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ANCIENT IRON PRODUCTION IN THE ONON RIVER BASIN OF MONGOLIA

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This study presents the results of excavations conducted at the Khajuu Bulag site in Dadal, Khentii Province, Mongolia, focusing on ancient iron production activities. The site, located near the historically significant birthplace of Genghis Khan, revealed three rectangular iron smelting furnaces constructed with stone slabs and clay, dating from the late 3rd to early 5th centuries CE based on radiocarbon dating. Excavations uncovered slag, furnace wall fragments, iron ore, charcoal, and pottery associated with the Burkhotoi culture. The furnaces show evidence of repeated use, with slag accumulated at the base and ventilation provided through multiple side vents. Charcoal analysis identified six pine species, indicating it was used as the primary fuel. The pottery, characterized by a thickened rim and horizontal shoulder ridge, closely resembles 3rd—4th century ceramics from neighboring regions and further supports the attribution of the site to the Burkhotoi culture. These findings suggest that the Khajuu Bulag site functioned as a significant iron production center within the context of the Burkhotoi cultural sphere, contributing important data to the understanding of early iron technology in Mongolia and its connections to broader cultural developments across the eastern Eurasian steppe.

Keywords: Mongolia, Burkhotoi culture, iron smelting, metallurgical furnaces, manufacturing center.

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ДРЕВНЕЕ ПРОИЗВОДСТВО ЖЕЛЕЗА В БАССЕЙНЕ РЕКИ ОНОН В МОНГОЛИИ

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В данном исследовании представлены результаты раскопок, проведённых на участке Хаджуу Булаг в Дадале, провинции Хэнтий, Монголия, с акцентом на древнюю деятельность по производству железа. На этом участке, расположенном недалеко от исторически значимого места рождения Чингисхана, были обнаружены три прямоугольные печи для выплавки железа, построенные из каменных плит и глины, датированные на основе радиоуглеродного анализа концом III — началом V в. н.э. В ходе раскопок были обнаружены шлаки, фрагменты стенок печей, железная руда, древесный уголь и керамика, относящиеся к бурхотуйской культуре. Печи демонстрируют признаки многократного использования: шлаки накапливались у входа, а доступ воздуха обеспечивался через многочисленные боковые вентиляционные отверстия. Анализ древесного угля выявил, что он представляет собой шесть видов сосны; это указывает на то, что данная порода использовалась в качестве основного топлива. Керамика, характеризующаяся утолщённым краем и горизонтальным выступом на плечиках, очень похожа на керамику III—IV вв. из соседних регионов и дополнительно подтверждает принадлежность раскопанного участка бурхотуйской культуре. Эти данные свидетельствуют о том, что археологический памятник Хаджуу Булаг функционировал как важный центр производства железа на территории бурхотуйской культуры, он предоставляет важные сведения для понимания ранних технологий обработки железа в Монголии и об их связи с более широким культурным развитием в восточно-евразийской степи.

Ключевые слова: Монголия, бурхотуйская культура, выплавка железа, металлургические печи, производственный центр.

INTRODUCTION

The Onon River, originating in the Khentii Mountains of northern Mongolia, flows eastward into Russia's Zabaykalsky Krai where it merges with the Shilka River before joining the Amur River and ultimately emptying into the Sea of Japan. As one of Mongolia's major rivers, the Onon River Basin is historically significant; according to the Secret History of the Mongols, it is considered the birthplace of the Great Mongol Empire, founded by Genghis Khan (birth name Temujin).

The village of Dadal, the administrative center of Dadal *sum* in Khentii Province, is located along the Balji River, a tributary of the Onon River. This area is home to the Delüün Boldog, a hill traditionally regarded as the birthplace of Temujin, and Khajuu Bulag, the spring where he is said

to have taken his first bath. Historical accounts suggest that the Mongol tribes, including Temujin and his father, Yesugei Baghatur, inhabited this region before rising to power.

Since 2006, the authors have conducted archaeological research in Mongolia in collaboration with the Institute of Archaeology of the Mongolian Academy of Sciences, focusing on iron production sites of the Xiongnu period. In 2023 and 2024, excavation surveys were carried out at the Khajuu Bulag ruins in Dadal, Khentii Province, Mongolia. This paper presents findings from these excavation surveys and examines the characteristics of ancient iron production in the region.

BACKGROUND TO THE SURVEY

Discovery of the Site and Preliminary Investigations. In the 1960s, Kh. Perley collected slag from Khajuu Bulag and hypothesized that blacksmiths were active in the area during the time of Genghis Khan. Decades later, in 2018, L. Ishtseren of the Institute of Archaeology of the Mongolian Academy of Sciences confirmed that multiple slag deposits had been recorded in historical site surveys. In 2019, Ch. Amartuvshin and Ishtseren conducted fieldwork in this area and recovered a small amount of slag from Bol Bulag in Dadal.

In March 2022, B. Bat-Erdene, a cultural heritage officer in Dadal, reported that "part of the slope of Delüün Boldog had collapsed, exposing a significant amount of slag." He sent samples of slag and charcoal to Ishtseren for analysis, along with the message.

During the summer of 2022, Noriyuki Shiraishi of Niigata University analyzed the charcoal he brought back to Japan using radiocarbon dating. The results indicated a calibrated age of "262—275 CE (5.2%), 347—428 CE (90.2%)" in the 2σ calendar age range. This evidence suggested that iron-making activities in the Onon River basin predated Perley's earlier assumptions.

In March 2023, Ishtseren and Shiraishi conducted a site survey. The presence of well-preserved iron production remains, including slag distribution patterns, confirmed the site's significance. Based on these findings, the Institute of Archaeology of the Mongolian Academy of Sciences and the Ehime University Center for Research on Ancient Asian Industrial Archaeology developed a formal excavation plan. Following the necessary approvals, excavation work at Khajuu Bulag commenced (fig. 1).

Survey Details. The survey at Khajuu Bulag (49°2' 45.942" N, 111°36' 51.6486" E, approximately 975 meters above sea level) took place from August 30 to September 11, 2023 and from September 3 to 12, 2024. Accounting for travel and site preparation, active excavation lasted ten days in 2023 and eight days in 2024.

Khajuu Bulag emerges from near the summit of Bayan'obo Mountain's northern slope, forming a round depression at its source. Slag

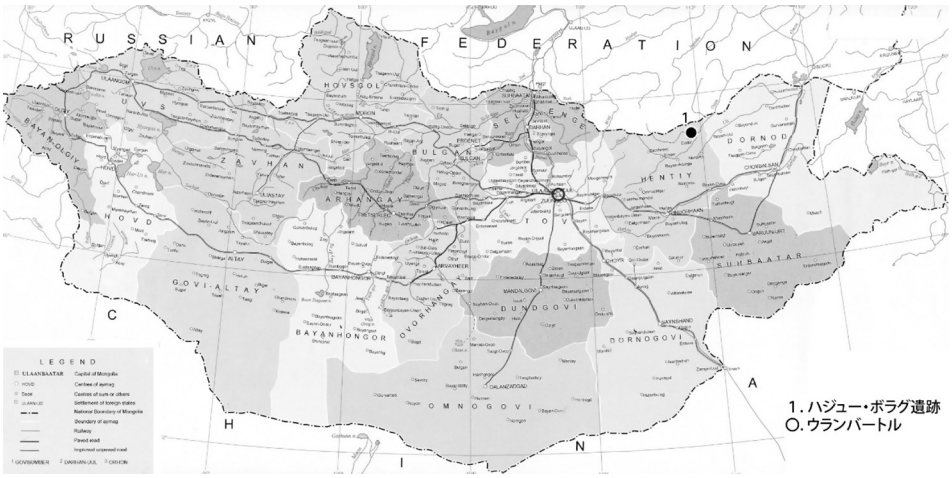


Figure 1. Location of the Khajuu Bulag sites ("1. Khajuu Bulag site O. Ulaanbaatar")

and other industrial remnants were discovered along the depression's southern (mountainside) edge. A wooden fence encircles the spring, following the natural contours of the land. A significant stone associated with an iron smelting furnace (Iron Smelting Furnace No. 1) was found in the ruts of an old road just outside the fence. An initial 4×4 m excavation area was designated to accommodate the stone and the surrounding slope. Excavation revealed that three iron smelting furnaces and a substantial slope descending toward the spring were visible (fig. 2, 3). This slope contained slag, furnace walls, and other materials in addition to soil and sand. Due to time constraints and preservation concerns, only the interior of the furnace was investigated, with no excavation extending below their base levels. However, excavation was only carried out in the northwestern part of the sloped area, and excavation activities in other parts were halted. In 2024, two additional excavation zones were established east and west of the original site to further explore the extent of the remains. After the surveys, the site was protected using sandbags, covered with sheeting, and backfilled with soil (fig. 2). The excavation team received invaluable assistance from Mr. Bat-Erdene and Deputy Chief Munhu Hoyag of Dadal District. We extend our sincere gratitude for their support.

EXCAVATION FINDINGS

The excavation uncovered three iron smelting furnaces, along with associated production artifacts such as slag, furnace wall fragments, and pottery. The iron smelting furnaces, numbered from west to east, are designated as Iron Smelting Furnace No. 1, Iron Smelting Furnace No. 2, Iron Smelting Furnace No. 3. Iron Smelting Furnace No. 1 was rectangular and made of stone slabs, with a long axis of N-45°-E, outer dimensions



Figure 2. Excavation area and Khajuu Bulag (spring)

of 130×90 cm, and inner dimensions of 110×40 cm. Furnace depth is not constant and is lowest at the mouth on the side near the spring after the slope of the terrain, where it is 110 cm deep from the observable surface. A rectangular pit had been excavated with stone slabs placed on its sides. A thick layer of clay had been applied to the stone slabs, giving the inside of the furnace a spindle shape, with finger marks visible in the clay. Meanwhile, the above-ground part is made up of piled-up clay blocks that form the furnace walls.



Figure 3. Panorama view of the excavation area (taken from the spring side, from the right; Iron Smelting Furnace No. 1, Iron Smelting Furnace No. 2, Iron Smelting Furnace No. 3)

By the time of the survey, it had long since caved in due to the pressure of the earth above, but a tunnel leading to the outside of the furnace had been provided at the bottom edge on the spring side (the lower side) using flagstones and other materials. It is believed that, at the beginning of operations, man-made (or natural) ventilation was also provided via this tunnel (the black part in the foreground of fig. 4). Considering the condition of the remaining furnace walls and stone slabs, we can assume that the furnace was operated multiple times by re-pasting clay to its molten walls.

Judging from the difference in the heat of the soil on the outside of the furnace, it is assumed that ventilation was only provided from the long western side. Holes in the remaining furnace wall revealed that there were six vents, each 11 cm wide (fig. 5). When we used a stick to measure the ventilation angle, we found this to be roughly 60° (see the pin pole in fig. 4).

Half of the furnace interior had been filled in with walls and other materials, except the area above, which seems to have been open for a certain time and was later filled in with soil from the mountainside. Iron Smelting Furnace No. 2 was also rectangular, having a long axis of N-30°-E, inner dimensions of 102×40 cm, and a depth of 60—70 cm from the visible surface. In order to protect the ruins, the survey was completed when



Figure 4. Iron Smelting Furnace No. 1 (the tunnel is in the foreground, with the pin pole indicating the angle of ventilation)

the inside of the furnace had been fully excavated. There was no survey carried out on the tunnel. Iron Smelting Furnace No. 2 possessed almost the same structure as Iron Smelting Furnace No. 1 (see the description of Iron Smelting Furnace No. 1 for details). A rectangular pit had been excavated, with flagstones placed along the sides and a thick layer of clay on the insides. The entrance on the spring side also had a tunnel. After operations, the iron blocks that had formed inside the furnace were removed and immediately backfilled with charcoal, furnace wall, slag, and similar materials.

Iron Smelting Furnace No. 3 (fig. 3, 6). Although part of the remnants extends outside the survey area, Iron Smelting Furnace No. 3 has a structure nearly identical to that of Iron Smelting Furnace No. 1 and No. 2 (see the explanation of Iron Smelting Furnace No. 1 for details). It has a long axis of N-30°-E, inside dimensions of 140×40 cm, and a depth of 110 cm from the visible surface. After operations, the iron blocks that had formed inside the furnace were removed and immediately backfilled with charcoal, furnace wall, slag, and similar materials (fig. 6).



Figure 5. Iron Smelting Furnace No. 1 ventilation mechanism (each side has six vents)



Figure 6. Sedimentation inside Iron Smelting Furnace No. 3

Production-related artifacts. Production-related artifacts excavated include furnace wall fragments (fig. 7), slag, iron ore, and charcoal. No clay tuyere (blower pipes), typically found in Xiongnu iron smelting furnaces, were recovered.

All slag consisted of furnace slag (fig. 8). Although a large amount of fluid slag was excavated, it indicated solidification rather than external slag discharge. At that time, no slag has been confirmed to have flowed



Figure 7. Excavated furnace wall fragments

outside the furnace, and we can conclude that it is unlikely any slag was discharged outside the furnace.

Earthenware (fig. 9). Several earthenware fragments were excavated from the soil layer covering the hearth, as well as from the inclusion layer within the survey area. Based on their characteristics, it is assumed that most of these fragments originated from the same earthenware. The earthenware exhibits a slightly tapered neck and a thickened band around its rim, with notching along the bottom. A horizontal ridge is present on the shoulder, but in some areas, this ridge is interrupted and bends downward at a right angle (fig. 9). Although there are insufficient data regarding the vessel's base, it is presumed to be flat. As discussed later, these earthenware vessels are attributed to the Burkhotoi civilization.



Figure 8. Excavated slag



Figure 9. Excavated fragments of earthenware

ANALYSIS OF THE IRON SMELTING FURNACES

All of the iron smelting furnaces discovered were rectangular in shape and made of stone slabs. Slag was deposited at the bottom of the furnaces, with no evidence of slag being discharged externally. Heat exposure patterns indicate that air was introduced from one of the long sides, and six ventilation holes were identified in the No. 1 Iron Smelting Furnace, with a ventilation angle of approximately 60°. These furnaces were used multiple times, undergoing repairs as needed. The No. 1 Iron Smelting Furnace is believed to have been used at least three times.

Analysis of the furnace walls revealed traces of reactive iron ore, suggesting that the raw material consisted of iron ore crushed into approximately 1 cm-sized chunks (fig. 10). Additionally, while a significant quantity of charcoal was excavated from beneath the furnaces, no coal was found, indicating that charcoal was used as the primary fuel. Examination of the charcoal remains identified six tree species, all coniferous



Figure 10. Kiln wall with reactive iron ore (white line)

Table 1

Results of radiocarbon dating of charcoal

Measurement number	Ruins data	$\delta^{13}C$ (‰)	Calendar year calibration date (yrBP±1σ)	^{14}C era (yrBP±1σ)	Age range of ^{14}C dates calibrated to calendar dates	
					1σ calendar age range	2σ calendar age range
PLD-50772 No. KHJB01	No. 1 Iron Smelting Furnace Location: Directly above hearth	−25.06±0.13	1694±22	1695±20	265—272 cal AD (6.84%), 351—356 cal AD (5.47%), 361—407 cal AD (55.96%)	259—279 cal AD (15.17%), 336—416 cal AD (80.28%)
PLD-50773 No. KHJB02	No. 1 Iron Smelting Furnace Location: Back edge of bonding stone, on floor	−25.40±0.18	1680±22	1680±20	364—415 cal AD (68.27%)	261—277 cal AD (10.46%), 340—419 cal AD (84.99%)
PLD-50774 No. KHJB03	No. 2 Iron Smelting Furnace Location: Directly above hearth	−24.13±0.20	1709±20	1710±20	262—275 cal AD (13.18%), 346—402 cal AD (55.09%)	257—282 cal AD (20.84%), 328—409 cal AD (74.61%)
PLD-50775 No. KHJB04	No. 2 Iron Smelting Furnace Location: In furnace wall	−24.42±0.12	1744±21	1745±20	251—264 cal AD (13.27%), 273—294 cal AD (19.84%), 314—350 cal AD (35.16%)	245—379 cal AD (95.45%)
PLD-50776 No. KHJB05	No. 3 Iron Smelting Furnace Location: Hearth	−23.76±0.13	1787±21	1785±20	239—253 cal AD (20.85%), 289—322 cal AD (47.42%)	220—259 cal AD (33.28%), 279—335 cal AD (62.17%)
PLD-50777 No. KHJB06	No. 3 Iron Smelting Furnace Location: Hearth	−24.14±0.12	1776±21	1775±20	244—255 cal AD (14.78%), 286—325 cal AD (53.49%)	233—262 cal AD (25.63%), 276—343 cal AD (69.82%)

and belonging to the genus Pinus (Pinus subgen. Diploxylon). Radiocarbon dating results are presented in Table 1. Two charcoal samples were collected from each iron smelting furnace for analysis. The results indicated that the No. 1 Iron Smelting Furnace dates to the late 3rd to early 5th century, the No. 2 Iron Smelting Furnace was used from the mid-3rd to late 4th century and the No. 3 Iron Smelting Furnace from the early 3rd to the mid-4th century. These findings suggest that the site functioned as an iron production facility between the late 3rd and early 5th centuries.

Iron smelting furnaces of this rectangular, slab-constructed type have also been reported in the Mongolian Altai (Murakami Yasumichi 2019) and Russian Altai (Zinyakov 1988). Yasumichi Murakami and colleagues have documented the Tsagaan Morit, and Borgochud ruins in the Mongolian Altai. In the Russian Altai, these iron smelting furnaces correspond to the so-called "Koç-Agash" type. Various dates have been proposed for the "Koç-Agash" iron smelting furnaces, but the most recent study by E.V. Vodyasov (Vodyasov et al. 2023) assigns them to the 3rd to 6th centuries AD, aligning with the estimated age of the Khajuu Bulag site.

ANALYSIS OF EARTHENWARE

All earthenware fragments excavated from the site (fig. 9) are associated with the Burkhotoi culture. These fragments include the rim, body, and bottom pieces. Although the fragments lack direct joins, the vessel is inferred to be a jar or deep bowl with a neck. It is blackish-brown in color and was not wheel-thrown. The outer rim features a thickened area with a notched lower edge and a neck just below the rim. A horizontal ridge, composed of thin clay string, encircles the shoulder. In some places, the ridge is interrupted and extends outwards.

The Burkhotoi civilization was first identified by A.P. Okladnikov, who placed it in Zabaykalsky Krai around the middle of the 1st millennium AD (Okladnikov 1960). Later, I.V. Aseev categorized Burkhotoi culture into several types, with the material from this site presumed to belong to the Onon type, dated between the 4th and 8th or 9th centuries (Aseev, Kirillov, Kovychev 1984). While the Burkhotoi culture spanned a long period, a detailed chronological framework has yet to be established.

Fig. 11 illustrates the evolution of pottery in eastern Zabaykalsky Krai and the neighboring Hulunbuir region of China from the 1st century AD to the 10th century (Kiyama Katsuhiko 2020). Although the chronology remains tentative, it provides a broad overview of earthenware development. Notably, no clear examples have been identified for the 5th to 7th centuries, making the specifics of this transitional period unclear. However, comparisons between 4th and 8th century pottery reveal similarities in shoulder ridges on the body, suggesting continuity in regional pottery

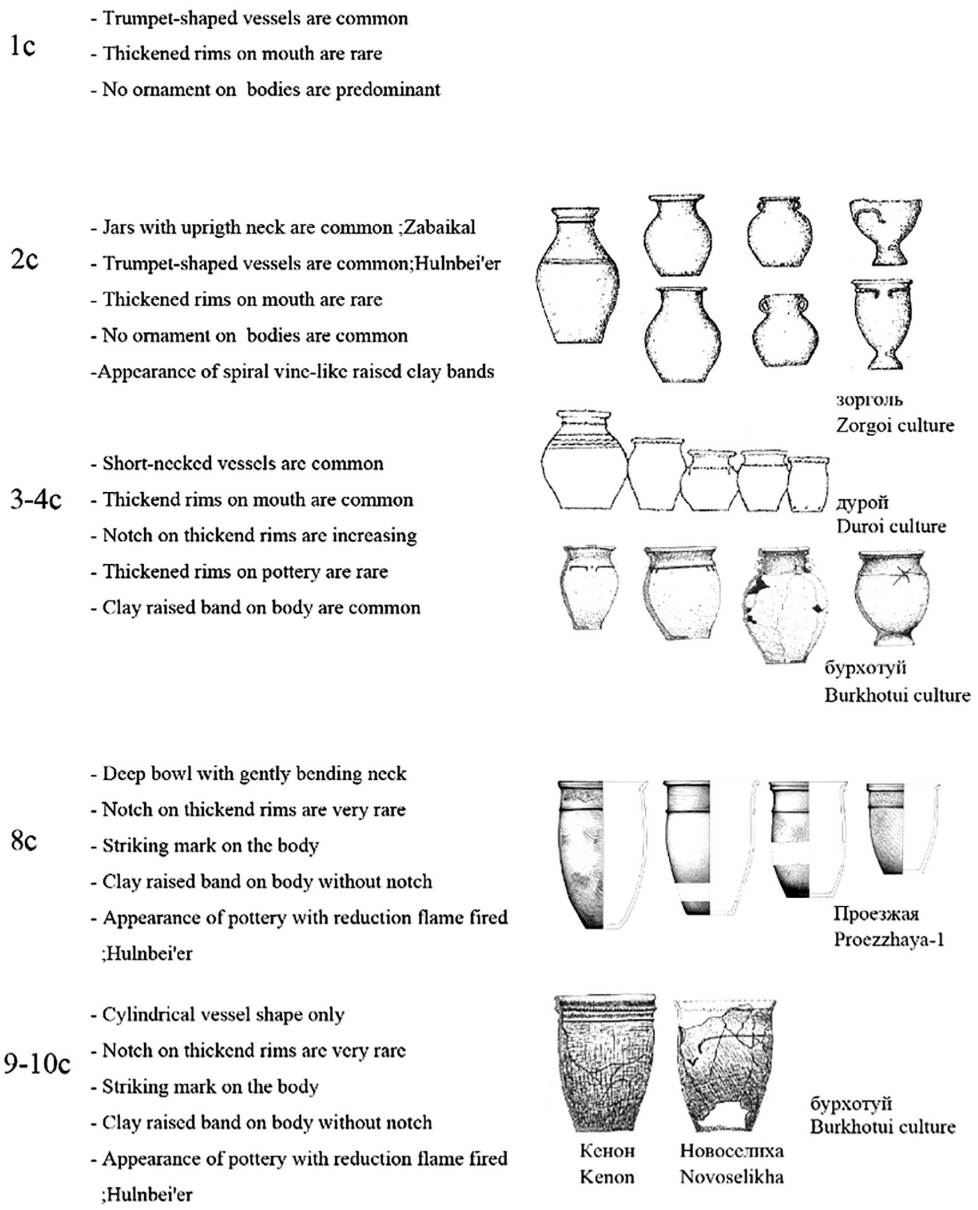
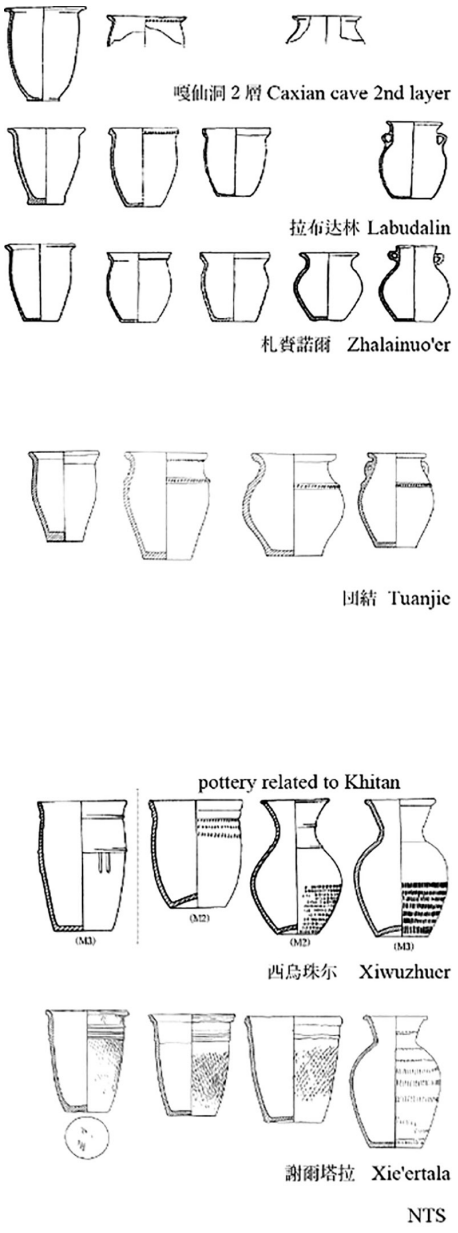


Figure 11. Preliminary pottery chronology on the east region of Zabaikal province and Hulunbei´er (partially modified plan in 2020)

traditions. During this period, vessel shapes appear to have become vertically elongated, with necks gradually transitioning into cylindrical forms. Additionally, the thickened rim markings observed in 4th century pottery disappear after the 8th century, and from that time onward, hammered surface markings became common.

The earthenware excavated from the Khajuu Bulag site features a distinct neck and thickened rim, similar to 3rd to 4th century pottery. It closely



resembles pottery found in Tomb No. 4 at the Ugurchin Herem site in Batshireet *sum*, Khentii Province, Mongolia. Radiocarbon dating of the charcoal deposits from the 3rd to 4th century date (Shiroishi Noriyuki 2021), which aligns with the age estimate for the Khajuu Bulag earthenware. However, since the lower radiocarbon dating limit for this site extends to the 5th century, it is also possible that the pottery dates from that time. Although full restoration of the vessel has not been possible, its proportions differ from those of later cylindrical vessels. Additionally, the absence of notches on the lower edge of the thickened rim band and the lack of hammered markings on the surface suggest that it is unlikely to date from the 8th century or later.

In any case, the excavated earthenware from this site provides invaluable insights into the early phases of the Burkhotoi culture.

SUMMARY

The findings presented here are the initial results of an excavation survey of an iron production site in the Onon River Basin. This represents the first identified iron-production site discovered, dating back to the Burkhotoi civilization. Initially, we hypothesized that the site contained iron smelting furnaces dating to the Xiongnu or the *Secret History of Mongolia* era. However, the evidence points to iron smelting furnaces from the 3rd to 5th centuries AD, an under-documented period in archaeology.

One challenge that emerged was the discrepancy in technological transition between these iron smelting furnaces and that in the Altai region (Murakami Yasumichi 2019), which are believed to have first appeared in the 4th to 5th centuries. However, due to limited data for direct

comparison, we have focused on presenting fundamental information about the region's iron smelting furnaces in the hope that future studies will expand on this research.

Given the chronological framework of these furnaces, historical groups like Xianbei and Jou-jan come to mind. However, the excavated earthenware is of the Onon type, characteristic of the Burkhotoi civilization, widespread throughout the Zabaykalsky Krai. This raises the question of whether the Xianbei, Dingling, or Gaoche were involved in the use of iron smelting furnaces. With recent discoveries of Xianbei sites in Mongolia, further research is necessary, particularly after the additional materials from this period are collected in the region.

REFERENCES AND SOURCES

Асеев И.В., Кириллов И.И., Ковычев Е.В. 1984. *Кочевники Забайкалья в эпоху средневековья (по материалам погребений)*. Новосибирск: Наука.

Aseev I.V., Kirillov I.I., Kovychev E.V. 1984. *Nomads of Transbaikalia in the Middle Ages*. Novosibirsk, Nauka Publ. (In Russ.)

Зиняков Н.М. 1988. *История черной металлургии кузнечного ремесла древнего Алтая*. Томск: Изд-во Томского университета.

Zinyakov N.M. 1988. *History of Iron Metallurgy and Blacksmith Craft of Ancient Altai*. Tomsk, Izd-vo Tomskogo universiteta Publ. (In Russ.)

Окладников А.П. 1960. Бурхотуйская культура железного века в юго-западном Забайкалье. *Труды Бурятского комплексного научно-исследовательского института*, вып. 3: 16—30.

Okladnikov A.P. 1960. The Burkhotuy Iron Age Culture in Southwestern Trans-Baikal. *Trudy Buryatskogo kompleksnogo nauchno-issledovatel'skogo instituta*, iss. 3: 16—30. (In Russ.)

Kiyama Katsuhiko 2020. The Mohe Jars of the Western Amur Basin. *Archaeology in Japan and Around the World: Olive Groves and Red Earth*. Tokyo, Rokuichi Shobo: 253—270.

Murakami Yasumichi 2019. Results of the Study of Iron-smelting Furnaces at the Balyktuyul Site in the Ulagan District of the Altai Republic, Russia. *Abstract of the 20th Research Association of North Asia Conference*. Matsuyama, Ehime University Publ.: 65—68.

Shiroishi Noriyuki 2021. Problems Concerning the Construction Age of Stone Wall at Uglugchiin Kherem. *Journal of the Japanese Association of Mongolian Studies*, No 51: 65—72.

Vodyasov E.V., Amzarakov P.B., Sadykov T.R., Shirin Yu.V., Zaitceva O.V., Leipe C., Tarasov P.E. 2023. Nine Types of Iron Smelting Furnaces in Southern Siberia in the First Millennium AD: A Review of Archaeological and Chronological Data. *Archaeological Research in Asia*, vol. 36: 100479.

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