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Argillite Artifacts and Final Pleistocene to Middle Holocene Cultural Links Across the Vitim River Basin (Baikal Region)

This paper presents the results of X-ray fluorescence and X-ray diffraction analyses of argillite artifacts from the site of Kovrizhka I on the Lower Vitim River and Ust-Karenga XVI on the Upper Vitim River near Lake Baikal, Russia. The specimens from cultural layer 2 of Kovrizhka I date to ca 6 ka BP and belong to an aceramic culture with associated microblades. Two ritual pits at Ust-Karenga XVI, dating to 7–6 ka BP and associated with the late stage of the Ust-Karenga Neolithic culture, contained clusters of artifacts made of dark brown argillite, including prismatic cores, blades, inserts, and end-scrapers made on blades. At both sites, similar argillite end-scrapers made on large blades were found in different excavation seasons. Chemical analysis of these artifacts suggests that the raw material used in their production was the same, attesting to cultural ties between localities in the past. The distance between the sites along the river is approximately 700 km—the largest geographic range of cultural connections yet known from the prehistoric Baikal area. Previous research demonstrated that an artifact from volcanic pumice, found at Ust-Karenga XVI, had been transported from the Udokan volcanic field, which was also a source of a piece of volcanic pumice found at Kovrizhka III. The same sources of raw material, then, were apparently exploited by various populations over a long time period. We suggest that these patterns are indicative of episodic contacts rather than a single population dispersed across the territory between Ust-Karenga and Kovrizhka.

Keywords: *Population mobility, ancient communications, X-ray analysis, Vitim River, Final Pleistocene, Early Holocene, Middle Holocene, Kovrizhka, Ust-Karenga.*

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Introduction

Science-based analytical methods are becoming widely used in archaeology. In lithic analysis, various scientific analytical techniques are now regularly employed for identification of lithic raw materials, including mineralogical, petrographic, and X-ray analyses. Recent studies have focused on means of identifying the sources and composition of lithic resources, such as obsidian (Glascock, Braswell, Cobean, 1998; Kimura, 1998; Vulkanicheskiye stekla…, 2000; Reuther et al., 2011), porcellanite (Mandal et al., 1997), argillite (Didier, 1975), and others. Such research now enables modeling of the transportation and use of lithic raw materials (Kulik, Shunkov, 2000; Kulik, Markin, 2003; Doronicheva, 2013; Derevianko et al., 2015).

The present study continues longstanding efforts aimed at exploring the composition and role of exotic raw materials in the lithic industries of the Vitim River—one of the major tributaries of the middle Lena River (Fig. 1) (Ineshin, Revenko, Sekerin, 1998; Vetrov et al., 2000; Alekseev et al., 2006; Demonterova et al., 2014). In 1974–1976, M.P. Aksenov and V.M. Vetrov, archaeologists from Irkutsk, discovered and subsequently examined a cluster of archaeological sites termed Ust-Karenga I–XVI (Aksenov et al., 2000). In 1985, E.M. Ineshin and V.M. Vetrov found the site of Bolshoi Yakor I, and initiated investigations in the lower Vitim area (Bodaibinsky District, Irkutsk Region). Near the mouth of the Mamakan River, several Paleolithic sites have been discovered: Invalidny III, Mamakan VI, and Kovrizhka I–V. This part of the river valley was designated as the Mamakan Geoarchaeological Region (Belousov et al., 2002). Primarily on the basis of the Ust-Karenga and Mamakan localities on the upper and lower Vitim, researchers have proposed cultural and chronological models for both these areas in the Final Pleistocene and in the Early and Middle Holocene (Vetrov, 1992, 1997; Ineshin, Tetenkin, 2010: 209–213; Tetenkin, 2011). One major challenge for the archaeology of the Vitim has been understanding and characterizing prehistoric cultural ties between populations living in this region in antiquity (Ineshin, Tetenkin, 2011; Demonterova et al., 2014).

This paper explores this question using X-ray diffraction and X-ray fluorescence analyses of dark brown argillite artifacts from Kovrizhka I on the lower Vitim and Ust-Karenga XVI on the upper Vitim.

Material and methods

The Ust-Karenga I–XVI cluster of sites is located on the right bank of the upper Vitim, near the mouth of Karenga River (Fig. 1). In 1979, at the site of Ust-Karenga XVI, Vetrov discovered two pits measuring 1.25 by 0.75 m and

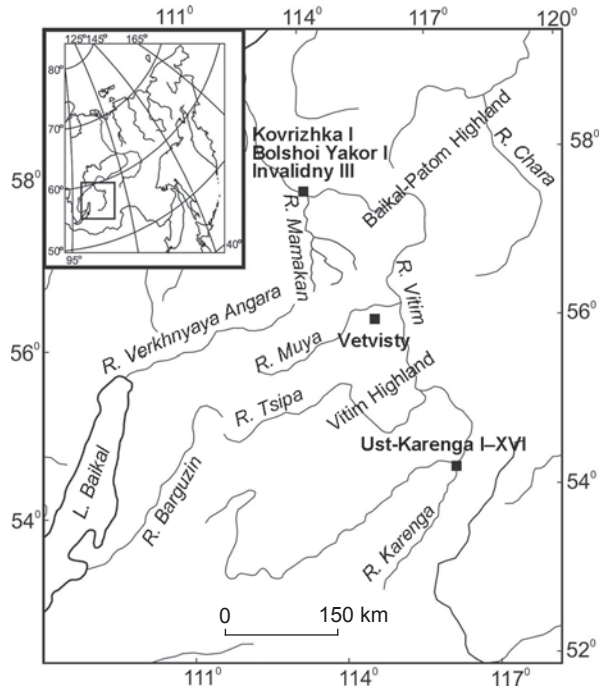

Fig. 1. Map showing the location of sites with argillite artifacts in the Vitim River basin.

0.70 by 0.47 m, and up to 1.0 m deep. Dense assemblages of lithic artifacts were recovered from the bottom of the pits. The pits are located 2 m from each other, on a sand ridge, 25 m above the river level. The presence of ocher at the pit bottoms hints at a ritual origin (Vetrov, 2008a). Over 90 % of the artifacts found in the pits were made of dark brown argillite, of a quality, color, and chemical composition unparalleled by other samples from Ust-Karenga I–XVI. Layer 7 of Ust-Karenga XII also contained several argillite artifacts, but they differed slightly in chemical composition and color.

The lithic assemblage from these ritual pits is composed of 311 specimens (60 from the first pit, and 251 from the second). Typologically, the argillite artifacts are represented by prismatic cores and bladelets detached from them, as well as large blades and end-scrapers fashioned on such blades; retouched inset blades; and combination tools (Ibid.). A polishing tool made of volcanic pumice, and a ground rhomboid artifact of graphitite round out the lithic assemblage.

Because the ledges of both pits correspond to the stratigraphic layer with inclusions of buried soil dating to the Atlantic period, the pits likely date to ca 7–6 ka BP. In the upper Vitim area, this time period corresponds to the late stage of the Ust-Karenga Neolithic culture. The artifact assemblage from the pits is not, however, quite typical of this culture: there are no Ust-Karenga ceramics, wedge-shaped cores, or transverse burins. However, prismatic cores (such as those found in this

Fig. 2. Argillite artifacts.
1–3 – Ust-Karenga XVI; *4–6* – Kovrizhka I, cultural layer 2.

assemblage) are characteristic of the middle and late stages of this culture.

Argillite artifacts visually similar in both material and morphology to Ust-Karenga XVI finds were discovered at Kovrizhka I (Fig. 2). The similarity of end-scrapers made on blades at these two localities has been noted in earlier scholarship (Tetenkin, 1999, 2000, 2010). Kovrizhka I is located in the lower Vitim area, on the right bank, 4 km downstream the Mamakan River mouth (Fig. 1). Cultural remains were discovered at a depth of 1.7 m within a 9–11 meter terrace, at the base of a slope of subaereal sediments overlying floodplain alluvium. The relevant cultural layer (layer 2) consists of a coal-rich bed that has been diagnetically altered by slope and cryogenic processes. Two radiocarbon dates were obtained from samples taken from this bed, producing estimates of 6095 ± 135 (SOAN-4245) and 5945 ± 90 BP (SOAN-4545). In 1997–2001, A.V. Tetenkin found five artifacts made of dark brown argillite: three end-scrapers, a bladelet, and a medial segment of a large trihedral blade. The end-scrapers were fashioned on large blades; two of them were made on a large blade (6.1 cm long) that had broken in half (Fig. 2, *4–6*). In addition to the argillite artifacts, the assemblage included a scraper and a bladelet of flint; two single side-scrapers made on a porphyrite flake and a pebble; and a combination core/chisel-like tool made of porphyrite.

Two scrapers made of similar argillite, though of different morphology, were found in cultural layer 6 of Kovrizhka IV, located on the same terrace as Kovrizhka I, 60 km apart (Tetenkin, Henry, Klementyev, 2017). A radiocarbon date of ca 15.7 ka was obtained for this layer. The artifact assemblage can be typologically attributed to the Final Paleolithic. It is characterized by wedge-shaped cores on bifaces, combination multiple-edge side-scrapers, end-scrapers on flakes, flakes with irregular marginal retouch, as well as burins and chisel-like tools fashioned on quartz flakes (rock crystal and smoky quartz).

We assessed the composition of rock used for manufacturing artifacts from various sites using nondestructive techniques. Chemical analysis was performed with the aid of S8 TIGER Wavelength Dispersive X-ray Fluorescence Spectrometer (produced by Bruker AXS GmbH, Germany) supplied with SPECTRA^{plus} software program*. We evaluated the content of basic oxides and certain microelements using X-ray fluorescence of both artifact sides in conjunction with the QUANT EXPRESS software.

X-ray diffraction analysis aimed at assessing mineral composition of the artifacts was performed with Bruker D8 Advance Diffractometer equipped with position-sensitive VANTEC-1 Detector (automatic data acquisition, CuK_α radiation, at 40 kV and 40 μA; scanning pitch 0.02 º2θ, 1 pitch/sec)**. We used DIFFRAC^{plus} (Eva) software for data processing.

Results

Data on mineral and chemical composition of brown argillite were obtained from the artifacts found at Ust-

*The spectrometer is installed in the Center for Geodynamics and Geochronology of the Institute of the Earth's Crust, SB RAS (Irkutsk); G.V. Pashkova, analyst.

**The instrument is installed in the Center for Isotope Geochemistry of the Vinogradov Institute of Geochemistry, SB RAS (Irkutsk); E.V. Kaneva, analyst.

Table 1. **Content of petrogenic elements in argillite artifacts (% wt)**

Site	Specimen number	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	TiO_2	MnO	Fe_2O_3*	Sum
Kovrizhka I, cultural layer 2	2_5	0.68	0.25	8.97	78.3	0.14	0.09	0.14	6.39	0.06	0.23	<	3.10	98.36
	2_20	0.97	0.71	12.2	72.7	0.17	0.13	0.24	7.78	0.1	0.3	0.02	3.96	99.30
Kovrizhka IV, cultural layer 6	11	2.23	0.20	11.6	72.6	0.87	0.28	0.43	7.56	0.47	0.19	0.03	3.43	99.90
	12	1.39/1.74	0.37/0.42	7.87/7.49	76.2/76.5	0.71/0.96	0.56/0.56	0.35/0.57	4.95/4.97	0.98/0.40	0.49/0.34	0.10/0.06	6.27/5.73	100.2/99.76
Ust-Karenga XII, cultural layer 7	1	0.60/0.76	0.23/0.18	9.86/7.80	81.2/79.5	0.30/0.37	0.13/0.71	0.17/0.89	5.57/7.84	0.19/0.29	0.11/0.19	0.03/<	1.36/0.85	99.70/99.30
	2	0.76/0.93	0.30/0.22	9.64/8.40	82.7/81.4	0.10/0.28	0.09/0.25	0.09/0.26	4.65/6.10	0.09/0.28	0.08/0.11	</<	1.24/1.33	99.73/99.59
	3	0.54/0.86	0.36/0.30	10.5/7.09	81.2/77.2	0.23/0.56	0.10/0.57	0.10/0.59	5.33/9.98	0.39/0.74	0.10/0.28	0.02/<	0.55/1.21	99.42/99.39
	4	0.50/0.61	0.29/0.24	7.78/6.64	85.1/80.2	0.19/0.57	0.13/0.38	0.07/1.80	4.05/6.89	0.23/0.40	0.08/0.17	0.02/<	1.26/1.50	99.68/99.40
	6-1a	1.1	0.33	9.56	80.17	0.17	0.24	0.28	6.26	0.30	0.13	<	1.11	99.65
	6-1b	1.23	0.32	9.29	80.24	0.33	0.34	0.19	5.85	0.32	0.12	<	1.31	99.54
Ust-Karenga XVI, ritual pit	7_1	1.9/2.5	0.49/0.40	12.2/11.38	75.6/76.6	0.29/0.18	0.22/0.15	0.17/0.19	4.93/4.54	0.21/0.18	0.40/0.3	0.02/0.02	3.25/3.17	99.67/99.61
	7_2	1.51/1.25	0.59/0.469	8.81/10.2	76.7/73.99	0.66/0.277	0.45/0.442	0.46/0.468	6.41/7.799	0.40/0.332	0.30/0.367	0.03/0.029	3.27/3.726	99.553/99.35

Note. Data relating to two sides of a specimen are separated by a slash; the < sign denotes an amount below the detection level.
*Total iron as oxide.

Karenga XII (cultural layer 7, ca 12–11 ka BP) and XVI (7–6 ka BP) on the upper Vitim, and at Kovrizhka I (cultural layer 2, ca 6 ka BP) and IV (cultural layer 6, ca 15.7 ka BP) on the lower Vitim (Table 1). Two groups of argillite, differing in chemical composition, were identified at Ust-Karenga XII and XVI (Fig. 3). Argillite of the first group, from layer 7 of Ust-Karenga XII, is characterized by a higher content of silica (SiO_2 77–85 % wt) and a lower content of magnesium (MgO 0.18–0.36 % wt), iron (Fe_2O_3 0.55–1.50 % wt), and natrium (Na_2O 0.50–0.93 % wt). Argillite of the second group, from the ritual pits at Ust-Karenga XVI, is high

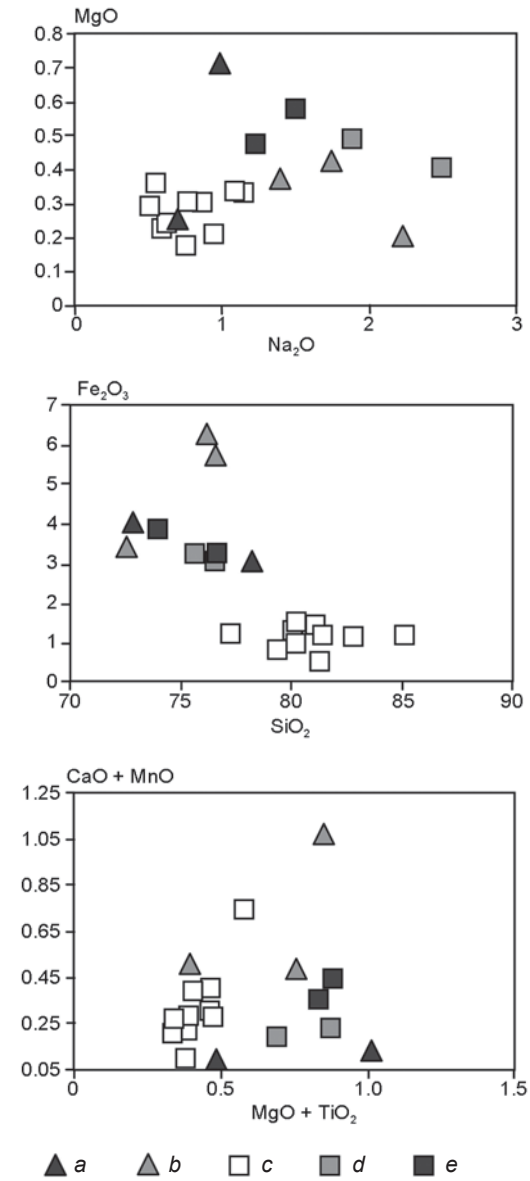

Fig. 3. Diagrams showing the chemical composition of argillites from Kovrizhka I (*a*) and IV (*b*), Ust-Karenga XII (*c*) and XVI (*d*, specimen 7_1; *e*, specimen 7_2).

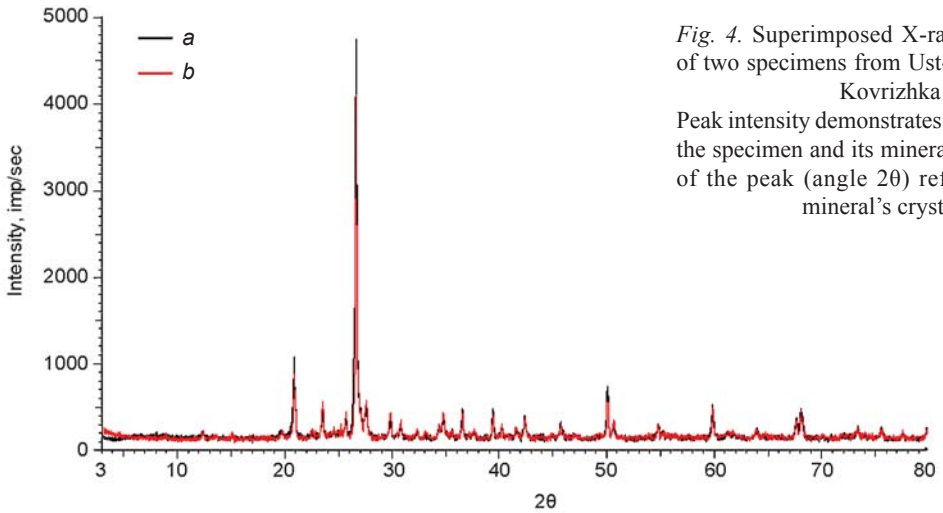

Fig. 4. Superimposed X-ray diffraction patterns of two specimens from Ust-Karenga XVI (*a*) and Kovrizhka I (*b*).
Peak intensity demonstrates the crystal structure of the specimen and its mineral content; the location of the peak (angle 2θ) refers to parameters of mineral's crystal lattice.

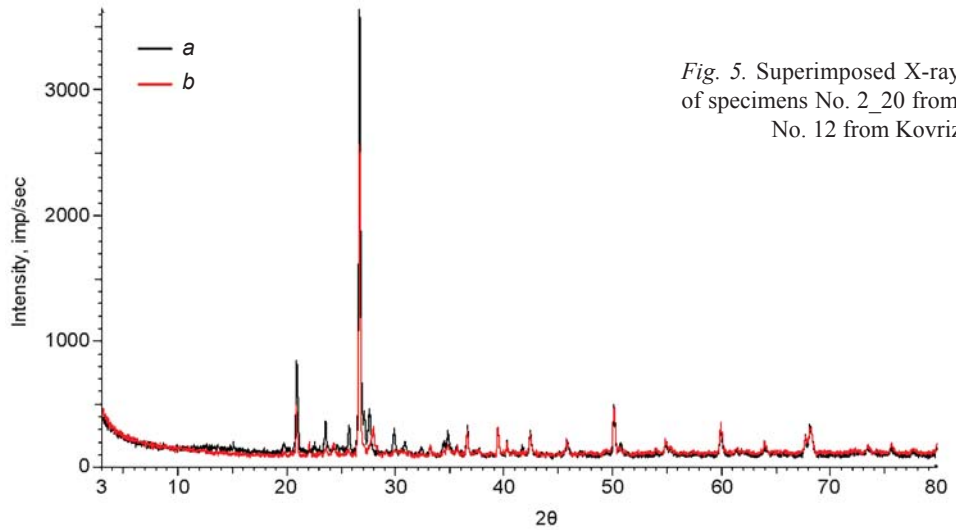

Fig. 5. Superimposed X-ray diffraction patterns of specimens No. 2_20 from Kovrizhka I (*a*) and No. 12 from Kovrizhka IV (*b*).

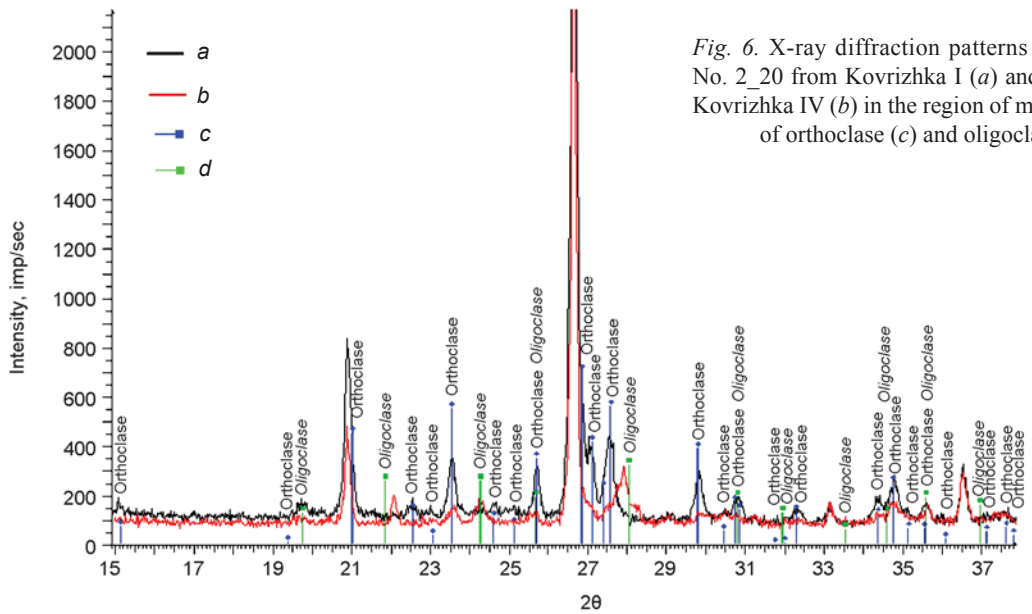

Fig. 6. X-ray diffraction patterns of specimens No. 2_20 from Kovrizhka I (*a*) and No. 12 from Kovrizhka IV (*b*) in the region of main reflections of orthoclase (*c*) and oligoclase (*d*).

in magnesium (MgO 0.40–0.58 % wt); the content of iron (Fe_2O_3 3.2–3.7 % wt) and natrium (Na_2O 1.25–2.50 % wt) is much higher, while silica content is lower (SiO_2 73–76 % wt). Chemical composition of artifacts from Kovrizhka I and IV is close to that of the second group (MgO 0.2–0.42, Fe_2O_3 3.4–6.3, Na_2O 0.80–2.23, SiO_2 72.6–76.5 % wt). The variation in the content of other elements is minor.

Further comparison of chemically similar argillites from Ust-Karenga XVI, Kovrizhka I and IV was based on X-ray diffraction analysis. All specimens contain quartz, orthoclase, and actinolite in minor proportion. Argillites from Kovrizhka I and Ust-Karenga XVI also contain clay minerals, such as montmorillonite and dickite. The X-ray diffraction spectra of both samples from these locations are identical in quality and quantity (Fig. 4), which is very unusual for polymineral rocks.

X-ray diffraction spectra of specimens from Kovrizhka I and IV also produced nearly identical results (Fig. 5). Argillite from Kovrizhka IV is primarily distinguished by the presence of oligoclase and by a lower content of orthoclase (Fig. 6).

Based on the results of comparison of artifacts, it can be concluded that the brown argillite was probably derived from a single geological source. Because the Kovrizhka I and Ust-Karenga XVI specimens are identical in both composition and the content of each mineral phase, we conclude that both artifacts were derived from a single rock or geologic deposit.

Discussion

Artifacts made of brown argillite have been recovered from the sites of Bolshoi Yakor I, Invalidny III, Kovrizhka II and IV on the lower Vitim; Vetvisty on the middle Vitim; Ust-Karenga XII and XVI on the upper Vitim. Chronologically, these sites belong to the broad time interval of ca 15.7–4.5 ka BP (Fig. 1, Table 2). At Bolshoi Yakor I (cultural layer 3B), Locus 1 of Invalidny III (cultural layer 1), and Vetvisty (cultural layer 1), such argillite artifacts form the largest portion of the assemblage. At the other sites, brown argillite is a comparatively rare or "exotic" raw material. Argillite artifacts vary typologically. In cultural layer 3B of Bolshoi Yakor I and in layer 1 of Invalidny III Locus 1, they are represented by wedge-shaped cores, flakes from bifacial preforms, ski spalls and edge flakes, microblades, and scraper- and knife-like tools on flakes (Ineshin, Tetenkin, 2010: 189–194, 211–212). Cultural layer 6 of Kovrizhka IV contained only two circular end-scrapers of brown argillite; while in the assemblage from Vetvisty, argillite artifacts were represented only by flakes and microblades (Vetrov et al., 2007). Only some argillite flakes were found in cultural layer 7 of Ust-Karenga XII. Thus, the pair of typologically similar end-scrapers on large blades from Ust-Karenga XVI and Kovrizhka I represent a unique case of artifact co-occurence (Fig. 2). In both cases, the artifacts date to ca 6 ka BP. Also distinguishing these finds from objects at other sites, these argillite artifacts are similar in chemical composition, and the unique similarity of X-ray diffraction spectra of the specimens suggests that the raw material was derived from a single source. Along with typological and chronological similarity, this supports the idea of cultural ties between the lower and upper Vitim populations during the mid-Holocene (Ineshin, Revenko, Sekerin, 1998; Ineshin, Tetenkin, 2011). Previously, researchers sought to identify sources of raw material for a pumice "polisher" from the ritual pit of Ust-Karenga XVI (Vetrov et al., 2015). Subsequent work revealed that the pumice had been transported from the Udokan volcanic field, located in the middle Vitim area (at the eastern margin of the Muya-Kuanda

Table 2. **Archaeological sites with artifacts made of brown argillite in the Vitim River basin**

Site	Date BP	Source
Bolshoi Yakor I, cultural layer 3B	12,000 ± 250 (GIN-6460), 12,080 ± 220 (GIN-6459)	(Ineshin, Tetenkin, 2010)
Kovrizhka I, cultural layer 2	5945 ± 90 (SOAN-4545), 6095 ± 135 (SOAN-4245)	(Tetenkin, 2010)
Kovrizhka II, cultural layer 3	8180 ± 130 (SOAN-5277)	(Ibid.)
Kovrizhka IV, cultural layer 6	15,558 ± 103 (Ua-50437), 15,740 ± 100 (LTL-16562A), 15,750 ± 60 (Beta-453119)	(Tetenkin, Henry, Klementyev, 2017)
Invalidny III, Locus 1, cultural layer 1	6120 ± 70 (SOAN-5166)	(Ineshin, Tetenkin, 2005)
Vetvisty, cultural layer 1	≥ 4390 ± 110 (SOAN-6326)	(Vetrov et al., 2007)
Ust-Karenga XII, cultural layer 7	10,750 ± 60 (GIN-8067), 11,240 ± 180 (GIN-8066)	(Vetrov, 1995)
Ust-Karenga XVI, ritual pits	7000–6000	(Vetrov, 2008a)

basin, approximately half waterway from Ust-Karenga to Kovrizhka). Pumice found in cultural layer 2 of Kovrizhka III (age ca 11 ka) was also apparently derived from that volcanic field (Demonterova et al., 2014).

The shared material, morphology, and chronology of these artifacts from Kovrizhka I and Ust-Karenga XVI may have various explanations. This pattern may testify to the prehistoric presence of a single population group occupying both the upper and lower Vitim, moving regularly across this region, sharing knowledge about rock sources and manufacture, or importing/exporting raw material or finished stone tools across this region. Argillite was apparently highly valued at both sites. At Kovrizhka I, the end-scraper on blade artifact was initially broken, and then a new working edge was formed on the fragment. The high prevalence of argillite in the assemblages from ritual pits is particularly suggestive of a high value of this raw material among the Ust-Karenga population.

For the first time, the identity of sources of rock at two sites, which are separated by 700 km, has been established using science-based methods. This episode of cultural exchange ca 6 ka BP attests to material, cultural, or information exchange at the regional and trans-regional level in the mid-Holocene, and raises the question of cultural distinctiveness between the upper and lower Vitim region in the past.

In the upper Vitim, researchers have documented Ust-Karenga ceramics, the earliest known ceramics in the region, dated to between ca 12.0–5.5 ka BP (Vetrov, 1997, 2000, 2006, 2008b, 2010). This cultural complex is also characterized by wedge-shaped cores and transverse burins typical of Final Paleolithic and Mesolithic industries (Vetrov, 1995). Such artifacts have the close parallels in the assemblage from the lower Vitim site of Bolshoi Yakor I, dated to ca 12.7–11.3 ka BP (Ineshin, Tetenkin, 2010: 107–200, 251–252). However, no ceramics of Ust-Karenga type have been found on the lower Vitim. The Ust-Karenga culture is most vividly represented in early cultural layers 8 and 7 (Final Pleistocene) and later layers 4 and 3 (Atlantic period) of Ust-Karenga I–XVI. Prismatic cores also appeared in its later stages. Small Early Holocene assemblages from layers 5 and 6 of Ust-Karenga sites on the upper Vitim are comparatively less well-stuided.

In contrast, the lower Vitim has yielded about 20 multi-layered Early Holocene sites (Kovrizhka I–V, Invalidny III Loci 1–3), which have been examined over the past two decades. Such research revealed new evidence of cultural variation, with sites sharing cultural traits attributed to both the Paleolithic (Avdeikha and Bolshoi Yakor) and Mesolithic Sumnagin (Bolshaya Severnaya) (Tetenkin, 2011). These sites are characterized by Yubetsu type cores (assemblages of the Bolshoi Yakor type), those with non-Yubetsu wedge-shaped microcores (assemblages of the Avdeikha type), and prismatic microcores (assemblages of the Bolshaya Severnaya type) (Tetenkin, 2013). The Mesolithic assemblages also appear to differ in raw material: artifacts were manufactured from imported colored flint and chalcedony. On the basis of form, discoveries from cultural layer 2 of Kovrizhka I can be considered among such assemblages.

On the upper Vitim, the archaeological record appears more homogenous—a pattern that is disrupted by the ritual pits with argillite artifacts at Ust-Karenga XVI. Despite numerous parallels between the upper and the lower Vitim assemblages, linking them to the Mesolithic and Neolithic of Eastern Siberia in general, archaeological cultures of these regions were not identical across the Final Pleistocene to the Middle Holocene.

Based on the chemical composition similarity of argillites from non-contemporaneous assemblages of Kovrizhka I (cultural layer 2) and IV (cultural layer 6) and pumice from Kovrizhka III (cultural layer 2) and Ust-Karenga XVI, we suggest that the same sources of rock were exploited by both Vitim groups in the period from the Final Pleistocene to the Middle Holocene.

Conclusions

This article represents a step forward in the study of prehistoric contacts using mineralogical and chemical composition analysis of artifacts made of exotic lithic material. This research establishes the similarity of archaeological argillites from Kovrizhka I and Ust-Karenga XVI, sites along the Vitim, separated by approximately 700 km. The physical sources of this dark brown argillite also remain unestablished. Geographically intermediate sites may help understand the dynamics of ancient raw material use and cultural exchange across this broad region. However, to date only one such locality has been discovered, located on the Vetvisty Brook, the right tributary of the Mudirikan River, flowing into the Muya, the left tributary of the Vitim (Vetrov et al., 2007).

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