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Water for the Khan: Unveiling the Hidden Well of Karabalgasun

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Abstract: This article presents the first study of the well of Karabalgasun (Ordu Baliq), the Uyghur capital in Mongolia's Orkhon Valley, integrating archaeological, historical, and conservation perspectives. Systematic excavations of the citadel from 2012 to 2018 uncovered prestigious architecture and a deep, technically complex well, built during the construction of the citadel. Exceptional finds – including lacquered wooden poles, jade books inscribed with Tang dynasty imperial decrees, high-status objects, and the skeleton of a traded gyrfalcon – provide insights into the courtly culture, diplomatic ties, and ritual practices spanning the Uyghur and Khitan periods. The multidisciplinary conservation project pioneered the use of trehalose-based methods in Mongolia, succeeding for the first time in preserving waterlogged wooden artefacts for detailed research and public exhibition. The findings illuminate the political importance of Karabalgasun, demonstrate its function as a hub for prestige, trade, and diplomacy on the Silk Road, and advance archaeological conservation science in Mongolia.

Keywords: Archaeology; conservation of waterlogged artefacts; Uyghur Khanate; water well; Orkhon Valley

Introduction

Karabalgasun (called Ordu Baliq by the Uyghurs), situated in the Orkhon River Valley of today's Central Mongolia (47°25'53.61" N, 102°39'32.72" E), was the capital of the Uyghur Khanate. It was founded in 745 and existed only until 840, when it was destroyed by the Yenisei Kyrgyz, after which the Uyghurs apparently abandoned this territory (Sinor et al., 1998). The city was built within a few years and was commissioned by the Uyghurs. There is little written evidence in written sources about the city. It is briefly mentioned in the travelogue of the Arab traveller Tamīm ibn Baḥr (Minorsky, 1948) and in the annals of the Chinese Tang dynasty, the old and the new Tángshu, compiled in 945 and 1060 respectively (Mackerras, 1972). During the brief period of its existence, Karabalgasun was an important residence, display of power and wealth, cultus, and a hub of the Silk Road trade network (on the history and archaeology of Karabalgasun see Dähne, 2017; Franken et al. 2019; Rohland et al. 2023). The remains of the city are still visible as impressive ruins in the landscape today (Figure 1). As part of the Mongolian-German Orkhon-Expedition (MONDOrEx) of the Mongolian Academy of Sciences, the National University of Mongolia in Ulaanbaatar, and the German Archaeological Institute in Bonn, the site has been intensively studied since 2007. The focus of the excavations from 2012 to 2018 was the citadel, a landmark, as its walls still rise to 12 m above its surroundings. It is part of the imperial city of Karabalgasun (Figures 1, 2), which is in turn the centre of the huge city, stretching about 44 km² through the valley of the Orkhon river (Franken et al. 2020).

Excavations at the Citadel of Karabalgasun

The imperial complex of Karabalgasun consists of a main enclosure of 460×390 m with an annex projecting further 300 m to the east (Figures 1,2). It is situated at the centre of the eastern edge of the city with its main gate facing east. The enclosed area is further subdivided by smaller walls. In the centre of the complex, there are the remains of two large temple-buildings and a large mound resembling a stupa (Figure 2) (Dähne 2017). The citadel itself occupies the south-eastern corner of the imperial complex (Figures 1, 3). It consists of an artificial mound made of rammed earth in the shape of a truncated pyramid; the platform at the top is approximately 60×70 m. The outer walls still rise up to 12 m over the surroundings, and the inner courtyard is elevated approximately 7 m above ground level. After several metres of burnt debris, which bear witness to the violent destruction of the city, had been removed, the remains of the buildings were uncovered. The general layout of the citadel can be imagined as follows: a large gate from the north, crowned

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Figure 1. The imperial city of Karabalgasun, is still an impressive landmark after almost 1200 years. Here the building complex is seen from the south-east. The highest elevation at the south-eastern corner of the main wall is the citadel.
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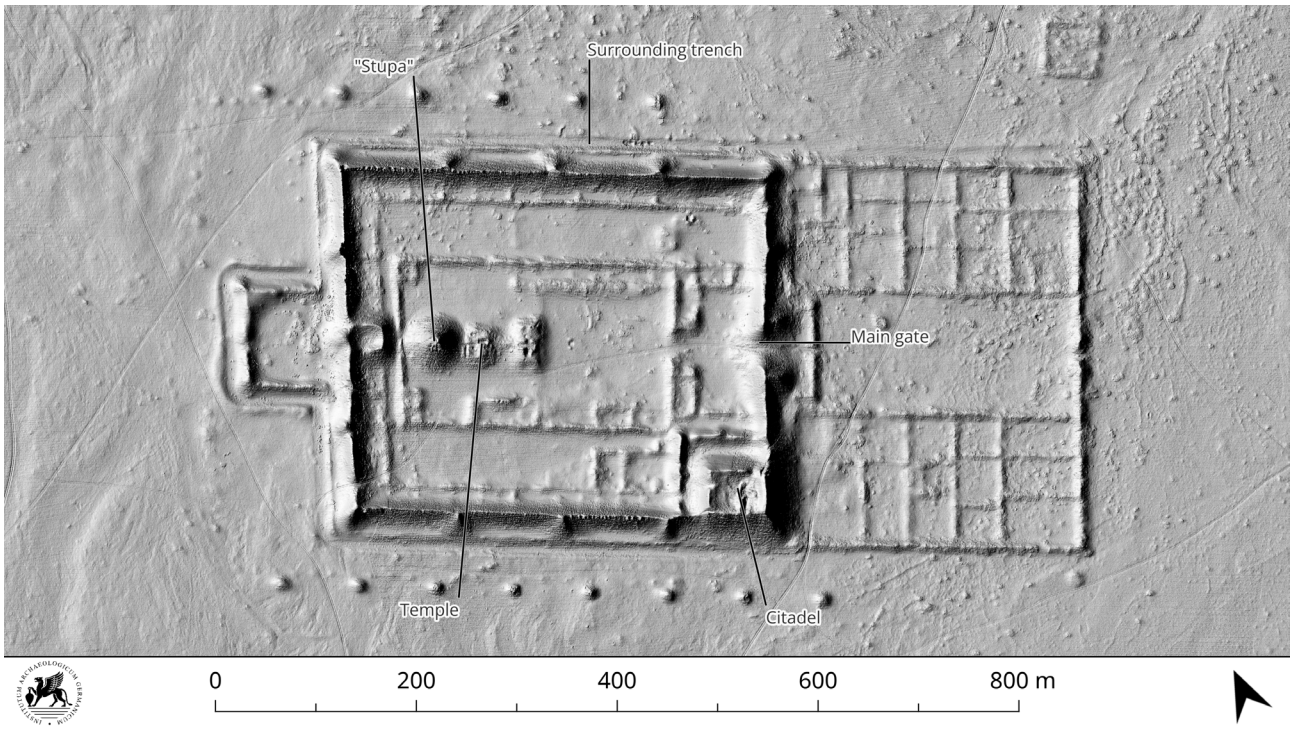

Figure 2. Elevation plan of the imperial city, derived from a Lidar-scan. The main features of the site are clearly recognisable. Main gate, two temple platforms and a large structure (a stupa for lack of a better word), are situated along the central axis from east to west. The citadel occupies the south-eastern corner of the imperial city.
© H. Rohland/DAI 2025; Elevation data: ArcTron/DAI.

Figure 3. The citadel, seen from inside the imperial city. The outer walls rise up to 12 metres above the surroundings. The citadel is separated from the inside of the imperial city by an additional rampart. © DAI / C. Franken

with a small tower or gatehouse, gave access to a paved courtyard surrounded by the columns of an ambulatory. In the south-eastern corner, opposite the gate, stood a large, square building which contained a prestigious seigneurial hall (Figure 4). The large quantity of debris in this area of the citadel suggests that there was a multi-storey building there, which thus can be designated as a tower or keep. To the west of the northern gate was an ambulatory, also enclosing the paved courtyard area, which was delimited by a Chinese-style hall building on its western side. The architecture of this building is characterised by a regular grid of column bases on an elevated platform. These supported a timber-framed construction, which in turn carried a roof covered with tiles made of burnt clay.

The excavation of the well of Karabalgasun

The buildings were arranged around a brick-paved courtyard, the exact extent of which we intended to clarify at the end of our summer excavation campaign in 2014 by means of a long trench from west to east of the citadel. However, it quickly became apparent that the courtyard's paving was not continuous but partially destroyed. Instead, a pit filled with earth and debris initially revealed the remains of a complete bird skeleton, several vessels, and some granite blocks. The arrangement and position of these findings suggested a deliberate deposition, perhaps in a ritual context, an assumption further supported by a closer examination of the bird skeleton. Scientists from the Museum Koenig in Bonn established that we had found the skeleton of a gyrfalcon, a species of falcon not native to Mongolia. Moreover, this gyrfalcon showed healed bone fractures from which the bird could not have recovered in the wild. These were the remains of a bird which must have arrived as a trade good or a gift from regions far north of the Orkhon Valley. After arriving here, it was held in captivity, probably for use in falconry. Radiocarbon dating revealed that the bird was not

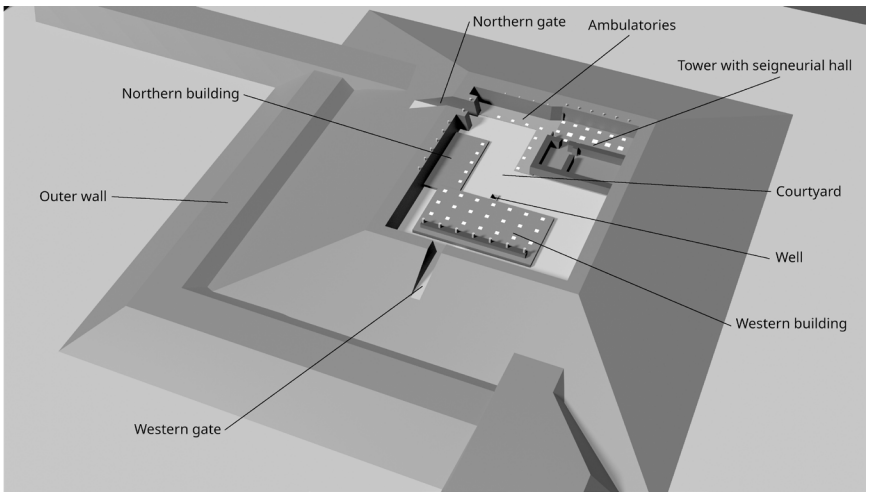

Figure 4. Sketch of the main features of the citadel according to the results of the excavations. The citadel is made of rammed earth. It has the shape of a truncated pyramid. The platform on the top featured a courtyard which was surrounded by buildings along the outer walls. © DAI/H. Rohland

deposited here in the Uyghur period, but in the 11th–12th century. This is the period when parts of Mongolia and northern China were ruled by the Khitan / Liao Dynasty. In the Orkhon Valley, there was so far little evidence of Khitan activity, in stark contrast with the preceding and succeeding Uyghur and Mongol periods. This is puzzling, given the important ideological meaning of the Orkhon Valley for the nomadic states of Mongolia. Hunting with gyrfalcons was a royal privilege in the Khitan state. The gyrfalcon might therefore be the first archaeological evidence of Khitan elite activities in the area (Töpfer et al. 2023).

This situation called for further study of the pit. Contrary to our original plans, we were unable to finish the excavation at the citadel and had to continue it during the following summer campaign to find an explanation for this unusual structure. The subsequent excavation campaign revealed that the pit was circular, had a diameter of three metres and considerable depth. The pit continued to extend deeper, and we were unable to finish its excavation in the given time of the campaign. By then, the excavation had become technically increasingly challenging. The soil was slowly brought to the surface passing the buckets from hand to hand. To ensure adequate safety and enable further digging, the upper part of the pit had to be repeatedly widened and benched to provide enough space for work even at greater depths. The deeper the excavation went, the wetter became the soil and water management became a major challenge (Figures 5, 6).

Only after another summer's work and thirteen metres down did we finally reach undisturbed soil and unveil the secret of the pit – we had discovered the well of the citadel of Karabalgasun! The pit descended as an almost vertical shaft with a circular shape and a diameter of about three metres and, starting at a depth of 5.40 metres; the well was encased by a rectangular wooden shaft, measuring 1.60×1.60 metres built into the rammed earth of the citadel. This rectangular wooden construction rested on a hexagonal stone casing, made up of twelve layers of six trapezoid granite stones each (Figure 6).

The stone casing was built into the substratum of sandy river gravel beneath the podium. It was supported below by a total of five massive wooden posts within a massive wooden casing, inside of which another rectangular wooden box formed the actual water reservoir of the well (Figure 7). The excavation of this feature posed immense technical challenges, regarding safety, transport and storage of excavated earth and – in the lower layers of the well – water management. All these challenges could only be overcome by the great dedication and trusting cooperation of the whole team and with local institutions and companies. The well currently represents the oldest known part of the citadel. It had been built even before the construction of the podium of the citadel began. First, the well was dug into the ground, it was secured with the stone casing and deeper down with a wooden chamber. Only after this was done, did the workers erect a wooden casing above the well and start to pile up layers of clay, and gravel. As the podium of the citadel grew, the wooden casing was extended to form a wooden shaft leading from the elevated courtyard of the citadel, down to the water in the well.

Artefacts Recovered from the Well

The filling of this well shaft consisted of alternating layers of rubble and burnt debris, in which fragments of bricks, burnt animal bones, and repeatedly remains of architectural decoration and construction elements were found. In addition, 46 fragments of "jade books" (polished stone tablets with Chinese characters inlaid in gold), were found in the citadel and also in the well. They have been identified as fragments of four decrees of the Tang-Chinese imperial court, granting titles to Uyghur rulers[1] (Figure 8). These exceptional artefacts highlight the close ties of the Uyghur rulers with the Tang court and the importance of the citadel for the facilitation of diplomatic contact and the display of legitimacy and power (Sodnomjamts et al. 2023).

With the increasing depth of the excavation, the soil became ever wetter, and in the lowest layers the fill consisted of highly anaerobic mud. Especially in these bottom layers, numerous finds, particularly organic material, were exceptionally well preserved. In addition, at least four almost completely intact ceramic scooping vessels and fragments of two stone lion statues also indicated the high quality of the material and hence the connection to the Uyghur elite. Metal finds, such as a large iron padlock with gilding and an intact bronze bell, were also discovered in an extraordinarily good state of preservation.

Particularly noteworthy were also well-preserved organic wooden remains, which included construction timbers as well as remnants of furniture and other small wooden objects (Figure 9). Two round wooden rods, approximately 1.60 metres long, proved to be of a major importance: They were coated with black lacquer and decorated with floral motifs (Figure 10). The floral decorations had been plated with silver, of which traces

[1] *The text fragments have been attributed to four different title-granting letters issued by the Chinese imperial courts on the occasion of the coronation of Uyghur rulers, the text of three of which has been preserved in Chinese written sources. Two of the letters are decreed for the coronation and a subsequent re-coronation of Ch'ung-te Khan (821), one for Zhao-li Khan (825); a fourth letter was dedicated to an unknown ruler. The translations of the fragments into Mongolian and their attribution to the texts of the title-granting letters can be found in Sodnomjamts et al., 2023. An English translation of this article is in planning.*

Figure 5. The soil had to be brought out of the trench by buckets passed from hand to hand. © DAI/H. Rohland

have been found during conservatory analysis. Such objects have never been found in Mongolia before. Back in their time, they have served to display wealth and power of the ruler, maybe as supports of a tent or baldachin. Together with additional, smaller lacquered wooden items they presented a particular conservation challenge.

As mentioned above, not all artefacts recovered from the excavation of the well are from the Uyghur period (744-840). The falcon skeleton mentioned above was dated by radiocarbon dating, pointing to the proto-Mongolian Khitan period (907-1125). It demonstrates that even centuries after the destruction, the site was possibly used for ritual depositions. Yet in the underlying layers, Uyghur ceramics were repeatedly recovered. Especially in the upper layers of the infill, artefacts from different ages had been mixed up by later digging activities, maybe by treasure-hunters searching for valuable items in the ruins of the city after its destruction.

The Restoration of the Artefacts

Although the items from the lower parts of the well had been in an extraordinary good state of preservation after almost 1200 years and we immediately stored them in provisional water ponds to prevent them from drying out, signs of damage became apparent soon after their recovery. The lacquer developed cracks and began to detach from the wood, making it evident that the artefacts could not be stored in the local Kharakhorum Museum as usual, but instead had to be taken to the National Centre for Cultural Heritage in Ulaanbaatar. After detailed telephone consultations with the director there, a conservation team – including staff from the National Centre for Cultural Heritage, the Kharakhorum Museum, and Nara University in Japan led by Dr M. Oyuntulga – was able to take over the local conservation work very soon after the recovery of the objects.

Figure 6. The stone casing of the well was skilfully crafted. The image also illustrates the challenges of the excavation: To work in the lower section of the well, permanent water management was necessary, using a pump, while at the same time ropes and winches were employed, to secure the person working in the well and to transport excavated soil and artefacts. © DAI / C. Franken

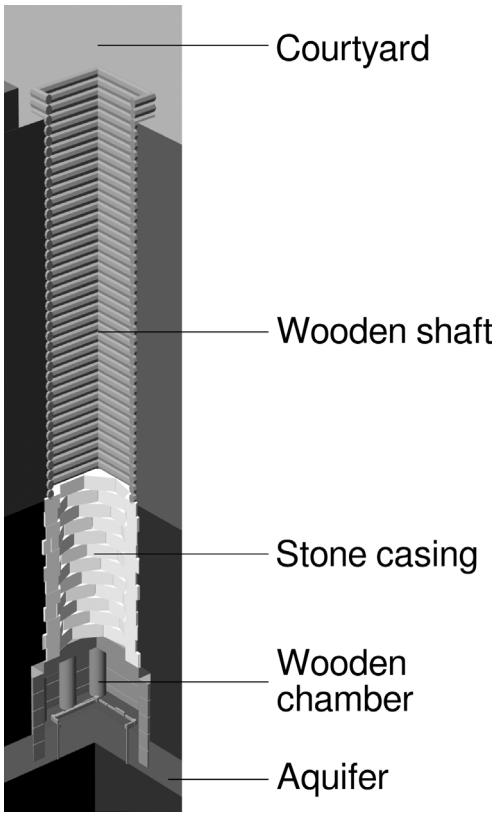

Figure 7. Section drawing of the well. It consisted of a wooden shaft, reaching down from the courtyard to the original ground level. From there, the construction was built as massive stone-cased shaft, which in turn rested on a wooden chamber. © DAI / H. Rohland

Waterlogged wooden artefacts are rarely found in Mongolia, and so it was a particular responsibility for us as archaeologists to recover material more than 1200 years old from such unusual contexts and in such an extraordinary state of preservation. While decomposition of organic matter proceeds very slowly in the permanent absence of oxygen, the process starts immediately upon first exposure to air, so we were greatly relieved when the conservators could take over the securing and treatment of the artefacts (Figure 11).

First we had to clarify fundamental questions on site: How can the organic and metal artefacts discovered in the extreme continental climate of Mongolia be protected during excavation? How can we create a suitable environment for storage under fieldwork conditions? How can preliminary cleaning be carried out, and how can we create special packaging to ensure safe transport to Ulaanbaatar? The goal of the joint archaeological and conservation project, now beginning with this extraordinary material, was to secure and analyse it, to make both the research results and the artefacts themselves accessible to the public in good condition.

The conservators first noted that, due to the low oxygen exposure and moist storage at a depth of twelve to thirteen metres with average temperatures of 0° C to 5° C, the condition of the metal and organic finds was still quite good. However, many of the artefacts had already deposited in the well damaged, burned, or broken. To minimise the decomposition processes that began after removal from the moist environment, the finds were immediately packed as airtight and moist as possible, and

Figure 8. Examples of inscribed stone tablets, "jade books" recovered from the citadel and its well bear witness to the close ties of the Uyghur rulers with the imperial court of Tang China. © DAI / M. Riemer

finally transported to Ulaanbaatar, where in autumn 2018 a German-Mongolian-Japanese research team was finally able to begin the conservation work. The work has been remarkably successful and is now almost complete.

It was fundamentally important to precisely define the circumstances of the find. Karabalgasun, and therefore also the well, lies in the steppe zone and geologically belongs to the category of brown soils in the permafrost carbonate of the taiga. The climate is extremely continental: average temperatures in January are -20° C to -25° C, in July +16° C to +20° C, with annual summer rainfall between 83-92 mm and a precipitation probability of 60-70%. The soil is slightly acidic, but not saline. Because of the low air supply, water exposure, low sulphur content, and well-sealed environment, the artefacts found on the bottom of the well have been in a good state of preservation, without corrosion or bacterial infestation. After defining the find circumstances, we were able to begin material analysis of individual artefacts.

Material Analysis and Conservation of the Bell and the Padlock

First, the bell and the padlock were examined by X-ray at Songdo Hospital in Ulaanbaatar, revealing that both items were structurally stable and coated with a solid layer of magnetite corrosion. Due to mechanical damage, the gold plating on the padlock was only present in a few places. Further examinations using X-ray-fluorescence analysis to determine the exact material composition showed that the body of the bell was made of a tin-copper alloy, in other words, bronze, while the bell's clapper was made from cast iron. The analysis of the padlock revealed that its body was also made of iron and then coated with a 55% gold plating. To ensure long-term stabilisation, both metal items were carefully cleaned of adhering clay particles with an ethanol solution and hardened with a Paraloid solution (Figsures 12, 13). While the metal artefacts could be secured quickly, the research and conservation of the wooden artefacts from the Karabalgasun well proved to be more challenging.

Figure 9. A skilfully carved wooden depiction of a wolf's hind leg and tail was recovered from the well, alongside other wooden implements. © DAI / M. Riemer

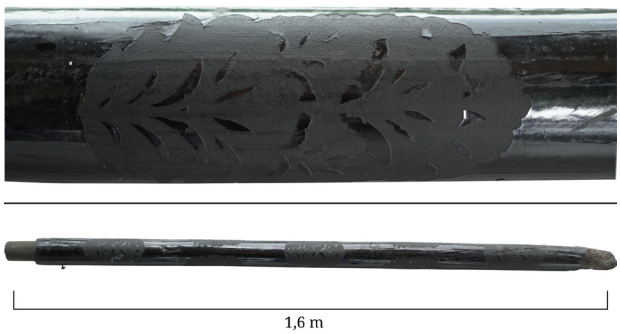

Figure 10. Top: One of the lacquered wooden poles recovered from the well. It featured floral decorations, carved out of the layer of lacquer. The areas appearing now in grey had been plated with silver. Bottom: detail of the decoration. © DAI / M. Riemer

Figure 11. To enable safe transport, the wooden objects received initial treatment by conservators on-site. © DAI / C. Franken

Material Analysis and Conservation of the Wooden Artefacts

First, wood samples from 36 artefacts were taken to identify the types of wood used by microscopic examination. Three tree species native to Mongolia were identified: larch (Larix), fir (Abies), and birch (Betula). Bamboo (Bambusoidae), another wood identified, does not grow in Mongolia, but mostly in tropical regions, indicating that a wrapped knife handle must have been an imported item or made from imported raw material. 28 of the 36 finds examined were made of larch, a hard and durable softwood with excellent processing properties. Much less frequently, four artefacts were made of birch, three of fir, and one of bamboo (Oyuntulga et al. 2021).

Further microscopic investigations showed that the wood cells were saturated with water due to the moist storage in the well's water reservoir. This stored moisture means that when drying begins, immediate cracking, shrinkage, loss of shape, and further damage to the wood is imminent. As early as November 2018, we therefore decided in a joint meeting at the National Centre for Cultural Heritage in Ulaanbaatar to use an internationally established method of wood conservation, in which water inside the wood cells is gradually replaced by a moisture- and volume-stable solution.

Since the 19th century, attempts have been made in Europe to preserve waterlogged wood by replacing the water inside it with potassium aluminium sulphate KAl(SO4)2. This method has been almost entirely replaced since the 1980s by the use of polyethylene glycol (PEG). This is a chemical, part of an oil, which loses its hardness at over 60% relative humidity. This often leads to discoloration and cracking of conserved objects, especially under exposure to light. Due to its coarse grain and high molecular weight, this solution also slowly penetrates into the interior of the wood.

To develop adequate alternatives for wood stabilisation, recent years have seen experiments with sugar solutions such as lactitol (C12H24O11) and trehalose (C12H22O11). Due to its low availability and high cost, lactitol is less suitable than trehalose. Japanese researchers have been increasingly and successfully investigating the use of trehalose for the conservation of organic remains since the 1990s, drawing international attention. Trehalose forms crystals that remain stable in environments with up to 90% humidity and, owing to its lower molecular weight, can penetrate deep into the wood. As it is crystalline, trehalose also reflects light, preventing discoloration of wood surfaces. As a naturally occurring food-grade sugar, it is also nontoxic in processing. Due to the longstanding cooperation between Mongolian and Japanese conservators, this method had already been experimented with in Mongolia, so colleagues at the National Centre for Cultural Heritage also had initial positive experiences.

When applying this method, the wooden object is soaked for fifteen days respectively in trehalose solutions with ascending concentrations, starting at 20% and increasing to 70%. To keep the sugar molecules sufficiently fluid, this process can only be conducted at a constant 80°C for the entire period, so the container with the wood to be treated must be kept in a special oven filled with sugar solution. Once the soaking process is complete, the surface is further treated with a 72% sugar solution. Progress is monitored by weighing the object. Finally, surplus sugar crystals are removed from the surface by steam cleaning, so the wooden artefact can be

Figure 12. The bronze bell after its recovery and preliminary cleaning. The bronze body of the bell is decorated with cloud patterns and an inscription in Chinese letters. © DAI / M.Riemer

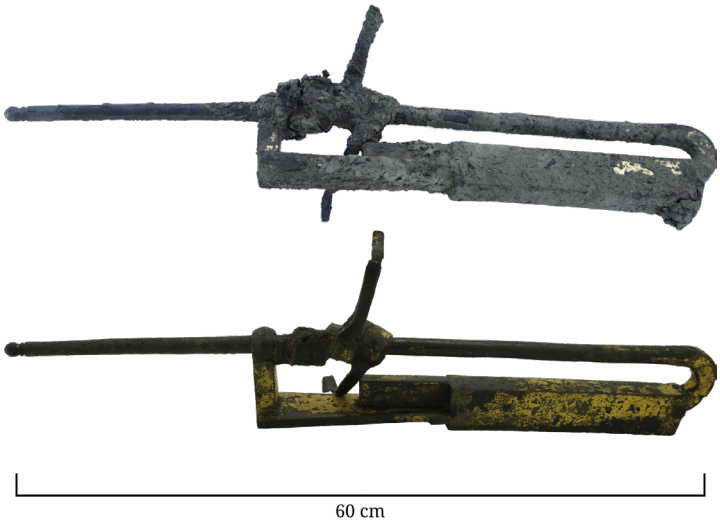

Figure 13. This exceptionally large, gilt iron padlock was recovered from the well. The top image shows the state of the padlock after recovery; the lower image shows its state after restoration. © top: DAI / M. Riemer, bottom: DAI / H. Rohland

stabilised and stored at normal room temperature without further conservation methods, and from that moment can be comprehensively studied for its function and use (Fig. 6).

A problem soon became apparent with the finds from the Karabalgasun well: some artefacts were far too large to be treated in the only oven available for this method at the National Centre for Cultural Heritage in Ulaanbaatar. With support from the Mongolian Ministry for Nature, Environment and Tourism, a larger oven for drying wood treated with conservation solution was obtained in 2019, now located at the Kharakhorum Museum in Kharkhorin. This oven was supplemented in November 2021 by a large, heated basin, which can be used to conserve pieces of wood over 1.5 metres long. Now the lacquered poles from Karabalgasun could be stored and treated in the Kharakhorum Museum. The establishment of a laboratory for wood conservation allowed these special artefacts to return to the Orkhon Valley, where they had been found, and to be stored and treated close to their original site.

Although these are also wooden artefacts, the procedure must be adapted due to the different chemical behaviour of lacquer, including lowering the oven temperature. Initial tests on small samples had been promising, and in November 2021 treatment began on the large wooden rods, which have now been successfully treated and are ready for further scientific analysis and public display.

Conclusions

On first sight the artefacts recovered from the well of Karabalgasun demonstrate the significance of the citadel as a place of display of wealth and power by prestigious objects, such lacquered wooden implements, stone inscription tablets, and elaborate architecture. All of this was destroyed during the sack of Karabalgasun

in 840. Part of the splendour ended up at the bottom of the well. It is hard to tell if this happened by accident, during the turmoil of pillaging, or intentionally as an act symbolically breaking the power of the Uyghur rulers. The uncovering of the skeleton of a gyrfalcon alludes to the possibility that the ruins of the destroyed city still had some significance in ritual or even political acts of the Khitan elites in 11th or 12th century.

Next to their archaeological-historical significance, they also provided an important stimulus to the development of archaeological conservation in Mongolia. Due to a lack of conservation options, wooden artefacts discovered during excavations have rarely, if ever, been preserved long-term. Rapid drying processes have led to severe cracking and destruction of wooden objects. Through this project, we have succeeded for the first time in ensuring the long-term preservation of waterlogged wooden objects from a site in Mongolia, thus enabling precise research into the function and use of the artefacts. The collaboration between Mongolian, Japanese, and German colleagues was characterised by excellent, goal-oriented communication and brought considerable progress to conservation science in Mongolia.

Outlook

After the completion of the restoration of the artefacts, the team is now looking forward to studying them in detail, so the citadel and its material can be published in its entirety. This will provide unprecedented insights into the courtly culture, craftsmanship, trade and political relationships of the Uyghur Empire. This will also enable us to present the artefacts to the Mongolian and international public within the context of their meaning for the history of Mongolia, Asia and the world.

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