicates the possibility that a wood coffin was placed

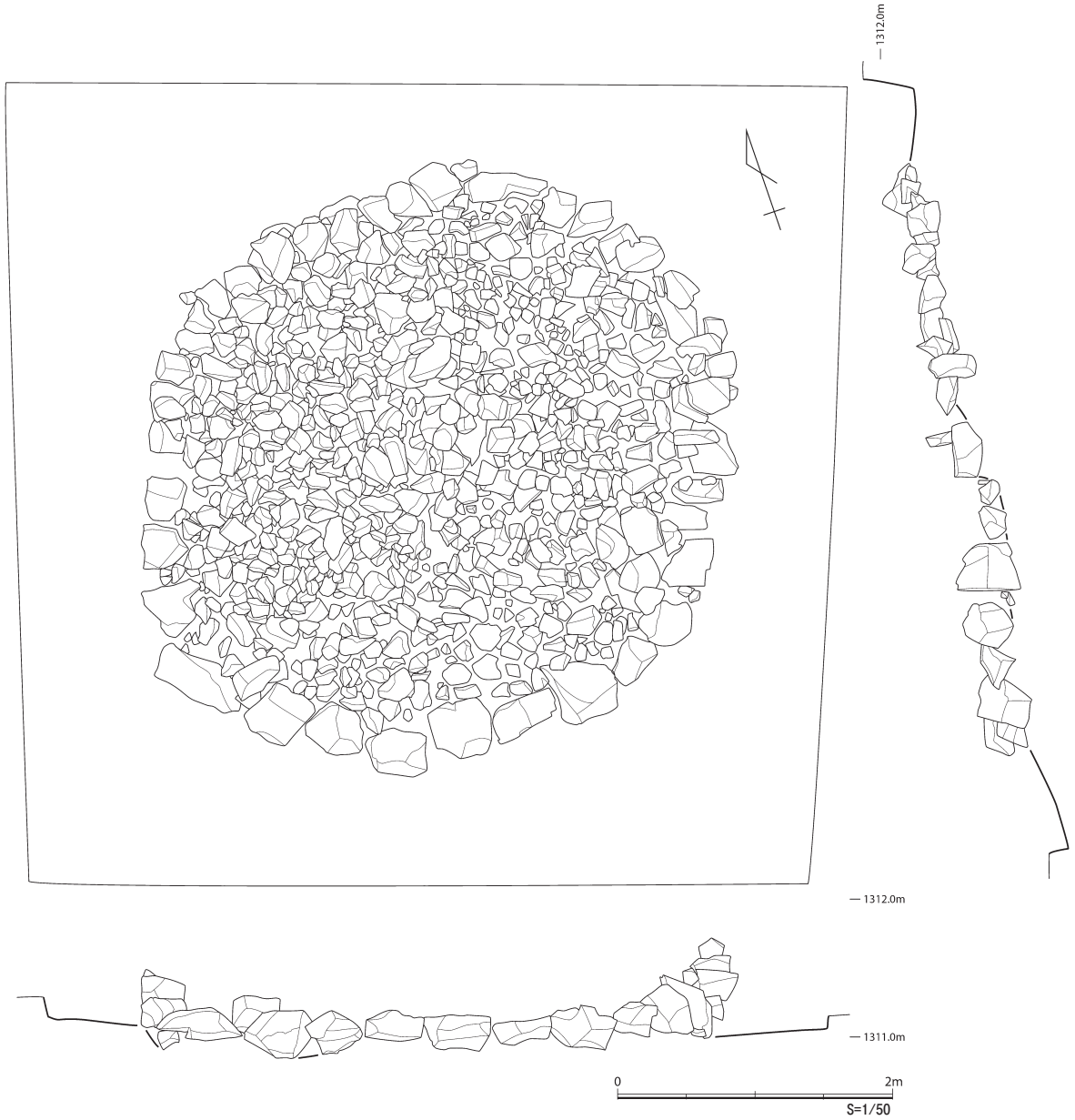


Fig.30 Grave No. 11 at Cemetery Unit No. 1 of Bor Ovoo Site

1 Before excavation *2 After removal of surface soils*

Fig.31 Grave No. 11 at Cemetery Unit No. 1 of Bor Ovoo Site

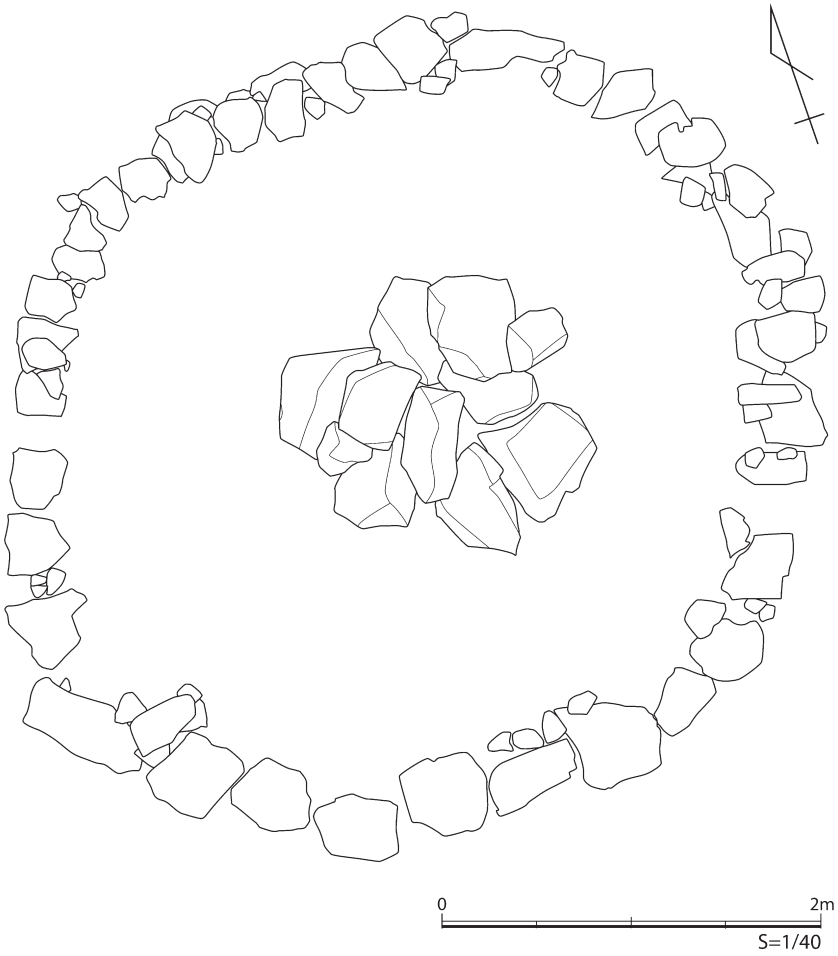


Fig.32 Stone fence and cover stones of Grave No. 11 at Cemetery Unit No. 1 of Bor Ovoo Site

1 Profile of stone mounds

2 After removal of stone mounds

3 Cover stones and stone fence

4 Burial pit and stone fence

Fig.33 Grave No. 11 at Cemetery Unit No. 1 of Bor Ovoo Site

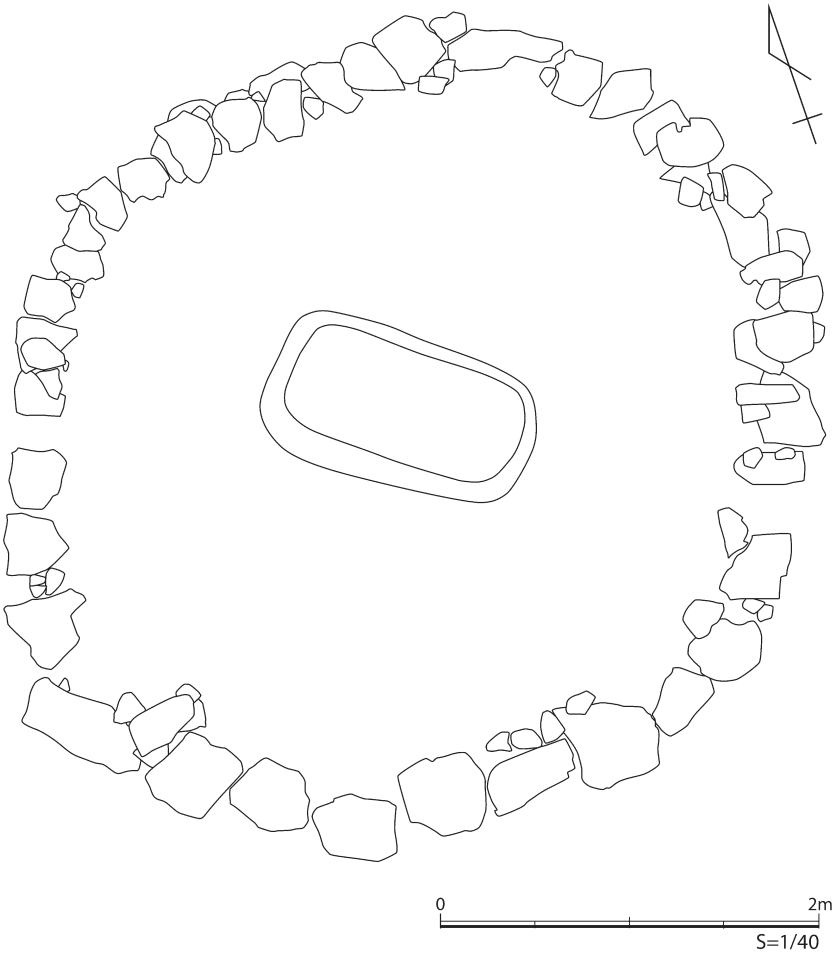


Fig.34 Stone fence and burial pit of Grave No. 11 at Unit No. 1 of Bor Ovoo Site

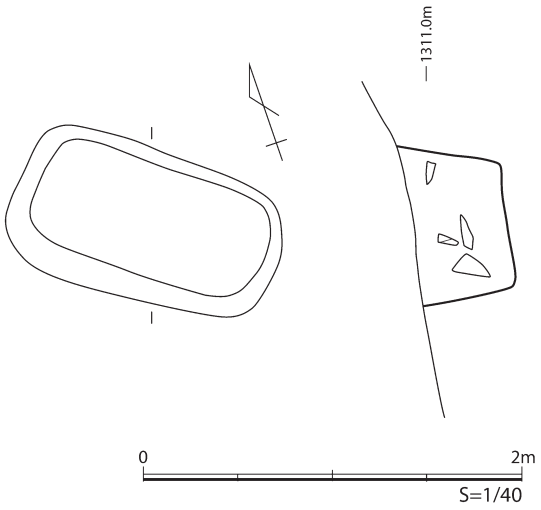


Fig.35 Burial pit and fence stone of Grave No. 11 at Unit No. 1 of Bor Ovoo Site

1 Stone mound *2 Looted pit*

3 Finding of human bones *4 Finding human bones*

Fig.36 Burial pit of Grave No. 11 at Cemetery Unit No. 1 of Bor Ovoo Site

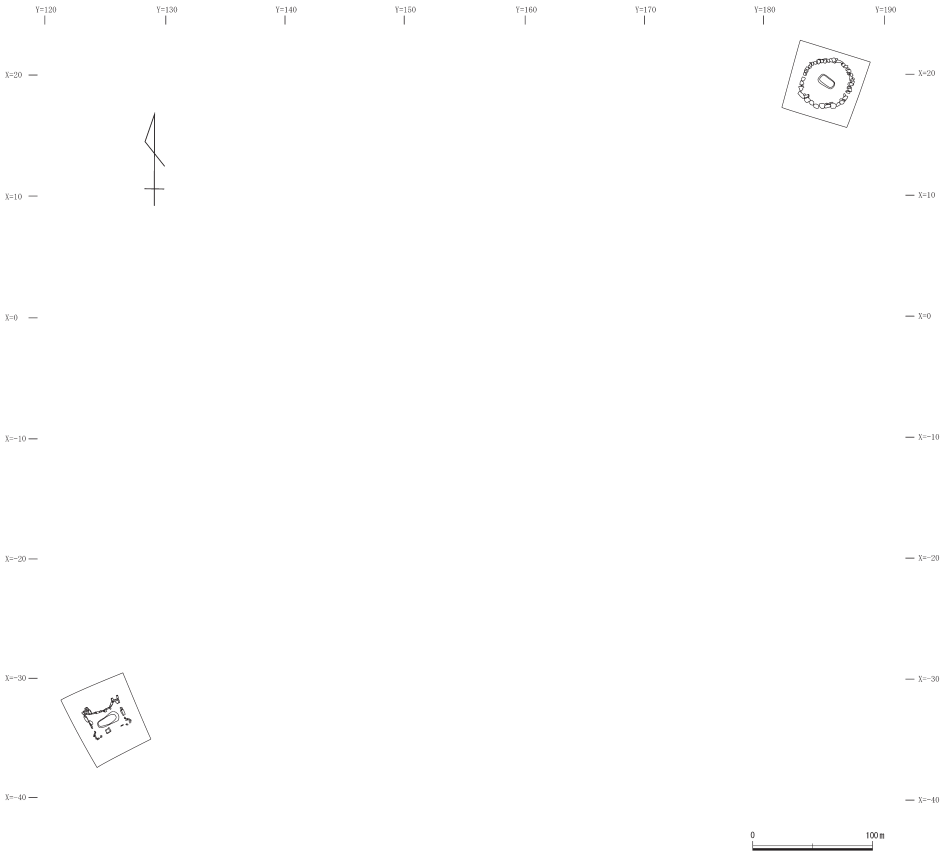


Fig.37 Grave No. 11 and Grave No. 8 at Unit No. 1 of Bor Ovoo Site

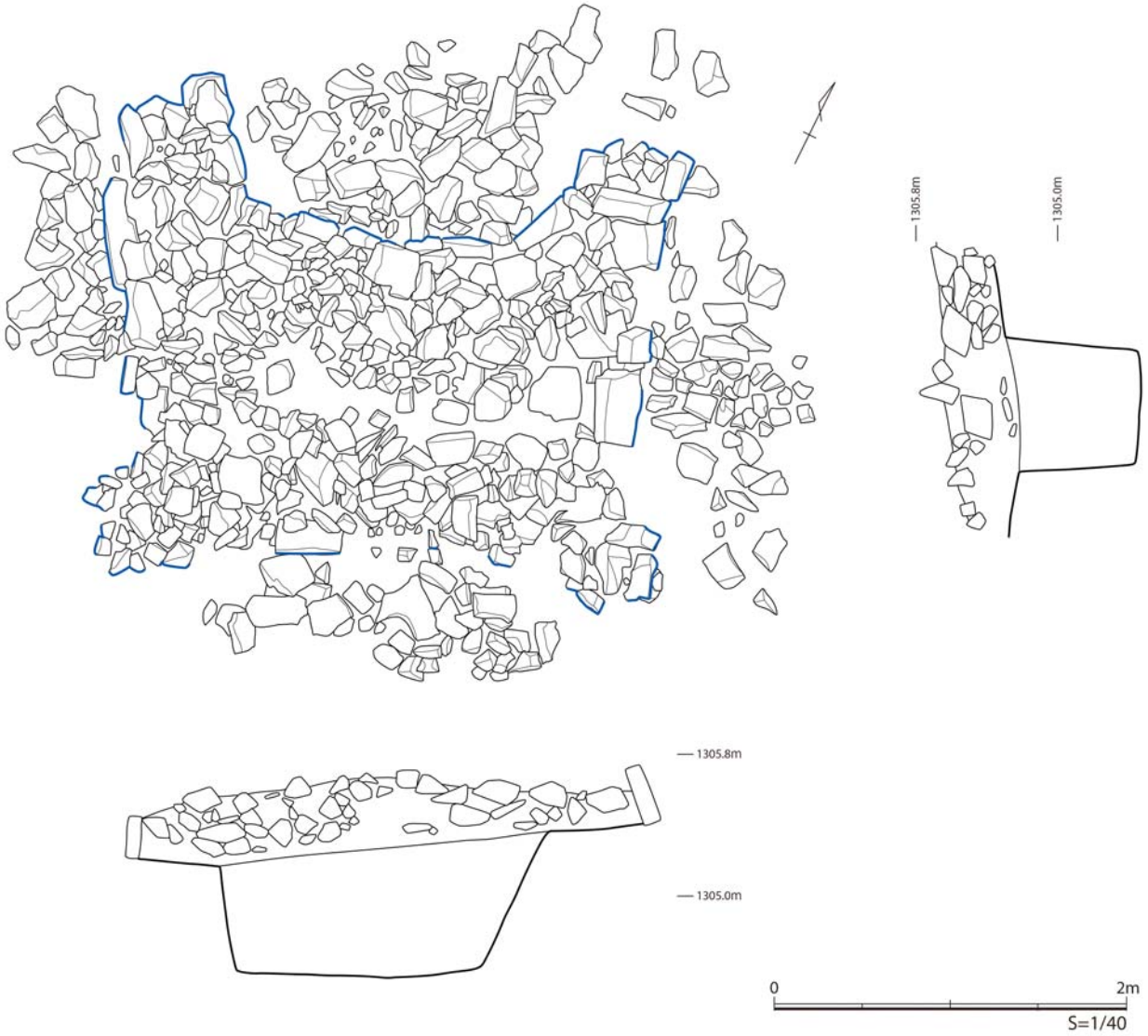


Fig.38 Grave No. 8 at Unit No. 1 of Bor Ovoo Site

in the burial pit (Fig. 26). The deceased individual was oriented to the west and was turned sideways to be erected to the north (Fig. 27, 28). Although no cover stones were discovered on the burial pit, some stones were found to have fallen inside the burial pit (Fig. 22, Fig. 25), which may indicate that a wooden coffin or a body wrapped in clothes had been placed in the burial pit. It is thought that some stones dropped into the burial pit after the disappearance of organic materials in the burial pit. The human skeleton has been identified as an adult male dating to 1316 – 1207 cal. BC (77.3%, 2 σ).

Bor Ovoo Grave No. 11 (Fig. 29 – Fig.35)

Grave No. 11 is located in the southeast of Cemetery Unit No. 1 (Fig. 12). This grave is also a relatively smaller round grave (Fig. 29). However, the stone mound is preserved relatively well (Fig. 31-1, Fig. 33-1), and it is believed that the original mound style resembles a Khirigsuur. Grave No. 11 is a stone mound that is 4.2 m. in diameter and 1m. in height, and the burial pit is located in the center of the grave under the surface (Fig. 30, Fig. 31). The burial pit is 1.4 m. in length, 0.8 m. in width, and 50 cm. in depth (Fig. 34, Fig. 35). No cover stones were found on the burial pit. It is thought that people constructed a stone mound piled up with stones after having filled in the burial pit. The burial pit did not contain any artifacts or human bones.

Grave No.11 is a round grave of the same kind as Grave No.1 and Grave No.2., in which the burial pit was dug from the surface and filled in again after the deceased individual had been placed in. Then, a round stone fence was constructed around the burial pit (Fig. 34) and a stone mound was constructed by piling up stones inside the round stone fence (Fig. 29).

Bor Ovoo Grave No.13 (Fig.36)

Grave No. 13 is a round grave with stone mounds measuring around 5 m. in diameter (Fig. 36-1). This grave had already been looted in recent years prior to our excavations (Fig. 36-2). After having cleaned up

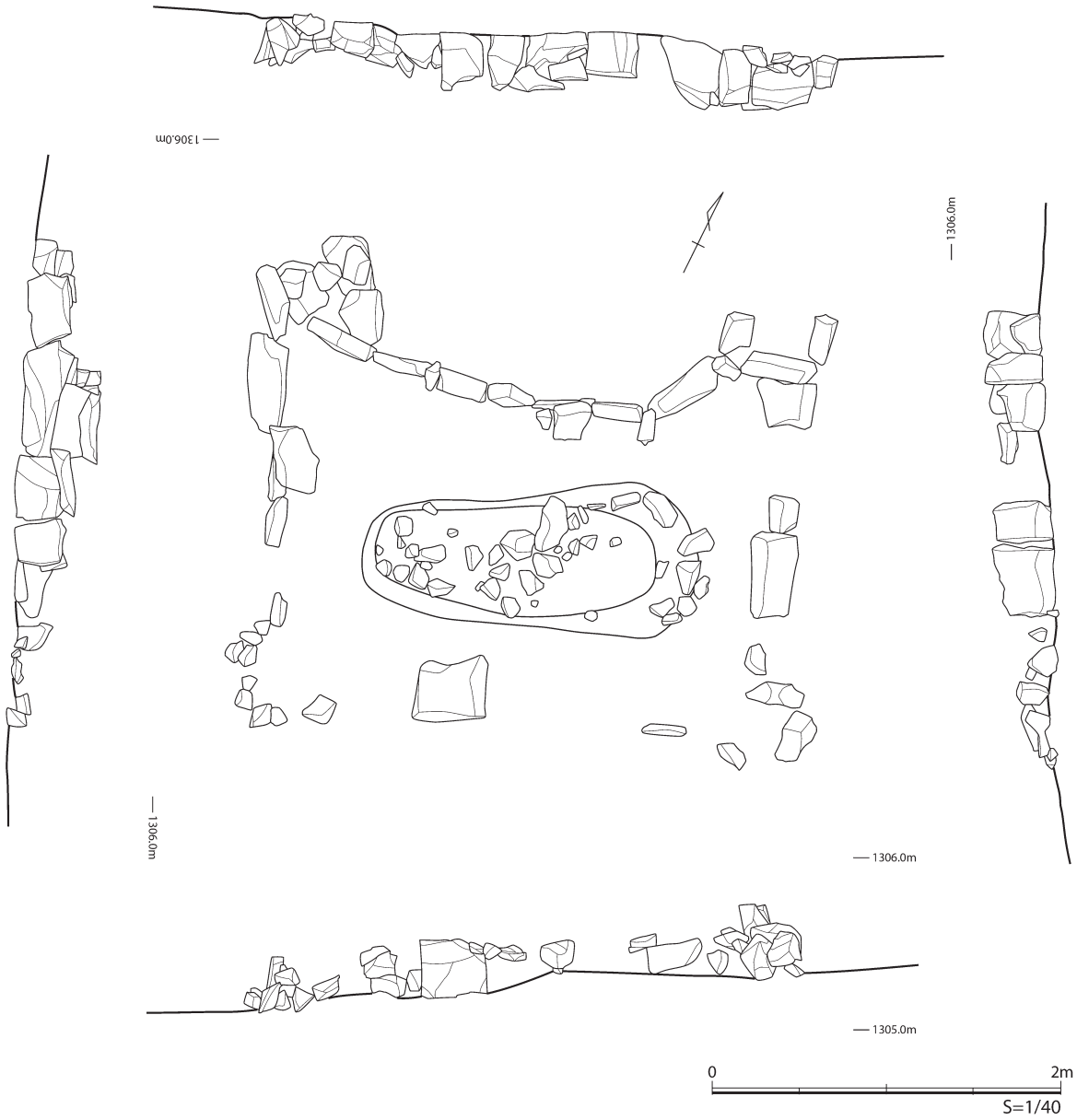


Fig.39 Grave No. 8 at Unit No. 1 of Bor Ovoo Site

1 Before excavation *2 After removal surface soils*

Fig.40 Grave No. 8 at Unit No. 1 of Bor Ovoo Site

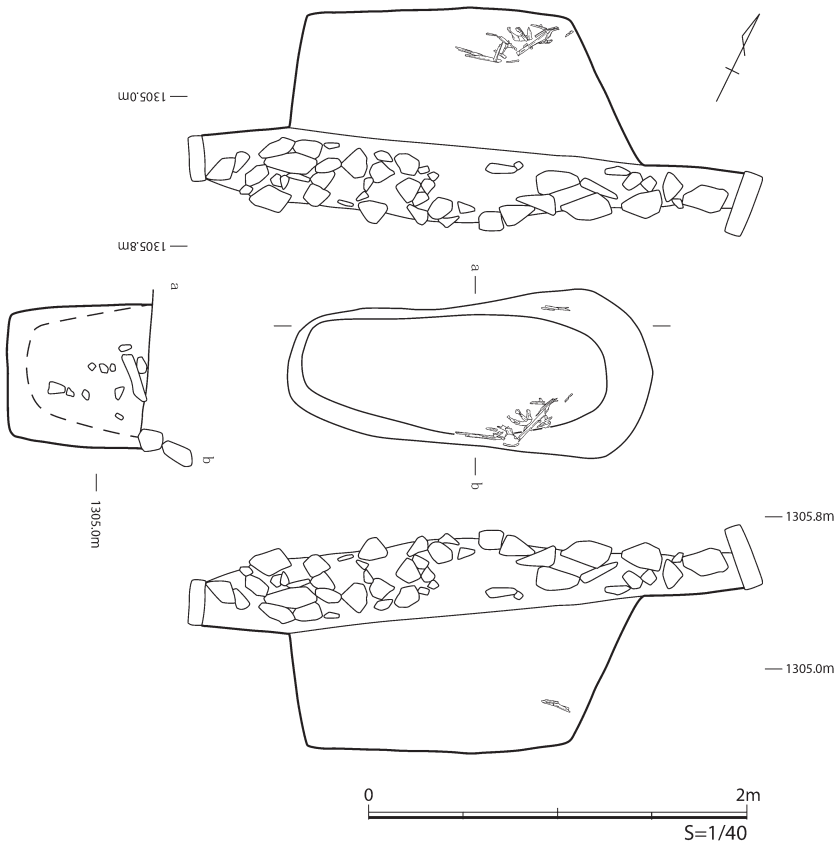


Fig.41 Grave No. 8 at Unit No. 1of Bor Ovoo Site

1 Figured grave

2 Figured grave

3 After removal of paved stones

4 Finding of human bones at burial pit

Fig.42 Grave No. 8 at Unit No. 1of Bor Ovoo Site

the looted pit, we found a human skeleton that had been left by the looters (Fig. 36-3, 4). We dated this skeleton and it dates to 1397 – 1259 BC (93.4 %, 2 σ). The dating is very similar that of Grave No. 2.

4. Figured graves

Grave No. 8 (Fig. 38 – Fig. 41)

Grave No. 8 is located southwest from grave No. 11 (Fig. 37). This grave is a smaller sized figured grave that is 3.0 m. in length and 2.6 m. in width (Fig. 38). Four corners extend out in a rectangular shape (Fig. 39, Fig. 42-1, 2, 3) and it is believed to date to a later time in the chronology of figured graves (Miyamoto 2016). Due to the grave's size, it has a burial pit which is located close to the stone fence (Fig. 39, 41). The burial pit had already been disturbed, and the human bones had been placed aside in two different long side directions (Fig. 42-4). The human bones consisted of a single individual. Because the rest of the human bones were in relatively good condition, it is probable that it was looted at an earlier stage. The human bones were identified as a young male. C14 dating of the human bones dates them to 1112 – 974 BC (91.2%). The other figured grave, No. 26, was constructed through the destruction of the enclosure of Khirigsuur No. 7 (Fig. 12). It is thought that the figured grave dates to a later period than the Khirigsuur or the round grave based in light of the nature of disturbance between the figured grave and Khirigsuur. In addition, the dating of human bones made it clear that Grave No. 8, a figured grave, is later than that of Grave No. 2 and No. 13, which are round graves.

5. Results of the research

Round graves at Bor Ovoo Site represent a different burial system to the usual Khirigsuur in that they have a burial pit instead of a stone cist. The results of these excavations indicate a remarkable discovery: that, Khirigsuur and round graves are earlier than figured graves in the chronological scheme. It is of particular note that the individuals buried in round graves were turned sideways.

Kovariev and Erdenebaatar mentioned that round graves of this kind are from what is called the Munkh-Khairhan culture, which dates to 1700 – 1400 BC and is distributed in central and western Mongolia (Kovalev & Erdenebaatar, 2009). The human bones in Grave No. 13, which was looted recently, date to 1397 – 1259 BC (93.4 %), which is the same dating as that of grave No. 2, dating to 1316 – 1207 cal. BC (77.3%). It is believed that the round graves in Bor Ovoo Site belong to a relatively late phase in the Munkh-Khairhan culture. Figured graves mainly distributed in middle Mongolia spread to this area to replace round graves. At least two group cemeteries as a unit of the clan or family group showing different animal symbols in rock art (Fig. 7 – Fig. 9) existed on the northern coast of Lake Olog Onur, where another social group originating from the middle of Mongolia moved here to construct figured graves in every cemetery. This situation seems to indicate the movement of a social group.

Through these excavations, we were able to clarify the dating of round graves and make a relative chronology between round graves and later figured graves. Because Khirigsuur and round graves co-existed in this cemetery site, these two grave customs may have existed comparatively close together on a temporal scale. Another issue which needs resolving in future research concerns the origin of round graves and the relationship between Khirigsuur and figured graves.

2 Excavations at Khyar Kharaach Site

Kazuo Miyamoto, Yoshinori Tajiri, Tsend Amgalantugs, Natsag Batbold and Lhagadorj Delgermaa

1. Purposes and location of the research site

Through excavations at Daram Site, Tevsh Site and Bor Ovoo Site conducted over the years, we have been able to construct a chronology of stone-slab graves in middle and eastern Mongolia (Миямото2013, Miyamoto, 2016). When we considered the locality of grave customs in the Mongolian Plateau, it became apparent that we needed a chronology of grave systems in western Mongolia. In order to resolve this issue, in 2014 we applied to undertake a JSPS research project entitled, "Interdisciplinary Research on the Formation Process of Herding Societies in the Eastern Eurasian Grasslands," which was accepted in 2015. Based on this JSPS Grant, the Kyushu University Advanced Asian Archaeological Center made an agreement on the "ANCIENT MONGOL KHUN PROJECT 2015 - 2018" a joint Mongolian-Japanese research project with the Institute of History and Archaeology in Mongolian Academy of Sciences. Following this, we conducted excavations at Khyar Kharaach Site. The excavations at Khyar Kharaach Site were held between the Kyushu University Advanced Asian Archaeology Research Center and the Institute of History and Archaeology in Mongolian Academy of Sciences from 13th to 23rd August, 2015. Professor Kazuo Miyamoto, Associate professor Yoshinori Tajiri, Dr. Keita Matsumoto and Mr. Masahiro Fukunaga from Kyushu University, and Mr. Tsend Amgalantugus, Mr. Natsag Batbold and Ms. Lhagvadorj Delgermaa from the Institute of History and Archaeology in Mongolian Academy of Science participated in excavations at this site.

Khyar Kharaach Site is located in Tonhil Som, Gobi Altai Aimag in Mongolia (Fig. 43). The site is situated on the slope of Mt. Khyar Kharaach, and several lakes exist in the north of the site. The site was discovered through a general survey conducted by a joint team of members from the Institute of Archaeology, Mongolian Academy of Sciences and National Research Institute of Cultural Heritage in

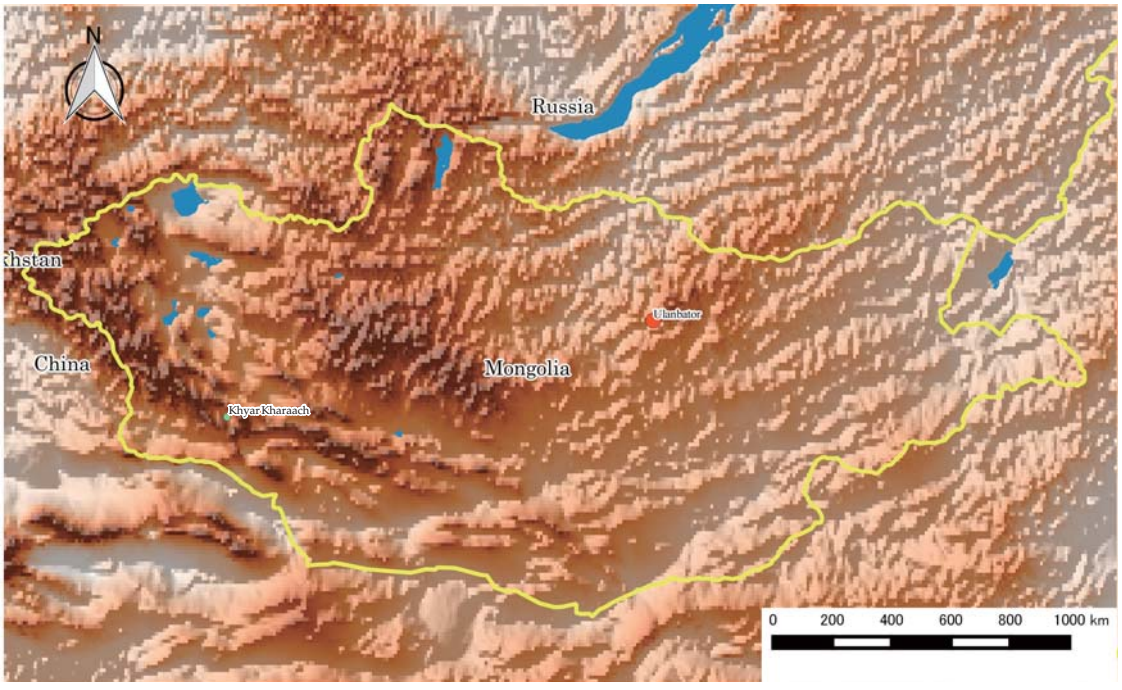


Fig.43 Location of Khyar Kharaach Site

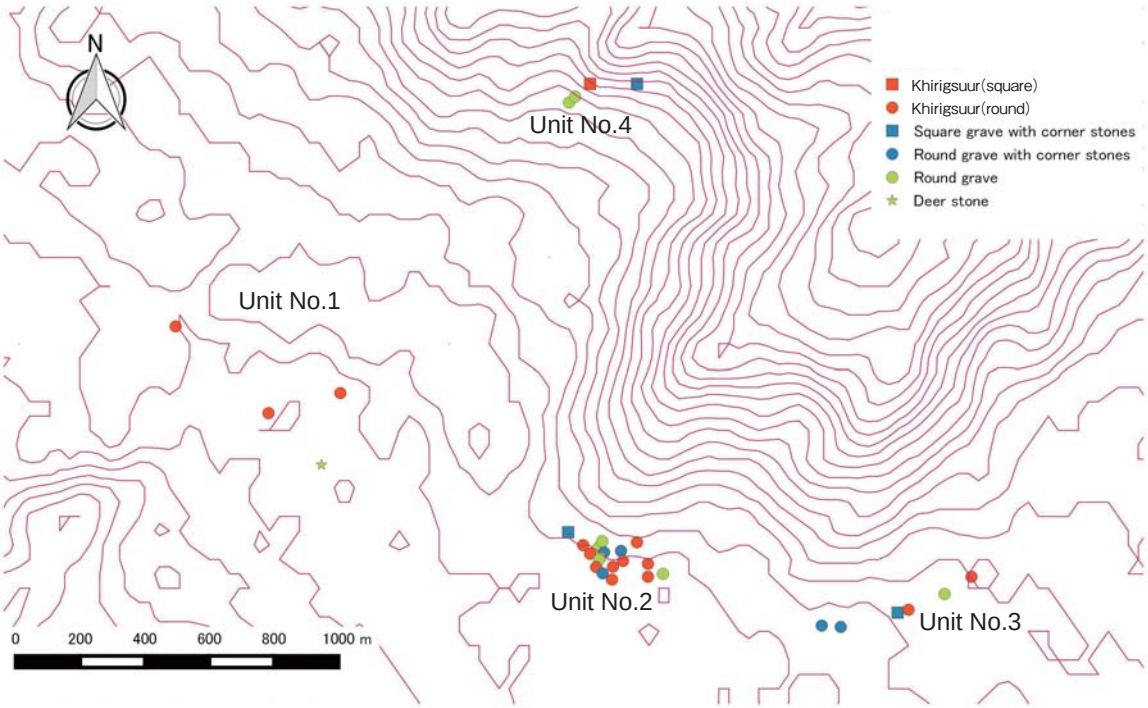


Fig.44 Distribution map of cemeteries at Khyar Kharaach Site

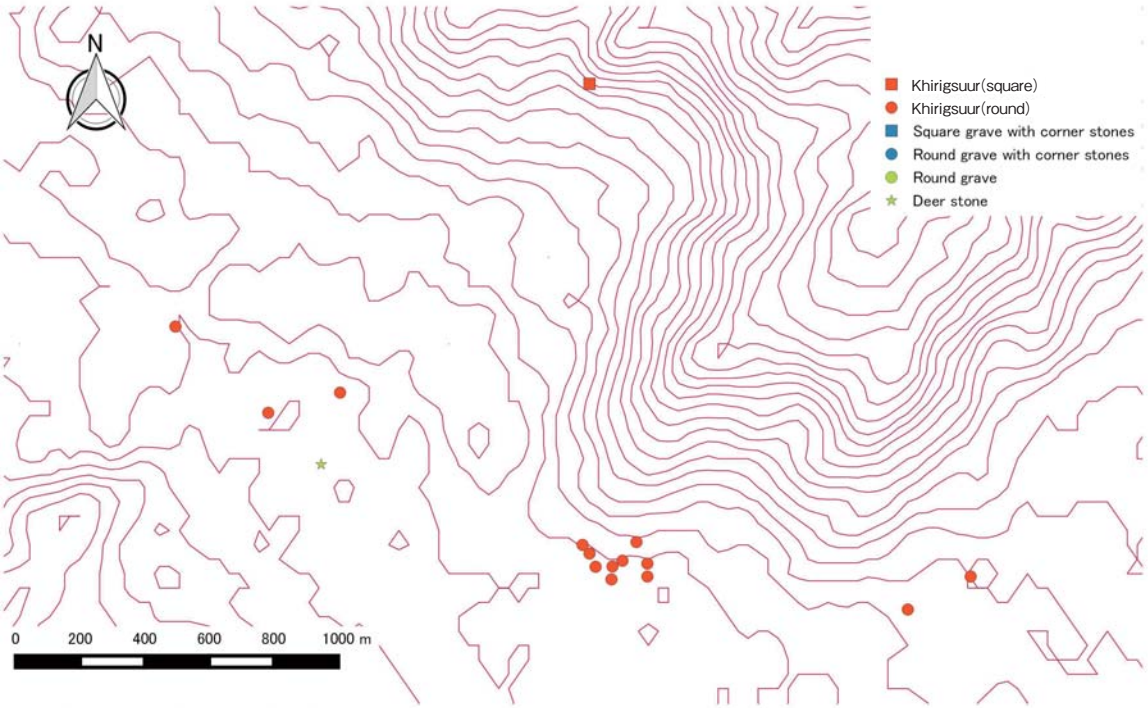


Fig.45 Distribution map of Khirigsuur and a deer stone at Khyar Kharaach Site

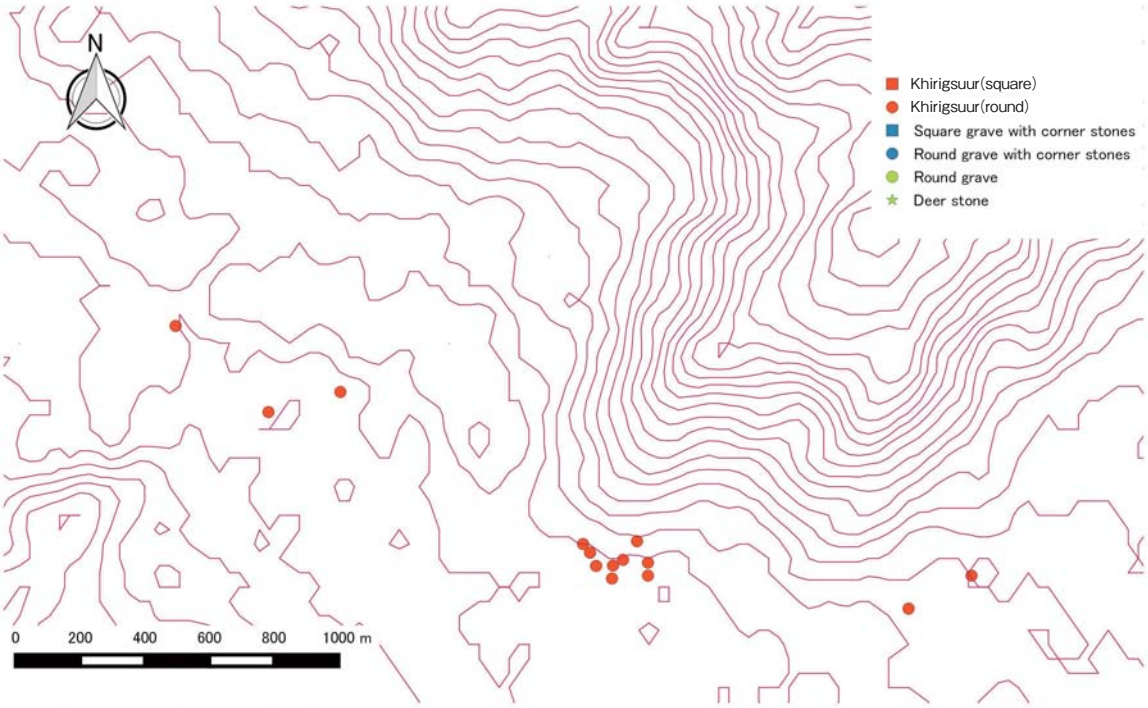


Fig.46 Distribution map of round Khirigsuur at Khyar Kharaach Site

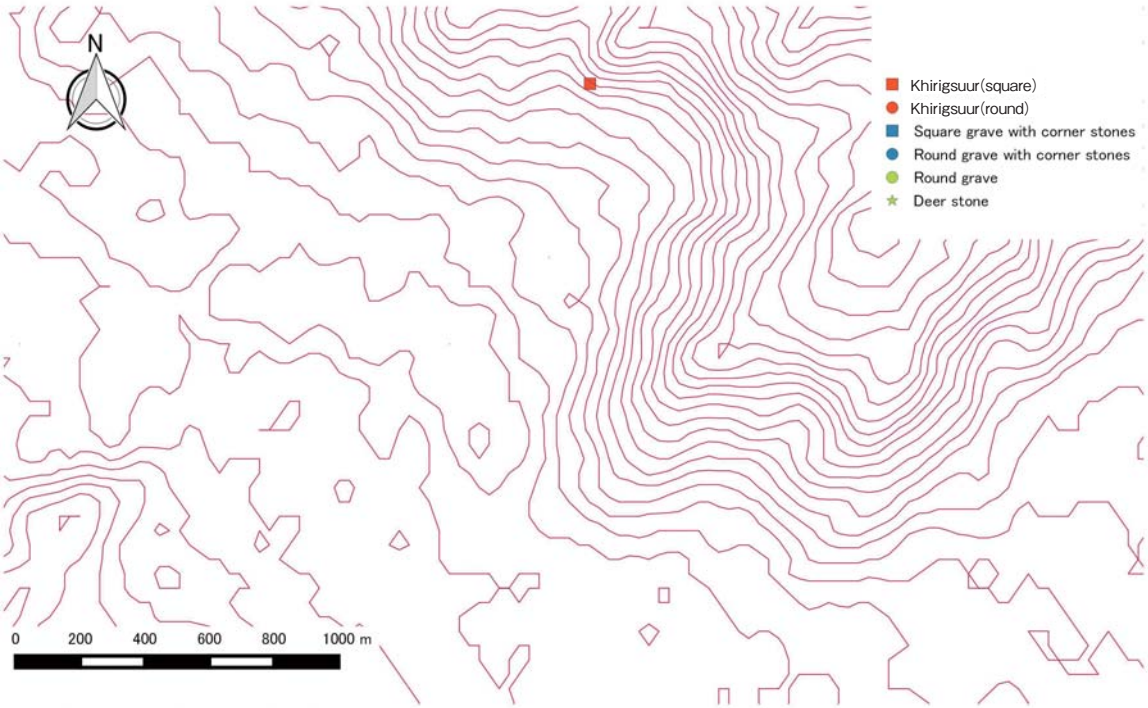


Fig.47 Distribution map of square Khirigsuur at Khyar Kharaach Site

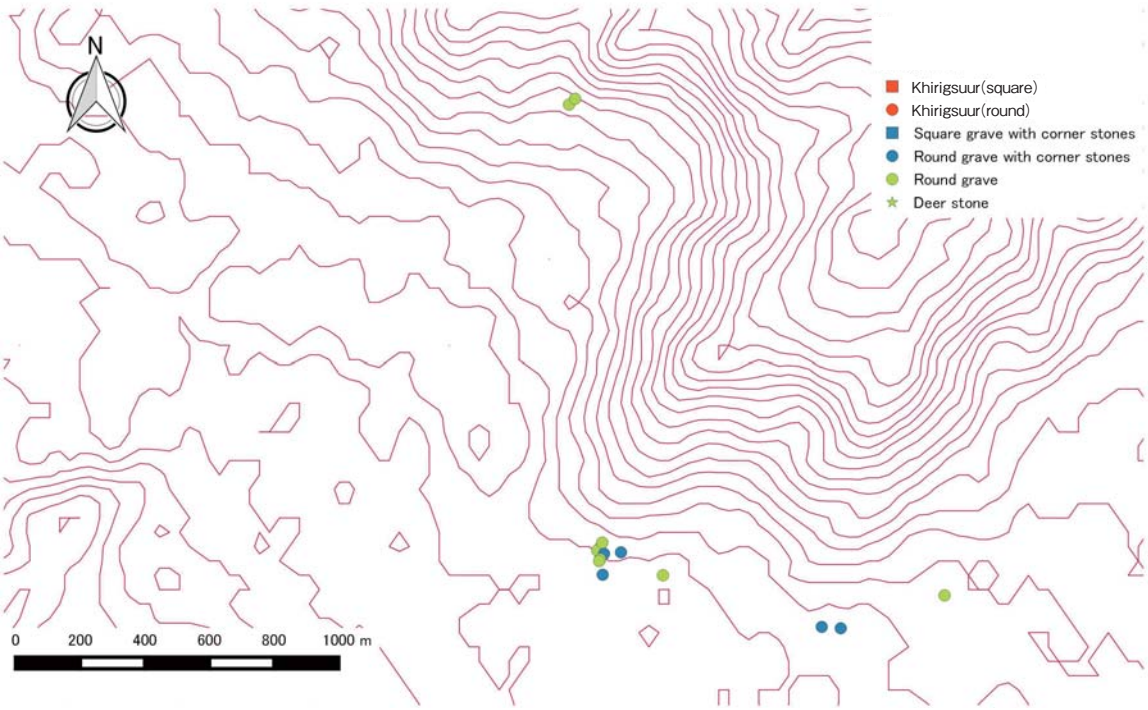


Fig.48 Distribution map of round graves at Khyar Kharaach Site

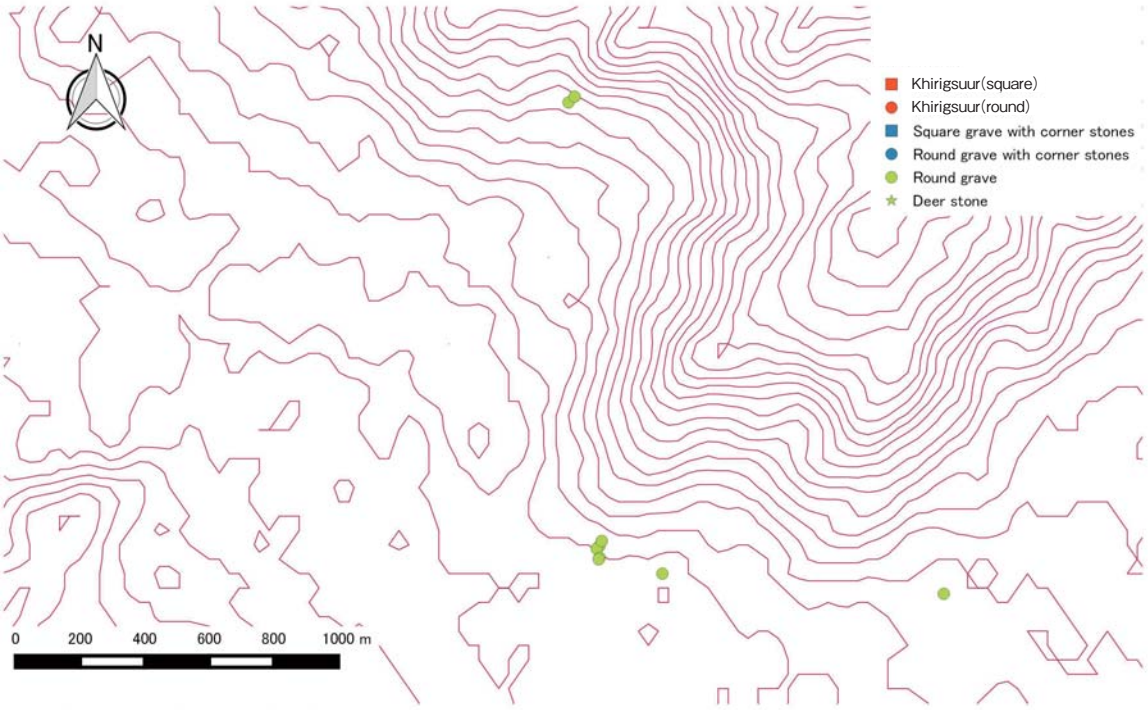


Fig.49 Distribution map of Munk-Khirhan type round graves at Khyar Kharaach Site

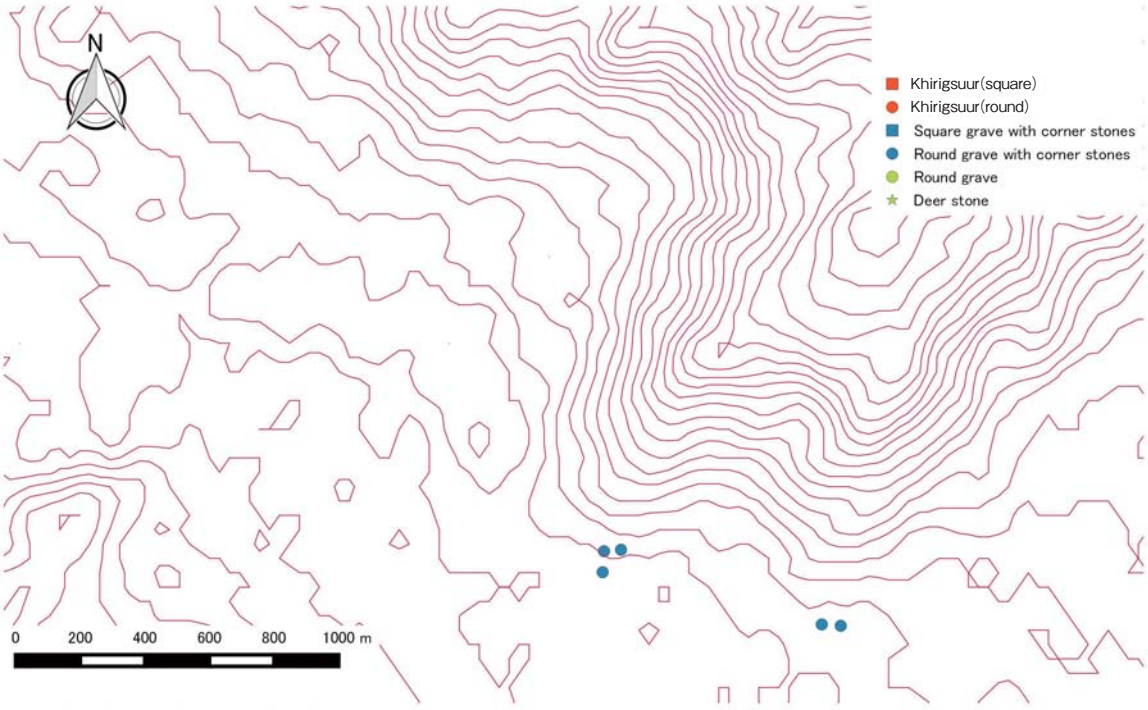


Fig.50 Distribution map of Khyar Kharaach type round graves at Khyar Kharaach Site

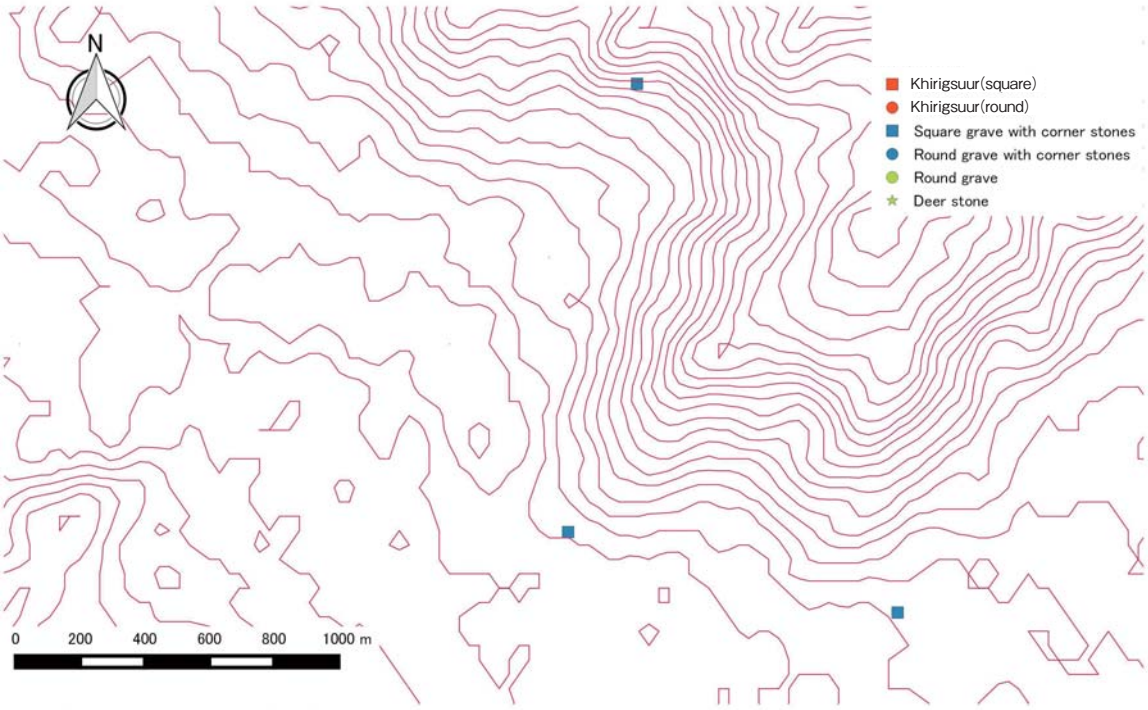


Fig.51 Distribution map of Khyar Khraach type square graves at Khyar Kharaach Site

Korea (National Research Institute of Cultural Heritage in Korea & Institute of Archaeology, Mongolian Academy of Sciences, 2012). The research report of this general survey focused not on the burial system but on the ritual archaeological features. In our general survey of this site, we focused on archaeological evidence suggesting that there are not only Khirigsuur but also round graves and other ritual stone structures consisting of square piled stones and the square erected stones. The purpose of our joint excavation is to ascertain the period and contents of square graves, round graves and ritual stone structures through excavations.

2. The arrangement of archaeological features at Khyar Kharaach Site

Khyar Kharaach Site is divided into four units (Fig. 44, Table 1). Unit No. 1 is composed of three typical Khirigrsuur and one deer stone (Fig. 45, 46, 52, 53). The other units, Unit No. 2 (Fig. 3), Unit No. 3 (Fig. 54) and Unit No. 4 (Fig. 55), include Khirigsuur, round graves and square graves (Fig. 46 – 51). The Khirigsuur with round enclosures in these three units differ from the typical Kirigsuur found in Unit No. 1 because of the presence of four corner stones on a round enclosure. Round graves are also divided into two types depending on whether or not there are four corner stones on the round enclosure (Fig. 48 – 50). On the other hand, round graves with four corner stones exist individually among the three units (Fig. 51). There is only one Khirigsuur with a square enclosure, found in Cemetery Unit No. 4 of the cemetery at Khyar Kharaach Site (Fig. 47).

In particular, Cemetery Unit No. 2 has 10 Khirigsuur graves with an enclosure containing four corner stones (Fig. 56 – 63, Table 2). It also has 8 round graves without enclosures, which belong to what is known as the Munk Khairhan culture (Kovalev & Erdenebaatar, 2009), and 1 square grave (Table 2). Also of particular note is that four round graves and a square grave have four corner stones of the same kind as those of Khirigsuur. We should distinguish round graves according to whether they have four corner stones or not. Round graves without four corner stones should be called Munk Khairhan culture type round graves. On the other hand, we could call round graves with four corner stones Khyar Kharaach type round graves (Table 2).

There are pairs of archaeological features at this site: a square-planned ritual site consisting of a square enclosure and piled stones, and square erected stones. There are seven pairs of these sets of archaeological features (Fig. 56). With the exception of square graves located on the western edge of the grave distribution, other Khirigsuur, round graves and pairs of ritual sites are concentrated together, and there is no regularity in terms of the grave distribution arrangement (Fig. 56). It is also difficult to understand the regular relationship for grave distribution between graves and pairs of ritual sites.

We planned to excavate at Grave No. 1, a square grave (Fig. 58-1), and at Grave No. 20, a medium-sized round grave (Fig. 61-4), in Cemetery Unit No. 2 (Fig. 64). We also planned to excavate at Ritual Sites No. 18 (Fig. 61-6) and No. 19 (Fig. 61-2, 3), which are located near to the Grave No. 20 and are relatively smaller and not well preserved (Fig. 61-2, 3).

3. Graves

Grave No. 1 (Fig. 65 – 68)

This grave has a square fence measuring 8.0 m. by 9.0 m. along with four erected corner stones on the corner of a square fence (Fig. 65). The square fence is composed of relatively large rectangular stones placed sideways. It consists of piled stones inside the square fence. A stone mound is also present in the center of the piled stones, which extends and connects with the square fence. The deceased individual was placed in a supine position in a western orientation in a stone cist on the surface (Fig. 66). This burial custom is very similar to that of standard Khirigsuur. The structure is such that there is a round stone mound in the center of a square grave, and it is thought that the round Khirigsuur with a square enclosure changed to a square grave as a result of connections between the square enclosure and round stone mound in Khirigsuur. On the other hand, square graves are supposed to have been influenced by the square stone construction of graves originating in the eastern Mongolian Plateau. The position of the buried individuals in these graves – i.e. placed sideways – is similar to that of the round grave at Bor Ovoo Site (Fig. 68-6, 7). On the other hand, the individual was not placed inside a burial pit but in a stone cist measuring 2.0 m. by 0.55 m. on the surface (Fig. 67). The human bones were preserved only on the left side of body, as the individual was placed on the surface and the bones on the right side were not well preserved. However, the human bones on the left side are in good condition. The results of dating on collagen in the human bones give the following two dates: 1306 – 1054 cal. BC (2σ, 90.1%) and 1325 – 1209 cal. BC (2σ, 68.8%). These dates indicate the same time periods as those of standard Khirigsuur and square stone construction graves. It is probable that

Table 1 Grave list of Khyar Kharaach Site

Unit	Grave number	A kind of grave	Latitude(N)	longtitude(E)	Hight(m)
No. 1	No. 1	Round Khirigsuur	45°57′02.2″	93°55′35.6″	2267
No. 1	No. 2	Round Khirigsuur	45°56′56.2″	93°55′44.9″	2275
No. 1	No. 3	Round Khirigsuur	45°56′57.6″	93°55′52.1″	2279
No. 1	No. 4	Deer Stone	45°56′52.6″	93°55′50.2″	2259
No. 2	No.1	Square grave with four corner stones	45°56′47.9″	93°56′14.9″	2271
No. 2	No.4	Round Khirigsuur	45°56′47.0″	93°56′16.4″	2276
No. 2	No.8	Round grave	—	—	—
No. 2	No.9	Round grave	—	—	—
No. 2	No.10	Round Khirigsuur	45°56′46.4″	93°56′17.1″	2273
No. 2	No.11	Round Khirigsuur	45°56′46.5″	93°56′18.5″	2276
No. 2	No.12	Round grave	—	—	—
No. 2	No.13	Round grave	—	—	—
No. 2	No.14	Round Khirigsuur	—	—	—
No. 2	No.15	Round grave with four corner stones	—	—	—
No. 2	No.16	Round Khirigsuur	45°56′44.6″	93°56′19.3″	2271
No. 2	No.17	Round Khirigsuur	45°56′45.5″	93°56′19.4″	2274
No. 2	No.20	Round grave with four corner stones	45°56′46.6″	93°56′20.2″	2277
No. 2	No.21	Round Khirigsuur	45°56′45.9″	93°56′20.4″	2275
No. 2	No.24	Round Khirigsuur	45°56′44.8″	93°56′22.9″	2271
No. 2	No.27	Round Khirigsuur	45°56′45.7″	93°56′22.9″	2272
No. 2	No.32	Round Khirigsuur	45°56′47.2″	93°56′21.8″	2275
No. 2	No.33	Round grave	45°56′45.0″	93°56′24.4″	2272
No. 2	No.34	Round grave	—	—	—
No. 3	No.1	Round grave with four corner stones	45°56′41.4″	93°56′40.3″	2272
No. 3	No.2	Round grave with four corner stones	45°56′41.3″	93°56′42.2″	2273
No. 3	No.3	Square grave with four corner stones	45°56′42.3″	93°56′47.9″	2277
No. 3	No.4	Round grave	45°56′42.5″	93°56′49.0″	2276
No. 3	No.5	Round Khirigsuur	45°56′43.6″	93°56′52.6″	2277
No. 3	No.6	Round Khirigsuur	45°56′44.8″	93°56′55.3″	2278
No. 4	No.1	Round grave	45°57′77.8″	93°36′15.0″	2296
No. 4	No.2	Round grave	45°57′18.2″	93°56′15.6″	2297
No. 4	No.3	Square Khirigsuur	45°57′19.1″	93°56′17.1″	2303
No. 4	No.4	Square grave with four corner stones	45°57′19.1″	93°56′21.8″	2318

Fig.52 Deer stone of Cemetery Unit No. 1 at Khyar Kharaach Site

Fig.53 Khirigsuur of Cemetery Unit No. 1 at Khyar Kharaach Site

Fig.54 Khrigsuur of Cemetery Unit No. 3 at Khyar Kharaach Site

Fig.55 Khrigsuur of Cemetery Unit No. 4 at Khyar Kharaach Site

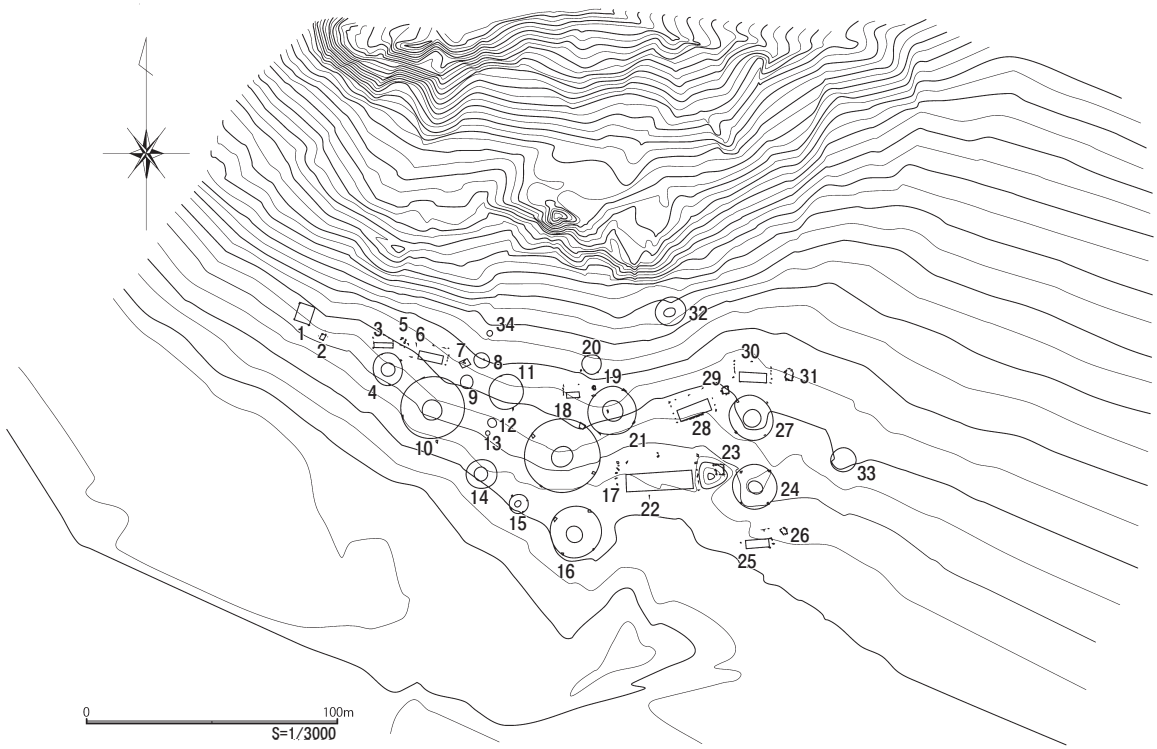


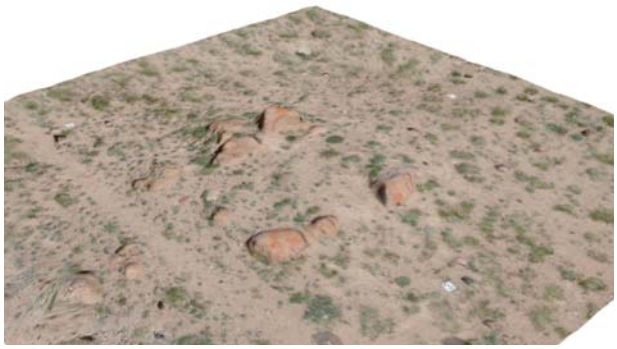
Fig.56 Distribution of graves at Unit No. 2 cemetery of Khyar Kharaach Site

Fig.57 View of graves at Cemetery Unit No. 2 of Khyar Kharaach Site

Table 2 Grave and Ritual Stone Structure list of Unit No. 2 cemetery of Khyar Kharaach Site

No.	Archaeological futures	Latitude(N)	Longtitude(E)	Hight(M)	Plan Size (m)
No.1	Square grave with four coner stones	45°56′47.9″	93°56′14.9″	2271	8×9
No.2	Rectangular stone construction	—	—	—	2×2.5
No.3	Ritual rectangular stone consturction	—	—	—	4.5×8 (2×8)
No.4	Round Khirigsuur with four corner stones	45°56′47.0″	93°56′16.4″	2276	12.7 (5.5)
No.5	Rectangular erected stones	—	—	—	2×2
No.6	Ritual rectangular stone construction	—	—	—	6.5×13 (3×10)
No.7	Rectangular erected stones	—	—	—	3×4
No.8	Round grave	—	—	—	6.5
No.9	Round grave	—	—	—	5
No.10	Round Khirigsuur with four corner stones	45°56′46.4″	93°56′17.1″	2273	25 (8)
No.11	Round Khirigsuur with four corner stones	45° 56' 46.5"	93° 56' 18.5"	2276	14
No.12	Round grave	—	—	—	3.5
No.13	Round grave	—	—	—	2
No.14	Round Khirigsuur	—	—	—	12 (6)
No.15	Round grave with four corner stones	—	—	—	8 (3)
No.16	Round Khirigsuur with four corner stones	45°56′44.6″	93°56′19.3″	2271	21(7)
No.17	Round Khirigsuur with four corner stones	45°56′45.5″	93°56′19.4″	2274	30 (8.5)
No.18	Ritual rectangular stone consturction	—	—	—	4.5×7.5 (2.5×6)
No.19	Rectangular erected stones	—	—	—	1×1.5
No.20	Round grave with four corner stones	45°56′46.6″	93°56′20.2″	2277	8
No.21	Round Khirigsuur with four corner stones	45°56′45.9″	93°56′20.4″	2275	19 (8)
No.22	Ritual rectangular stone construction	—	—	—	12×32 (7×27)
No.23	Rectangular erected stones	—	—	—	3.5×4
No.24	Round Khirigsuur	45°56′44.8″	93°56′22.9″	2271	17.5 (5.5)
No.25	Ritual rectangular stone construction	—	—	—	8×12 (3.5×9)
No.26	Rectangular erected stones	—	—	—	2.5×2.5
No.27	Round Khirigsuur with four corner stones	45°56′45.7″	93°56′22.9″	2272	18 (7)
No.28	Ritual rectangular stone construction	—	—	—	9×17 (5×13)
No.29	Rectangular erected stones	—	—	—	2.5×2.5
No.30	Ritual rectangular stone construction	—	—	—	8×15 (4×11)
No.31	Rectangular erected stones	—	—	—	3×4
No.32	Round Khirigsuur	45°56′47.2″	93°56′21.8″	2275	11 (3.5)
No.33	Round grave	45°56′45.0″	93°56′24.4″	2272	9.5
No.34	Round grave	—	—	—	2.5

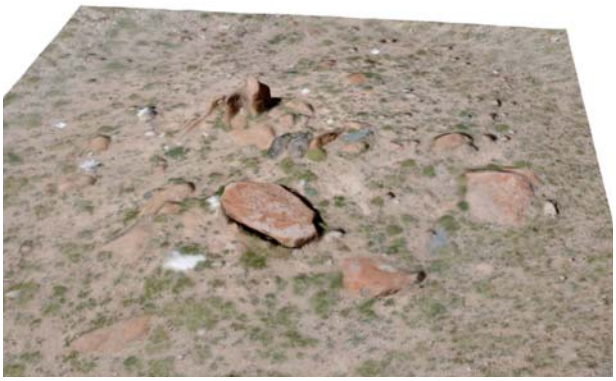
1 Grave No. 1



2 Unknown Stone Structure No. 2

3 Ritual Stone Structure No. 3

4 Grave No. 4



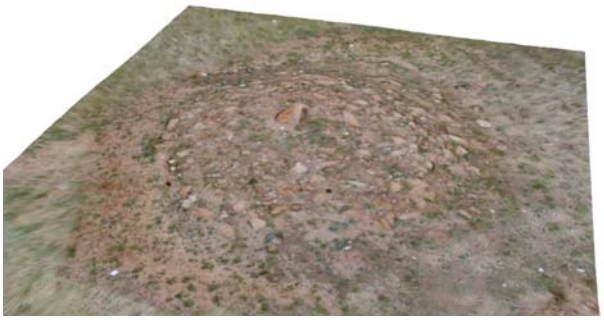
5 Ritual Stone Structure No. 5

6 Ritual Stone Structure No. 6

7 Ritual Stone Structure No. 7

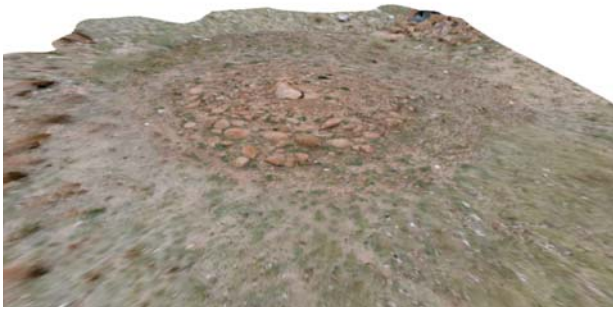
8 Ritual Stone Structure No. 7

Fig.58 Graves at Cemetery Unit No. 2 of Khyar Kharaach Site



1 Grave No. 8

2 Grave No. 8



3 Grave No. 9

4 Grave No. 9

5 Grave No. 10

6 Grave No. 11

7 Grave No. 12

8 Grave No. 12

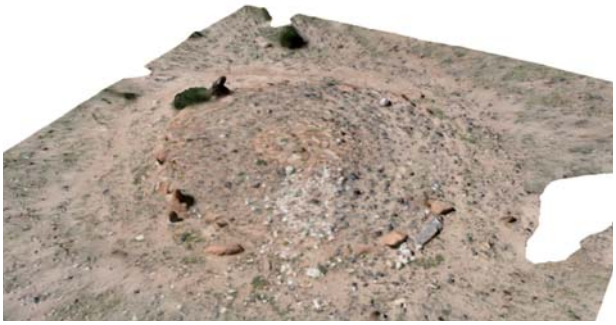
Fig.59 Graves at Cemetery Unit No. 2 of Khyar Kharaach Site

1 Grave No.13

2 Grave No.13

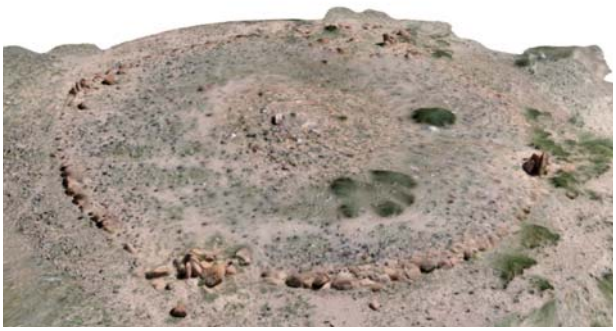
3 Grave No.14

4 Ritual Stone Structure No. 18



5 Grave No. 15

6 Grave No. 15



7 Grave No. 16

8 Grave No. 16

Fig.60 Graves at Cemetery Unit No. 2 of Khyar Kharaach Site

1 Grave No. 17

2 Ritual Stone Structure No. 19

3 Ritual Stone Structure No. 19

4 Grave No. 20

5 Grave No. 21

6 Ritual Stone Structure No. 22

7 Ritual Stone Structure No. 23

8 Ritual Stone Structure No. 23

Fig.61 Graves at Cemetery Unit No. 2 of Khyar Kharaach Site

1 Grave No. 24

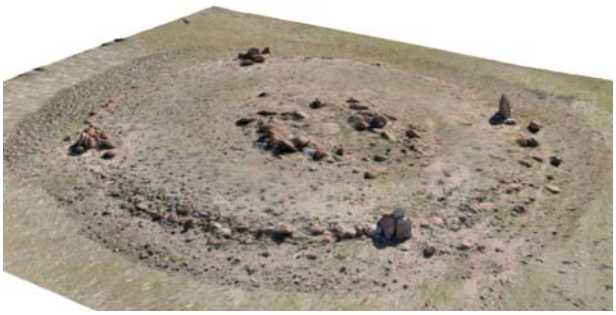
2 Ritual Stone Structure No. 25

3 Ritual Stone Structure No. 25

4 Ritual Stone Structure No. 28

5 Ritual Stone Structure No. 26

6 Ritual Stone Structure No. 26



7 Grave No. 27

8 Ritual Stone Structure No. 30

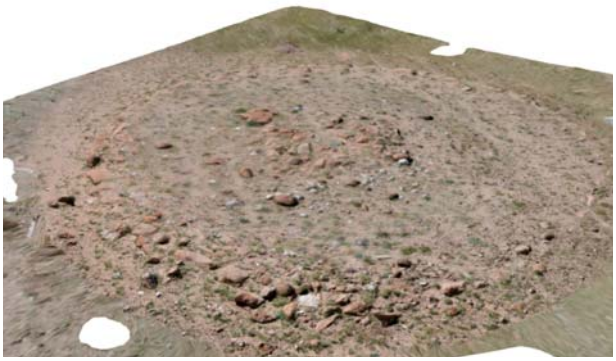
Fig.62 Graves at Cemetery Unit No. 2 of Khyar Kharaach Site

1 Ritual Stone Structure No. 29

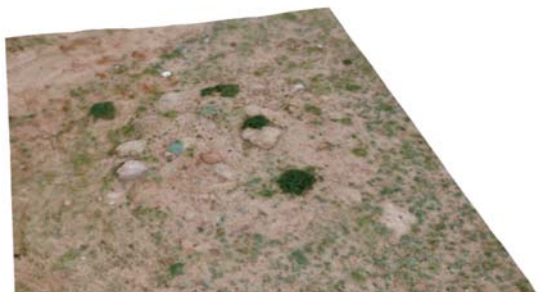
2 Ritual Stone Structure No. 29

3 Ritual Stone Structure No. 31

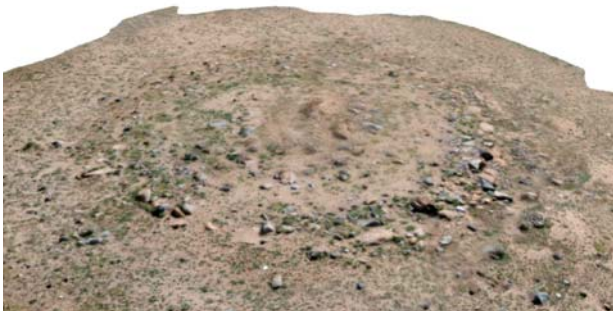
4 Ritual Stone Structure No. 31



5 Grave No. 32



6 Grave No. 34



7 Grave No. 33

8 Grave No. 33

Fig.63 Graves at Cemetery Unit No. 2 of Khyar Kharaach Site

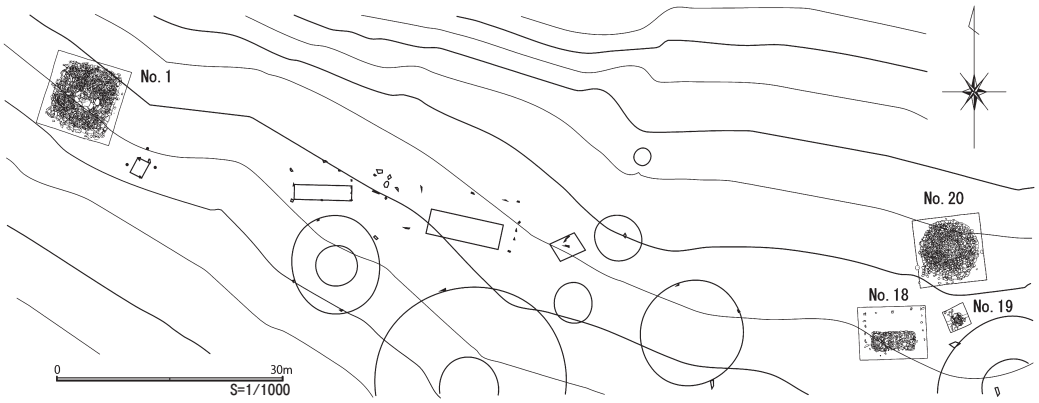


Fig.64 Excavation location at Cemetery Unit No. 2 of Khyar Kharaach Site

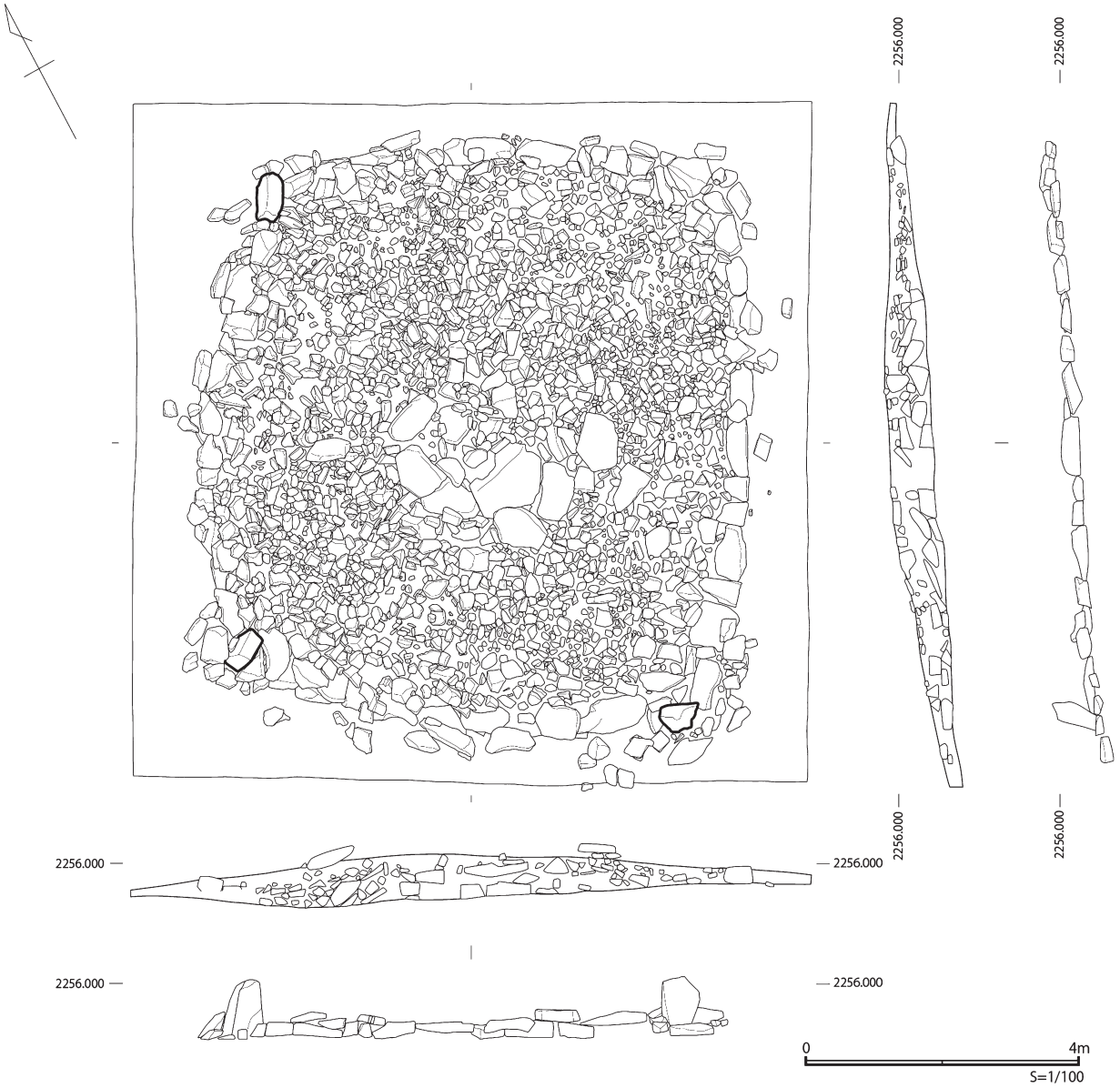


Fig.65 Grave No.1 at Cemetery Unit No. 2 of Khyar Kharaach Site

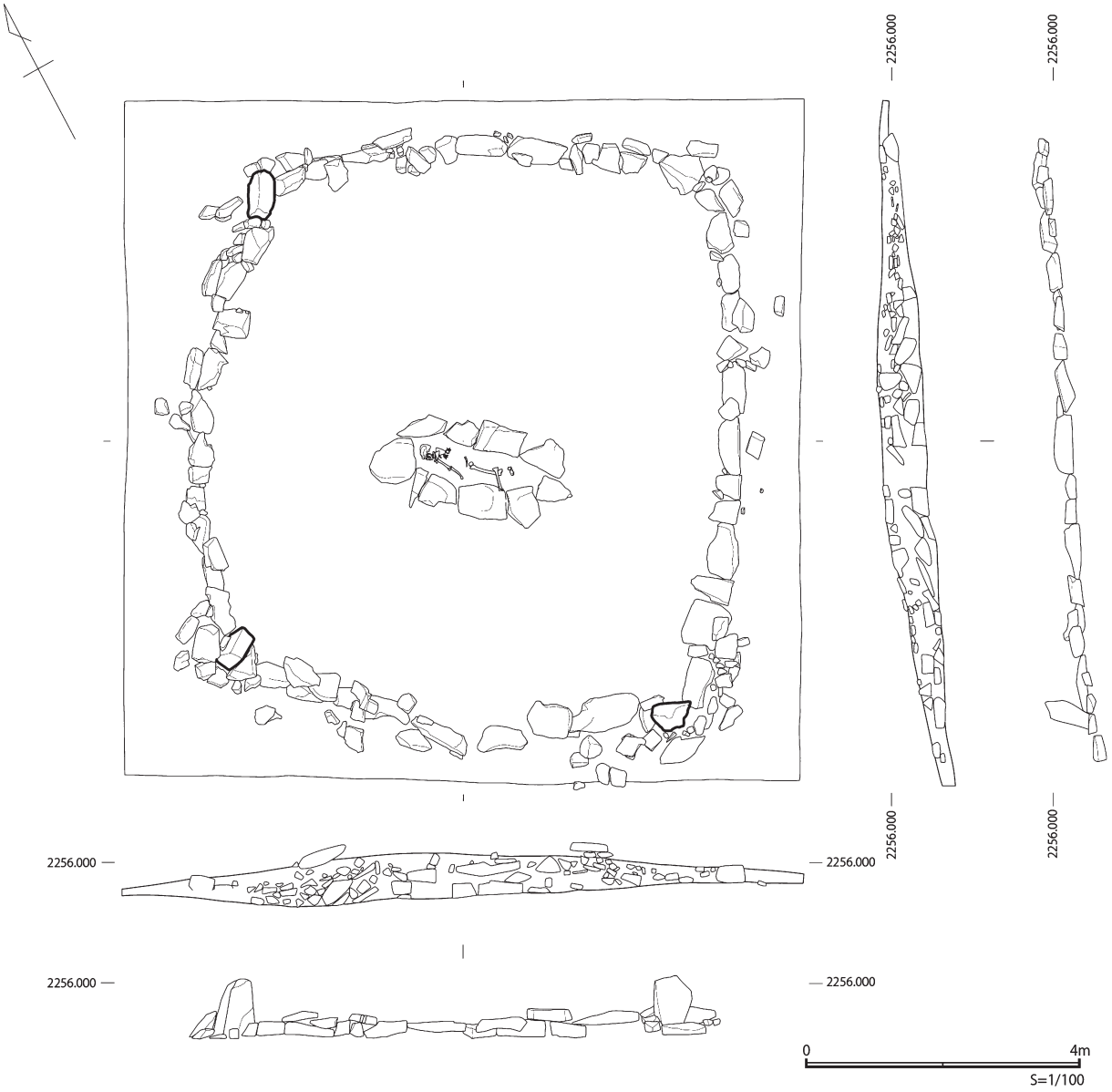


Fig.66 Grave No.1 at Cemetery Unit No. 2 of Khyar Kharaach Site

the production of square graves with four corner stones was influenced by Khrigsuur and square stone construction graves. The estimated height of the buried individual is 169.5 cm, the same height as those found in figured graves at Tevsh Site. This particular individual is a mature or old male belonging genetically to northeastern peoples of Mongoloid line. A micro-lithic core (Fig. 77-1, 78-1) which is not thought to be related with this grave was collected on the surface near to Grave No. 1.

Grave No. 20 (Fig. 69 – 73)

This is a round grave measuring 8.0 m. in diameter (Fig. 69, Fig. 73-1, 2). It is piled up with stones like a stone mound and has a fence made of long stones (Fig. 70). This burial system is known as the Munk-Khairhan culture (Kovalev and Erdenebaatar, 2009), and it was discovered at Bor Ovoo Site. However, it differs from standard round graves in that it has four corner stones on the stone fence, something which is particular of round graves at Khyar Kharaach Site. As such, this type of grave can be classified as a Khyar Kharaach round grave. It is probable that the stone fence and stone mound originally developed from Khirigsuur, which consist of a round enclosure and round stone mound. The burial pit is 1.9 m. long, 0.7 m. wide and 0.5 m. deep under the surface. The deceased individual was oriented to the west in a supine position and placed sideways in the burial pit (Fig. 71). The structure including the burial style of this round grave is the same as that of Bor Ovoo Site except for the four corner stones. The human bones were found in a perfect state of preservation. The individual was placed sideways from the left shoulder to the left legs upward, the same position as in Grave

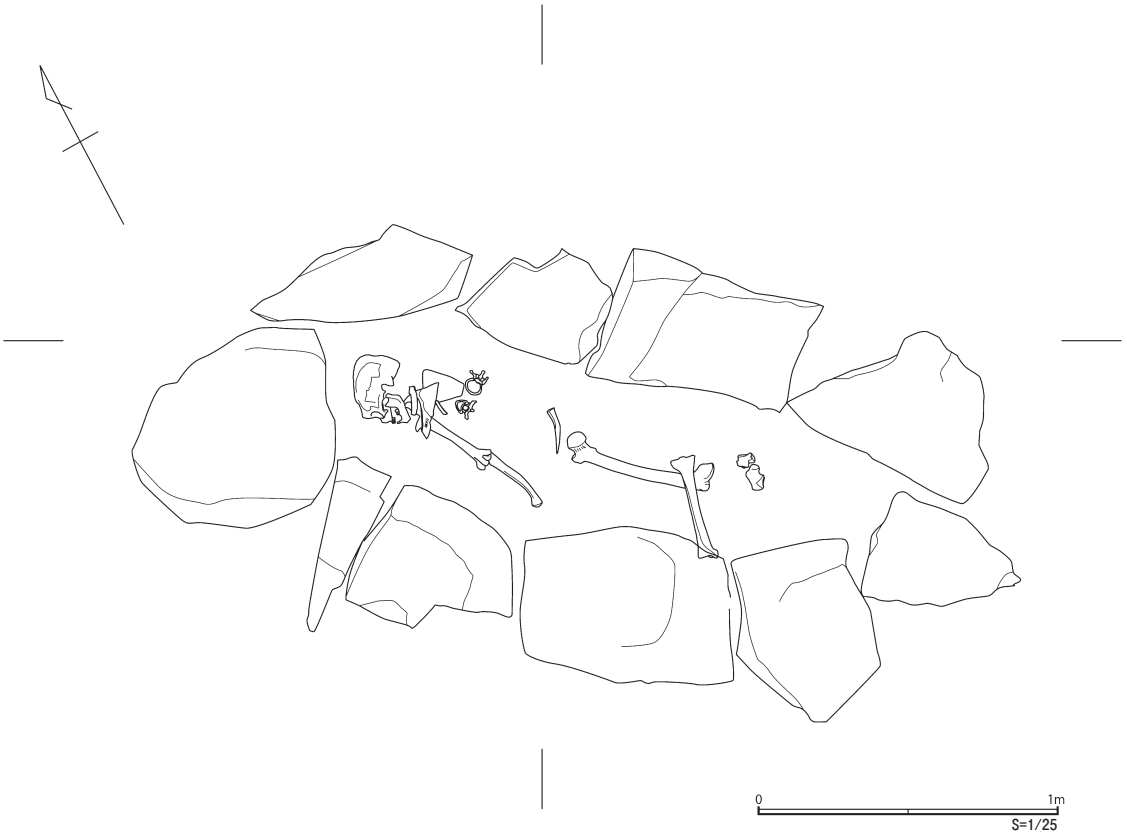


Fig.67 Human skeletons from Grave No.1 at Cemetery Unit No. 2 of Khyar Kharaach Site

No. 1. Collagen analysis dates the human bones to 1397 – 1259 cal. BC (2 σ , 93.4%), which is roughly the same period as those found in Grave No. 1. Therefore, this shows that the two burial types – round graves with four corner stones and square graves with four corner stones – existed simultaneously. The buried individual has an estimated height of 164 cm, and is a male. Physical anthropological identification indicates that the individual belongs to the ancestral Eurasian people of the Caucasian line. In addition, the nose bones and left hand bones were found to have been injured. Given the nature of these injuries, it is probable that the individual belonged to a horse riding people. And it is probable that the individual in the round grave was a herding immigrant from central Eurasia. Pottery fragments (Fig. 77-3, Fig. 78-3) were found in the surface soils of Grave No. 20. These are small fragments of pottery decorated with pressed holes. It is uncertain whether the pottery belonged in this grave.

4. Ritual sites

Ritual Stone Structure No. 18 (Fig. 74 - 80)

Ritual Stone Structure No. 18 is located in close proximity to Grave No. 20 (Fig. 72). This ritual site comprises of a pair of ritual stone structures: No. 18 and No. 19 (Fig. 72). Ritual Stone Structure No. 18 has a structure consisting of a square plan and a combination of small erected stones and square piled stones (Fig. 74). The small erected stones make up a square space that is 7.5 m. in length and 4.5 m. in width, which is thought to have been a ground dwelling or enclosure consisting of cloth tied to the erected stones.

A pit hole and black ash layer under the piled stones which is 6.0 m. in length and 2.5m in width were found (Fig.75). Inside this ash layer, which included sheep, goat or cattle bones, a wooden pole was found which is 35 cm. in diameter and 40 cm. in depth (Fig. 80-6, 7). An unformed area of ash soils which is 1.0 m. long and 0.9 m. wide was found near to the surface soils (Fig. 76). It is thought that, taken together, these archaeological features constitute a Ritual Stone Structure. It is believed that people here conducted ritual ceremonies involving the burning of sheep, goats or cattle (Fig. 79). It is probable that the small erected stones and pit hole formed a pair at the location and were used simultaneously (Fig. 76). We envisage that they burned sacrificed animals in the pit hole inside the enclosure roped off with cloth tied to wooden poles combined with small erected stones. The selective use of white stones (Fig. 80-1, 2) suggests that these white stones had some kind of symbolic

1 Before excavation

2 After removal of surface soils

3 Stone mound and four corner stones

4 Stone fence and cover stones

5 Stone cist

6 Human skeletons at stone cist

7 Human skeletons at stone cist

8 After removal of human skeletons

Fig.68 Grave No. 1 at Cemetery Unit No. 2 of Khyar Kharaach Site

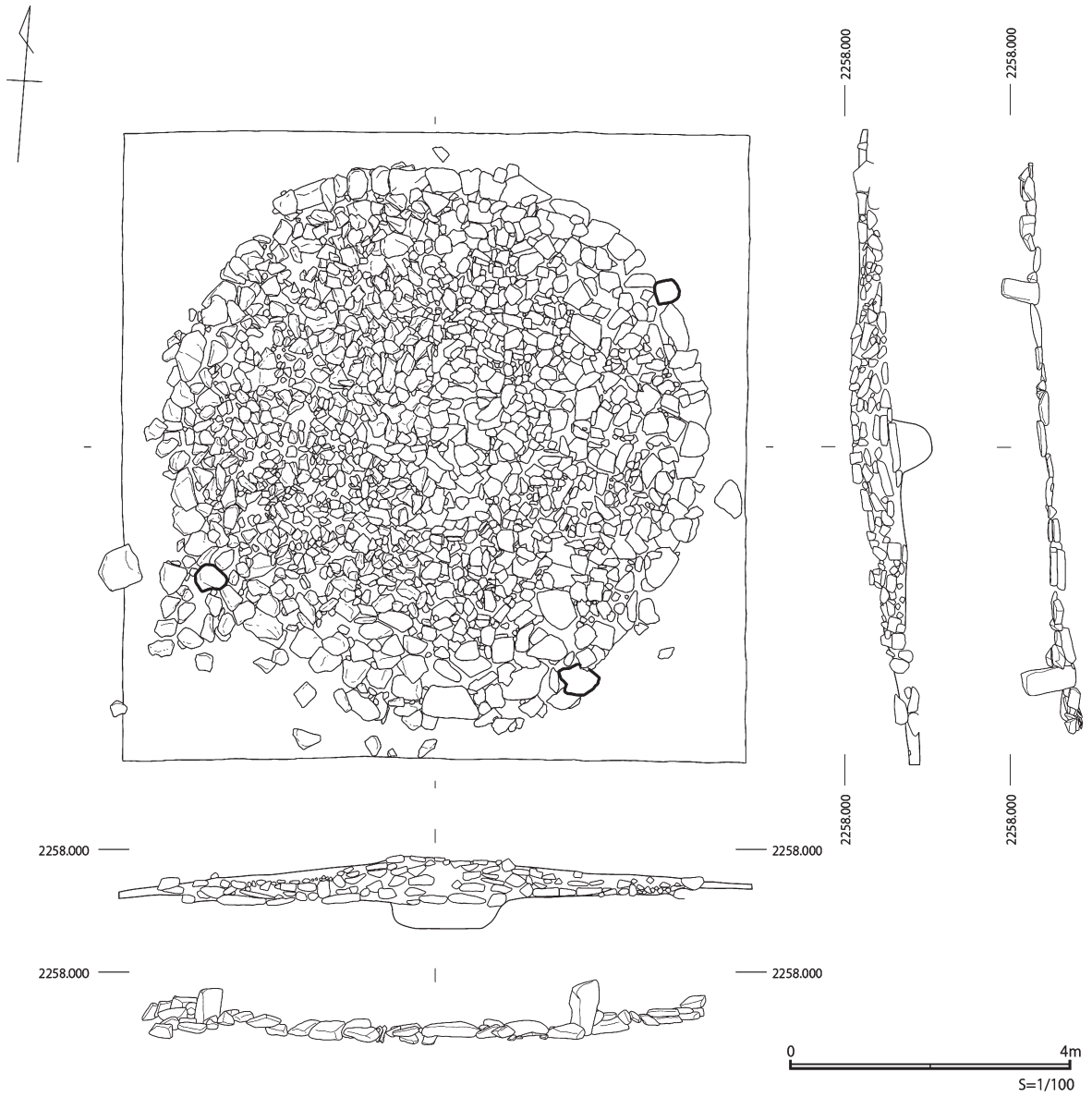


Fig.69 Grave No. 20 at Cemetery Unit No. 2 of Khyar Kharaach Site

meaning which could be seen from a far distance. It is believed that ritual activity was conducted here on several occasions and that the rectangular plan of piled stones with white stones acted as a signal. The tang portion of a spear stone point (Fig. 77-2, 78-2) was found in surface soils at this site. This spear stone head is made of chert and probably dates to the Bronze Age of the second millennium BC. Therefore, it is supposed that people stayed for some duration at this ritual site. We attempted carbon dating on the fired bones, but dating proved impossible due to a shortage of collagen.

Ritual Stone Structure No. 19 (Fig. 81, 82)

Ritual Stone Structure No. 18 consists of erected stone slabs which are 1.5 m. in length and 1.0 m. in width (Fig. 81). Stone slabs have been placed vertically in a longwise axis along a square pit which is 3.3 m. in length, 3.1 m. in width, 0.9 m. in depth, and erected stones like stone cists was constructed a square plan after having filled in the pit with soil. No artifacts were found in the pit, so it is difficult to understand the function of this archaeological feature. This site could form a pair with Ritual Stone Structure No. 18. It is thought that people here conducted some unknown ritualistic activities in coordination with ritual ceremonies at Ritual Stone Structure No. 18.

5. Conclusion

Cemetery Unit No. 2 of Khyar Kharaach Site consists of round Khirigsuur and round graves of a kind which are the usual grave systems found in western Mongolia, as well as a single square grave. In addition, one common feature of all the round

Fig.70 Grave No. 20 at Cemetery Unit No. 2 of Khyar Kharaach Site

Khirigsuur, round graves and square graves is that they have four corner stones. This feature can also be seen also in the adjacent Cemetery Units No. 3 and No. 4, which are located around Unit No. 2 of Khyar Kharaach Site. Therefore, Khirigsuur with four corner stones on the enclosure can be classified as Khyar Kharaach type Khirigsuur. Furthermore, round graves with four corner stones can be classified as Khyar Kharaach type round graves. Stylistically speaking, it is believed that both types of grave must have existed simultaneously and belonged to the Khyar Kharaach type culture.

As the individual buried in Grave No. 20 has been identified as belonging to a central Eurasian people of the Caucasian genetic line, it is believed that this site was either influenced culturally from western regions or through the migration of peoples from central Eurasia. Strontium stable isotopic analysis of teeth from Grave No. 1 and Grave No. 20 indicates the possibility that either of the two individuals migrated to this site from other areas, as the two figures for strontium stable analysis are different. It is remarkable that Xiaohe Cemetery and Gumu Cemetery in Xinjiang Province, China contained individuals of Caucasian origin dating to the former half of the second millennium BC, and that this situation continued into the latter half of the second century BC to trigger migration from a westward direction, even in western Mongolia. Such movements of people indicates that exchanges took place between people beyond the Sayan Altai Mountains during the Seima Trubino culture period and Karasku culture period in accordance with the movement of bronze culture from west to east.

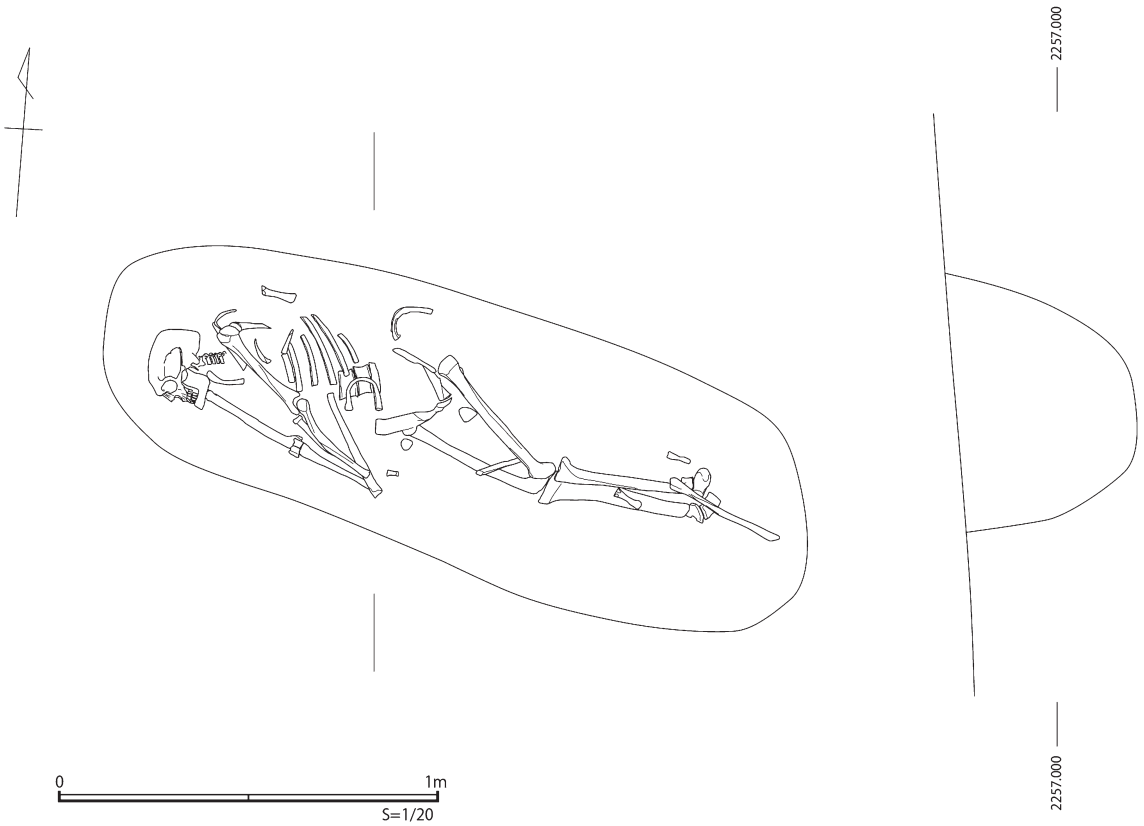


Fig.71 Burial pit of Grave No. 20 at Cemetery Unit No. 2 of Khyar Kharaach Site

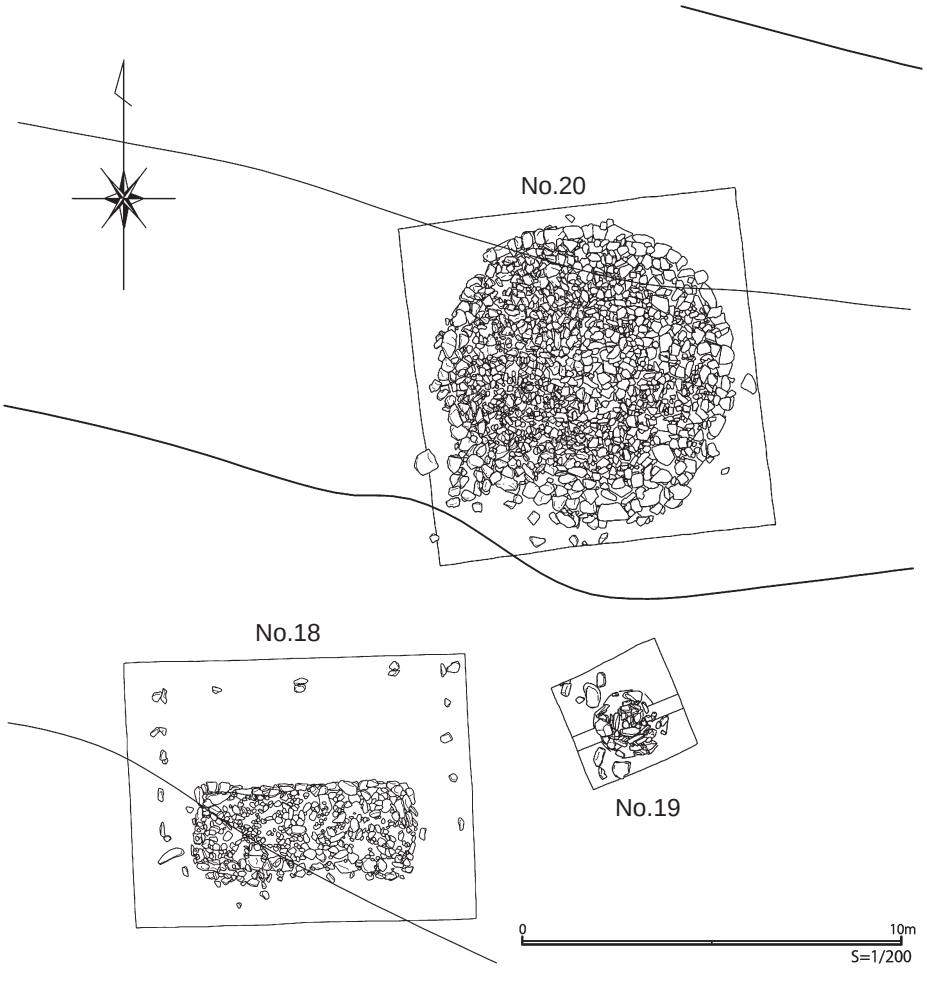


Fig.72 Location of Grave No. 20, Ritual Stone Structure No. 18 and No. 19 at Cemetery Unit No. 2 of Khyar Kharaach Site

1 Before excavation

2 After removal of Grave No. 20

3 Stone mound

4 Profile of stone mound and stone fence

5 Cover stone

6 Burial pit

7 Burial pit

8 After removal of human skeletons

Fig.73 Grave No. 20 at Unit No. 2 cemetery of Khyar Kharaach Site

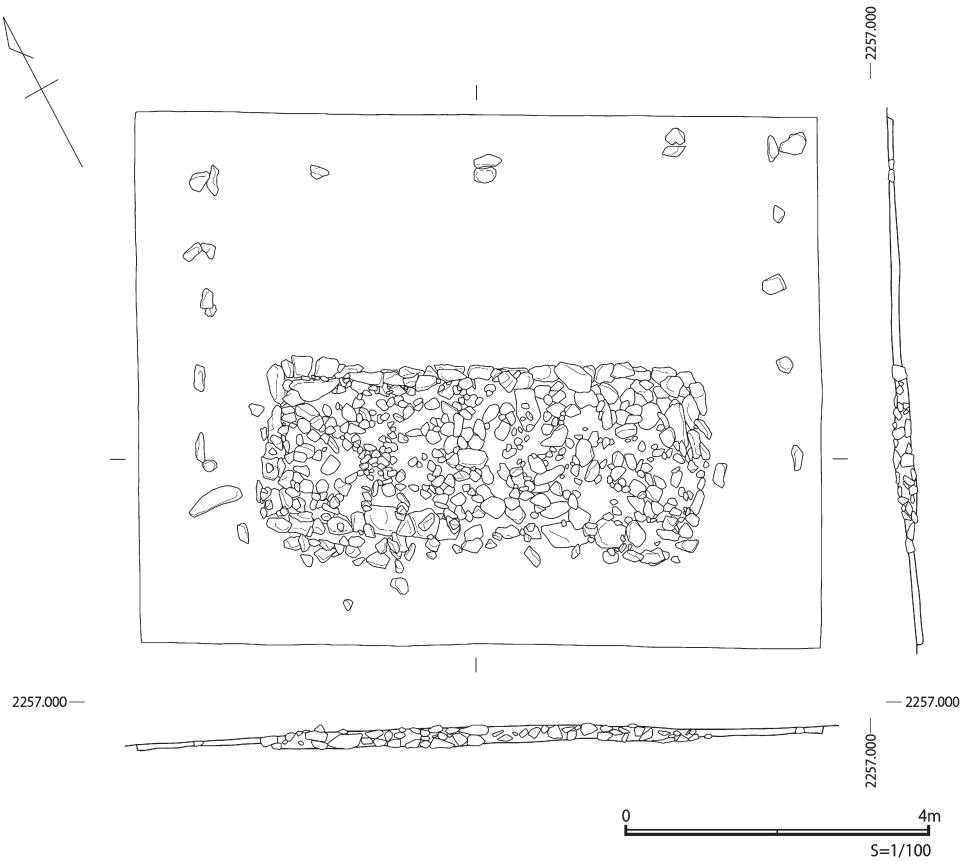


Fig.74 Ritual Stone Structure No. 18 at Cemetery Unit No. 2 of Khyar Kharaach Site

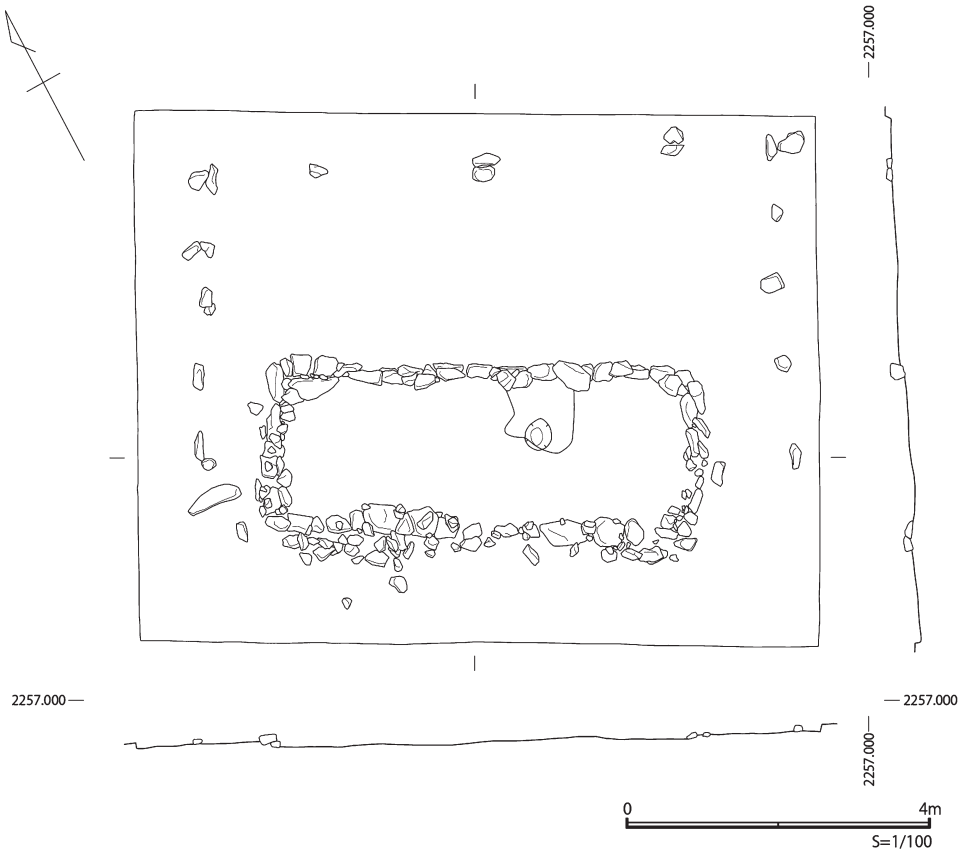


Fig.75 Ritual Stone Structure No. 18 at Cemetery Unit No. 2 of Khyar Kharaach Site

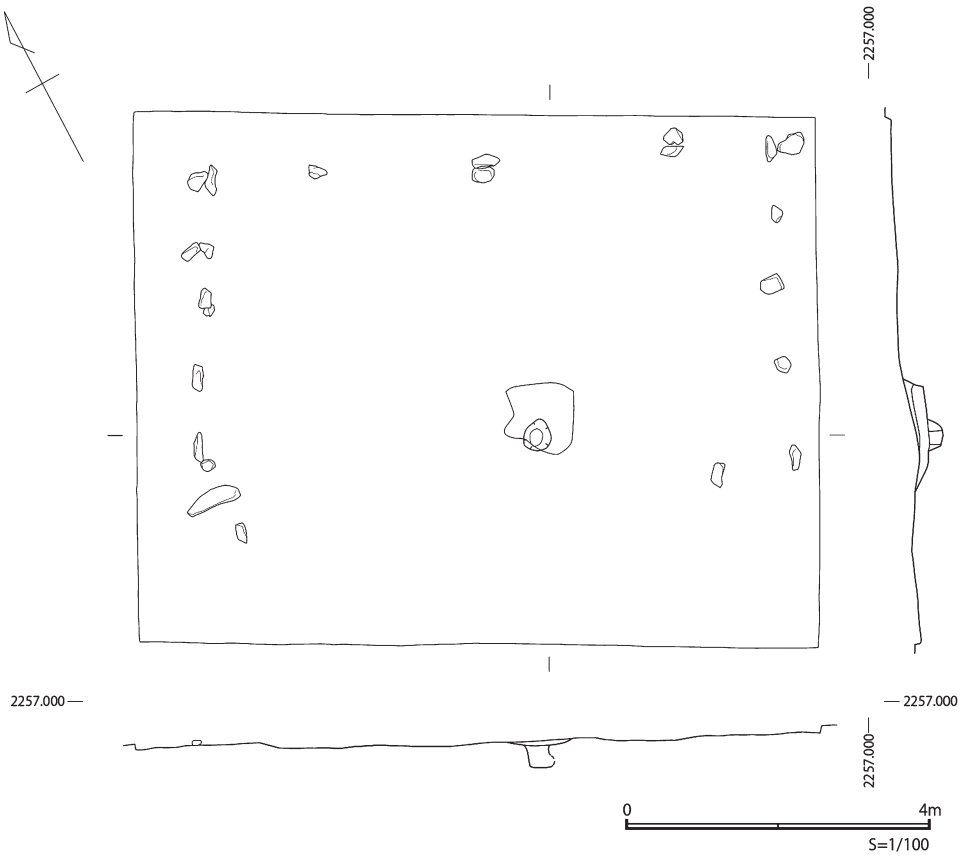


Fig.76 Ritual Stone Structure No. 18 at Cemetery Unit No. 2 of Khyar Kharaach Site

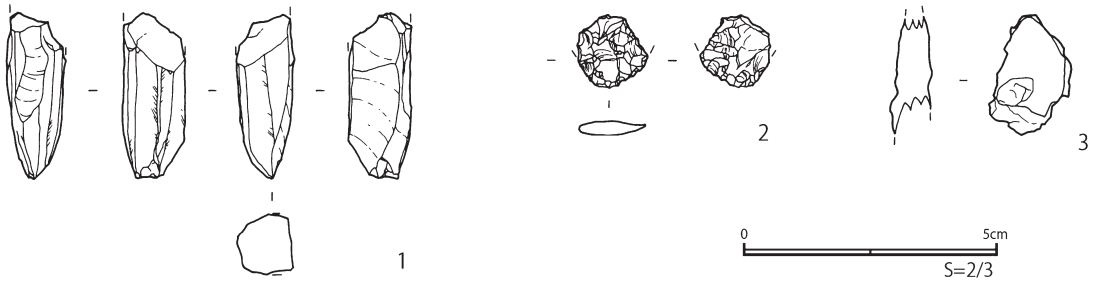


Fig.77 Artifacts found at Cemetery Unit No. 2 of Khyar Kharaach Site

Fig.78 Artifacts found at the Cemetery Unit No. 2 of Khyar Kharaach Site

Fig.79 Animal bones found at the pit of Ritual Stone Structure No. 18 at Cemetery Unit No. 2 of Khyar Kharaach Site

1 Before excavation

2 After removal of surface soils

3 After removal of surface soils

4 After removal of paved stones

5 Finding of the firing place

6 Burned pit buried with carbon ash soils

7 Profile of the burned pit

8 After excavation

Fig.80 Ritual Stone Structure No. 18 at Cemetery Unit No. 2 of Khyar Kharaach Site

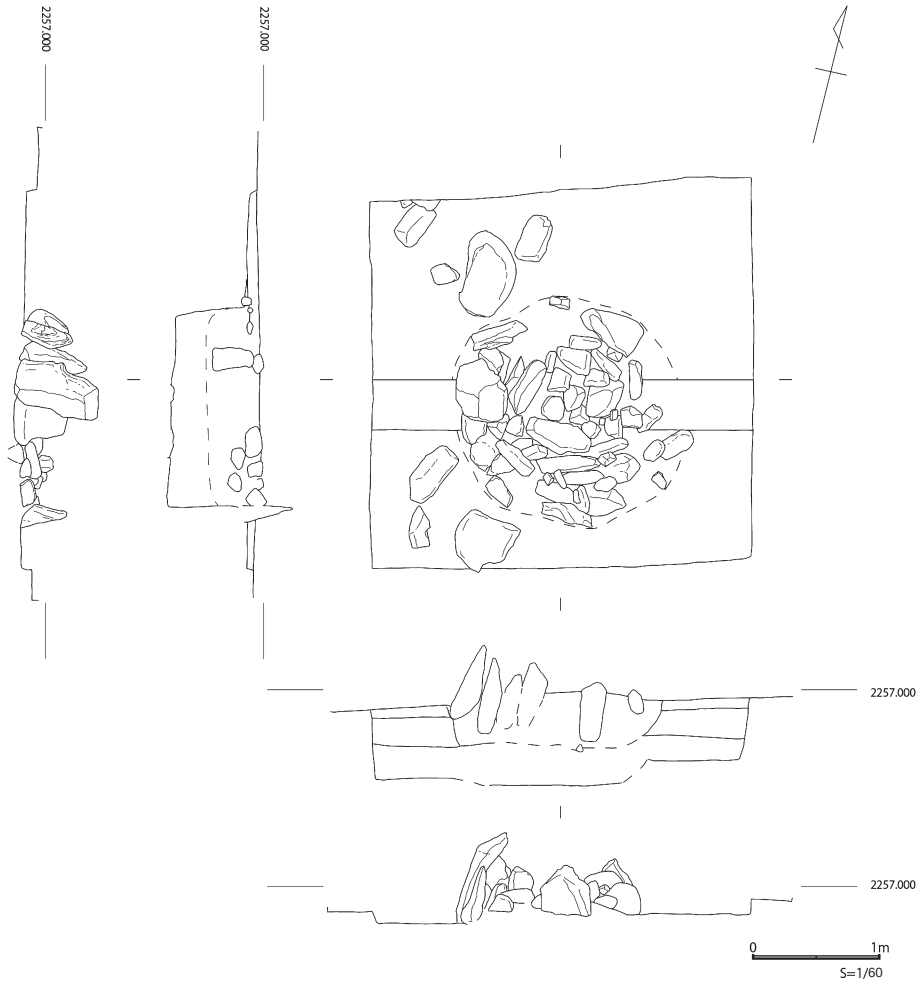


Fig.81 Ritual Stone Structure No. 19 at Cemetery Unit No. 2 of Khyar Kharaach Site

1 After removal of surface soils

2 After removal of surface soils

3 The profile of surface soils

4 After excavation

Fig.82 Ritual Stone Structure No. 19 at Cemetery Unit No. 2 of Khyar Kharaach Site

In addition, it is probable that they practiced various ritual activities, such as the animal sacrifices seen at Ritual Stone Structures No. 18 and No. 19. This probably indicates that these cemeteries were dwelling points in winter. The geographical environment here is such that it is an ideal place to escape monsoon winds in winter coming from the mountains north of this site. It is believed that this dwelling place for winter became not only an area for ancestral burials but also a space for the performance of ritual activities.

3 Human skeletal remains of the Bronze Age unearthed from the both sites of Khyar Kharaach in the Govi-Altai province and Bor Ovoo in the Bayankhongor Province, Mongolia

Kenji Okazaki and Shiori Yonemoto

1. Introduction

In August, 2015, Mongolian (the Mongolian Academy of Sciences) and Japanese (Kyushu University) joint team had excavated the Khyar Kharaach site in the Govi-Altai province site, and found the two individuals of the human skeletal remains of the Bronze Age. We cleaned and analyzed the human bones from the both sites of Khyar Kharaach and Bor Ovoo from August to September in 2015. In this chapter, we report the morphological traits of these human bones.

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) and followed cranial suture closure (Meindl and Lovejoy, 1985).

We primarily followed the measurement method of Martin (Baba, 1991). Individuals selected for use were examined visually and scored for musculoskeletal stress markers (MSMs) severity based on the scoring method of Hawkey and Merbs (1995). Cranial and limb measurements were done by K.O., MSMs observations by S.Y., and paleopathological observations by the both authors.

3. Basic information

A. Khyar Kharaach site

Two skeletal individuals were excavated from each tomb of the square (M-1) and circle (M-20). See the other chapter of this book on the state of affairs when these skeletal remains had been just unearthed.

Burial individual M1

Preservation: the cranium was most perfectly preserved, while the most parts of trunk were lost except for two thoracic and two lumber vertebrae and three right ribs (Fig. 83a). The scapulae of both sides, right humerus, right ulna, right femur, and right patella, tibiae of the both sides, right talus and calcaneus were preserved among limb bones.

Sex: the morphological traits of the skull indicated that the biological sex was male as well as the size of limb bones.

Age: The detailed age at the death was hardly determined due to the lack for the hip bones. Although the tooth wear is significantly severe, it could not account for aging since the wear pattern was not normal as mentioned below. The cranial suture closure was assigned to 19 score in the vault and 9 score in the lateral-anterior sutural ages (Meindl and Lovejoy, 1985). These stages ranged over 50 years.

Pathological observations: the dental wear was significantly heavy especially in the upper teeth compared to the lower ones. In the upper jaw, four of ten teeth had a noncarious pulp exposure (Fig. 84). The most teeth were worn out over the cement-enamel junction (CEJ). The right first molar tilted buccally and exposed the lingual root. The left all molars and the right first premolar lost antemortem probably because of such a severe dental wear. In the lower jaw, the dental wear was slightly milder, but still produced very flat occlusal surfaces (Fig. 85). The right all molars and the left both premolars lost antemortem. An abscessing existed on the buccal surface of alveolus in the right first premolar. A severe masticatory environment of the M1 individual was supported by the tempo-mandibular joint (TMJ) arthritis. A porosity was observed on the articular tubercle of the right temporal bone.

Osteometric measurements: The estimated stature was 169.5 cm or 176.1 cm according to the numerical formula of Pearson and Stevenson respectively using the maximum length of the right femur (Hiramoto, 1981).

83-a) the whole skeletal body

83-b) the front view of cranium

83-c) the side view of cranium

83-d) the top view of cranium

Fig.83 The Khyar-Kharaach M1 individual

Fig.84 The maxillary dental arch of the Khyar-Kharaach M1 individual (the inferior view)

Fig.85 The maxillary and mandibular dental arches of the Khyar-Kharaach M1 individual (the obliquely front view)

86-a) the whole skeletal body

86-b) the front view of cranium

86-c) the side view of cranium

86-d) the top view of cranium

Fig.86 The Khyar-Kharaach M20 individual

Musculoskeletal stress markers (MSMs): The MSMs scores of this individual were generally high. The observable parts are right humerus, right ulna, right femur, tibiae of both sides. The attachment sites of muscles in *pectoralis major* showed score 5 that mean stage of stress induced lesion defined by Hawkey and Merbs (1995). The attachment sites of muscles in *teres major and latissimus dorsi* and *deltoidus* also showed high scores. Other MSMs scores on the upper limbs were as following; the *supinator, pronator quadratus and brachialis* of right ulna were scores 2, 3 and 2 each. Moreover, the MSMs scores on the lower limbs were as following; the *iliopsoas, gluteus maximus, Vastus lateralis, Vastus medialis* and *linea aspera* of right femur were scores 2, 3, 3, 3 and 3 each. *The tibialis posterior and flexor digitorumlongus* and *soleus* of right tibia were scores 2 and 3 each, and these attachment sites of left tibia were scores 3 and 3 each.

Burial individual M20

Preservation: the most parts of skeleton were completely preserved (Fig. 86). The parts lost were following: left 12th rib, some of phalanges, metacarpals, carpals, metatarsals, and tarsals.

Sex: the morphological traits of the pubis and the greater sciatic notch suggested that the biological sex was male.

Age: the condition of the pubic symphysis was assigned to the eighth stage according to the standard

87-a) the palmar view

87-b) the proximal view the 5th metacarpals of the both sides

87-c) the wrist of the left side including ulna, radius, lunate, scaphoind

Fig.87 The antebrachial, the carpals and the metacarpals of the Khyar-Kharaach M20 individual

Fig.88 The piriformis of the Khyar-Kharaach M20 individual (the inferior view).

of Todd (1920), while the condition of the auricular surface of the hip bones did the fifth stage according to the standard of Lovejoy et al. (1985). These stages ranged the first half of forties.

Pathological observations: Malunion was observed in the ulna and the fifth metacarpal of left side, and nasal bones. The distal end of left radius was slightly dorsally bent as like a fork (Fig. 87a). The styloid process of left ulna was also crushed. They were clinically called the Colles' fracture, which often occurred to put own hand on the ground with extending the elbow joint in falling down. The base of the fifth metacarpal of left side was crushed (Fig. 87b). It was clinically called the fifth CM joint dislocation fracture, which often occurred to put own hand on the ground with gripping something in falling down. In modern societies, this kind of fracture often occur at some traffic accidents using bike or motorcycle. The both fracture followed severe arthritis in the wrist. Some eburnations were seen on the ulna head and the lunate bone (Fig 87c). The end of nasal bones (rhinion) was asymmetry pressed, which followed the curved nasal septum (Fig. 88). It could occur antemortem by a direct external force.

The degenerative arthritis was asymmetry observed on the articular surfaces from cervical to lumber of vertebra. The bony margin and lipping formed on the superior and inferior articular processes and the vertebral body (Fig. 89abc). Some porosity and Schmorl nodes were also seen on the superior and inferior surface of vertebral body. The degree of these arthritis was more advanced in left side in cervical and the first and second thoracic vertebrae, in right side from the third thoracic to the second lumber vertebra, and again in left side from the third to the fifth lumber vertebra. As a result, the vertebral column organized mild scoliosis when articular processes were jointed among the vertebrae (Fig. 89d).

89-a) the superior view of the cervical vertebrae

89-b) the superior view of the thoracic vertebrae

89-c) the superior view of the lumber vertebrae

89-d) the dorsal view of the thoracic vertebrae

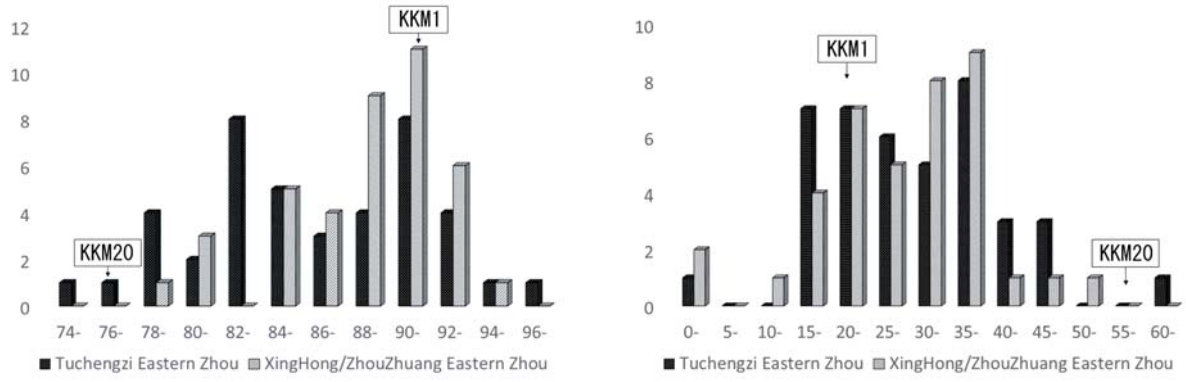
Fig.89 The vertebrae of the Khyar-Kharaach M20 individual

The ossified thyroid cartilage was preserved.

Osteometric measurements: the M20 individual showed a significantly three-dimensional nasal root. Figure 90a indicated the histogram of the prominence index of nasal root (50:IA) using the data for the group of the Bronze Age at the northern Great Wall region (the Tuchengzi site of Inner Mongolia, Nakahashi, unpublish data) and the Central Plains (the XingHong and ZhouZhuang sites, Nakahashi and Fan, 2014). The value of the M20 individual was much lower (three-dimensional) than the rest of the groups, while that of the M1 individual located on the mode (90-92 %) of the group at the Central Plains. Figure 90b indicated the histogram of the simotic index of flatness (SS:SC). The value of the M20 individual was still much higher (three-dimensional) than the rest of the groups, while that of the M1 individual was even lower than the average of the groups.

The estimated stature was 164.0 cm or 169.0 cm according to the numerical formula of Pearson and Stevenson respectively using the maximum length of the right femur.

Musculoskeletal stress markers (MSMs): The MSMs scores of this individual were generally high. The observable parts are clavicles, humeri, ulnae, radii, femurs and tibiae of both sides. The attachment site of muscle in *pectoralis major* on right humerus and the attachment sites of ligament in *costoclavicular ligament* on right and left clavicles showed score 4 that mean stage of stress induced lesion defined by Hawkey and Merbs (1995). Other MSMs scores on the upper limbs were as following; the *teres major and latissimus dorsi, deltoideus*, and *coracobrachialis of* right humerus were scores 3,2 and 3 each and these attachment sites of left sides were scores 3,2 and 3. The *supinator, pronator quadratus* and *brachialis* of right ulna and pronator teres, biceps brachii of right radius were scores 1, 3, 2, 2 and 3 each and these attachment sites of left sides were scores 1, 2, 3, 3 and 3. The asymmetry of right scores and left scores is



90-a) the prominence index of nasal root (50:IA)

90-b) the simotic index of flatness (SS:SC)

Fig.90 The histogram of the degree of three-dimensional nasal root using the data for the Eastern Zhou groups at the Inner Mongolian and the Central Plains (Nakahashi, 2014)

small. Moreover, the MSMs scores on the lower limbs were as following; the *iliopsoas*, *gluteus maximus*, *Vastus lateralis*, *Vastus medialis* and *linea aspera* of right femur were scores 3, 3, 1, 2 and 3 each and these attachment sites of left femur were scores 3, 3, 2, 1 and 3. *The tibialis posterior and flexor digitorumlongus* and *soleus* of right and left tibia were scores 2 and 2 each.

B. Bor Ovoo site

Three skeletal individuals were unearthed in the Grave No.2, Grave No.8, and Grave No.13. See the other chapter of this book on the state of affairs when these skeletal remains had been just unearthed.

Burial individual M2

Preservation: the most parts of skeleton were partly preserved although these bones were fragile. The parts of maxillary, mandible, temporal bones and cranial vault around lambda were confirmed among cranium. The postcranial bones were also partly/fragilely preserved. Sternal body, right clavicle, and left ulna were completely lost.

Sex: the greater sciatic notch was partly preserved, but could not be sufficiently observed due to the damage on it. The size of the cross section of long bones showed different criteria between the both limbs of upper and lower. Accordingly, the biological sex was unknown.

Age: the condition of the auricular surface was assigned to the third stage according to the standard of Lovejoy et al.. This stage ranged the first half of thirties.

Pathological observations: healed porotic hyperostosis was confirmed on cranial vault around lambda (Fig. 91). The 1st IP and the MP joint of foot showed a severe inflammation (Fig. 92). A surplus tooth crown was impacted under the right maxillary central incisor (Fig. 93). It was the most common supernumerary tooth, which was clinically called mesiodens.

Burial individual M8

Preservation: the preservation was not good. The following parts of skeleton were partly confirmed: mandible, left scapula, humerus, radius, femur and, right tibia.

Sex: The hip bone was not available. The size of the cross section of long bones took an overlap range between males and females. Accordingly, the biological sex was unknown.

Age: The condition of interalveolar septum and occlusal wear of the lower third molar suggested that it was soon after the eruption. The timing of the eruption relatively varied but ranged from the late teens to twenties in ordinary.

Pathological observations: A localized reactive bone was present on the long bones (Fig. 94). They were periostitis, which caused by trauma or infection.

Burial individual M13

Preservation: Only small pieces of bones were preserved in cranium. The following parts of trunk were confirmed: each one of cervical and thoracic vertebra, and the lower part of sacrum and coccyges. The following parts of upper limb were confirmed: clavicles and humeri of both sides and some metacarpals and phalanges. The following parts of lower limb were confirmed: right femur, tibiae of both sides, left fibula, some tarsals, metatarsals and phalanges.

Sex: the total size of the limb bones was relatively small, which suggested that the biological sex was female.

Age: the all epiphyseal lines disappeared, which

Fig.91 The healed porotic hyperostosis on cranial vault around lambda of Bor-Ovoo M2 individual.

Fig.92 The severe inflammation in the 1st IP and MP joint of foot of the Bor-Ovoo M2 individual.

Fig.93 The surplus tooth crown impacted under the right maxillary central incisor (mesiodens) of the Bor-Ovoo M2 individual.

Fig.94 The reactive bones caused by periostitis on the right tibia of the Bor-Ovoo M8 individual.

Fig.95 The inferior facets of the distal tibiae caused by he habitual squatting posture of the Bor-Ovoo M13 individual.

indicated that the age at the death was over 20 years, but unknown in detail.

Pathological observations: The enlarged articular facets were confirmed on the distal tibiae (Fig. 95). Baba (1970) called them inferior facet, which caused by the habitual squatting posture.

Musculoskeletal stress markers (MSMs): The MSMs scores of this individual were generally moderate. The state of being possible to investigate is left clavicle, right and left humeri and right femur. MSMs scores on the upper limbs were as following; the *costoclavicular ligament* of left clavicle was score 2. The *deltoideus*, and *coracobrachialis* of right humerus were scores 2 and 1 each, and these attachment sites of left sides were scores 2 and 2. The MSMs scores on the lower limbs were as following; the *gluteus maximus*, *Vastus lateralis*, and *linea aspera* of right femur were scores 2, 2 and 2 each.

4. Conclusion

The results of the examination on the human skeletal remains excavated from the both site of Khyar

Fig.96 The obliquely front view of crania; Khyar-Kharaach M20 at the front left, Khyar-Kharaach M1 at the middle, Tevsh M3 at the back right

Kharaach and Bor Ovoo were summarized as followings. The human bones were relatively good preserved in the Khyar Kharaach site compared to the Bor Ovoo site. In the Khyar Kharaach site, the M1 individual was old adult (over 50 years) male, and the M20 individual was middle adult (the first half of forties) male. The MSMSs scores of both skeletal remains were generally high and symmetry. In both skeletal remains, the upper limbs have specific gravity of the MSMs development than lower limbs. In the Bor Ovoo site, the M2 individual was young adult (the first half of thirties). The M8 individual was late adolescence or young adult (late teens or twenties). The M13 individual was adult (over 20 years) female.

The pathological conditions were observed on the bones or the teeth of the all individuals. Severe masticatory environment was evident in the teeth worn out to the CEJ, the defected alveolar bones and the TMJ arthritis of the Khyar Kharaach M1 individual. The noncarious pulp exposure of four teeth suggested that the second dentine deposition could not catch up with such a rapid dental wear progress. The Khyar Kharaach M20 individual also showed three regions or types of malunion, which were the Colles' fracture, the fifth CM joint dislocation fracture and nasal bone fracture, respectively. Although it was unknown if these three fractures simultaneously happened, they often occurred at some traffic accidents using bike or motorcycle in modern societies.

In the osteometric measurements, the values were significantly different in the nasal root prominence and the simotic index of flatness between the both individuals of M1 and M20 of the Khyar Kharaach site. It conveyed us a very different impression of their faces (Fig. 96).

Table 3. Measurements of cranium

Site	Khyar Kharaach	
Sample No. Sex	M1 Male	M20 Male
1. Maximum cranial length	192	187
5. Basal length	107	104
8. Maximum cranial breadth	164	146
9. Minimum frontal breadth	98	96
17. Basi-bregmatic height	135	132
23. Horizondal circumference	563	534
24. Transverse arc	345	325
25. Total sagittal arc	383	369
40. Facial profile length	103	99
45. Bizygomatic breadth	149	143
46. Bimaxillary breadth	114	104
47. Total facial height	(123)	121
48. Upper facial height (sd)	74	72
50. Anterior interorbital breadth	20.8	18.3
IA. Anterior interorbital arc	23.0	24.0
51. Orbital breadth	43	46
52. Orbital height	35	36
54. Nasal breadth	29	28
55. Nasal height	54	54
57. Least nasal breadth	5.3	7.6
FC. Frontal chord	97.5	102.0
FS. Frontal subtense	15.2	18.8
SC. Simotic chord	5.3	7.6
SS. Simotic subtense	1.3	4.3
ZC. Zygomaxillary chord	108.2	103.5
ZS. Zygomaxillary subtense	19.0	24.0
72. Facial profile angle	90	87
73. Middle facial profile angle	91	88
74. Alveolar profle angle	77	77
8:1 Cranial length-breadth index	85.4	78.1
17:1 Cranial length-height index	70.3	70.6
17:8 Cranial breadth-height index	82.3	90.4
47:45 Kollmann's total facial index	82.6	84.6
48:45 Kollmann's upper facial index	49.7	50.3
47:46 Virchow's total facial index	107.9	116.3
48:46 Virchow's upper facial index	64.9	69.2
50:IA Prominence index of nasal root	90.4	76.3
52:51 Orbital index	80.2	77.8
54:55 Nasal index	53.7	51.4
FS:FC Frontal index of flatness	15.5	18.4
SS:SC Simotic index of flatness	24.5	56.7
ZS:ZC Zygomaxillary index of flatness	17.6	23.2
65 Bicondylar breadth	136	132
66 Bigonial breadth	101	105
68 Mandibular body length	78	77
69. Mandibular symphysis height	39	41
70 Mandibular ramus height	67	60
71 Mandibular ramus breadth	39	39
79 Mandibular angle	110	120
71:70 Index of mandibular ramus	57.9	65.5

Table 4. Measurements of the upper limbs

	Site	Khyar Kharaach	
Sample	No.	M1	M20
	Sex	Male	Male
Clavicle			
1. Maximum length	L	—	152
	R	—	146
4. Vertical diameter of the mid-shaft	L	—	10
	R	—	10
5. Sagittal diameter of the mid-shaft	L	—	12
	R	—	13
6. Circumference of the mid-shaft	L	—	34
	R	—	36
4:5 Mid-shaft index	L	—	82.6
	R	—	76.9
6:1 Length-circumference index	L	—	22.0
	R	—	24.3
Humerus			
1. Maximum length	L	—	316
	R	320	331
2. Total length	L	—	313
	R	317	326
5. Maximum diameter of the mid-shaft	L	—	21
	R	27.5	22
6. Minimum diameter of the mid-shaft	L	—	18
	R	20	19
7. Least circumference of the shaft	L	—	63
	R	71	63
6:5 Mid-shaft index	L	—	83.3
	R	72.7	86.4
7:1 Index of robustness	L	—	19.8
	R	22.2	19.0
Radius			
1. Maximum length	L	—	—
	R	—	248
2. Physiological length	L	—	—
	R	—	230
3. Minimal circumference of the distal shaft	L	—	41
	R	—	43
4. Maximum transverse shaft diameter	L	—	19
	R	—	19
5. Sagittal shaft diameter	L	—	12
	R	—	12
3:2 Length-circumference index	L	—	—
	R	—	18.5
5:4 Shaft index	L	—	63.2
	R	—	63.2
Ulna			
1. Maximum length	L	—	261
	R	258	265
2. Physiological length	L	—	233
	R	226	234
3. Least circumference of the shaft	L	—	38
	R	41.5	37
11. Dorso-Volar shaft diameter	L	—	13
	R	15.5	12
12. Transverse shaft diameter	L	—	14
	R	19.5	16
3:2 Length-circumference index	L	—	16.3
	R	18.4	15.8
11:12 Shaft index	L	—	92.9
	R	79.5	75.0

Abbreviations: L, left; R, right.

Table 5. Measurements of the lower limbs

	Site	Khyar Kharaach	
Sample	No.	M1	M20
	Sex	Male	Male
Femur			
1. Maximum length	L	—	430
	R	469	440
2. Oblique length	L	—	429
	R	467	438
6. Sagittal diameter of the mid-shaft	L	—	29
	R	36	29
7. Transverse diameter of the mid-shaft	L	—	28
	R	28	28
8. Circumference of the mid-shaft	L	—	88
	R	98	89
9. Transverse subtrochanteric diameter	L	—	33
	R	30	33
10. Sagittal subtrochanteric diameter	L	—	27
	R	32	27
8:2 Length-circumference index	L	—	20.5
	R	21.0	20.3
6:7 Pilastric index	L	—	103.6
	R	130.9	103.6
10:9 Platymeric index	L	—	81.5
	R	106.7	80.3
Tibia			
1. Total length	L	361	355
	R	363	365
1a. Maximum length	L	(368)	361
	R	372	372
8. Maximum diameter of the mid-shaft	L	34	31
	R	32	31
8a. Maximum diameter of the nutrient foramen level	L	37	36
	R	37	35
9. Transverse diameter of the mid-shaft	L	27	22
	R	25	23
9a. Transverse diameter of the nutrient foramen level	L	29	25
	R	27	26
10. Circumference of the mid-shaft	L	91	83
	R	87	83
10b. Minimum circumference of the shaft	L	80	72
	R	76	74
9:8 Mid-shaft index	L	77.9	72.1
	R	78.1	75.4
9a:8a Cnemic index	L	78.4	70.4
	R	73.0	74.3
10b:1Length-circumference index	L	22.2	20.3
	R	20.9	20.3
Fibula			
1. Maximum length	L	—	357
	R	—	—
2. Maximum diameter of the mid-shaft	L	—	14
	R	—	15
3. Minimum diameter of the mid-shaft	L	—	12
	R	—	13
4. Circumference of the mid-shaft	L	—	41
	R	—	45
4a. Least circumference of the shaft	L	—	33
	R	—	36
3:2 Mid-shaft index	L	—	85.7
	R	—	86.7
4a:1 Length-circumference index	L	—	9.2
	R	—	—

4 The Strontium analysis on the human skeletal remains from the Khyar Kharaach site in the Gobi Altai, Mongolia

Shiori Yonemoto, Tatsuro Adachi, Kyoko Funahashi, Nobuhiko Nakano and Yasuhito Osanai

1. Introduction

The strontium (hereafter Sr) isotope analyses in archaeological skeletal remains were introduced by Ericson (1985). This method has been established as one of the most effective method to examine prehistoric human mobility (e.g. Bently et al. 2004; Bently 2006).

This analysis is based on the Sr isotope (hereafter $^{87}Sr/^{86}Sr$) ratio that is conveyed from weathering rocks, through the soil and water, into food chain. Humans that eat animals and plants and drink water acquire the $^{87}Sr/^{86}Sr$ ratio of local. Particularly, tooth enamel is formed in one's childhood without remodeling. The $^{87}Sr/^{86}Sr$ ratio in tooth enamel is a signature of Sr from a person's childhood habitat. Therefore, the $^{87}Sr/^{86}Sr$ ratio in tooth enamel reflects the geology of the place where one has been brought up.

Most previous studies of Sr isotope analysis in archaeology have been performed using thermal ionization mass spectrometry (TIMS) which is applicable for solution of entire teeth. The third molar was used for these analyses, because there was little influence on morphological researches. The third molar is generally formed from 9 years old to 13 years old (Hillson 1996). It suggests that $^{87}Sr/^{86}Sr$ ratio of the third molar are limited information to this age stage. Hence, these analyses cannot be clarified about 87Sr/86Sr ratio in one's childhood. The advent of laser-ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) acquires smaller volume of the samples than TIMS (Porhaska et al. 2002; Horstwood et al. 2008). It means that LA-MC-ICP-MS enables the analysis with less damage and is applicable for any tooth type, not only the third molar. Particularly, analysis of incisor can examine. This tooth is formed at the age of 0-4 years old. It is possible that $^{87}Sr/^{86}Sr$ ratio from the incisor more directly reflect Sr isotope ratio from person's childhood geological habitat than those from the third molar. We suggested that Tevsh No.1 and No.3, who were buried in the same area, may have been grew in different place, because their $^{87}Sr/^{86}Sr$ ratio were very different (Yonemoto et al., 2016). We investigate the $^{87}Sr/^{86}Sr$ ratio of humans who were buried in same burial site in Bronze age of Mongolia to reveal their childhood habitat. This analysis will be clarified the constitution of group sharing same graveyard. In this article, we investigate two human skeletal remains from the Khyar Kharaach site in the Gobi Altai, Mongolia.

2. Materials and Method

For this study, we used samples of two individuals from the Khyar Kharaach sites.

As comparative data, the samples from Tevsh sites, Chandman Khar sites (Yonemoto et al., 2016), Ulaan Boom sites, Khushuut 1 and 2 sites, Houvsgol sites (excavation years are 2006 and 2007) and Zuun Bel sites were used. Table6 shows the details of individuals analyzed.

The morphological analysis on the human skeletal remains from Khyar Kharaach site is reported by Okazaki et al. in this book. The biological sex in Grave No.1 individual (KK1) is male and age range over 50 years. The biological sex in Grave No.20 individual (KK20) is male and age range ranged the first half of forties. The radiocarbon ages on the human skeletal remains from Khyar Kharaach site is reported by Yoneda et al. in this book. The teeth analyzed are right lower first incisor and canine of KK1 and right lower second incisor of KK20. The odontogenesis age of the analysis point on KK1 is regarded as 3-4 years old and the odontogenesis age of the analysis point on KK20 is regarded as 2-4 years old (Hillson 1996). KK1 and KK20 were excavated in one cemetery. However, KK1 and KK20 are markedly different in facial traits. The details of different are written down in Okazaki et al. in this book. Moreover, the information about biological sex and age assessment of other skeletal remains are shown as Table6. However, some human skeletal remains analyzed in this paper are unidentified yet on the morphological characters at present. These human

bones were remained blank in Table6.

We used LA-MC-ICP-MS (Thermo Scientific Neptune Plus) combined with LA system (Photon Machine Analyte G2 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 in order to obtain the stability of the signal. Second, isotopic analyses were performed using LA-MC- ICP-MS. Isotopic ratios were calculated based on data correction protocols described by Horstwood et al. (2008). In this paper, we analyzed not only $^{87}Sr/^{86}Sr$ ratios but also $^{43}Ca/^{88}Sr$ ratios. Because main ingredient of teeth is apatite ($Ca_5(PO_4)_3(F, Cl, OH)_2$), the concentration of Ca is approximately constant and Sr is trace amount. Content of Sr can be estimated by checking $^{43}Ca/^{88}Sr$ ratios. Finally, the analysis traces was observed using scanning electron microscope (SEM, Keyence VHX-D500). The analysis carried out for each tooth more than five lines which were used to calculate weighted means of $^{87}Sr/^{86}Sr$ ratios to check deviation of the obtained date. Weighted means of 87Sr/86Sr ratios were also used to calculate probability density to reveal the cluster of these values.

3. Results

The results and weighted mean are presented in Table 6. Figure 97 and figure98 show $^{87}Sr/^{86}Sr$ ratios and $^{43}Ca/^{88}Sr$ ratios, respectively.

The $^{87}Sr/^{86}Sr$ ratios in RLC of KK1 is 0.71185 ± 0.00063 and in RLI1 of KK1 is 0.71135 ± 0.00041, varying in the range of 0.71040 - 0.71258. There is not outliner in KK1. The $^{87}Sr/^{86}Sr$ ratios of the KK1 are relatively in union. The $^{87}Sr/^{86}Sr$ ratios in RLI_2 of KK20 is 0.71057 ± 0.00044, varying in the range of 0.71029 - 0.71123. There is not outliner in KK20. The $^{87}Sr/^{86}Sr$ ratios of KK20 are also relatively in union. The values were arranged based on the location of site from west to east. As shown in Figure97, there is a little difference in $^{87}Sr/^{86}Sr$ values between KK1 and KK20, although the overlap in the $^{87}Sr/^{86}Sr$ ratios between RLI_1 of KK1 and RLI_2 of KK20 is slightly seen. In the case of the KK1, the variation of $^{43}Ca/^{88}Sr$ ratios is large (Fig.98). Particularly, the differences between types of teeth are large. But, in one type of teeth the variation of $^{43}Ca/^{88}Sr$ ratios is relatively small. 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 $^{43}Ca/^{88}Sr$ ratios in KK1 and KK20 have little influence on $^{87}Sr/^{86}Sr$ ratios.

Figure 99 illustrated $^{87}Sr/^{86}Sr$ values of all samples with probability density distribution. The values were arranged based on the location of sites from west to east. The calculated age by probability density distribution were 0.708996 ± 0.0001, 0.71069 ± 0.0001 and 0.71227 ± 0.0003. The obtained data means that there are three clusters based on three peak point in the $^{87}Sr/^{86}Sr$ ratios of all Mongolian samples in this study. The $^{87}Sr/^{86}Sr$ ratio of KK1 cluster around 0.71227 ± 0.0003. On the other hand, the $^{87}Sr/^{86}Sr$ ratio of KK20 cluster around 0.71069 ± 0.0001. The result also supports the finding that there is a little difference in $^{87}Sr/^{86}Sr$ values between KK1 and KK20.

Moreover, the experimental results of other samples are also shown as Figure99. The clusters having lowest point (i.e. 0.708996 ± 0.0001) are as follows; all samples excavated from Zuun Bel, C26 (i.e. Chandman burial no.26), H2 (i.e. Houvsgol2006 burial No.2) and H10 (i.e. Houvsgol 2007 burial no.10). The $^{87}Sr/^{86}Sr$ ratios of every individuals from Zuun Bel sites don't have the clear difference. The $^{87}Sr/^{86}Sr$ ratios of Z9 is 0.70896 ± 0.00068, of Z14 is 0.70907 ± 0.00023, of Z15A is 0.70950 ± 0.00180 and 0.70901 ± 0.00084, of Z15B is 0.70795 ± 0.00041 and of Z16 is 0.70750 ± 0.00110. The clusters having highest point (i.e. 0.71227 ± 0.0003) are as follows; KK1, T1 (Tevsh burial No.1), UB2 (Ulaan Boom No.2) and probably T3 (Tevsh burial No.3). Other samples are belonged to middle cluster (i.e. 0.71069 ± 0.0001).

4. Discussions

These results suggest that there is a little difference of $^{87}Sr/^{86}Sr$ ratios between KK1 and KK20. To interpret this result, we considered the archaeological context. The two human remains were also different in burial styles. The differences in burial styles between burial no.1 and no.20 in Khyar Kharaach site is reported by Miyamoto in this book and Miyamoto (2016). Moreover, these two graves were different for around 50 years in C14 dating. These results were in good agreement with the difference of $^{87}Sr/^{86}Sr$ ratios. Then, we interpret the result as difference in childhood habitat between KK1 and KK20 from Khyar Kharaach sites. It is difficult to determine where each individual childhood only from strontium isotopes, because the Mongolian geological feature is complicated. However, we can conclude that the place where they were brought up in their childhood were different.

Given the data from Fig.99, we will speculate the possibility of regional differences in Mongolia. The $^{87}Sr/^{86}Sr$ ratios of these sites in west side, i.e. Khushuut1, Khyar Kharaach, Ulaan Boom and Houvsgol in Fig.100, cluster around 0.71069 ± 0.0001.

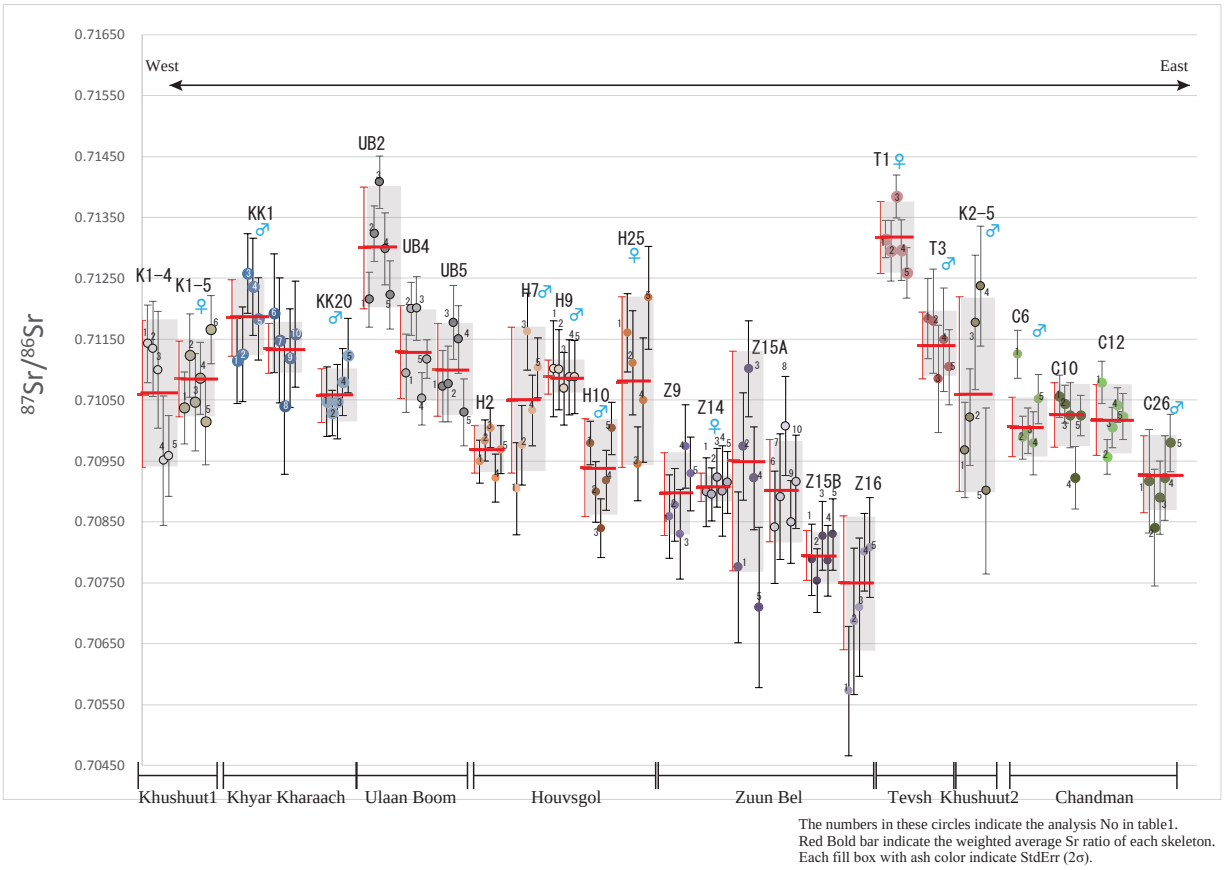
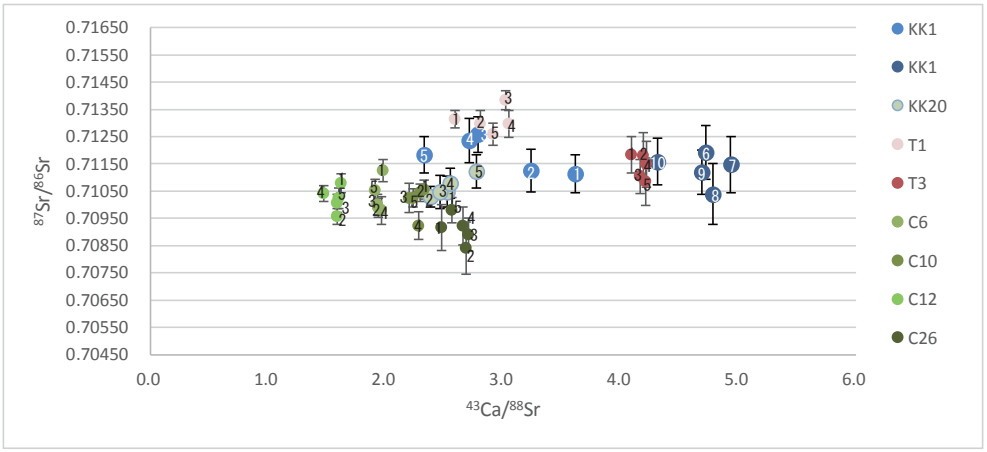


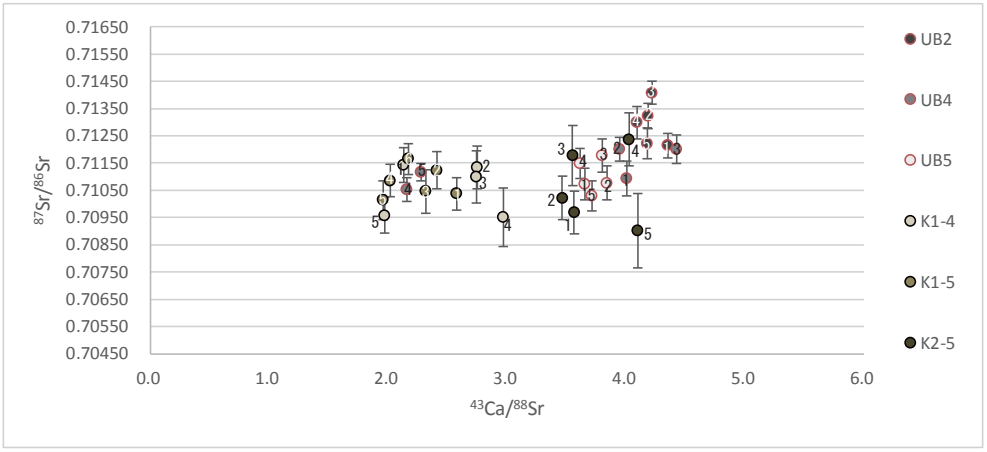
Fig.97 $^{87}Sr/^{86}Sr$ ratios

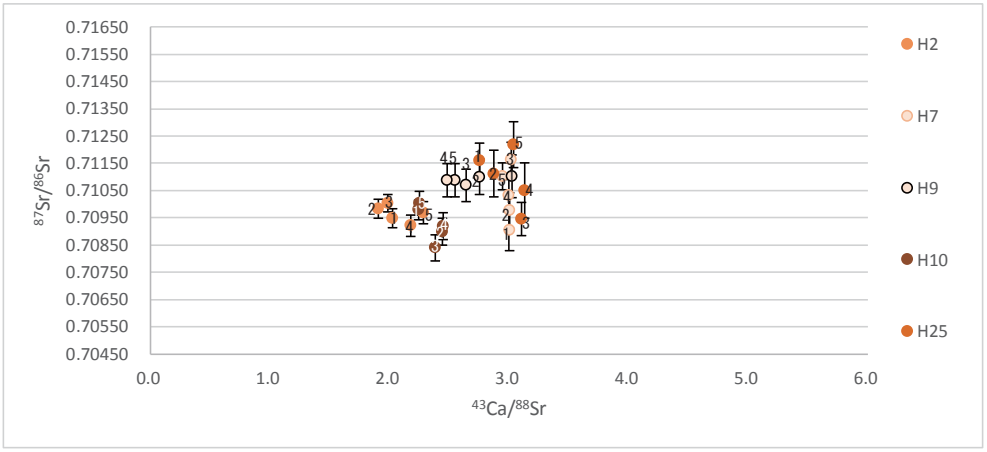
The specificity of the $^{87}Sr/^{86}Sr$ ratios of Zuun Bel may come from Permian granite located on these sites (Fig.100). The $^{87}Sr/^{86}Sr$ ratios of H2 and H10 in Houvsgol sites are around the lowest value in this area. Because Houvsgol site is near to ZuunBel site, the $^{87}Sr/^{86}Sr$ ratios of H2 and H10 may be related to the human mobility from ZuunBel site. However, Houvsgol site and ZuunBel site were greatly difference in period (Table 6), we cannot rush to this conclusion. What is important here is that the $^{87}Sr/^{86}Sr$ ratios of skeletal remains from sites on west side of Mongolia clustered around the middle value, including Khyar Kharaach Grave No.20 where western influence may be strong. Then, Fig.99 suggests that the human group from Chandman site might have been caused by migration from west to east. The $^{87}Sr/^{86}Sr$ ratios of KK1, T1, UB2 and probably T3 cluster around the highest point. The cause for these highest values might be pursued in the east, because Khyar Kharaach Grave No.1 might have been affected by strongly eastern influence. However, each of them lacked a decisive ground, and no exact conclusion has been reached yet. We need to further our examination in regard to that.

5. Conclusions

We investigate the possibility of mobility in individuals who were buried in Khyar Kharaach sites. The strontium isotopes result indicated that there is a difference in $^{87}Sr/^{86}Sr$ ratios between KK1 and KK20. The results suggested that the geographic origins are difference between KK1 and KK20 who were buried in the same sites.







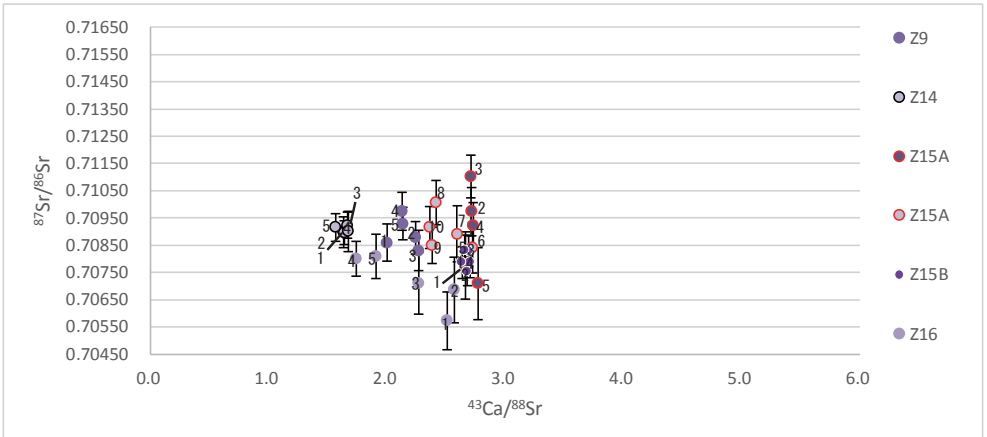
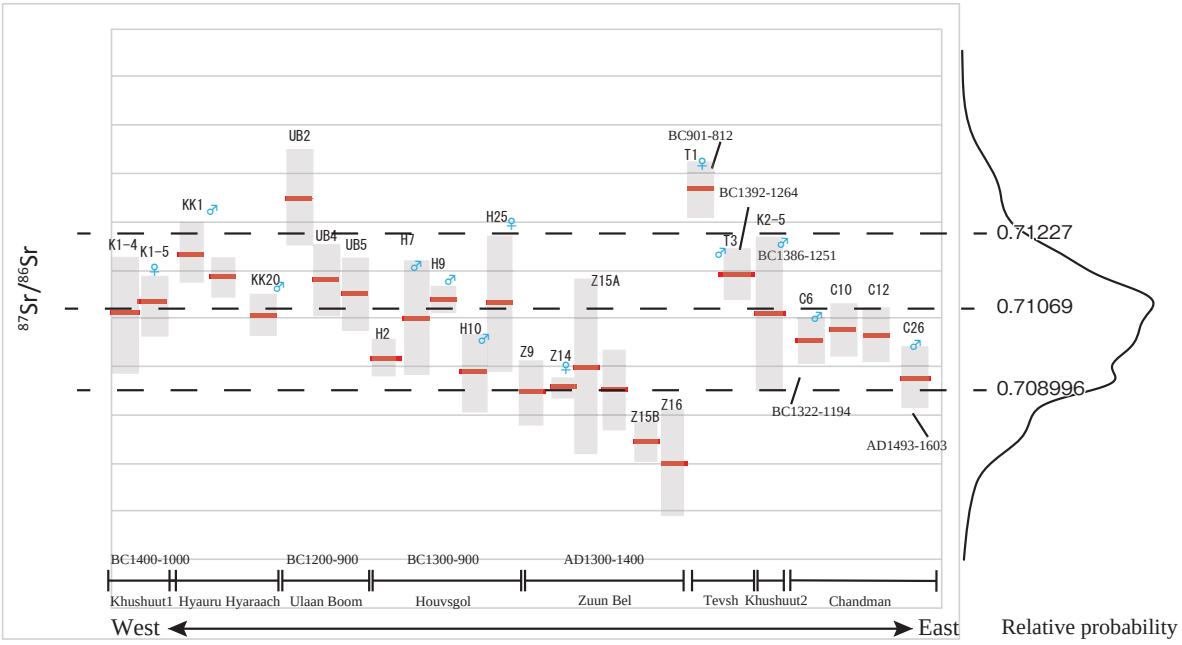


Fig.98 Diagram of $^{43}Ca/^{88}Sr$ ratios vs $^{87}Sr/^{86}Sr$ ratios of each site



Red Bold bar indicate the weighted average Sr ratio of each skeleton.
Each fill box with ash color indicate StdErr (2σ).
Black line graph indicate probability density plot.
Three broken line indicate calculated age.

Fig.99 $^{87}Sr/^{86}Sr$ ratio with the result of relative probaility

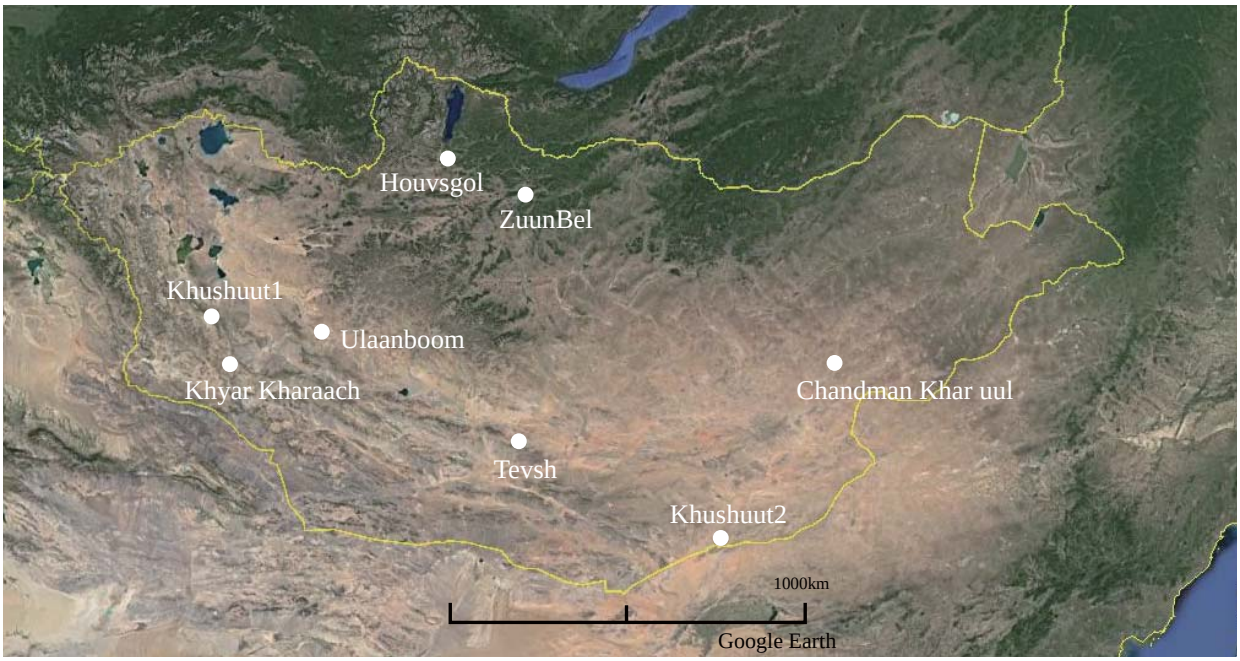


Fig.100 The site locations

Table 6 Characters, 87Sr/86Sr ratio and $^{43}Ca/^{88}Sr$ ratio of human skeletal remains who were analyzed in this study.

Sitename	Grave No.	Individual skeleton No.	sex	age	Teeth type	Age estimated by Analysis point	Analysis No.	$^{87}Sr/^{86}Sr$	StdErr (2σ)	$^{43}Ca/^{88}Sr$	Weighted mean	SD	MSWD	Calibrated ^{14}C age (*Yoneda 2016, ** unpublished data by Yoneda, HH is published in this book by Yoneda)"
Khyar Kharaach	No.1	KK1	Male	Middle adult	RLC	3-4years old	1	0.71115	0.00070	3.6125	0.71185	0.00063	3.3	1265BC(94.2%)1108BC
							2	0.71125	0.00078	3.2325				
							3	0.71258	0.00065	2.7859				
							4	0.71236	0.00080	2.7095				
							5	0.71183	0.00068	2.3282				
					RLI_1	3-4years old	6	0.71192	0.00098	4.7216	0.71135	0.00041	1.2	
							7	0.71148	0.00103	4.9333				
							8	0.71040	0.00111	4.7812				
							9	0.71119	0.00081	4.6864				
							10	0.71158	0.00087	4.3105				
	No.20	KK20	Male	Middle adult	RLI_2	2-4years old	1	0.71048	0.00057	2.5225	0.71057	0.00044	1.9	1306BC(90.1%)1054BC
							2	0.71029	0.00037	2.3801				
							3	0.71048	0.00061	2.4643				
							4	0.71080	0.00055	2.5467				
							5	0.71123	0.00061	2.7684				
Tevsh Uul	No.1	T1	Female	Middle adult	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				
	No.3	T3	Male	Middle adult	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	Male	Middle adult	RUI^1	3-4years old	1	0.71125	0.00040	1.9792 *	0.71006	0.00049	2.4	1322BC(81.4%)1194BC**
							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				
	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				
	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				
	No.26	C26	Male	Young adult	RUI^1	4-5years old	1	0.70917	0.00085	2.4779	0.70928	0.00063	2.4	1493AD(76.1%)1603AD**
							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				
Ulaan Boom	No.2	UB2			RUi^1	Birth-6month	1	0.71215	0.00045	4.3489	0.71300	0.00100	12	1266BC(95.4%)1113BC**
							2	0.71323	0.00046	4.1848				
							3	0.71408	0.00043	4.2149				
							4	0.71298	0.00059	4.0884				
							5	0.71223	0.00056	4.1764				
	No.4	UB4			RUI^1	4-5years old	1	0.71094	0.00064	4.0048	0.71129	0.00076	8.2	1216BC(89.0%)1052BC**
							2	0.71200	0.00044	3.9451				
							3	0.71201	0.00052	4.4232				
							4	0.71052	0.00043	2.1567				
							5	0.71117	0.00031	2.2738				
	No.5	UB5			LLI_1	2-4years old	1	0.71073	0.00059	3.6504	0.71100	0.00076	4.5	1133BC(88.1%)976BC**
							2	0.71077	0.00062	3.8396				
							3	0.71177	0.00060	3.7979				
							4	0.71150	0.00055	3.6112				
							5	0.71030	0.00054	3.7092				
Khushuut1	No.4	K1-4			LLi_2	2month	1	0.71142	0.00064	2.1269	0.71060	0.00120	6.1	1214BC(92.7%)1041BC**
							2	0.71134	0.00078	2.7455				
							3	0.71100	0.00096	2.7415				
							4	0.70951	0.00106	2.9653				
							5	0.70958	0.00066	1.9671				
	No.5	K1-5	Female	Young adult	RLI_2	2-4years old	1	0.71037	0.00059	2.5735	0.71085	0.00062	3.4	1390BC(93.5%)1259BC**
							2	0.71123	0.00068	2.4092				
							3	0.71046	0.00080	2.3149				
							4	0.71086	0.00059	2.0136				
							5	0.71014	0.00070	1.9548				
							6	0.71166	0.00056	2.1673				

Sitename	Grave No.	Individual skeleton No.	sex	age	Teeth type	Age estimated by Analysis point	Analysis No.	$^{87}Sr/^{86}Sr$	StdErr (2 σ)	$^{43}Ca/^{86}Sr$	Weighted mean	SD	MSWD	Calibrated ^{14}C age (*Yoneda 2016, ** unpublished data by Yoneda, HH is published in this book by Yoneda)"
Khushuut2	No.5	K2-5	Male	Middle adult	LLI_2	1-5years old	1	0.70968	0.00078	3.5620	0.71060	0.00160	7.3	1386BC(85.5%)1251BC**
							2	0.71022	0.00079	3.4618				
							3	0.71177	0.00110	3.5490				
							4	0.71237	0.00098	4.0245				
							5	0.70901	0.00136	4.0962				
Houvsgoll2006	No.2	H2	Unknown	Child	LLI_2	2-3years old	1	0.70949	0.00035	2.0268	0.70969	0.00039	3.1	1010BC(95.4%)901BC**
							2	0.70984	0.00034	1.9021				
							3	0.71004	0.00032	1.9846				
							4	0.70922	0.00039	2.1759				
							5	0.70969	0.00039	2.2802				
	No.7	H7	Male	Old adult	RLI_2	2-3years old	1	0.70904	0.00076	2.9995	0.71050	0.00120	9.4	1126BC(95.4%)978BC**
							2	0.70976	0.00065	3.0027				
							3	0.71163	0.00063	3.0192				
							4	0.71033	0.00058	2.9961				
							5	0.71103	0.00049	2.9429				
Houvsgol2007	No.9	H9	Male	Young adult	LUI^2	2-4years old	1	0.71102	0.00079	3.0219	0.71088	0.00028	0.16	1262BC(95.4%)1122BC**
							2	0.71100	0.00066	2.7540				
							3	0.71069	0.00060	2.6365				
							4	0.71088	0.00062	2.5443				
							5	0.71088	0.00060	2.4784				
	No.10	H10	Male	Middle adult	RUI^2	2-3years old	1	0.70979	0.00036	2.2415	0.70939	0.00080	8.6	1316BC(73.7%)1213BC**
							2	0.70899	0.00050	2.4409				
							3	0.70839	0.00048	2.3815				
							4	0.70918	0.00049	2.4460				
							5	0.71004	0.00043	2.2480				
	No.25	H25	Female	Old adult	RLI_2	2-3years old	1	0.71161	0.00064	2.7547	0.71080	0.00140	9.4	1291BC(94.1%)1127BC**
							2	0.71111	0.00086	2.8698				
							3	0.70945	0.00060	3.1033				
							4	0.71050	0.00102	3.1293				
							5	0.71218	0.00085	3.0333				
Zuun Bel	No.9	Z9			RLI_2	2-4years old	1	0.70859	0.00069	2.0003	0.70896	0.00068	2.8	
							2	0.70878	0.00060	2.2422				
							3	0.70830	0.00074	2.2697				
							4	0.70974	0.00069	2.1301				
							5	0.70929	0.00061	2.1364				
	No.14	Z14	Female	Young adult	LUI^1	2-3years old	1	0.70899	0.00057	1.6317	0.70907	0.00023	0.23	
							2	0.70895	0.00043	1.6379				
							3	0.70923	0.00048	1.6641				
							4	0.70901	0.00074	1.6742				
							5	0.70915	0.00051	1.5636				
	No.15A	Z15A			RUc	Birth-9month old	1	0.70776	0.00124	2.6653	0.70950	0.00180	9.2	1299AD(75.0%)1370AD**
							2	0.70974	0.00088	2.7130				
							3	0.71101	0.00079	2.7104				
							4	0.70922	0.00084	2.7314				
							5	0.70709	0.00132	2.7695				
					LLM_1	5-7years old	6	0.70841	0.00093	2.7224	0.70901	0.00084	2.8	
							7	0.70891	0.00103	2.5930				
							8	0.71007	0.00081	2.4129				
							9	0.70850	0.00068	2.3844				
							10	0.70916	0.00076	2.3609				
	No.15B	Z15B	Unknown	Child	LUI^1	2-4years old	1	0.70788	0.00059	2.7036	0.70795	0.00041	1.3	1340AD(57.7%)1397AD**
							2	0.70753	0.00052	2.6803				
							3	0.70827	0.00057	2.6915				
							4	0.70786	0.00058	2.6353				
							5	0.70829	0.00058	2.6593				
	No.16	Z16			RUC	2-3years old	1	0.70572	0.00106	2.5101	0.70750	0.00110	4.3	
							2	0.70687	0.00121	2.5673				
							3	0.70710	0.00113	2.2701				
							4	0.70801	0.00064	1.7373				
							5	0.70808	0.00082	1.9093				

* indicate the outlier value

5 Carbon and nitrogen stable isotope ratios and radiocarbon ages on the skeletal remains from Bor Ovoo and Khyar Kharaach sites, Mongolia.

Minoru YONEDA, Takayuki OMORI, Hiromasa OZAKI, Shigeru ITO

1. Introduction

In order to determine the absolute ages of burials and ancient dietary habit of the Bronze Age of Mongolia, we have analyzed a series of human bones from the Bor Ovoo and Khyar Kharaach sites. We have obtained well preserved protein (collagen) from 4 of 7 bone samples, which will give us reliable radiocarbon ages and dietary information through stable carbon and nitrogen isotopes. Results were compared with previous data obtained by our project (Yoneda et al. 2016).

2. Materials and Methods

Three human bone samples form Bor Ovoo and four bone samples, consisted of two humans and two animals, from Khyar Kharaach were treated for extraction of collagen and measurement for stable carbon and nitrogen isotope ratios, in addition to radiocarbon dating. The collagen extraction was conducted by the following manner.

Collagen Extraction

We have conducted alkali treatment and gelatinization to extract collagen (Longin et al. 1971; Yoneda et al. 2002). First, surface of bone was removed by sandblasting and ultrasonic cleaning in pure water for 10 min. Adhering organic matters was removed by soaking in 0.2 M NaOH overnight, and then washed with pure water. After lyophilisation, the sample was crashed into fine powder by an iron mortar and pestle. Then, powder was sealed in cellulose tube and demineralized with 1.2 M HCL overnight at the temperature of 4ºC, and washed with pure water overnight at the temperature of 4ºC. Remaining organic matter was recovered by centrifugation and freeze-dried to weigh. Recovered organic matter was heated at 90ºC in pure water overnight to extract gelatin. Dissolved gelatin was purified through Watman GF/F filter and lyophilized. The weight of extracted gelatin was recorded and fraction was applied for the following analyses.

Elemental and isotopic analyses (EA-IRMS)

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 sequentially 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 $\delta^{13}C$ and AIR for $\delta^{15}N$). Typical uncertainties with carbon and nitrogen isotopic ratios were 0.1‰ in $\delta^{13}C$ and $\delta^{15}N$ notation. When any gelatin sample showed atomic C/N ratios out of the range between 2.9 and 3.6, it is highly possible that collagen was contaminated with soil organic matter or degraded in amino acid composition (DeNiro 1985, van Klinken 1999). In that case, we eliminated its data from dietary reconstruction and radiocarbon dating.

Graphitization and radiocarbon dating (AMS)

After evacuation, 2.5 mg of collagen was sealed in a dual quartz tube with CuO and Surfix and heated at 850ºC 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 450ºC for 8 hours with an excess amount (2.2 times of CO_2) of H_2 with 2 mg 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. (with PLD code, Kobayashi et al. 2007) and the University Museum, the University of Tokyo (with TKA code). A series of international standards were measured at the same time for correction and $\delta^{13}C$ 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 7 samples and we can obtain enough amount of gelatin for elemental analysis. In general, the gelatin yield less than 1% empirically suggest the degradation of collagen (van Klinken 1999). One human sample from Bor ovoo Figured Grave No. 8 and two animal bones from Khyar Kharaach Ritual Site No. 18 showed gelatin yield less than 1%. Other 4 samples showed much higher yield from 7% to 15%.

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 one human form Bor Ovoo (FG-8) and two animal bones from Khyar Kharaach (-5 and -6) showed C/N ratios higher than 3.6, suggesting the possible contamination and/or degradation in collagen (Table 1). Bor Ovoo FG-8 human was measured for radiocarbon date as a reference, while its radiocarbon age could be affected by diagenetic alteration. Hence, we eliminated these three samples for further discussion and radiocarbon dating. Remaining 4 human bones from Bor Ovoo and Khyar Kharaach sites are expected to keep biological information in extracted gelatin as pure collagen.

Stable carbon and nitrogen isotope ratios in collagen reflecting animals' protein sources were measured (Table 7). Figure 101 illustrated the carbon and nitrogen isotope ratios in human bone collagen from Bor Ovoo and Khyar Kharaach in comparison with humans and animals from Daram uul and Tevsh uul (Yoneda et al. 2016). The human data analyzed in this study are similar to humans from Tevsh uul and slightly higher than Daram uul human. The carbon isotopes suggest all humans exploited protein from the terrestrial ecosystem based on C3 plants, while C4 plants such as millets and aquatic animals did not contributed significantly. In Mongolia, the wild flora contains very limited amount of C4 plants (Pyankov et al. 2000), which agree that animals consumed by C3 plants mainly. However, we cannot divide wild weed and cultivated C3 crops including wheat, barley, rye, and rice. The higher δ^{15}N values in humans than those of cattle, horse and sheep/goat suggest that animal meat and milk, not plant, could be main source for human.

The conventional radiocarbon ages (in year BP unit) on human and animals were shown Table 8 with one standard deviation error, and calibrated with IntCal13 calibration curve (Reimer et al. 2013) using OxCal calibration software (ver.4.2; Bronk Ramsey 2009). The calibrated ages showed general agreement of two sites and Tevsh uul. Both humans from Bor Ovoo and Khyar Kharaach assigned to 14-12 C. BC. The human from Bor Ovoo FG-8 which were measured for reference showed younger age than others, suggesting the diagenetic effect on collagen at this site contaminated younger organic matter with the original carbon in collagen.

Interestingly, higher δ^{15}N from Bor Ovoo and Khyar Kharaach are close to two human from Tevsh uul of the same period, suggesting the meat/milk contribution become minor in later period corresponding to Daram uul burials. But another possible explanation is change in ecological baseline of δ^{15}N related to climate change. One animal (sheep or goat) from Tevsh showed higher δ^{15}N but the age is much younger (Yoneda et al. 2016). For more detailed comparison between sites and periods, we have to analyze a series of animal remains to confirm the ecological niche of human at each site.

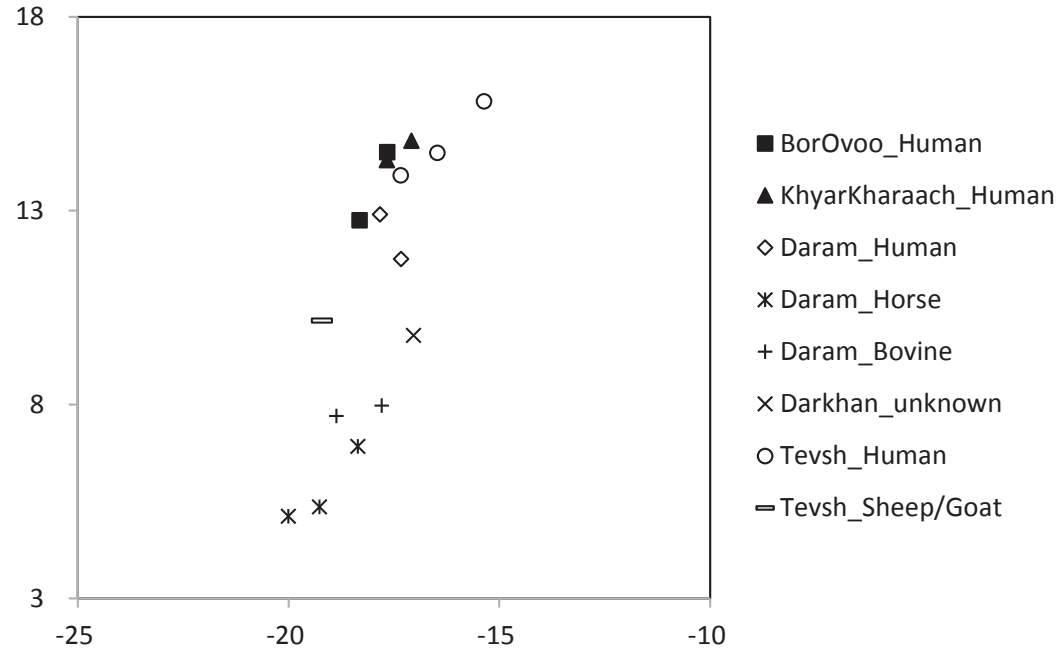


Fig.101 Stable carbon and nitrogen isotope ratios in human and animal from Mongolian Bronze age sites at Daram uul and Tevsh uul.

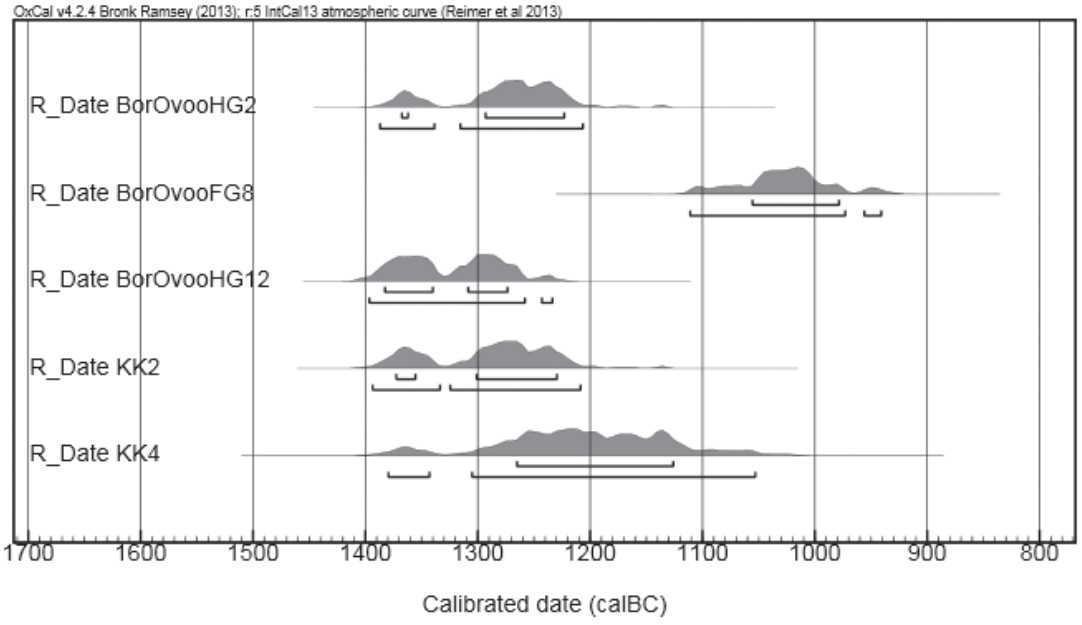


Fig.102 Calibrated radiocarbon ages for Bor Ovoo and Khyar Kharaach sites.

Table 7. Result of preparation and elemental analysis on bone samples.

sample	material	Location	gelatin yield	$\delta^{13}C$	$\delta^{15}N$	C content	N content	atomic C/N
Bor Ovoo HG-2	human bone	Bor Ovoo Khereksuur Grave No. 2	7.8%	-18.3 ‰	12.8 ‰	45.0%	16.7%	3.1
Bor Ovoo FG-8	human bone	Bor Ovoo Figured Grave No. 8	0.7%	-16.5 ‰	15.1 ‰	44.3%	12.9%	4.0
Bor Ovoo HG-12	human bone	Bor Ovoo Khereksuur Grave No. 13	7.7%	-17.7 ‰	14.5 ‰	47.4%	17.8%	3.1
Khyar Kharaach-2	human bone	Khyar Kharaach Grave No. 20	14.6%	-17.1‰	14.8‰	46.2%	17.0%	3.2
Khyar Kharaach-4	human bone	Khyar Kharaach Grave No. 1	13.6%	-17.7‰	14.3‰	46.6%	17.1%	3.2
Khyar Kharaach-5	animal bone 8	Khyar Kharaach Ritural Site No. 18	0.3%	-20.0‰	9.1‰	43.7%	9.9%	5.2
Khyar Kharaach-6	animal bone 3	Khyar Kharaach Ritural Site No. 18	32.4%	-20.7‰	9.2‰	37.9%	6.6%	6.7

Table 8. Conventional and calibrated radiocarbon ages. Bor Ovoo FG-8 is not reliable date because of possible diagenetic effect.

sample	Lab code	Conventional ^{14}C age	$\delta^{13}C$ for correction	calibrated age (1 SD)	calibrated age (2SD)	Remarks
Bor Ovoo HG-2	PLD-26017	3023 ± 23 BP	-15.11 ± 0.37 ‰	1368BC(3.6%)1363BC 1294BC(64.6%)1224BC	1388BC(18.1%)1339BC 1316BC(77.3%)1207BC	
Bor Ovoo FG-8	PLD-26018	***2861 ± 21 BP***	***-15.13 ± 0.34 ‰***	***1056BC(68.2%)979BC***	***1112BC(91.2%)974BC*** ***957BC(4.2%)942BC***	diagenetic effect (C/N = 4.0)
Bor Ovoo HG-12	PLD-26019	3054 ± 21 BP	-15.87 ± 0.33 ‰	1383BC(37.1%)1341BC 1309BC(31.1%)1274BC	1397BC(93.4%)1259BC 1244BC(2.0%)1234BC	
Khayrn Kharaach-2	TKA-16562	3031 ± 27 BP	-18.83 ± 0.67 ‰	1373BC(11.9%)1356BC 1302BC(56.3%)1230BC	1394BC(26.6%)1334BC 1325BC(68.8%)1209BC	
Khayrn Kharaach-4	TKA-16563	2982 ± 43 BP	-18.35 ± 0.58 ‰	1266BC(68.2%)1127BC	1380BC(5.3%)1344BC 1306BC(90.1%)1054BC	
Khayrn Kharaach-5	ND	ND	ND	ND	ND	
Khayrn Kharaach-6	ND	ND	ND	ND	ND	

Closing Remarks

Kazuo Miyamoto

Through excavations at Bor Ovoo Site and Khyar Kharaach Site, we were able to construct a chronology for Bronze Age graves in western Mongolia. Khirigsuur were distributed in western Mongolia and spread eastward to the middle Mongolian Plateau in the latter half of the second millennium BC. At the same time, round graves were also distributed in western Mongolia. Round graves can be classified into two types according to whether or not four corner stones are present. Round graves without four corner stones are thought to belong to the Munk–Khairhan culture (Kovalev and Erdenebaatar, 2009). Bor Ovoo Site contains round graves from the Munk–Khairhan culture along with typical Khirigsuur without four corner stones on the round enclosure. Round graves at Bor Ovoo site can be dated to the 14th and 13th centuries BC, which is later than those of the Munk–Khairhan culture, dating from the 17th to 14th centuries BC (Kovalev & Erdenebaatar, 2009). Khyar Kharaach Site has both Khyar Kharaach type Khirigsuur and Khyar Kharaach type round graves with four corner stones dating to the 14th and 13th centuries BC. The presence of four corner stones indicates stylistic similarities with Khyar Kharaaach type culture. The two different types of burial customs belonging to the Munk–Khairhan culture and Khyar Khyaraach type culture date to a similar period at both Bor Ovoo Site and Khyar Kharaach Site.

On the other hand, square graves emerged in the southeastern Mongolian Plateau and spread westward in the latter half of the second millennium BC (Miyamoto 2016). Square graves changed into figured graves mainly in the middle Mongolian Plateau at the same time. In the latter half of the second millennium BC, during the Karask period, there were two separate burial customs in the east and west of the Mongolian Plateau: a stone-slab culture and Kirigsuur culture. Two separate social groups were a part of the same bronze culture in the Mongolian Plateau. The figured graves of the stone-slab culture spread to Bor Ovoo Site from the 12th to 10th centuries BC after the Munk–Khairhan culture.

In the first millennium BC, the typical type of stone-slab grave emerged and became distributed throughout the middle and eastern Mongolian Plateau from the 8th to 3rd centuries BC (Miyamoto, 2016). The typical type of stone-slab grave distributed in the eastern part of the Mongolian Plateau belongs to one of the social groups of the Tagar culture. These stone-slab graves developed differences in terms of 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 and figured graves. However, we do not yet know how the typical type of stone-slab grave originated. Grave No. 1 at Khyar Kharaach Site is one of the grave types of the Khyar Kharaach type culture. It is probable that this square grave dating to between the 14th and 11th centuries BC is the origin of the typical type of stone-slab grave because of similarities in the grave structure. Both types of grave have a square plan of piled stones with four corner stones.

According to physical anthropological research, the individuals buried at Khyar Kharaach Site, like the Daram and Tevsh Sites, are taller in height compared with other prehistoric peoples in East Asia (Okazaki et al., 2016). The peoples found at Khyar Kharaach Site, like the Daram and Tevsh Sites, sustained far more injuries than other hunter-gatherers or farmers as a result of accidents related to riding horses (Okazaki et al., 2016). Herding societies would have been based on a more nomadic lifestyle than other peoples.

Physical anthropological analysis suggests that human bones excavated from Grave No. 20 at Khyar Kharaach Site are genetically from the Caucasian line and human bones from Grave No.1 are genetically from the Mongolian line. It is probable that the individual concerned moved from central Eurasia on horseback. Strontium analysis on teeth at Khyar Kharaach Site indicates that one of the two different peoples between Grave No.1 and Grave No. 20 came to this site from another area. These results also indicate the probability that the people of the Khyar Kharaach type culture, which includes Grave No. 20,

were a herding people of Caucasian genetic line who migrated westward from central Eurasia. On the other hand, people of the Khyar Kharaach type culture, which includes Grave No. 1, were a local herding people of the Mongolian genetic line. However, the results were inconclusive due to insufficient specimens.

This excavation report is published by the grand of a JSPS research project (the title No. 15H02608).

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