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A Functional Analysis of Stone Tools from Bronze Age Burials in the Baraba Forest-Steppe, Based on Findings from Sopka-2

Lithics from chronologically diverse burials at Sopka-2, the Baraba forest-steppe, Western Siberia, were subjected to experimental use-wear analysis. We selected relatively well preserved specimens, suitable for microscopic examination and representing cultures such as Ust-Tartas, Odino, Krotovo, etc. Wear traces indicate the functions of tools and their places among the industries of the region. It was found that the tools had not been specially destined to be funerary items—they all display some wear and are well-suited for efficient use. Comparative characteristics of degree of wear are proposed. At the early stages, stone tools had been placed only in female burials, but at later stages they were distributed among burials of females, children, and males. The findings provide a basis for a functional and morphological typology of lithics used during that period.

Keywords: *South Siberia, Baraba forest-steppe, Late Bronze Age, burials, stone tools, functional analysis.*

Introduction

The Sopka-2 cemetery, containing chronologically diverse burials, is one of the remarkable archaeological sites in the Baraba forest-steppe. It is located in the Sopka area, in the Vengerovsky District of the Novosibirsk Region. Sopka-2 was excavated in the late 1970s to early 1980s by V.I. Molodin (Molodin, 1980, 2001, 2012; Molodin, Grishin, 2016, 2019; Molodin, Efremova, Solovyev, 2021; Molodin, Solovyev, 2004; etc.). The obtained materials illustrate several cultural formations of the ancient population of the Baraba forest-steppe over a fairly long period of time. The concept of the cultural and historical development of the ancient population of Western Siberia was proposed and published by Academician V.I. Molodin and his co-authors (Molodin, 1977, 1985, 2001, 2012, 2015; Molodin et al., 2013; etc.).

The archaeological assemblage from Sopka-2 includes relatively few, but diverse, lithic artifacts (Molodin, Grishin, 2016: 239–241). In addition to flakes, knife-like blades, and scraper-like tools, it contains abrasive stones, hammer-stones, grinders, and other tools. The study of this set of items from Sopka-2 burials seems to be a timely task today; the functional analysis of stone tools can serve as a basis for fruitful development of their typology, which will contribute to our understanding of the toolkit and the household activities of the people who inhabited the region during various historical periods. The purpose of the study is to identify and analyze specific use-wear marks on lithic artifacts and to determine the functional purposes of the tools.

Study materials

The functional analysis was carried out on selected artifacts with rather well-preserved surfaces suitable for microscopic examination, from the Bronze Age burials of

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Western Siberia. Finds with significant surface damage resulting from washing, crumbling, and other effects, were not considered.

The studies were focused on 17 artifacts registered as follows: artifacts of the Bronze Age Ust-Tartas culture – No. 1–4; the Odino artifacts – No. 5–10; the Krotovo – No. 11, 12, 14, 15; the Late Krotovo (Cherno-Ozerye) – No. 16, 17; the artifact attributed to the Mongolian period – No. 13. Notably, some of the studied artifacts constitute a complex (Fig. 1). Several graves yielded sets of lithic artifacts: burial 22 mound 44 (Ust-Tartas culture) produced No. 2 and 3; burial 40 mound 22 (Odino culture) – No. 6 and 7; burial 42 mound 25 – No. 8–10; flat-grave burial 652 (Krotovo culture) – No. 14 and 15.

Methodology and analytical techniques

Functional analyses of the selected lithic artifacts were based on the method of experimental use-wear analysis proposed by S.A. Semenov (1957) and G.F. Korobkowa (1999). We also applied the synthesized technique of use-wear analysis adapted for studying the materials from sites in North and Central Asia (Volkov, 2013: 94–154). Previous experimental studies, which contributed to the replenishment of the traceological collection of reference stone tools from Siberia and the Far East (Ibid.: 66–99), showed that the wear of the studied stone tools was generally standard (see (Semenov, 1957: 88–90, 170–174)). Experiments with abrasive stones of

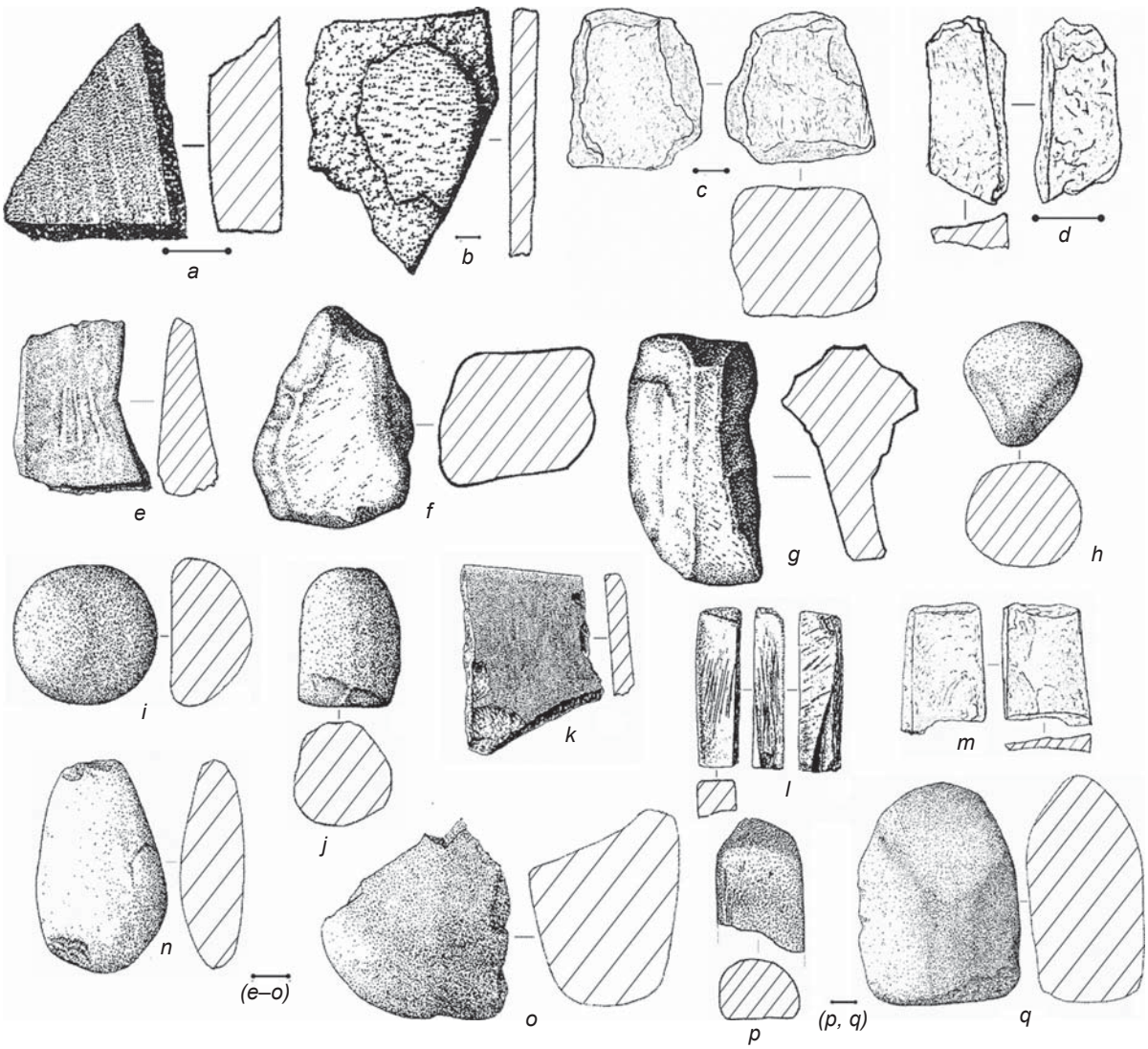

Fig. 1. The lithic assemblage from the graves at Sopka-2.
a, *b* – Ust-Tartas culture (4th to first half of 3rd millennium BC, Early Bronze Age); *c*, *d* – Comb-Pit ceramic culture (4th to first half of 3rd millennium BC); *e–j* – Odino culture (3rd millennium BC); *k*, *l*, *n*, *o* – Krotovo culture (3rd to early 2nd millennium BC); *p*, *q* – Late Krotovo (Cherno-Ozerye) culture (late 3rd to early 2nd millennium BC); *m* – Mongolian period (13th–14th centuries AD) (Molodin, 2001: 67, 32; 2012: 32, 47, 81; Molodin, Grishin, 2016: 64, 86, 210; 2019: 18, 42).

various grain-sizes that were carried out as part of this study enabled the authors to identify the characteristics of wear marks depending on the type of stone used, and to determine the relative degree of wear of some artifacts from the archaeological collection. With the help of experimental tools, the casting defects in the form of the turning edge of the bronze dagger's blade were removed. Differences between linear microtraces on abrasive stones, resulting from various operations, were noted: the signs of forming areas adjoining the blade and those of sharpening the blade-edges of various types of dagger. The studies of the surfaces of the coarse and fine-grained abrasive stones allowed us to reveal the origins of traces of efficiency loss in such tools: this occurred owing to formation of wear in the form of smoothness in their working zones; also, we identified the start and end of the development of a characteristic groove-like microrelief on the surfaces of rasps. Special attention was paid to the general deformation of the abrasive surfaces, the formation of linear microtraces, and the remains of materials processed on the abrasive stones. To study the wear resistance of tools made from local raw materials, experiments were carried out clarifying the features of the process of application of burnishers in skin processing.

Description of wear marks and functional characteristics of tools

Ust-Tartas culture

Object of study No. 1 (Fig. 2, *a*; 3, *a*), catalogue code S-2 k 31 p 15, skeleton No. 3. The artifact is a fragment. Use-wear marks were noted on its wide surface, which is the only working area of the tool. The natural surface of the stone in the working area of the tool was flattened as a result of wear. Linear microtraces are not noted. The tool belongs to the group of active abrasive tools. It was probably used as a grinder, polishing the areas adjoining the cutting edges of metal knives. The degree of wear* is relatively moderate. The tool was used for a single purpose (monofunctional), and was not applied for other operations.

Object of study No. 2 (see Fig. 2, *b*; 3, *b*), catalogue number S-2 k 44 p 22. The artifact together with object No. 3 were recovered from burial 22. The study object consists of two fragments of a single item. Wear marks are noted on a wide surface, which is the only working area of the tool. The natural surface of the stone in the working area is relatively lightly flattened as a result of wear. Linear microtraces are not noted. The tool belongs to the group of active abrasive tools. It was probably used as a rasp to remove irregularities on relatively wide surfaces of metal products. The degree of wear is relatively low. The tool was used for a short time, it was not used in other operations.

Object of study No. 3 (see Fig. 2, *c*; 3, *c*), collection code S-2 k 44 p 22. Artifact 22, together with find No. 2, was found in one burial. Wear marks are noted on a wide surface, which is the only working area of the tool. The stone working area is flattened by wear. Linear microtraces were not noted. The tool has been attributed to the group of active abrasive tools. It was probably used as a grinder for smoothing relatively wide surfaces of metal products. The artifact possibly served as a pestle for grinding relatively hard inorganic materials on a hard surface. The degree of wear is relatively moderate.

Study object No. 4 (see Fig. 2, *d*; 3, *d*), catalogue code S-2 p 626. This artifact was recovered from burial 626. Traces of wear are observed on its wide surface, which is the only working area of the tool. The concavity in the working area of the tool was formed during its extensive use. Linear microtraces are not noted. The tool belongs to the group of active abrasive tools. The processed material was not determined. The degree of wear is relatively high. The tool was used for a single purpose, it was not used in other operations.

Odino culture

Object of study No. 5 (see Fig. 2, *e*; 3, *e*). Catalogue code S-2 84 to 22 p 24. The artifact was found in burial 24. Traces of wear are noted on two wide surfaces. The surface of the stone in the working area of the tool is noticeably deformed by contacts with the workpiece. Linear macrotraces are relatively parallel; these are relatively deep and long channels with a U-shaped cross-section and smoothed sides. The tool belongs to the group of passive abrasive tools. It was probably used for processing the items made of solid organic materials (sharpening the points made from bone, horn, etc.). The degree of wear is relatively high. The tool is monofunctional, it was not used in other operations.

Object of study No. 6 (see Fig. 2, *f*; 3, *f*), catalogue code S-2 85 k 22 p 40. This artifact was found together with find No. 7 in burial 40. Traces of wear are observed over the entire surface of the artifact. The tool is

*Relative degrees of wear of all the considered stone tools was determined. An important result of the experimental work is the establishment of paired standard tools (wear-nonwear); they show the contrast between the working zones and the areas with an undisturbed stone structure on the tool's surface. Paired photographs of the main working areas of the objects of study cases No. 1–17 are designated sequentially by the letters "a"–"q" (see Fig. 3). Letter "r" marks the surface of object No. 17 (Late Krotovo (Cherno-Ozerye) culture) showing traces of metal.

Fig. 2. Artifacts of the Ust-Tartas (*a–d*), Odino (*e–j*), Krotovo (*k*, *l*, *n*, *o*), Late Krotovo (Cherno-Ozerye) (*p*, *q*) cultures and Mongolian period (*m*) bearing use-wear signs. The scale bar is 1 cm in all the images.

multifunctional. It was used mainly as a burnisher for processing fresh and non-rigid skins. Both surfaces are worn out; one of them shows more extensive wear. The relief of the stone working area is flattened; it is smoothed and burnished. The traces of wear are most visible on the protruding parts and edges of the stone tool. Linear microtraces are not noted. The degree of wear is relatively high. The tool is attributed to the group of active tools. It served not only as a burnisher, but also as an anvil (group of passive tools) for splitting solid, probably inorganic, materials. The degree of passive wear is moderate. At the narrow end of the tool, traces of use for crushing purposes (group of active tools) are noted. The degree of crushing wear is high.

Object of study No. 7 (see Fig. 2, *g*; 3, *g*), catalogue code S-2 85 k 22 p 40. This artifact was found in burial

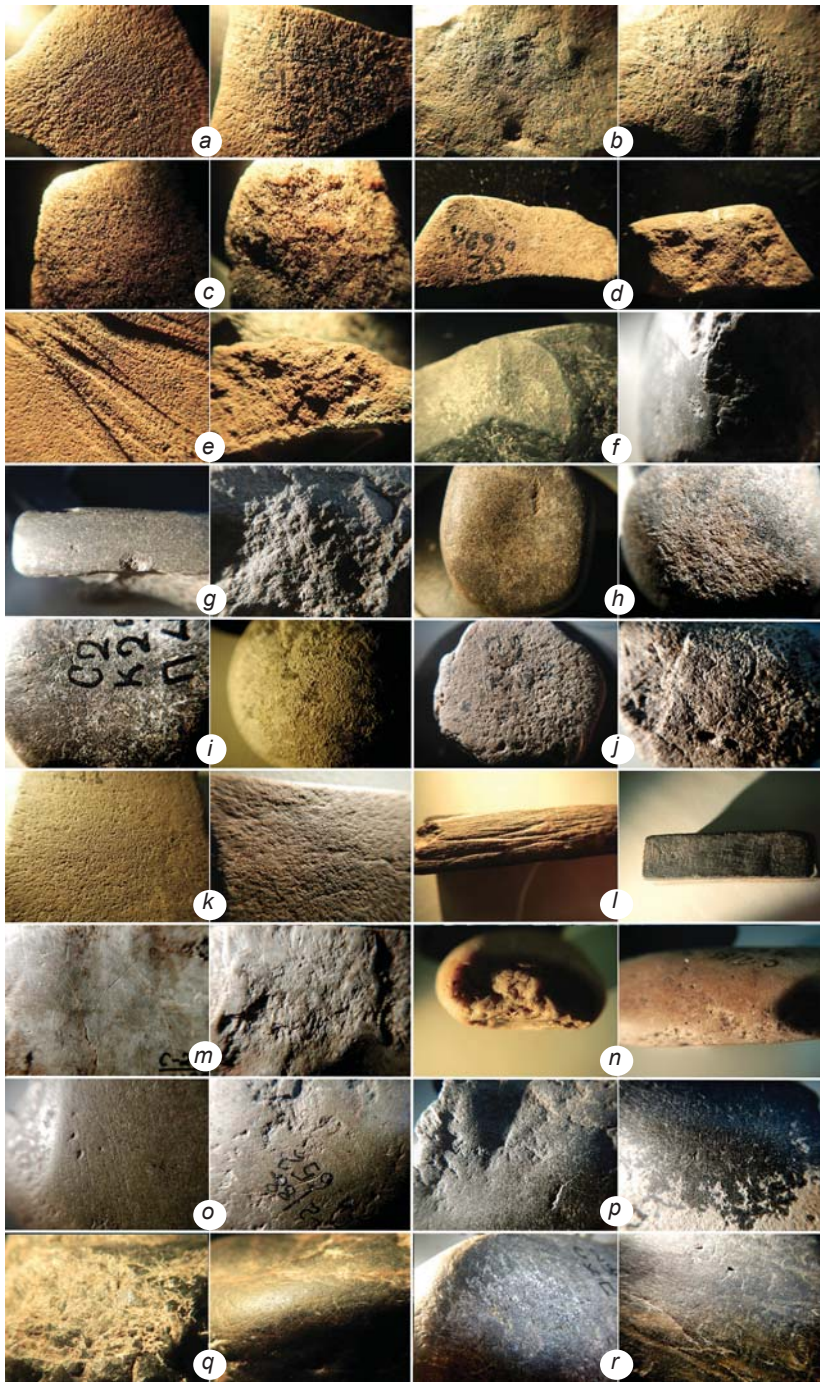

Fig. 3. Use-wear signs and natural surfaces of the tools. All the photos are taken at ×2 magnification.

40 together with find No. 6. Traces of wear are noted on the convex edge and the narrow face of the artifact. The relief of the stone working area is smoothed out by wear, the surface is slightly convex. Linear micro-traces of wear are not observed. The tool belongs to the group of passive abrasive tools for metal working. It was probably used as a grinder, smoothing the areas adjoining the cutting edge of a knife. The degree of wear is relatively high. The tool is monofunctional, it was not used in performing other operations.

Object of study No. 8 (see Fig. 2, *h*; 3, *h*), catalogue code S-2 k 25 p 42. This artifact was recovered from burial 42 together with finds No. 9 and 10. Traces of wear are noted over the flattened part, which is the only working area of the tool. It was used mainly as a burnisher in skin processing. Wear traces of the stone working area have

the form of smoothed spots with typical polish. The most distinct traces of wear are noted on the protruding parts of the stone and the edges of the tool. Linear microtraces are not observed. The degree of wear is relatively high. The tool is monofunctional, it belongs to the group of active tools.

Object of study No. 9 (see Fig. 2, *i*; 3, *i*), catalogue code S-2 k 25 p 42. The artifact was recovered from burial 42 together with finds No. 8 and 10. It is a solid tool, similar in morphology to item No. 8. Wear marks, the same as on the tool described above, are noted on the flattened part, which is the only working area of the tool. It was mainly used as a burnisher in skin processing. The relief of the stone working area is flattened by wear, smoothed and burnished. The most distinct traces of wear are observed on the protruding parts of the tool. Linear microtraces are not identified. The degree of wear is relatively high. The tool is monofunctional, it belongs to the group of active tools.

Object of study No. 10 (see Fig. 2, *j*; 3, *j*), catalogue number S-2 k 25 p 42. The artifact was recovered from burial 42 together with finds No. 8 and 9. Traces of wear are noted on the flattened narrow face, which is the only working area of the tool. It was used mainly as a pestle-grinder for working on flat and rigid surfaces. The relief of the stone working area is flattened and smoothed by wear. Linear microtraces are not observed. The degree of wear is relatively high. The tool is monofunctional; it belongs to the group of active tools for grinding relatively hard, probably organic, materials.

Krotovo culture

Object of study No. 11 (see Fig. 2, *k*; 3, *k*), catalogue code S-2 k 22 p 11. Traces of wear are noted over one of the wide surfaces, which is the only working area of the tool. The relief of the stone working area is flattened by wear. Linear microtraces are not observed. The artifact belongs to the group of active abrasive tools. It was probably used as a grinder, processing the areas adjoining the cutting edge of a knife. The degree of wear is relatively moderate. The tool is monofunctional, it was not used in performing other operations.

Object of study No. 12 (see Fig. 2, *l*; 3, *l*), catalogue code S-2 k 25 p 64. The artifact is a solid tool on a small tetrahedral stone block. Wear marks are noted on all the edges. Linear microtraces in the form of shallow grooves, relatively parallel to one another, are observed. Linear traces are oriented both along the long axis of the tool (on three faces out of four) and almost across the elongate-subrectangular working area on one of the faces of the tool. The artifact belongs to the group of active abrasive tools for metal working. It was probably used as a grindstone for forming and straightening the areas adjoining the cutting edge, removing notches, etc. The degree of wear on the two faces of the tool with longitudinally and transversely oriented linear traces of use is relatively high. Two faces with longitudinally oriented linear traces are identified as the main working edges of the tool; the other two faces are determined to be auxiliary working areas. The tool is monofunctional.

Object of study No. 14 (see Fig. 2, *n*; 3, *n*), catalogue code S-2 / 88 p 652. The artifact was recovered from burial 652 together with find No. 15. Traces of wear are noted on the two opposite narrow ends of an oval-shaped pebble. The original form of the stone has been destroyed and flattened by wear at the two working areas. Linear microtraces are not noted. The tool is attributed to the group of active tools. Judging by the characteristic crushing of the stone surface in the zone of contact with processed material, the item could have served as a percussion tool for crushing relatively fragile materials. Use of the tool as a hammer-stone for splitting stone is unlikely: no signs of short, differently oriented micro-splits typical of a hammer-stone have been traced in the zone of wear. The degree of wear is relatively moderate. The tool is monofunctional, it was not used in performing other operations.

Object of study No. 15 (see Fig. 2, *o*; 3, *o*), catalogue code S-2 / 88 p 652. This artifact was recovered from burial 652 together with find No. 14. The tool is a fragment of an original pebble. Traces of the most extensive wear are seen on the flattened part, which is the main working area of the tool. The tool was used as a burnisher for skin processing. The relief of the stone working area is noticeably flattened, smoothed and polished. Linear microtraces (several short tracks) were probably formed during short working of contaminated material. The degree of wear is relatively high. Notably, the artifact was used as a burnisher not only before, but also after fragmentation. At the second stage of using the tool, the zone of wear was formed on the other side of the artifact, opposite the first wear zone. The tool is monofunctional, it belongs to the group of active tools. At the second utilization stage, it was used for a relatively short time.

Late Krotovo (Cherno-Ozerye) culture

Object of study No. 16 (see Fig. 2, *p*; 3, *p*), catalogue code S-2 k 11 p 1. The artifact is a solid tool made of a split pebble. Wear marks are noted on the flattened part, which is the main working area of the tool. The tool was utilized as a burnisher for skin processing. In the working area, traces of smoothing and characteristic polishing of the protruding parts of natural pebble surface are observed. Linear microtraces are not recorded. The degree of wear is relatively moderate. Traces of wear were found

not only on the main working edge, but also on other parts of the artifact, retaining pebble crust. The tool is monofunctional, it belongs to the group of active tools.

Object of study No. 17 (see Fig. 2, *q*; 3, *q*), catalogue number S-2 k 18 p 9. The artifact is a solid pebble tool. Traces of wear in the form of surface micro-damage are observed on all protruding areas of the pebble. The narrow end is identified as the main working edge, judging by the extensive wear. Linear microtraces are not recorded. The tool presumably served as a hammer-stone (pestle) for crushing relatively hard materials. The degree of wear is relatively moderate. Microscopic examination of the unworn surface of the artifact revealed traces of metal (see Fig. 3, *r*), the origin of which was not determined. The tool is monofunctional, it belongs to the group of active tools.

Mongolian period

Object of study No. 13 (see Fig. 2, *m*; 3, *m*), catalogue number S-2 87 No. 601. The artifact is a single piece. Wear marks are found on a wide surface, which is the only working area of the tool. The surface of the stone working area is slightly flattened, owing to wear. Linear microtraces are not recorded. The tool belongs to the group of active abrasive tools. It was probably used as a grinder for smoothing the areas adjoining the cutting edge of a knife. The degree of wear is relatively low. The tool is monofunctional, it was not used in performing other operations.

Discussion

The presence of several stone tools in a single burial is recorded in the graves of the Ust-Tartas (burial 22), Odino (burials 40 and 42), and Krotovo (burial 652) cultures (Fig. 4). Notably, the share of tools for metal processing in these burials is only 1/3; moreover, one of the tools could also be used for working with other solid inorganic materials. The share of monofunctional tools designed for grinding or crushing solid inorganic materials is even smaller, about 1/5. Most of the tools in the studied sample are burnishers (44.44 %), which were used for skin processing.

Identification of the raw material's provenance is a complicated task, and was not the purpose of this study. However, one can hardly assume that the rocks were delivered to Baraba from the foothills of the Altai or the Ob riverbed; these areas are separated by hundreds of kilometers. Most likely, the pebbles found by chance on the banks of rivers or former riverbeds in the immediate vicinity of settlement sites were used as raw material. This is indirectly evidenced by the diverse mineralogical composition of the raw materials in the tool assemblages of the studied archaeological cultures.

Fig. 4. Abrasive stones for metal processing (*a*, *b*, *d*), tools for working other hard inorganic materials (*g*, *h*) and for skin processing (*c*, *e*, *f*, *i*). The scale bar is 1 cm in all the images.

The studied items do not show traces of the use as burnishers or other tools in making ceramics. Our findings do not support the assumption that pottery was subjected to abrasive finishing of surfaces as was traditional for the studied cultures.

One artifact (No. 6) of the Odino culture, one (No. 14) of the Krotovo, and two artifacts (No. 17 and 18) of the Late Krotovo (Cherno-Ozerye) were identified as tools for crushing the processed material (pestle-hammer stones). These were apparently used for crushing grog in the ceramic manufacture.

V.I. Molodin noted that the lithic artifacts at the Odino cemetery (Sopka-2/4A) were found only in female burials, while at the younger Krotovo cemetery (Sopka-2/4 B, C) three items were recovered from women's graves, two from men's graves, and one from the infant's grave (Molodin, Grishin, 2016: 242). The data from the Krotovo and Late Krotovo (Cherno-Ozerye) burials are as follows. Burial No. 158 (female, individual 50–60 years old) and burial No. 124 (male, individual 30–35 years old) did not yield any tools except for the above-mentioned items. The grave goods of burial No. 282 included a bronze celt, bone and stone arrowheads, four crucibles, four bone spatulas, a boar's tusk with traces of working, casting molds, a stone funnel, three bow end-caps, horse and elk incisors, a dog's tooth, and a stone end-scraper. Burial No. 652 (infant), in addition to the hammer stone and abrasive tool described above, yielded a disintegrated vessel, clay coating, ocher, a burnisher, and an unused flake. Burial No. 78 (female, individual 14–15 years old) contained a bone dagger, a spoon, an engraved blade, a pendant (a dissected phalanx of an animal), and a fragment of a horn handle.

Quite few stone tools were recovered from the medieval burial grounds of Sopka-2/11 and -13. At the former, one artifact was found in a female burial; at the latter, two lithic artifacts were found in two male burials (Molodin, Solovyev, 2004: 31).

Noteworthy are the occurrences of such tools as a grindstone for finishing a knife's cutting edge and an abrasive tool for relatively rough processing of metal products in the Ust-Tartas archaeological materials, which include a relatively small number of bronze artifacts (Molodin, 2019).

Conclusions

The functional analysis of lithic artifacts from the Baraba forest-steppe showed that the derived data can serve as a basis for the development of a functional-morphological typology of the tools used in the period under study. This will add to our knowledge of the household activities of the populations inhabiting the south of Western Siberia in the Late Bronze Age.

In the late 5th to the first half of the 3rd millennium BC, the toolkit of the autochthonous Ust-Tartas culture was dominated by stone and bone products of an archaic appearance (arrowheads, pendant ornaments, borers, needle cases and needles, etc.); more rarely, personal ornaments made from shells occurred; ceramic pieces were few, and metal items were singular. The population in the 4th to the first half of the 3rd millennium BC used pottery and characteristic bone and stone products. The Odino people (first half of the 3rd millennium BC) had a developed bronze-casting industry. Their assemblages include stone tools, numerous bone items (borers, needle cases, needles, knitting needles, combs, etc.), bronze artifacts (daggers, needles, awls), ornaments (earrings, tubular beads), and ceramics. The Krotovo material complex (mid-3rd to early 2nd millennium BC) shows similarities with the Odino toolkit. The Late Krotovo (Cherno-Ozerye) culture is characterized by tools made of bone and bronze, and ornaments, as well as specific pottery. A diverse toolkit of the medieval population consists of pottery, bone and metal (mainly iron) items (Molodin, 1977, 1985, 2001, 2012, 2019; Molodin, Grishin, 2016, 2019; Molodin, Solovyev, 2004; and others).

The present study has not revealed lithic any artifacts manufactured specifically for funerary purposes. All the studied tools display signs of wear and are quite suitable for further use.

Insufficiency of the available data hampers the identification of stable links between the burial rite and the composition of the grave goods including the studied stone tools. However, further field studies in the region and the expansion of the database on the use of stone tools will hopefully make this possible in the future.

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