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V.I. Molodin[1], D.V. Selin[1], L.N. Mylnikova[1, 2], I.A. Durakov[3], and N.S. Efremova[1]

[1]Institute of Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences, Pr. Akademika Lavrentieva 17, Novosibirsk, 630090, Russia
E-mail: Molodin@archaeology.nsc.ru; selin@epage.ru; L.Mylnikova@yandex.ru; efremova@archaeology.nsc.ru
[2]Novosibirsk State University, Pirogova 1, Novosibirsk, 630090, Russia
[3]Novosibirsk State Pedagogical University, Vilyuiskaya 28, Novosibirsk, 630126, Russia
E-mail: idurakov@yandex.ru

Late Bronze Age Smelting and Processing Furnaces of the Eastern Variant of the Pakhomovskaya Culture in the Baraba Forest-Steppe

We describe smelting furnaces found in southwestern Siberia, at the Tartas-1 ritual site, representing the eastern variant of the Pakhomovskaya culture. This is so far the only known site where the ritual complex, which includes post holes, and utility and ritual pits, adjoins a special manufacturing area with furnaces for smelting copper ore and processing bronze. The pits, differing in form, depth, and size, belonged to a structure. Furnaces are of two types: deep ones, dug into virgin soil, and shallow ones with domes. The former were destined for smelting ore, and the latter for processing metal. The construction of both types is described in detail. The smelting furnaces are peculiar and have no direct parallels in the Late Bronze Age settlements and sanctuaries of southwestern Siberia, while being somewhat similar to smelting furnaces of the Early Iron Age Itkul culture of the Trans-Urals. Furnaces of the second type resemble those of the local Late Irmen culture. Apparently, in the Baraba forest-steppe, where no copper ore outcrops are available, the ritual complexes included furnaces destined for both smelting ore and processing metal. The bronze metallurgy in the region may have been introduced by immigrants practicing both copper ore smelting and metal processing.

Keywords: *Archaeology, Bronze Age, Baraba forest-steppe, Tartas-1, smelting furnaces, hearths.*

Introduction

At the end of the Bronze Age, in the Baraba forest-steppe, processes took place that seriously changed the cultural and historical situation of this part of the Ob-Irtysh region. The Andronovo community was disintegrating. New Andronovo-type cultures inherited the elements of material culture both from the Andronovo and the indigenous populations. Under the impetus of natural and cultural factors, new population groups migrated to this territory: from the west—the carriers of the Pakhomovskaya and Suzgun cultures; from the north—the carriers of the Atlym culture; and from the south—the carriers of the Begazy-Dandybai,

Alekseyevka-Sargary, and Berlik cultures (Molodin, 2010; 2014; Chicha…, 2009).

The emergence and functioning of a unique ritual complex of the eastern variant of the Pakhomovskaya culture, which is currently being studied at the Tartas-1 site (Vengerovsky District, Novosibirsk Region) (Fig. 1) pertains to the Final Bronze Age. That site was discovered in 2003 by O.V. Sofeikov. Large-scale excavations conducted in 2005–2019 by the employees of the Western Siberian Unit of the Institute of Archaeology and Ethnography of the SB RAS under the supervision of Academician V.I. Molodin have shown that the site was a combination of burial, habitation, and ritual objects from various periods (from the Neolithic to the Late Middle Ages) (Molodin, 2015).

The ritual complex is located in the eastern part of the site, and adjoins the old riverbed of the Tartas River, which in the Late Bronze Age could have been a part of the existing river system. Post holes, and household and ritual pits have been found over an area of 2225 m^2 (Fig. 2). Post holes often form rows, but it is difficult to reconstruct the design of the frame-and-post structures on their basis, although such attempts were made earlier (see: (Molodin, Nagler, Hansen et al., 2012; Molodin, Kobeleva, Nagler et al., 2013; Molodin, Durakov, Kobeleva et al., 2014; Efremova, Mylnikova, Molodin et al., 2017)). The complex of holes in sq. F^{III}–M^{III}/54–64 (Fig. 2) can be interpreted as the remains of a structure. Large pits had different shapes and depths, and contained pottery with ornamental features of the eastern variant of the Pakhomovskaya culture (Fig. 3) and fragments of animal bones. Small pits also yielded the finds of frequently discovered types. In plan view, the structure is close to rectangular shape, and covers the area of 180.2 m^2 (10.6 × 17 m).

Fig. 1. Location of the Tartas-1 site.

Notably, in the immediate vicinity of pits No. 532–535, together with accumulation of cow bones, fragments of human pelvic bones have been found. In the filling of small oval pit No. 517, together with fragments of the Eastern Pakhomovskaya pottery, a heel bone of an adult has been discovered (Molodin, Nagler, Hansen et al., 2012).

The ritual complex also includes other pits of various shapes and depths, as well as amorphous structures containing bronze items (see Fig. 2). Two pits yielded spearheads, and one an arrowhead of peculiar shape (Ibid.; Molodin, Kobeleva, Nagler et al., 2013; Molodin, Durakov, Kobeleva et al., 2014; Efremova, Mylnikova, Molodin et al., 2017; Selin, 2018). The complex also includes smelting furnaces (see Fig. 2).

The entire territory occupied by the ritual complex is distinguished by high saturation of the layer with pottery fragments, technical ceramics (crucibles, ladles, casting molds, plaster), calcined animal bones, calcareous nodules, fine ocher, and bronze items.

The complex has been identified as ritual because on its territory there are no objects typical of settlements, such as hearths or utility pits, but there is a specially designated area for production or ritual activities associated with metal smelting. In addition, the finds include bronze items without traces of use, yet in some cases intentionally damaged, as well as fragments of human bones, which might have been associated with ritual practices or ceremonies of sacrifice. Furthermore, the complex is located in the immediate vicinity of the place of simultaneous burials of people with traces of post-mortem manipulations, and burial grounds of the contemporaneous and earlier cultures.

Results

Two types of smelting furnaces were identified in the ritual complex at Tartas-1: 1) deep ones, dug into virgin soil, and most likely associated with ore smelting; 2) shallow ones with domes, associated with metal processing. In addition, objects “imitating” smelting furnaces were discovered.

In the southwestern part of the ritual complex, five smelting furnaces were found, located close to each other (see Fig. 2).

Pit No. 1184 (Fig. 4, *1*, *2*, *7–9*; 5–8) was recorded at the level of virgin soil in the form of a rounded dark gray spot, with a section of burnt soil around the edge. The filling of the pit shows several layers (see Fig. 4, *2*).

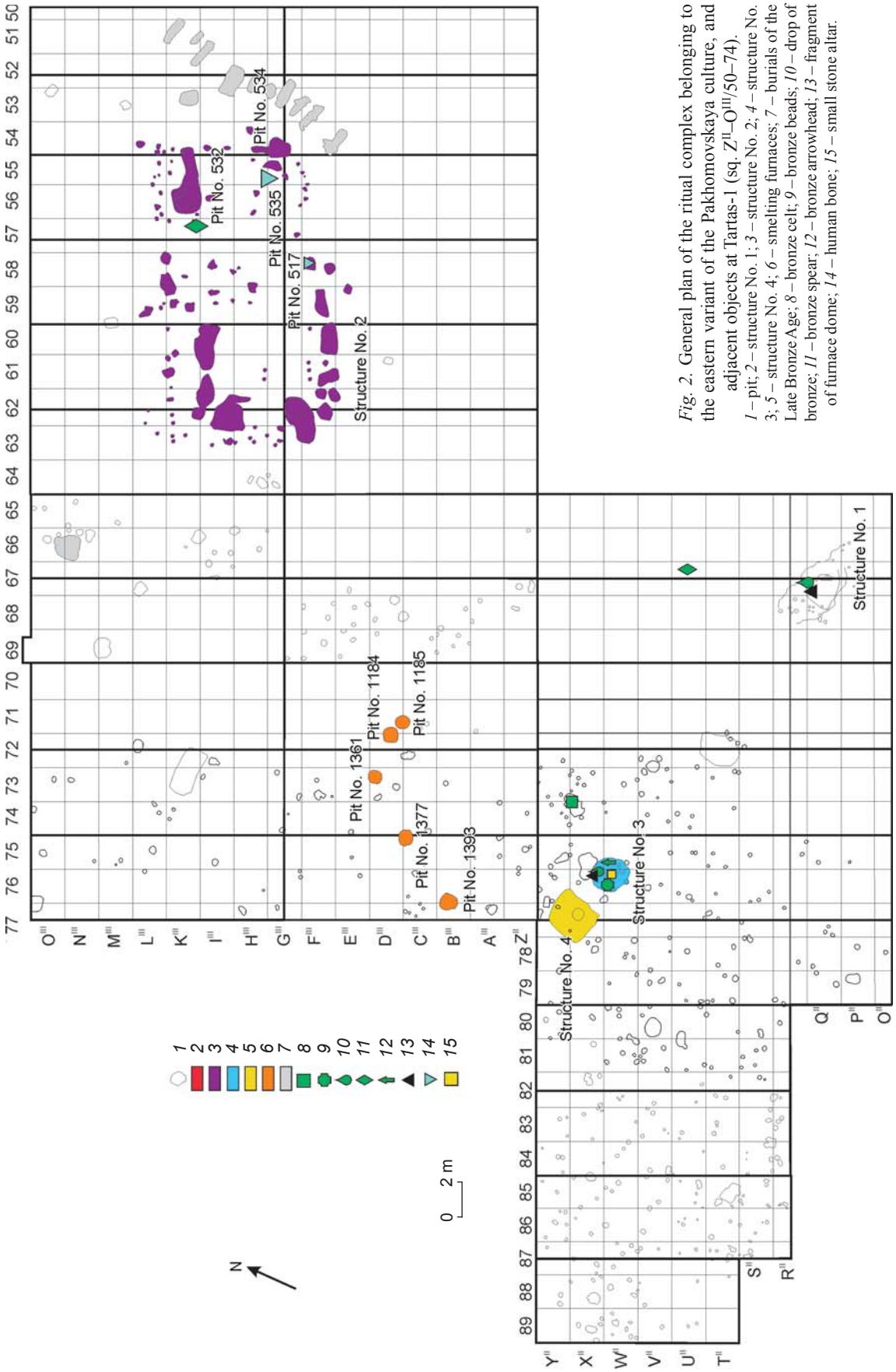

Fig. 2. General plan of the ritual complex belonging to the eastern variant of the Pakhomovskaya culture, and adjacent objects at Tartas-1 (sq. Z^{II}–O^{III}/50–74). *1* – pit; *2* – structure No. 1; *3* – structure No. 2; *4* – structure No. 3; *5* – structure No. 4; *6* – smelting furnaces; *7* – burials of the Late Bronze Age; *8* – bronze celt; *9* – bronze beads; *10* – drop of bronze; *11* – bronze spear; *12* – bronze arrowhead; *13* – fragment of furnace dome; *14* – human bone; *15* – small stone altar.

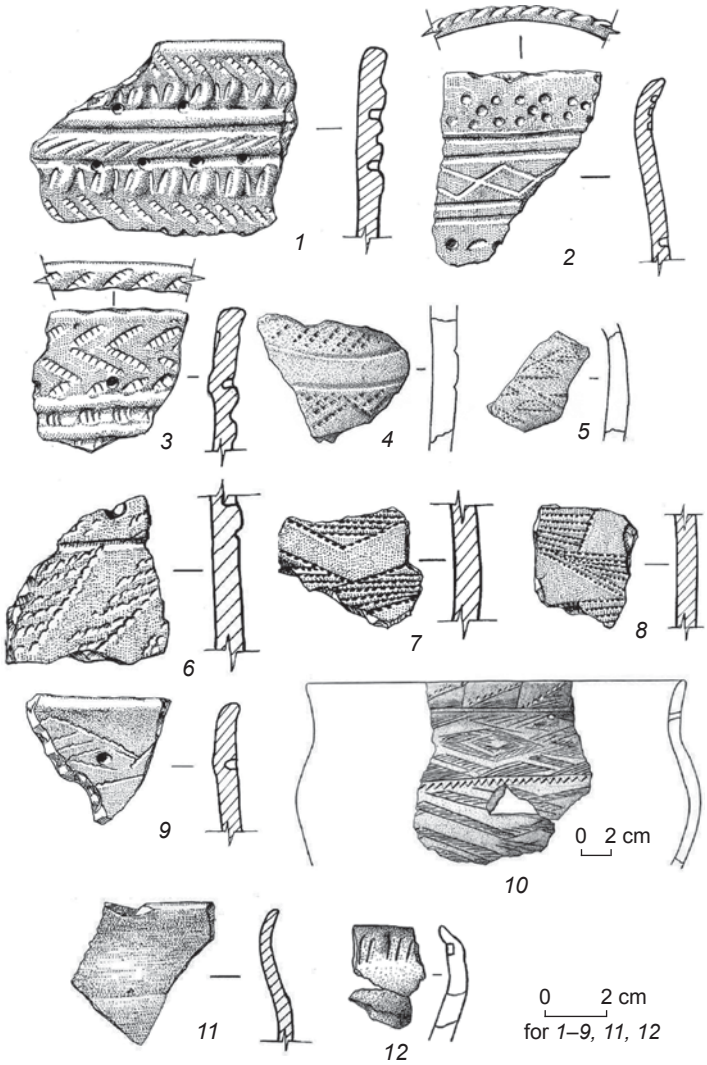

Fig. 3. Pottery from the ritual complex of the eastern variant of the Pakhomovskaya culture.
1–5, *11* – from the cultural layer; *6–9* – from pit No. 1442; *10* – from structure No. 2; *12* – from structure No. 4 (Molodin, Nagler, Hansen et al., 2012).

In the upper part, there is black soil (up to 0.1 m thick). Underneath, there is a dark gray-brown layer of soil (up to 0.15 m thick). Below, black soil is deposited, with inclusions of ash and charcoal (up to 0.13 m thick). On the walls of this pit, lenses of burnt loam were found. The layer of the discharged black soil is up to 0.02 m thick and overlaps a part of burnt soil around the perimeter of the pit.

The pit has a rounded shape, with an uneven upper edge, and measures 0.79 × 0.73 m along the upper contour, and 0.83 × 0.77 m along the lower contour; the depth from the level of virgin soil reaches 0.33 m (see Fig. 4, *1*). The walls are S-shaped; the bottom is even. The finds include calcareous nodules (24 spec.; see Fig. 6, *2*), fragments of calcined bones, and a pottery fragment from the eastern variant of the Pakhomovskaya culture.

Pit No. 1185 (Fig. 4, *3*, *4*; 8) was recorded at the level of virgin soil in the form of a rounded dark gray spot, with burnt soil around the edge. The filling of the pit consists of black soil with inclusions of ash and charcoal (up to 0.4 m thick) (see Fig. 4, *4*). The pit is of rounded shape, 0.65 × 0.6 m along the upper contour; the depth from the level of virgin soil is 0.4 m (see Fig. 4, *3*). The walls are sloping, with burnt areas most frequently occurring in the upper part; the bottom is even. The finds include calcareous nodules (22 spec.) and fragments of calcined bones.

Pit No. 1361 (see Fig. 4, *5*, *6*). The main part of the filling consists of dark gray sooty soil (up to 0.52 m thick). In its western part, at a depth of 0.14 m from the level of virgin soil, a lens of mixed brown-gray soil (up to 0.18 m thick) was found. The pit has a rounded shape, with a diameter of 0.88 m. The walls are slightly sloping, calcined; the bottom is even. The depth from the level of virgin soil is 0.47–0.52 m. The finds include small individual fragments of animal bones and small pottery fragments belonging to the eastern variant of the Pakhomovskaya culture. At a depth of 0.02 m from the level of virgin soil, in the eastern half of the pit, an accumulation of fish bones (0.3 × × 0.3 × 0.02–0.1 m) was discovered (see Fig. 4, *5*).

Pit No. 1377 (see Fig. 4, *10*, *11*). The filling in the upper part is dark gray soil interspersed with brick-red or orange partially decomposed backed clay. In the lower part, a layer of coal-black sandy loam with rare inclusions of mixed gray-yellow native loam is recorded. Small pieces of charcoal and charred fragments of wooden planks occur. A lens of burnt orange loam up to 0.11 m thick was discovered closer to the walls in the middle part of the filling. The pit is oval in shape, 0.86 × 1.02 m. The walls are straight; the bottom is even. The diameter along the lower contour reaches 0.74 m; the depth from the level of virgin soil is up to 0.68 m. The finds include calcareous nodules, 10 small pottery fragments, and 25 fragments of animal bones.

Pit No. 1393 (see Fig. 4, *12*, *13*). The filling of that pit in the upper part is uniform dark gray soil. A layer of gray-brown burnt soil (0.22–0.3 m thick) lies underneath. In the bottom part, there was black sooty soil containing calcareous nodules. A layer of burnt loam of orange color (0.08–0.02 m thick) occurs along the walls of the pit. In the western part, traces of clay coating are found. The pit is rounded in shape, 1.03 × 1.0 m along the upper contour, 1.15 × 1.13 m in the central part, and 1.05 × 0.95 m at the bottom level (see Fig. 4, 12). The walls are uneven: vertical from the level of virgin soil and have a negative slope at a depth of 0.13–0.18 m; after that they are slightly sloping. The bottom is even;

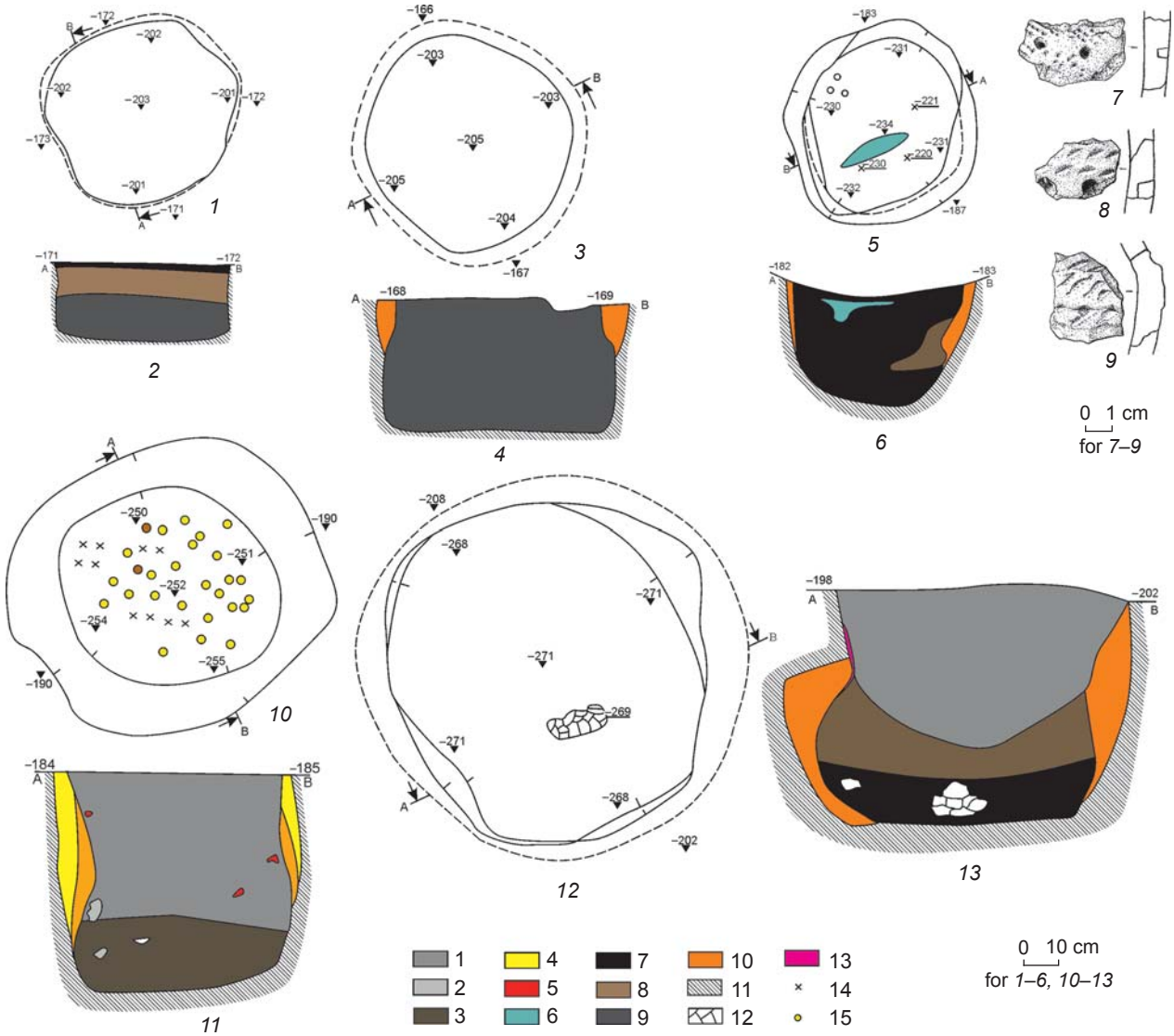

Fig. 4. Plans and profiles of pits No. 1184 (*1*, *2*), 1185 (*3*, *4*), 1361 (*5*, *6*), 1377 (*10*, *11*), 1393 (*12*, *13*), pottery fragments (*7–9*).

1 – dark gray soil with inclusions of fragments of baked clay; 2 – gray-white ashen soil; 3 – black soil with inclusions of native loam; 4 – spot of burnt soil; 5 – inclusions of baked clay; 6 – area with fish-bones; 7 – black sooty soil; 8 – dark gray-brown soil; 9 – black carbonaceous soil; 10 – burnt native loam; 11 – yellow native loam; 12 – calcareous nodules; 13 – clay coating; 14 – pottery fragment; 15 – bone fragment.

the depth is 0.7 m. The finds include 77 fragments of animal bones, 2 animal bones with bronze oxides, and 22 small pottery fragments of the eastern variant of the Pakhomovskaya culture. The second layer contained particles of orange sintered clay. Calcareous nodules were found in the bottom part.

Thus, the discovered structures are similar both planigraphically (see Fig. 2) and in their design—they are rounded (or suboval) pits measuring 0.79 × 0.73 × 0.6 m.

Fig. 5. Pit No. 1184 before extraction of the filling.

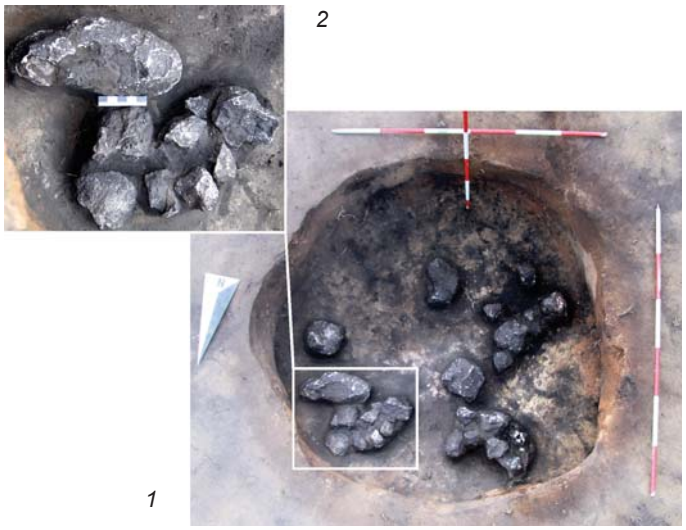

Fig. 6. Pit No. 1184 during extraction of the filling (*1*), calcareous nodules in its filling (*2*).

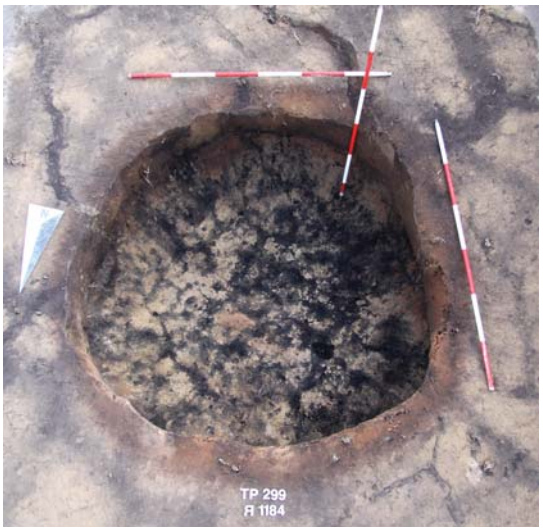

Fig. 7. Pit No. 1184 after extraction the filling.

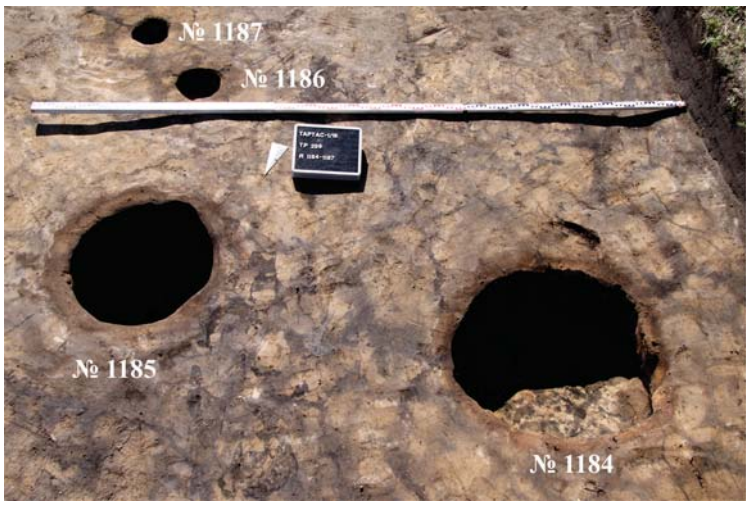

Fig. 8. Pits No. 1184–1187 after extraction the filling.

All pits have specially made S-shaped walls covered with clay (Fig. 9). The filling consists of several layers. On top, there is black soil up to 0.1 m thick. Underneath, there is a layer of black soil with inclusions of ash and charcoal (up to 0.4 m thick). On the walls, areas of burnt soil (up to 0.22–0.35 m thick) are observed. In some pits, ash layers (up to 0.03 m thick) are present between black soil and burnt areas. Finds include a large number (up to 25 spec.) of fragments of burnt calcareous nodules occurring at different levels in each explored object*.

*According to the results of technical and technological analysis of pottery fragments, nodules were crushed and then used as additive to clay during the manufacture of pottery (Selin, 2016, 2018; Efremova, Selin, Molodin et al., 2017).

Small fragments of calcined animal bones and charcoal have also been found. The presence of calcined bones with traces of bronze oxides in the filling of furnace No. 1393 suggests that these smelting furnaces were part of the bronze foundry. Noteworthy is the small number of individual finds (except for the nodules) in these objects. The furnaces could have been cleaned of production waste and prepared for further use. Pottery fragments of the eastern variant of the Pakhomovskaya culture discovered in these objects testify that these smelting furnaces belonged to the said culture (see Fig. 4, 7–9).

According to their design, the furnaces described above resembled ore smelting kilns of the second class and third subclass of the Itkul metal processing center of the Early Iron Age (Beltikova, 1981: 123–124).

Scholars have repeatedly mentioned the relationship between bronze casting activities and ritual practices (for more detail see: (Chernykh, 2007, 2018)). It seems quite natural that a special area intended for producing various artifacts, including bronze items, was located in the immediate vicinity of ritual structures of the eastern variant of the Pakhomovskaya culture; it was a part of this complex. We should mention the absence of fire traces at the Irmen ritual complex discovered at the Sopka-2 burial ground, which suggests that fire played different roles in the ritual practices of representatives of the Irmen culture and the eastern variants of the Pakhomovskaya culture (Molodin, Efremova, 2015: 75).

Analysis of the planigraphy of the ritual complex has shown that the furnaces were located outside the buildings,

on a separate ground in a natural hollow with a vertical drop of about 1 m. Rows of post holes, possibly associated with enclosures or wind-shelter partitions, were found 4 m east of the furnaces. The tradition of building heat-protecting, moisture-protecting, and wind-sheltering structures around manufacturing areas is well known from archaeology and ethnography (Bobrinsky, 1991: 70–83).

Post holes remaining from one or several frame-and-post structures were located to the south of the smelting furnaces. Currently, it is difficult to interpret the structural features of these buildings. However, judging by the planigraphy, these were oriented along a NW-SE line and were located at some distance from the manufacturing area with furnaces.

Fig. 9. Traces of clay coating on the wall in pit No. 1393.

Another type of smelting furnace on the territory of the complex is represented by a part of ***structure No. 1*** (see Fig. 2). It had an oval shape and uneven walls partially embedded into virgin soil, and was accompanied by a system of pits on the north, west, and south. A bronze casting area (marked by a depression), ground hearth, and ash pit were components of the structure.

The oval-shaped smelting structure (ground hearth) could have been a metal casting furnace, measuring 0.60 × 0.22 m. The remains of the dome, in the form of backed pieces of clay, have been preserved in its upper part, and a bronze splash was discovered under them. The thickness of the dome was 8–9 cm. Hearths with clay domes, built on the ground or weakly embedded in the ground, are quite common both in dwellings and on special grounds at the sites of the Irmen culture (Matveev, 1993; Sidorov, Novikova, 1991; Durakov, 2009).

The ritual complex is characterized by structures No. 3 and 4. The objects associated with ***structure No. 3*** are the better preserved (Fig. 10) and include a round cup-shaped depression with a diameter of 1.95 × 2.2 m and a depth of 0.08–0.15 m from the level of virgin soil. The bottom decreases slightly toward the center. Near the northeastern wall of the depression, two large clusters of items were found. The first cluster consisted of large fragments of technical ceramics. The second cluster included large fragments of casting molds and the vault of the smelter. Under the vault, two bronze beads and an animal bone were located. An oval pit 0.7 × 0.58 m in size and 0.2 m deep was in the center of the structure. At the bottom of the pit, there was a large flat stone measuring 0.15 × 0.23 m, and 0.03–0.04 m thick, which apparently served as a small altar. The filling revealed rounded calcareous nodules, fragment of a casting mold, piece of ocher, and animal bones. The layer is saturated with ash and small inclusions of burnt soil.

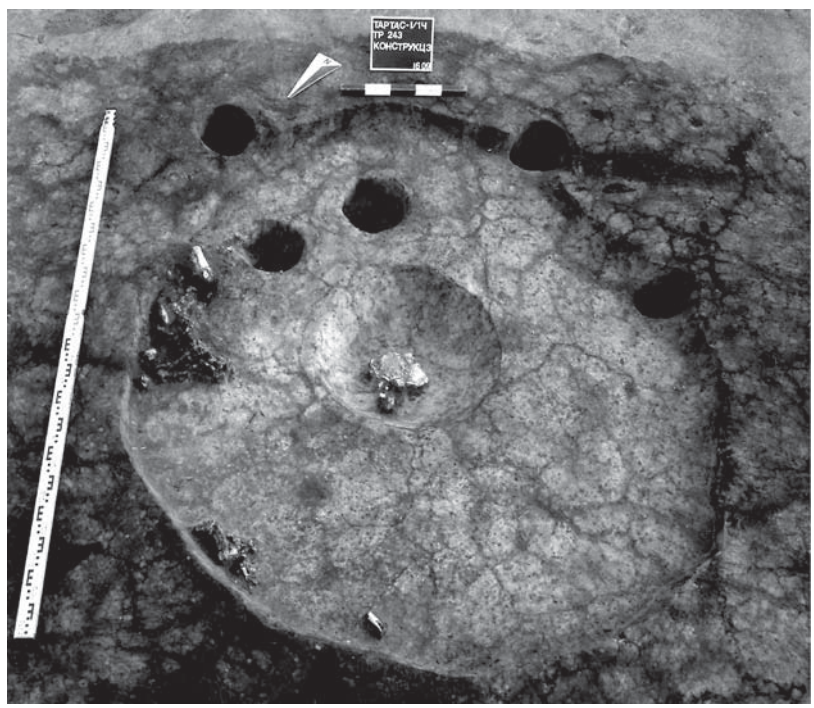

Fig. 10. Structure No. 3. View from the northwest.

However, there are no traces of fire traces on the walls of the structure.

All artifacts found at this site and associated with bronze foundry had been removed from manufacturing areas. According to the results of technical and technological analysis, the mold was made according to the West and North Kazakhstan traditions, without using a bottom board. The autochthonous traditions of using the bottom board have been recorded from the Early Bronze Age to the end of the transitional period from the Bronze Age to the Early Iron Age (the Late Irmen culture). Western tradition of manufacturing casting molds was typical of the artisans of the Krasnoozerka, Itkul, and Berlik cultures (Durakov, 2009: 229). The presence of the furnace vault without the furnace, waste from bronze casting production, bronze beads, and a stone altar may point to the sacral nature of the object.

Discussion

As mentioned above, the closest parallels to the smelting furnaces of the first type occur at the sites of the Early Iron Age in the Itkul metal processing center. G.V. Beltikova attributed them to ore smelting kilns of the second class, third subclass (1981: 123–124). These were intended for crucible ore smelting.

Similar structures have been found at the sites of the Pakhomovskaya culture in the Tobol-Irtysh interfluve. For example, in the northern part of the Oskino Boloto settlement, on the bank of a water body, a system of structures was discovered, which included hearths, household pits, post holes, and an ash pit containing numerous pottery fragments, burnt animal bones, and fragments of technical ceramics (Tkachev Al.Al., 2014, 2017; Tkachev Al.Al., Tkachev A.A., 2017). Unfortunately, descriptions of the ground-plans and profiles of the discovered hearths and associated finds have not yet been published. However, it can be stated with confidence that creation of special manufacturing areas for bronze casting was typical not only of the carriers of the Pakhomovskaya culture, but also of the representatives of its eastern variant.

Hearths inside dwellings of the Pakhomovskaya culture have the form of shallow pits of oval, rounded, or sub-rectangular shape; some show traces of clay coating. The walls of the pits are sloping; the bottom is even or cup-shaped, which is absolutely atypical for the structures described above (Korochkova, 2009, 2010; Nesterova, Tkachev, 2011: 65; Matveev, Chikunova, 1999: 44). In the settlements of the eastern variant of the Pakhomovskaya culture, hearths inside dwellings are rounded or oval burnt spots deepened in shallow pits or built on virgin ground (Bobrov et al., 2018: 220; Evdokimov, Stefanov, 1980; Tataurova, Polevodov, Trufanov, 1997).

The presence of special production sites is known from the habitation sites of the cultures contemporaneous with the Pakhomovskaya culture, such as Chicha-1 (Barabinskaya), Linevo-1 (Cis-Salair), and Berezovy Ostrov (Novosibirsk region of the Ob) (Durakov, 2009; Mylnikov, Mylnikova, 2015; Mylnikova, Durakov, 2004, 2008). These have areas with the concentration of hearths, furnaces, and kilns intended for bronze casting. At the settlements of the Irmen and Late Irmen culture, hearths in the dwellings are pits, rounded or oval in plan view, sometimes with traces of covering the walls with clay (Molodin, 1985; Molodin, Chemyakina, 1984; Matveev, 1993; Sidorov, Novikova, 1991; Molodin, Efremova, 2015). Smelting furnaces with adobe dome, built on the ground, can be considered to be parallels to the smelting structures of the second type. For instance, a furnace with similar design was found in structure No. 3 at Bystrovka-4 (Novosibirsk region of the Ob) (Matveev, 1993: 65). Hearths in dwellings No. 3 and 9 at Milovanovo-3 (Novosibirsk region of the Ob) also had adobe domes (Sidorov, Novikova, 1991). A kiln found at the bronze casting ground from excavation pits “C” and “D” at Chicha-1 (Durakov, 2009: 216) had the dome made of fired clay. In the Ob region, hearths of that type were used until the beginning of the Early Iron Age in the Ordynskoye-9 and Milovanovo-3a settlements of the Bolsherechensk culture, and the Kizhirovo settlement of Kamenny Mys (Novosibirsk region of the Ob) (Troitskaya, Durakov, 1999).

Representatives of the Suzgun culture built hearths in pits or directly on the floors of their dwellings. In some cases, walls of the hearths were covered with clay “cakes” (Matveev, Gorelov, 1991, 1993; Polevodov, 2003; Potemkina, Korochkova, Stefanov, 1995). In the settlements of the Elovka culture, hearths were located on the ground. They were laid around with stones, which probably served as walls, in oval pits or on bedrock exposures (Matyushchenko, Igolnikova, 1966; Matyushchenko, 1974: 107; Titova, Troitskaya, 2008: 92). In the settlements of the Begazy-Dandybai culture, fireplaces located on the floor of dwellings, as well as four- or five-angled hearths with stone alignments, and hearths in pits, are known (Beisenov, Varfolomeev, Kasenalin, 2014: 81; Margulan, 1979). In the dwellings of the Krasnoozerka culture, there were fireplaces on the ground, and in rare cases hearths made of clay with walls reinforced by vertically mounted poles (Borzunov, Matyushchenko, 1994; Nesterova, 2015). Furnaces built above well shafts occur at the sites of the Sintashta-Petrovka period (Koryakova, Panteleeva, 2019: 23).

Large ash pits saturated with pottery fragments, charred animal bones, clay coating, technical ceramics, or special areas for storing production waste were located next to all production grounds discovered in settlements

of the Late Bronze Age to the transitional period to the Early Iron Age. Such objects have not been found near the first-type smelting furnaces in the territory of the ritual complex of the eastern variant of the Pakhomovskaya culture at Tartas-1, which may indicate a special method of production waste disposal or a different purpose for the objects. Near the furnace of the second type, there is an ash pit.

Conclusions

Analysis of the archaeological evidence suggests that construction of special manufacturing areas with smelting furnaces, associated with ritual complexes, was rather an exception for the cultures of the Late Bronze Age to the transitional period to the Early Iron Age. The ritual complex of the eastern variant of Pakhomovskaya culture at Tartas-1 is still the only known structure of this kind.

Smelting furnaces of two types appear within the boundaries of the ritual complex: deep ones, dug into virgin soil, and most likely associated with ore smelting; and shallow ones with domes, intended for metal processing.

The design of the studied furnaces of the first type does not find direct parallels among the evidence from settlement and ritual complexes of the contemporaneous cultures of the Final Bronze Age in southwestern Siberia. Some connection with the structures of the Itkul culture (Beltikova, 1981: 123–124), intended for ore smelting, can be observed. However, the delivery of copper ore to the Baraba forest-steppe would have required its transportation over considerable distances. No ore or waste from its processing has been found at the site. The design of the hearth of the second type corresponds to the local Late Irmen metal processing tradition.

The appearance within the ritual complex of structures intended for almost the complete cycle (ore smelting and metal processing) of metal production in the Baraba forest-steppe, where there is no ore, was most likely associated with the arrival of new population groups. It can be assumed that they were migrants from the territory where two types of activity had not been separated yet: a foundry man was also metal maker. The carriers of this tradition, who migrated to the Baraba forest-steppe, brought the entire production cycle with them.

The production complex might have been created on the sacral territory of the complex for ritual purposes. It is also possible that these are the "traces" of the initial stage of adaptation of an imported technology to the new conditions of real production. Further excavations of the site will hopefully make it possible to clear this issue.

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