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Case report

Obsidian sourcing analysis by X-ray fluorescence (XRF) for the Neolithic sites of Slavnaya 4 and 5, Sakhalin Islands (Russia)

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ABSTRACT

Here we report the results of obsidian sourcing analysis by XRF for 13 specimens in total from the two Neolithic sites of the Slavnaya 4 and 5 on Sakhalin Islands (Russia). The results show that stone tools and blade cores from Slavnaya 4 and 5 sites were made of obsidian from two sources on Hokkaido (Japan): Shirataki-Akaishiyama and Oketo-Tokoroyama. Evidence of on-site reduction of two blade cores from Shirataki Akaishiyama obsidian suggest that the Neolithic people transported sizeable blade cores > 400 km from the source for the purpose of primary blade reduction to supply blanks for tool manufacture.

1. Introduction

Here we present results of obsidian compositional study by X-ray fluorescence (XRF) for 13 artifacts from two early Neolithic sites of Slavnaya 4 and 5 on Sakhalin Islands, Russia, situated in the eastern margin of northeastern continental Asia and adjacent to the northernmost extent of Japan. Previous studies on Sakhalin Island, revealed that peoples have long utilized obsidian as a raw material for stone tools, including the Upper Paleolithic, Neolithic, and Iron Ages (Vasilevski, 2008; Grishchenko, 2011; Vasilevski and Grishchenko, 2011, 2012), while knappable local cherts were also exploited in the northern half of the Islands (Grishchenko, 2011). Geological surveys on Sakhalin Island have not identified any geological sources of obsidian (Kuzmin and Popov, 2000: 91). Prior to compositional analysis of artifacts, archaeologists have relied on visual identification to suggest that obsidian was transported from adjacent regions such as Hokkaido (Golubev and Lavrov, 1988; Kimura, 1992, 1995, 1997, 1998; Kimura, 2012).

A series of papers by Kuzmin and his colleagues attempted geochemical analysis of the archaeological obsidian on Sakhalin (Kuzmin, 2011, 2014; Kuzmin and Glascock, 2007; Kuzmin and Popov, 2000; Kuzmin et al., 2002). They analyzed 79 obsidian samples from 35 archaeological sites by neutron activation analysis (NAA) and assigned the artifacts to mainly the Shirataki and Oketo sources. The age of the artifacts ranged from the Upper Paleolithic to the Iron Age. Further NAA for 157 archaeological samples from 75 sites in Sakhalin support the previous analysis, suggesting that obsidian was obtained from Hokkaido through either direct-transportation and/or exchange, with some temporal changes in the specific source used most.

In addition to the initial studies of the archaeological obsidian research on Sakhalin, obsidian compositional studies on Hokkaido have made significant progress in recent years, particularly in terms of (1) the implementation of systematic source characterization studies that have identified and characterized 21chemically-distinct sources using a combination of XRF and neutron activation analysis (NAA) (Ferguson et al., 2014) and (2) the application of XRF aimed a systematic approach to artifact sourcing that minimizes time, expense, and sample destruction while achieving a high rate of confident source assignment by employing a comprehensive source database (e.g., Izuho et al., 2014, 2015; Izuho and Ferguson, 2016).

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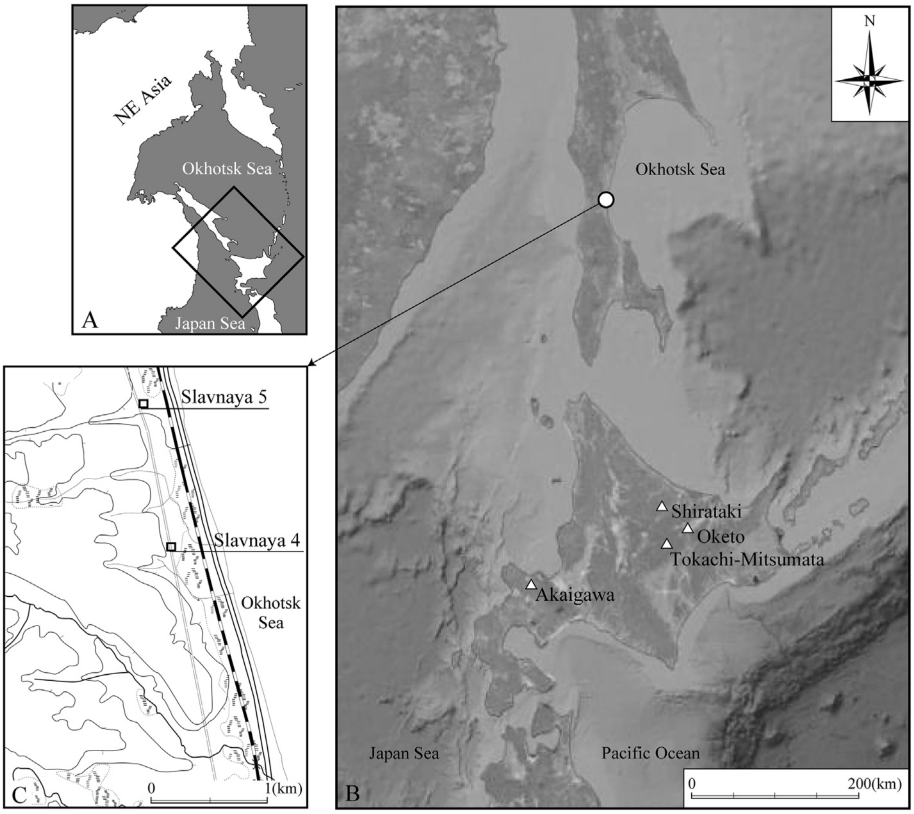

Fig. 1. The map of Slavnaya 4 and Slavnaya 5 sites. Sakhalin Island.

2. Slavnaya 4 and 5 sites

The Slavnaya sites are located on the eastern side of the southern portion of Sakhalin Island (Slavnaya 4: 47° 43′ N, 142° 32′ E, 13 m above sea level, Slavnaya 5: 47° 42′ N, 142° 32′ E, 14 m above sea level) (Fig. 1). The sites are situated on the lower terrace 400 m away from the contemporary coast line of the Okhotsk Sea to the west, and approximately 1.2 km separates the sites. Archaeologists affiliated with Sakhalin State University undertook full excavations under the export-oriented oil and gas project of Sakhalin 2 (Grishchenko, 2011:41–50). A total of 726 m^2 for Slavnaya 4 and 407 m^2 for Slavnaya 5 were excavated during the campaigns in 2006. Slavnaya 4 and 5 sites are classified as blade-arrowhead assemblages of the Early Neolithic that were widely distributed across NE Asia, including Sakhalin and Hokkaido (Grishchenko, 2011; Fukuda et al., 2015). Early Neolithic assemblages were recovered from 0.1–0.6 m below the surface in Holocene brown soil layers (Grishchenko, 2011). A second excavation was conducted at the third block excavation at Slavnaya 5 by a joint Japanese- Russian Project in 2013 (Fukuda et al., 2015). Occupational ages are estimated to a period of 9500–8400 Cal yr BP at Slavnaya 4, and 9000–7800 Cal yr BP at Slavnaya 5 (Fukuda et al., 2015).

The stone tool composition at Slavnaya 4 includes bifacial and unifacial points (arrowheads) (Fig. 2: 3), knives (4), burins, side scrapers (6) on blades, and conical blade cores (1, 2), as well as fishing net sinkers (8), ground axes and adzes (7). The diagnostic Akatsuki pottery which have single Patinopecten shell imprint on the vessels' bottoms were also found (9–12) (Grishchenko, 2011; Fukuda et al., 2015). Stone tool composition at Slavnaya 5 site, on the other hand, includes blade-arrowheads (Fig. 3: 3–8), burins, end scrapers, side scrapers (9–13), and conical blade cores (1, 2). Several ground stone tools are also included such as adzes (15), specific long rounded rods used as sinkers and forks of the fishing hooks (14). The limited pottery assemblage recovered is characterized by minute holes from the burned- out organic temper and the numerous scratches from the smoothing of the vessel's surface (16–18).

3. Materials and methods

A total of 13 obsidian artifacts (n = 4 for Slavnaya 4, and n = 9 for Slavnaya 5,) (Table 1, 2) were submitted for analysis by XRF with following procedures; (1) Grishchenko selected the archaeological samples of Slavnaya 4 and 5 for analysis, 50% of all artifacts from Slavnaya 5 site and 30% of early Neolithic artifacts from Slavnaya 4 site made from obsidian in each assemblage (Grishchenko, 2011), (2) Izuho and Yamada performed the XRF analysis at the Archaeology Museum of Sakhalin State University, and (3) Izuho and Ferguson each independently matched the artifacts to source reference groups and generated the same source assignments.

XRF analysis was performed using a Bruker Tracer III-SD XRF. The spectrometer is a handheld portable instrument which has a rhodium-based X-ray tube operated at 40 kV and a thermoelectrically-cooled silicon detector. Each sample was analyzed for 60 s using a protocol outlined in previous papers (Ferguson et al., 2014; Izuho et al., 2014, 2015; Izuho and Ferguson, 2016). The obsidian calibration used employs a set of 37 very well-characterized obsidian sources with data from previous ICP, XRF, and NAA measurements (Glascock and Ferguson, 2012). The elements measured include Mn, Fe, Zn, Ga, Pb, Th, Rb, Sr, Y, Zr, and Nb; however, reliable data was only available for Rb, Sr, Y, Zr, and Nb source discrimination of obsidian sources on Hokkaido. Niobium concentrations for Hokkaido sources are low enough (generally < 5 ppm) that this element is not helpful in discriminating between sources.

Source identification follows a method established by Ferguson et al. (2014) and tested for source identification in Hokkaido (Izuho et al., 2014). Statistical analysis was carried out on base-10 logarithms of concentrations for both datasets. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements such as iron and trace elements such as yttrium. Transformation to base-10 logarithms also yields a more normal distribution for many trace elements. The interpretation of compositional data obtained from the analysis of archaeological materials is discussed