THE ROLE OF RAW MATERIAL IN MICROBLADE TECHNOLOGY AT THREE LATE PALAEOLITHIC SITES, RUSSIAN FAR EAST

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ABSTRACT

This paper discusses the relationships among raw material use and the technology of microblade core production during the Late Paleolithic period in Primorsky Krai in Far East Russia. The study is based on a study of the Risovoe 1, Novovarvarovka 1, and Molodezhnaya 1 sites. The presence of particular microcore types links these new sites with others in Primorsky Krai and allies them chronologically to the Late Paleolithic, dated to around 8-13,000 B.P. These sites have yielded numerous stone artifacts made from various raw materials, most of which were obtained from local streams in the form of cobbles of different size.

INTRODUCTION

Sites in the southern part of the Russian Far East with microblade technology have been studied for a long time. Most studies have described different tool types and made typological analyses and technological reconstructions of microblade production (Kuznetsov 1992; Diyakov 2000; Garkovik *et al.* 1998; Kononenko and Kluyev 1998; Sakanasy 1998). More recent work has applied approaches derived from behavioural archaeology (Derevyanko and Kononenko 2003; Gomez and Kluyev 2005). With the exception of Derevyanko and Kononenko (2003), the effects of raw material on the methods used to make microblades have not been sufficiently investigated. A previous study by Anoikin and Postnov (2005) of assemblages from Siberia has demonstrated the important role of raw material in understanding the stone assemblages of ancient sites. The main point they make is that defining the criteria for raw material selection is essential for understanding technologies of flaking, adaptive behaviour and migration routes of ancient human groups. My study uses these basic insights to understand how raw material may have influenced the character of microblade complexes in the Late Paleolithic industries located in the central part of Primorsky Krai.

Three technological components linked to blade, bifacial and microblade productions are commonly distinguished in microblade complexes (Gomez 2005: 48). The microblade component is closely interconnected to the other categories because blades and bifaces were used as blanks for the manufacture of Yubetsu and Togesita microcore types. A third type of microcore, Horoko, is commonly used in microblade complexes of the Primorsky region. It employs the bipolar technique to split small obsidian cobbles (Sakanasy 1998:44).

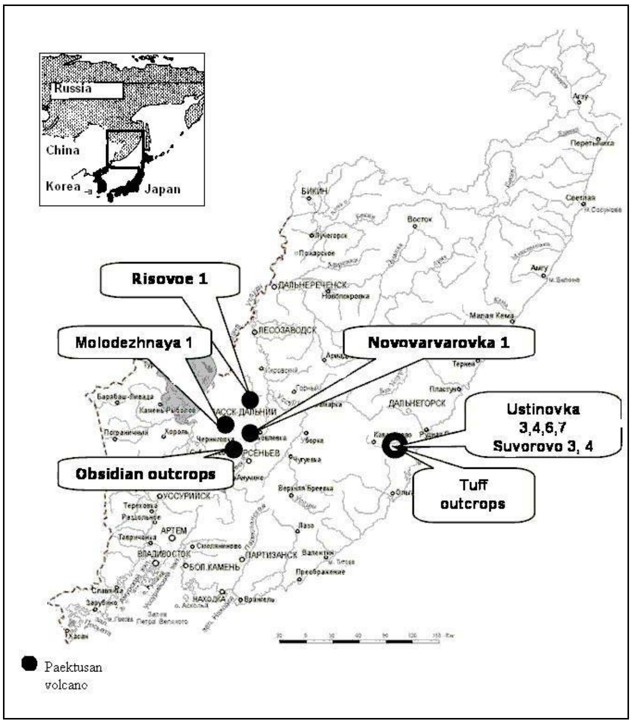

Figure 1. General location of the study area, assemblages studied, and raw material sources.

Three sites with microblade technologies have been chosen for research. Risovoe 1 and Novovarvarovka 1 are situated in the central part of the Primorsky region in a broad flat valley of the Arsenyevka River (Figure 1). Some material from the Molodezhnaya 1 site, located in a valley of the Ilistaya River, has been previously published (Garkovik *et al.* 1998; Sakanasy 1998). This group of sites with microblade complexes is dated to the period 8-13,000 B.P which represents the final Paleolithic in this region (Figure 1). Dates for the microblade assemblages are based on radiocarbon dating at nearby sites and by reference to sites in the wider area (Kononenko and Kluyev 1998; Kuznetsov 1992). For example, the lowest layer at the Gorbatka 3 site on the Ilistaya River, situated close to the Molodezhnaya 1 site, has microblade material and has been radiocarbon dated at 13,500±200 bp. (SOAN-1922) (Kuznetsov 1992: 11). A mixed layer containing microblade material at the Ilistaya 1 site was dated by radiocarbon to 7840±60 bp (KI-3163) (Kuznetsov 1992: 20).

In the first stage of the technological and typological analyses of collections, the kinds of raw material were determined. The second stage of work involved the quantitative analysis of artifact types in terms of the counts and weights for each kind of raw material. Quantitative analyses of the raw materials used for various categories of artefacts have shown that some types of artifacts were preferentially made with particular raw materials. This paper therefore considers the relationship between raw material and specific aspects of microblade technology.

RAW MATERIALS

Three main groups of raw materials were used during the Paleolithic in the study area: (1) various kinds of silicified rocks; (2) obsidian; and (3) tuff. The most popular raw materials were silicified rocks, which were used for making large flakes for the manufacture of microblade cores. These rock types occur naturally as large pebbles in local riverbed deposits. Obsidian was also a popular raw material. Both outcrops of obsidian and riverbed deposits with material suitable for flaking have been discovered in the Primorsky region. Distinctions between the form, quality and the sizes of raw material, which relate to the source as either a primary or secondary context, have been revealed and described (Doelman *et al.* 2004; in press). Obsidian pebbles occur in the beds of the Arsenyevka and Ilistaya rivers. The size, quality and degree of rounding of the raw material depends on the distance traveled from the primary sources located at the head of the Ilistaya River. Close to the study sites, in the range of 30-35 km from outcrops, obsidian usually occurs as material in the size range of 5-8 cm in diameter with average or high quality flaking properties and in the form of roundish and angular pebbles with well rounded cortex,

Identification of obsidian sources was based on the data obtained from a Russian-Australian project that is studying obsidian movement in antiquity (Doelman *et al.* 2004). Density analysis using sodium polytungstate allows discrimination of basaltic glass (local, Primorsky sources) from rhyolitic glass (Paektusan volcano, North Korea). The results have been confirmed by the PIXE-PIGME method which measures the chemical composition in terms of a large range of elements. The value of the method based on density is that it allows the testing of large quantities of material to reveal obsidian from different sources (Doelman *et al.* in press).

The third group of raw material is tuff of light colour easily recognisable by its physical attributes. The nature of production for the tuff artefacts is probably related to different economic factors because this raw material has been transported over greater distances than silicified rocks and obsidian. Outcrops of similar tuff are currently unknown in the central part of the Primorsky region. A number of relevant hypotheses can be proposed to explain how this raw material might have reached these sites:

1) Tuff may have reached the central part of the Primorsky region as a result of migration of hunter groups from the basin of the Zerkalnaya River located on the east coast (about 250 km from the study sites), where this raw material was the main rock used for knapping. The sites in the central part of Primorye could have been occupied seasonally or for a short time during movement between different sites. However, the relative technological and typological homogeneity of all Late Paleolithic complexes and the absence of a sufficient number of absolute dates do not allow an adequate test of this hypothesis at present;
2) Secondly, tuff may have been transported to central Primorye from the Zerkalnaya River valley as a result of exchange between ancient groups, who occupied different areas of the region. The continental groups could offer obsidian to people resident on the coast (Kononenko and Kluyev 1998). This hypothesis is plausible but not supported because obsidian is extremely rare at the coastal sites;
3) Unidentified outcrops of tuff may exist in the study area. Certainly, the abundance of this material in the Risovoe 1 assemblage demonstrates that tuff sources were used actively. Since implements produced from this kind of raw material indicate inputs of time and energy were minimized to some degree, it seems likely that the outcrops were not close by, but were within a distance in which material could be gathered in the context of other activities. Although embedded procurement seems likely, the distance must have been far enough that people reduced the amount of raw material to be carried by partially preparing the cores before transport. For example, cortex flakes are entirely absent at Risovoe 1, only one exhausted core of tuff was recovered, and the larger sizes of blades and blade flakes are the most common. This hypothesis cannot be supported until outcrops of volcanic tuff are found in the central Primorsky Krai.

THE TECHNOLOGICAL COMPLEXES

I now turn to a discussion of the relationships among raw materials, artifact typology and technology for each of the assemblages. A breakdown of artefacts into the main technological categories is presented in Table 1 and forms the basis for this discussion. The proportions of raw materials in the sites are presented in Figures 4, 5, 7 and 8.

Risovoe 1 site

The Risovoe 1 site is located in the basin of the Arsenyevka River on top of a discrete hill (Figure 1). Excavations during several field seasons have revealed a number of different cultural complexes. Technological and typological features of these complexes have enabled the precise differentiation of Final Paleolithic and Paleometallic

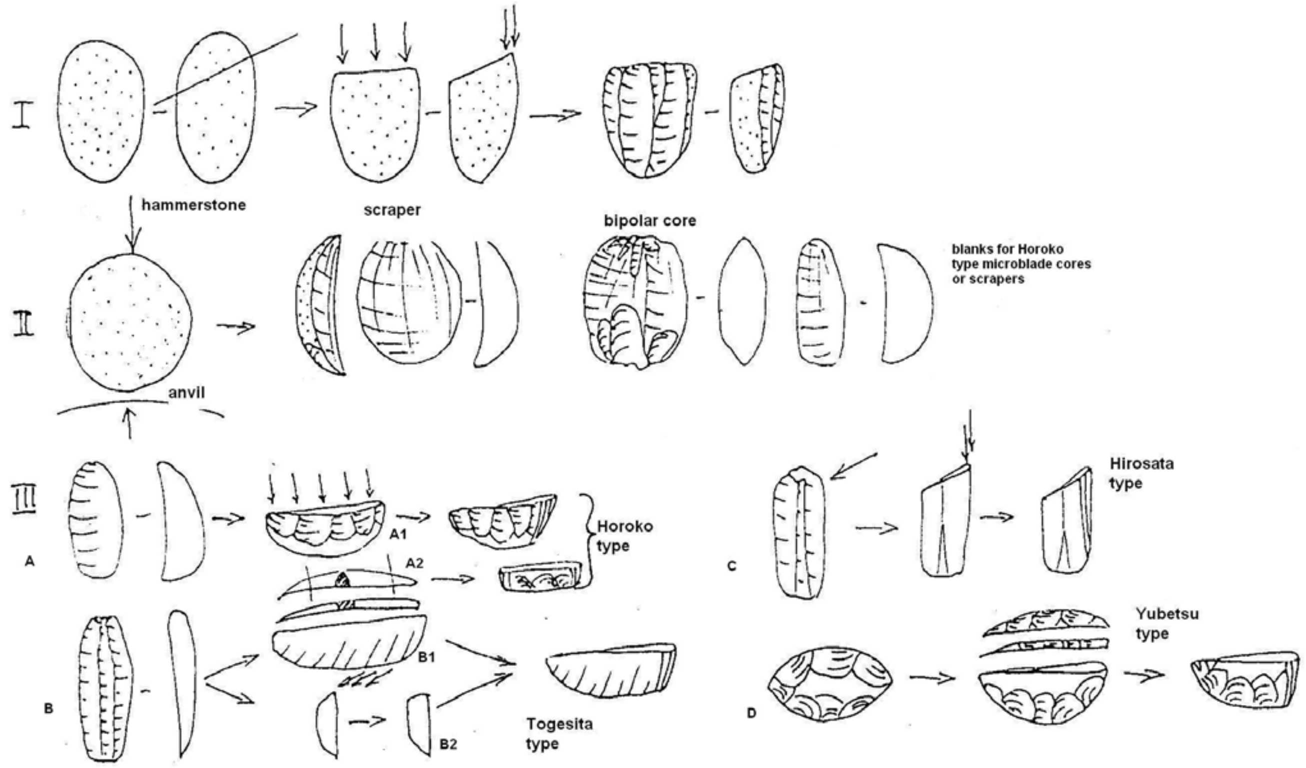

Figure 2. The manufacturing sequence for obsidian cobbles and microblade cores. I. The manufacture of sub prismatic cores from an obsidian cobble. II. The bipolar flaking of obsidian cobbles and varieties of bipolar debitage. III. Manufacturing sequence for different microblade core types.

uses of the site (Kluyev 1997; Kluyev 1998; Kluyev 2001). The Final Paleolithic complex is characterised by the later stage of stone working.

Primary debitage (7.6 % of the total assemblage) is uncommon. The proportion of cores and related debris is also small (0.9 %). Both the cores and technical spalls display methods of sub-prismatic and unsystematic flaking that depends on the quality of raw material. The number of striking platforms varies. Some obsidian cores were produced by method I illustrated in Figure 2. The oblique striking platform was prepared by one or several blows followed by the further removal of flake and blade-like flakes on the open-ended front of the wide side of the core. Some rounded, medium-sized pebbles with a lentiform section were also split in this way. One core produced from tuff has features that suggest it was exhausted. The platform was prepared by several flakes and faceted along the edge. The core body preserves two negative scars of blade removals (Figure 3:22).

Rounded obsidian cobbles were broken up by the most suitable technique (bipolar technique) because they do not have a surface suitable for a striking platform (Figure 2:II). It is possible that the use of this technique was to minimize time and energy inputs for getting suitable blanks for further use. The morphological features connected with the bipolar technique are distinctive and easy to recognise in archeological complexes (Kuznetsov 1992). The bipolar technique of flaking was applied to obsidian pebbles only (1. 5 % of the total assemblage). Experimental studies by Kononenko show that the bipolar technique of flaking can produce specific types of debitage which were suitable for the further production of microblade cores of the Horoko type as well as some small tools, such as end scrapers, burins, drills, etc. (Kononenko and Mamunin 1996:138) (Figure 2:II).

The microblade component at Risovoe 1 is represented by microblade cores, their blanks and some technical spalls (7.9%) and microblades (4.4%) (Figure 3:11-16; Table 1). These kinds of artifacts provide the necessary data for reconstructing the technological sequences of manufacturing different types of microblade cores. The Horoko type of microblade core (63.8 % of all microblade cores and blanks) is the most numerous (Figure 3:11, 13, 16). These artifacts were made on flakes with a thick cross section. In these cases the ventral surface was used as a pressure platform. Of the Horoko microblade cores, 65.2 % are produced from obsidian, 26.1 % from silicified slate, and 8.7 % from tuff. The fragments of obsidian pebbles split by bipolar flaking, thick flakes of silicified rock and crested spalls from tuff provided blanks for the Horoko microblade cores (Figure 2:II, IIIA). The crested spalls are so small in size (height of front is c. 6 mm), that the microblades detached from their cores could hardly be used (Figure 2: IIIA2).

The Togesita type of microcore (33.3 % of all microblade cores and blanks) is manufactured on blade flakes and flakes. The pressure platform was formed by the removal of crested spalls (Figure 2:IIIB1) from its margin

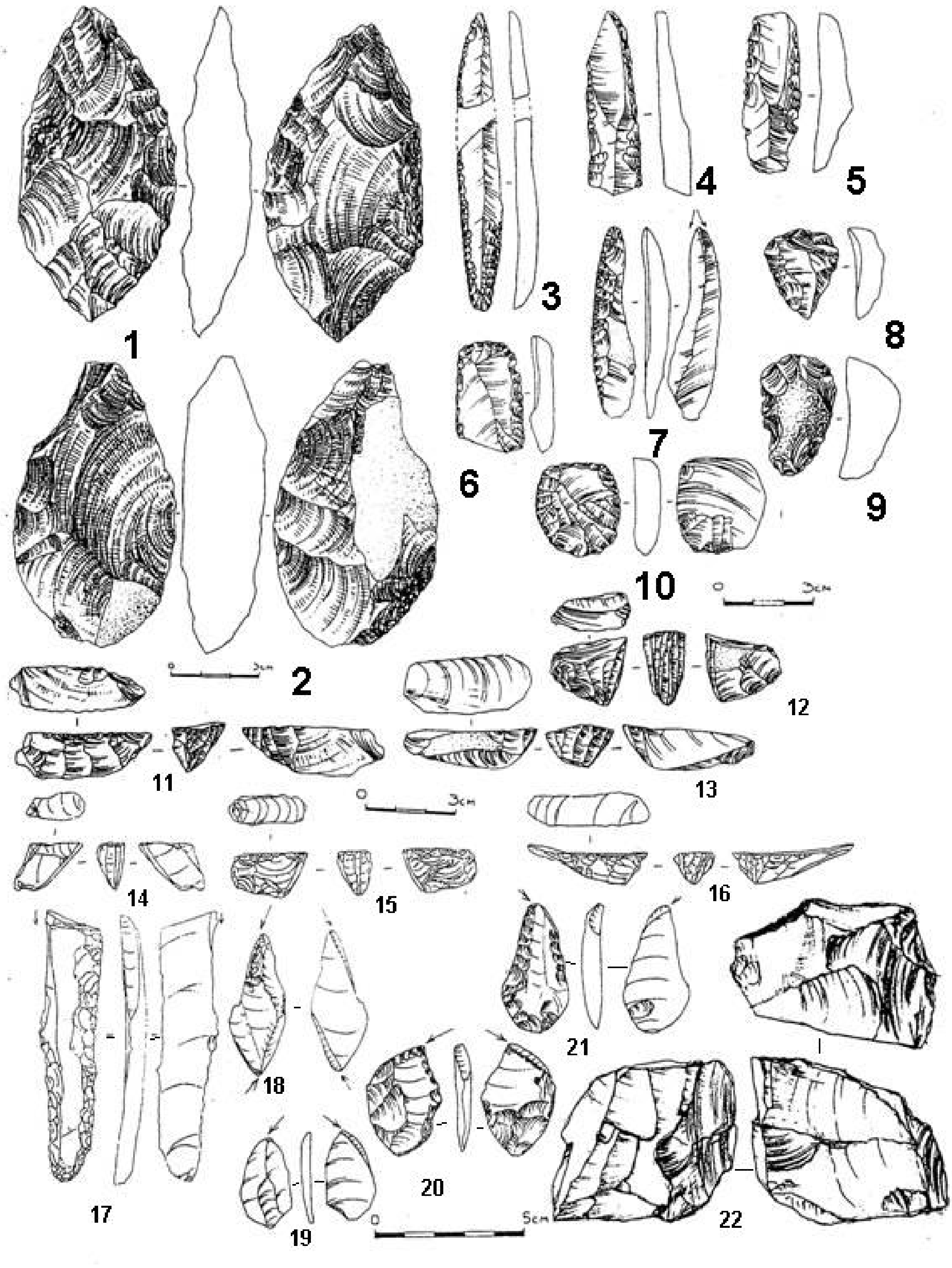

Figure 3. Characteristic artifacts from the Risovoe 1 site. 1. Biface (diabase); 2. Biface (diabase); 3. Retouched blade (tuff); 4. Retouched blade (silicified rock); 5. Retouched blade (tuff); 6. Retouched blade (silicified rock); 7. Crested spall from blade (tuff); 8. End scraper (obsidian); 9. End scraper (obsidian); 10. End scraper (obsidian); 11. Microblade core, Horoko type (silicified rock); 12. Microblade core, Togesita type (obsidian); 13. Microblade core, Horoko type (silicified rock); 14. Microblade core, Togesita type (Paektusan obsidian); 15. Microblade core, Togesita type (obsidian); 16. Microblade core, Horoko type (obsidian); 17. Burin (tuff); 18. Burin (tuff); 19. Burin (tuff); 20. Burin (tuff); 21. Burin (silicified rock); 22. Core (tuff). (1-17 cited in Kluyev, N.A. 1998, 2001).

or through flattening by abrupt retouch (Figure 2: IIIB2). The technical spalls and flakes used to prepare pressure platforms of this type of microblade core demonstrate the full sequence of manufacturing Togesita microcores on this site (Figure 3:7). Obsidian (58.3 % of all Togesita microblade cores), tuff (33.3 %) and silicified slate (8.4 %) were used as raw materials for this type. In one case an obsidian flake with features of bipolar flaking was used as a blank. Finally, the Yubetsu microcore type is represented by one artifact produced from silicified slate. The blank is a biface. The pressure platform was shaped by crested and ski spalls removed from the longitudinal edge (Figure 2:IIID).

The most common type of blanks and debitage are flakes of mean and below mean sizes (68.2 % of the total debitage). This shows that the majority of the debitage is derived from the later stages of core reduction and tool manufacture. Among them diabase is most common (41.3 %). The proportions of obsidian, tuff and silicified slate within the total number of flakes are 30.6 %, 11.7 % and 9.6 % respectively. Blade flakes are not numerous (5.6 % of the total assemblage) and are made from tuff (37.2 %), silicified slate (25.6 %), obsidian (11.5 %) and diabase (1.3 %). Blade flakes were used as blanks for end scrapers and burins. Some blades made from tuff were simply retouched by short flakes on the dorsal side of their perimeter (Figure 3:3-6, 17). These products find analogies in some sites located in the Primorsky region and dated to the Late Paleolithic (Kuznetsov 1992; Vasilyevsky and Gladyshev 1989). Researchers interpret their functions differently: e.g. scrapers, knives, points. I think such products could be generalised tools for a range of operations. With continuing use they could be broken and reshaped into different tools or be used as blanks for manufacturing Togesita microcores, as confirmed by technical spalls (Figure 3:7).

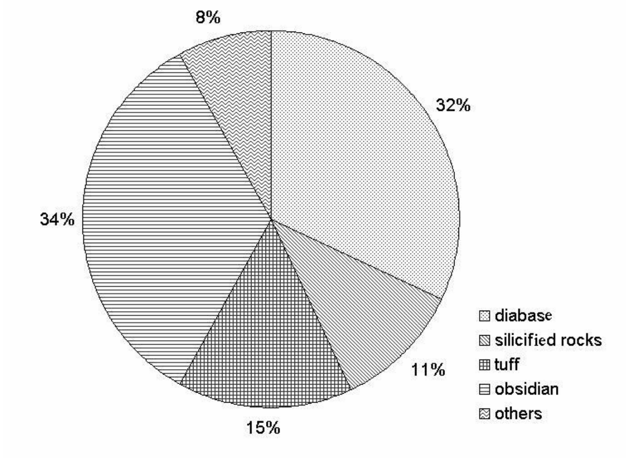

Figure 4. Risovoe 1. Proportion of different raw materials in the assemblage as measured by counts.

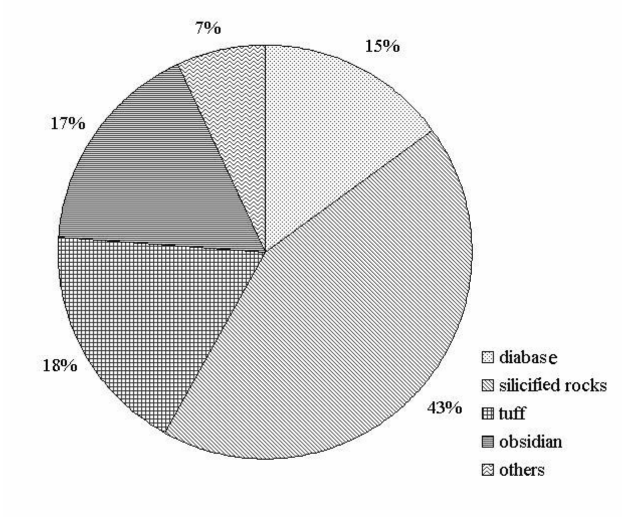

Figure 5. Risovoe 1. Proportion of raw materials as measured by weight.

My calculations show that the proportions of artefacts in terms of the various kinds of raw material do not correspond directly to assemblage composition considered in terms of weights (Figures 4, 5). Considering artifact numbers, obsidian (34 % of the total assemblage) and diabase (32 %), which are often found in riverbed deposits, make up a much lower proportion of the assemblage when calculated in terms of weight (17 % and 15 % accordingly). In contrast, tuff makes up approximately the same proportion in both counts and weights because the form and size of raw material blanks that were imported to the site, e.g. as blades, blade flakes and cores, needed insignificant reworking and therefore generated very little debitage.

Novovarvarovka 1 site

Novovarvarovka 1 is located on the southern extremity of a 20-meter terrace of the Arsenyevka River (Figure 1). The majority of the collection was obtained from a disturbed part of the site. A small excavation revealed the stratigraphic position of an early complex including part of a workshop (Kluyev 1997). Fieldwork and analysis of the collection have confirmed the presence of a single occupation at the site so that materials from both excavation and surface collection can be combined for statistical analysis.

The primary debitage is 29 % of the total assemblage. Cores (0.9 % of all artifacts) are made from several raw material types including silicified rock, jasper, diabase and obsidian (Figure 6:1, 2). The obsidian cores are made in the same manner as at Risovoe 1. A core made from jasper shows a variant of the method for detaching flakes from the front of the blade core (Figure 6:2). In the case of silicified rock, the presence of technical spalls from reforming the striking platforms demonstrate blade cores were made of this material. They were large-scale: one of the spalls is a core-tablet 11x 8 cm in size. The striking platform of such cores was cortical or prepared by flakes arranged in a full or semi-circular pattern. The front of the

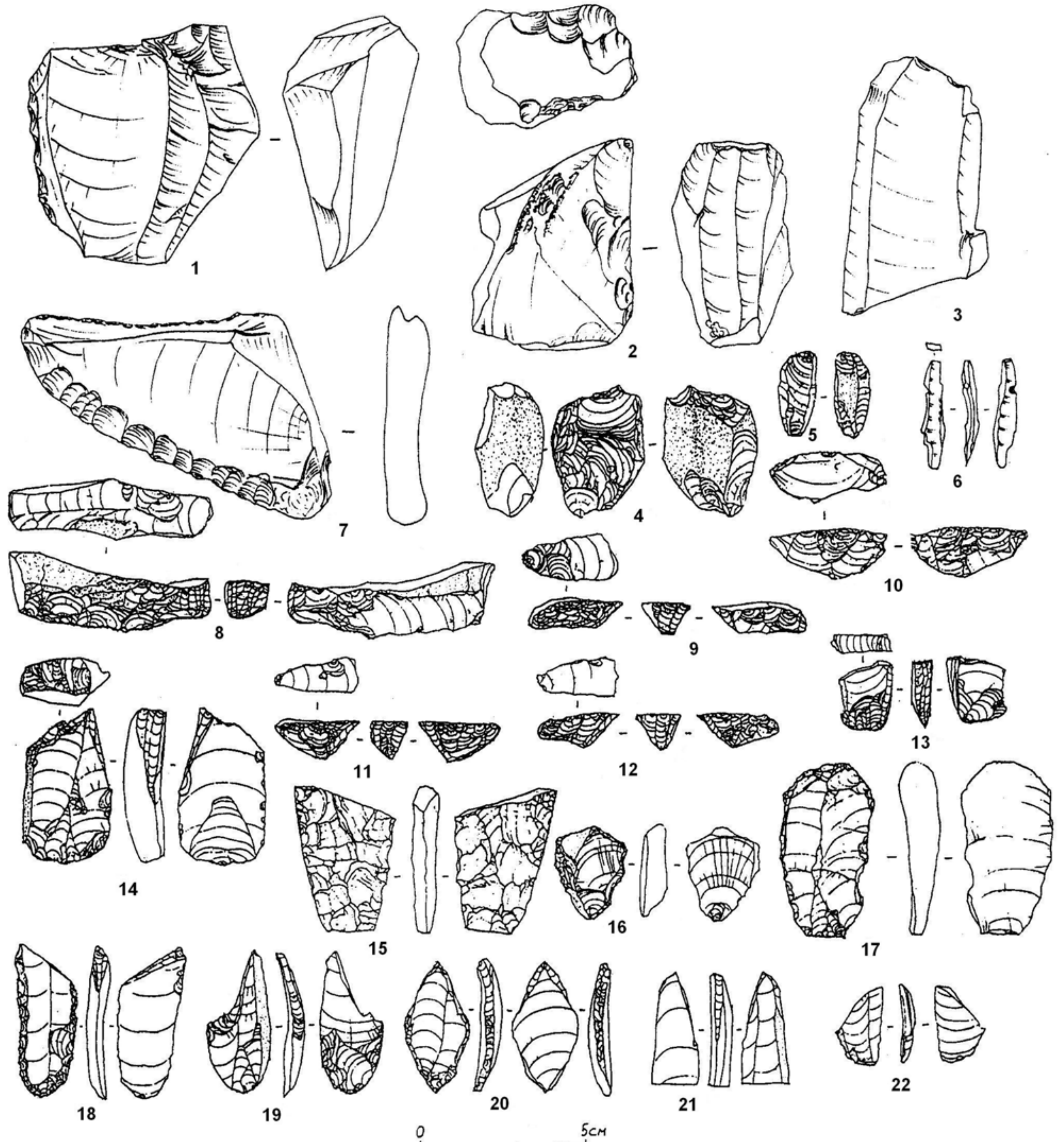

Figure 6. Characteristic artifacts from the Novovarvarovka 1 site. 1. Core (diabase); 2. Core (jasper); 3. Fragmented blade (silicified rock); 4. Bipolar flaked pebble (obsidian); 5. Bipolar core (obsidian); 6. Ski spall (Paektusan obsidian); 7. Side scraper (diabase); 8. Microblade core, Togesita type (tuff); 9. Microblade core, Horoko type (obsidian); 10. Microblade core, Horoko type (obsidian); 11. Microblade core, Horoko type (obsidian); 12. Microblade core, Horoko type (obsidian); 13. Microblade core, Togesita type (Paektusan obsidian); 14. Microblade core, Hirosata type (Paektusan obsidian); 15. Broken biface (diabase); 16. End scraper (obsidian); 17. End scraper (tuff); 18. Burin (tuff); 19. Burin (obsidian); 20. Burin (obsidian), 21. Burin (silicified rock); 22. Burin (silicified rock). (4-5, 8-22 after Kluyev1997).

core was usually convex. Such cores produced large blades, blade flakes and flakes as confirmed by the sizes of debitage from silicified rock (Figure 6:3). The bipolar technique was also used at the site (3.1 % of total assemblage) (Figure 6:4, 5).

The microblade component is represented by several different types of microblade cores, their blanks, burin spalls and microblades (Table 1; Figure 6:6, 8-14). The

Horoko microcore is the most common type (67 % of all cores), all of which were made from obsidian. There are two Togesita microcores, one in obsidian and the second one made on a fragment of a tuff blade flake (Figure 6:8, 13). Another microblade core is reminiscent of the Togesita type but has some different features (Figure 2:III C). It was made on a large obsidian blade. Its distal edge was truncated and used as a pressure platform and one of its longitudinal edges became the face for microblade removals (Figure 6:14). Derevyanko and Kononenko (2003:Figure 2) call this type Hirosata. The Hirosata and Togesita type cores were made from obsidian which visually and in density corresponds with obsidian derived from the Paektusan volcano (Doelman *et al.*: in press).

At Novovarvarovka 1 the basic type of blank is a flake (63.5 %; Table 1). Flakes < 3 cm were made from obsidian (43.2 % of all flakes). Obsidian artefacts found at the site are comprised of small obsidian pebbles with heavily water-rolled cortex that indicates they were derived from

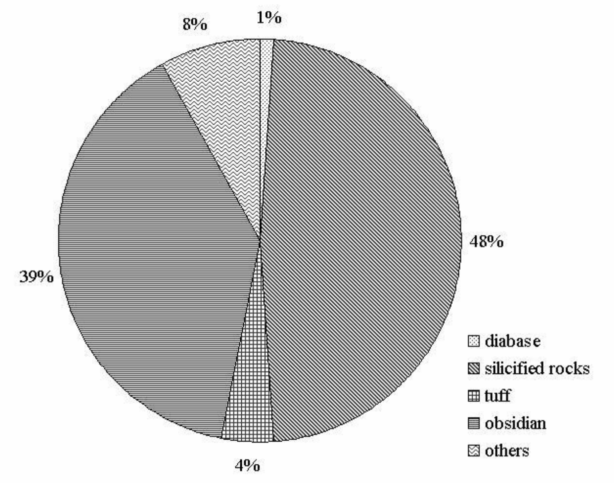

Figure 7. Novovarvarovka 1. Proportion of different raw materials in the assemblage as measured by counts.

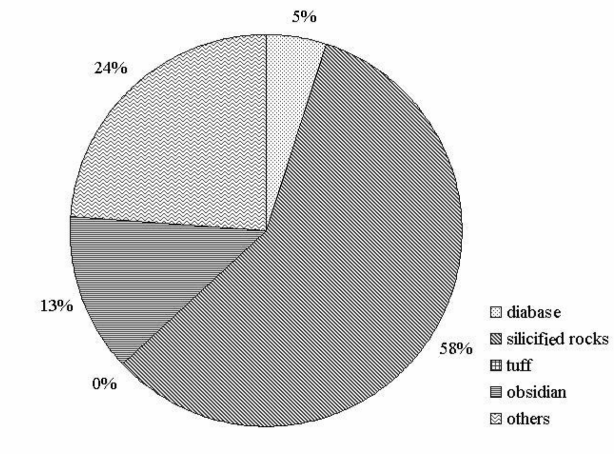

Figure 8. Novovarvarovka 1. Proportion of different raw materials in the assemblage as measured by weight.

riverbed sources (Doelman *et al.* 2004), as well as angular cobbles of average and poor quality obsidian similar to those from the immediate proximity of the outcrops (Doelman *et al.* in press). The poor quality raw material has single flake scars derived from testing. This shows that inhabitants of the site brought raw material from the outcrops without checking it first and then abandoned it. This pattern may indicate procurement by people along a migration or hunting route. The straight line distance from Novovarvarovka 1 to the area of the outcrops is about 30 km.

Large flakes (>5 cm) as well as the majority of blades and blade flakes were made from silicified rock (51 %). These were used as blanks for manufacturing large tools (Figure 6: 7).

The quantitative analysis of counts and weights of the assemblage in terms of raw material produces interesting results (Figures 7 and 8). In terms of counts, obsidian was the second most popular raw material (39 %), of which a small number of artefacts were made from Paektusan obsidian (4 % of the total obsidian), including a microcore and some flakes. The most frequently used material was silicified rock (48 %). The contribution of tuff by number is only 4 % (Figure 7). This picture is very different when weights of each raw material are considered. The large artefacts derived from the reduction of cores made in silicified rock accounts for 58 % of the total weight (Figure 8). In contrast, obsidian represents only 13 %, tuff is insignificantly small, and 29 % of the large artifacts are made from other kinds of raw material (Figure 8). The abundance of silicified raw material reflects its extraction from the immediate proximity of the site and the minimal expense of its transportation, whereas the obsidian sources were located further away. In contrast, economy in its use results in the small size of the pieces made from tuff.

Molodezhnaya 1

Molodezhnaya 1 is located on a river terrace on the southern side of the Gorbatka River, which adjoins the Arsenyevka River (Garkovik 1998) (Figure 1). The material from this site is close in technological and typological characteristics to the Risovoe 1 and Novovarvarovka 1 sites as well as to the Gorbatka 3 site also located in the Gorbatka River valley. As in these sites large blanks were produced from silicified rocks acquired as large pebbles in the river bed. There is also the common use of obsidian pebbles for the manufacture of microcores and small forms of tools together with the wide use of the bipolar technique of flaking (Garkovik and Korotky 2005). The presence of unbroken obsidian pebbles in the complex suggests that the river might have been much closer in antiquity, so that procuring this raw material did not demand a large expense of effort and time.

The size of cores varies from large (diabase) to average (obsidian), but all were produced by a single method of sub-prismatic flaking. The rounded form of available obsidian raw material led to the frequent application of the bipolar technique. Preliminary counts have revealed about 20 % of flakes and 93 % of broken pebbles have features characteristic of the bipolar technique (Sakanasy 1998). The wide use of bipolar flaking explains the prevalence of microcores made from obsidian pebbles (83.7 % of all microblade cores).

Eight microblade core types were identified by their technological and morphological characteristics: Horoko, Yubetsu, Rankoshi, Togesita, and four types that combine characteristics of different types (Sakanasy 1998:44-45). The most common among them is the Horoko type made from the results of bipolar flaking (Figure 2:II). The tool kit includes leaf bifaces, end scrapers, burins, and retouched blades made from various raw materials. However, the general tendency at this site was to manufacture large forms from silicified rocks.

DISCUSSION

Having described the assemblages at these three sites, I can now turn to an interpretation of the behaviors they represent. Analysis of the raw material composition in relation to counts and weights of artifacts at the sites has led to a number of important observations. We have to remember that each site may have had different functions and been occupied at various times of the year, and these would also have influenced the assemblage composition.

The characteristic features and the sizes of the debitage at the Risovoe 1 site testify to manufacturing, reshaping and resharpening of a range of tools. The absence of primary, cortical flakes points to initial flaking at other locations. The tool kit comprised end scrapers, burins, and bifaces which indicates the products of hunting were processed at the site. These observations together with the size and form of tools, the scarcity of cores, and the diabase and tuff blanks on which some tools and microcores were made after having been brought to the site, indicate that the site represents a base camp occupied over a long time period. Secondly, since the cores and tools were repeatedly reused and recycled, the site was probably occupied during winter when it would have been impossible to collect raw material from frozen and snow-covered river beds. Winter conditions raise the expense of searching for suitable raw material and even make this process impossible. Lack of raw material would have created the need to stockpile suitable raw material for this season and, subsequently, to use it economically. The cache of blanks noted by Derevyanko and Kononenko (2003: 68) at the Ustinovka 3 site was possibly a response to similar factors.

Features of the complex at the Novovarvarovka 1 site and some spatial observations of this site had a different function. The main concentration of artifacts includes the large core and microblade core rejuvenating flakes, burins, scrapers and broken, large blade flakes. The concentration of most of this material in one part of the trench indicates that it may have been a workshop for various stone knapping activities. Also, the debitage points to activities connected with processing raw material and manufacturing blanks in the form of large flakes, blades and microblades as well as tool resharpening. All of these point to the short-term occupation of the Novovarvarovka 1 site, where raw material was shaped, cores were split, etc. Probably it was a stopover camp between long-term base camps in other areas.

The function of the Molodezhnaya 1 site cannot be determined at present as the collection has not been fully studied, although a hypothesis may be made on the basis of the data available in the literature. This site was probably repeatedly used as a warm season camp located close to the river bed with easy access to raw material.

Despite the location of the Risovoe 1 and Novovarvarovka 1 sites in similar settings within the Arsenyevka River valley and presumably with access to similar raw materials, their complexes reflect differences in raw material preferences. First, the inhabitants of Novovarvarovka 1 used the various silicified rocks for manufacturing large tools and blanks. The presence of much working debris with a high percentage of primary flakes is evidence that the source of silicified rock was nearby. Raw material with limited availability was used as efficiently as possible to prolong the length of use life and to minimize the expense of raw material procurement in the manner discussed by Binford (1979). This explains the presence of a Hirosata microcore made on a large blade of Paektusan obsidian, the burin on a large blade made from tuff, and a Togesita microblade core made in tuff. The technology of manufacturing these types is not hard, but it requires skill and the application of specific ways of flaking that reduce the material loss and increase the use-life. Good quality stone can guarantee control over the flaking process and reduce the expense of raw material. Observations of the final negative flake scars on microcores have shown that the Horoko microcore type produced short convex microblades. In contrast, Togesita and Yubetsu microblade core types, which yielded better long and direct microblades, were made from better quality raw material (Gomez and Kluyev 2005).

The Risovoe 1 collection shows some differences from the Novovarvarovka 1 and Molodezhnaya 1 sites in terms of the use of raw material. A comparison of the number and weight of artifacts demonstrates that tuff was treated the same way as the other raw materials, obsidian and diabase. This indicates that the inhabitants of the site were well acquainted with the properties of the tuff and brought it to the camp in equal volume to other rocks. Tuff was probably obtained by specialized expeditions. At present, it is difficult to tell which were the most important features of tuff, but it is clear that this material was primarily used for tools manufactured on blades, blade flakes and their fragments: i.e. end scrapers, burins; Togesita microcores. Also tuff was imported to the sites (Risovoe 1, Novovarvarovka 1, and Molodezhnaya 1) as blades, blade flakes and cores.

Despite small differences in raw material preferences at the sites, it is clear that the quality and size of silicified rocks have determined which manufacturing strategies were used for some categories of artifacts, especially bifaces, big scrapers, large cores and blanks. Small blanks could be used for microcore manufacturing.

There are a number of reasons for the popularity of obsidian, beginning with its excellent flaking properties and the production of sharp edges, as well as its external features such as shininess and color. As was noted above, the form and the size of obsidian pebbles promoted the use of bipolar flaking. This is especially the case at the Molodezhnaya 1 site. The connection between the manufacture of the Horoko microblade core type and bipolar technique differs at the various sites. There is only 1 microcore manufactured on a bipolar blank at the Risovoe 1 where other bipolar products were more commonly used for the manufacture of tools. There is one Togesita microblade core manufactured on a bipolar blank at Risovoe 1. In contrast, at Molodezhnaya 1 microcores are made on pebbles split the bipolar way. These differences probably point to the acquisition of obsidian from different source areas. Another reason derives from the ongoing choice of angular obsidian pebbles at Risovoe 1 and Novovarvarovka 1 because flaking them produces flakes and blade flakes, which is difficult when using bipolar flaking. Thus Horoko microblade cores, which are the easiest to produce, are usually made from obsidian. Togesita and Yubetsu microblade core types are less common because of the larger cost of their manufacture and their requirement for higher quality raw materials.

In summary, this paper has described three sites located in comparable landscapes with similar resources and with assemblages that closely resemble each other in technological and typological terms. Despite differences in site function, the pattern of using specific raw materials to manufacture particular, well-defined artifact categories remained constant. We can therefore conclude that ancient inhabitants across this whole region all carefully matched their technology for stone tool production with the most appropriate raw material. Finally, the use of exotic raw materials (Paektusan obsidian and tuff) needs further investigation to determine whether migration, exchange, or some other social factors were involved in their long distance transportation and how these might relate to intercultural communication in this region.

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