LONG-DISTANCE OBSIDIAN TRANSPORT IN PREHISTORIC NORTHEAST ASIA

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ABSTRACT

A brief overview of recent obsidian source studies in Northeast Asia (Japan, Russian Far East, Korea, and Northeast China) is presented. Obsidian was a valuable commodity since the early Upper Palaeolithic (ca. 30,000–10,000 BP), and the length of distances between sources and utilisation sites at that time was up to 800 km. In the Jomon period of Japan, several large exchange networks existed, with obsidian transportation up to 1000 km from source to sites, often across open waters. The use of multiple obsidian sources shows the complex nature of raw material acquisition and use in prehistory.

INTRODUCTION

During the last 20–30 years, significant progress has been achieved in the study of obsidian exchange patterns in Northeast Asia, including the Japanese Islands, Russian Far East, Korean Peninsula, and Northeast China (Manchuria). The majority of investigated sites belong to the Upper Palaeolithic and Neolithic in Russia and Northeast China, and to Upper Palaeolithic and Jomon periods in Japan. In later times, the role of obsidian as a raw material was less significant due to the introduction of metals (bronze and iron), though its use persisted in some areas of Northeast Asia (such as Kurile Islands and Kamchatka Peninsula).

The determination of the primary sources of obsidian and the presence of this raw material in prehistoric assemblages plays a vital role in understanding the patterns of prehistoric exchange and migrations (e.g. Williams-Thorpe 1995). In this overview, the current state of obsidian sourcing in Northeast Asia is presented, based on recent summaries (Kuzmin 2006, 2008, 2010) with incorporation of the latest data.

MATERIALS AND METHODS

Several geochemical analytical methods, primarily Energy Dispersive X-ray Fluorescence (EDXRF or PXRF) and Neutron Activation Analysis (NAA), and less commonly Proton-Induced X-ray Emission and Proton-Induced Gamma-ray Emission (PIXE and PIGME, respectively), were employed to retrieve data on the elemental composition of obsidian from the Russian Far East and Korean Peninsula (e.g. Kuzmin *et al.* 2002a, 2002b; Kim *et al.* 2007; Doelman *et al.* 2008; Jia *et al.* 2010, see Table 1). The statistical processing of these results provides a high degree of precision (probability of at least 95%) for determining the geochemical signature of primary obsidian sources in prehistoric stone assemblages (for details see: Glascock *et al.* 1998). The geochemical signature can be used to determine the location of the obsidian source that was used by ancient populations. A variety of analytical methods was used to study the geochemistry of Japanese obsidian sources and artefacts (e.g. Izuho and Hirose 2010; Tsutsumi 2010; Obata *et al.* 2010).

The importance of the NAA application to regions which were not previously studied for obsidian provenance is highlighted by the fact that it allows the detection of a large number of chemical elements (up to 28). This makes the determination of source groups, which are primary sources and associated artifacts, more secure compared to routine EDXRF and other methods (e.g., PIXE–PIGME) that identify the content of only 10–14 elements. In the latter case, it may be impossible to distinguish some primary sources. This is the case with the Akaigawa and Tokachi-Mitsumata sources on Hokkaido Island (Japan) which were not originally discriminated by T. Warashina using EDXRF (see Izuho and Hirose 2010:13–15) but later were separated by both NAA (Kuzmin *et al.* 2002b) and improved EDXRF (Hall and Kimura 2002).

In this review, only the southern part of the Russian Far East, including Primorye [Maritime] Province, Amur River basin, and Sakhalin Island, is considered. The northern part of the region, namely Kamchatka and the Kuril Islands, is not discussed due to size limitation. Relevant research in archaeological obsidian provenance of the northern Russian Far East can be found in recent summaries (Grebennikov *et al.* 2010; Kuzmin *et al.* 2008; Phillips 2010).

RESULTS AND DISCUSSION

Long-distance prehistoric exchange of obsidian in mainland Northeast Asia

The number of primary obsidian outcrops in the mainland Northeast Asia is relatively small; throughout the 20 years

Table 1. Elemental composition of major obsidian sources in the southern Russian Far East measured by NAA (after Glascock *et al.* 2011; Kuzmin and Glascock 2007; Kuzmin *et al.* 2002a), in parts-per-million (ppm), unless otherwise indicated. Source abbreviations: BP – Basaltic Plateau; OP – Obluchie Plateau; PK – Paektusan; SAM – Samarga; S-A – Shirataki-A; S-B – Shirataki-B; O-A – Oketo-A; O-B – Oketo-B.

Element	BP	OP	PK*	SAM	S-A	S-B	O-A	O-B
Na (%)	2.35 ± 0.1	2.84 ± 0.05	3.06 ± 0.09	2.92 ± 0.10	2.88 ± 0.06	2.95 ± 0.05	2.82 ± 0.05	3.25 ± 0.04
Al (%)	7.90 ± 0.39	7.92 ± 0.28	—	7.22 ± 0.24	6.75 ± 0.26	6.72 ± 0.31	6.49 ± 0.23	6.94 ± 0.18
Cl	91 ± 38	75 ± 26	724 ± 63	349 ± 29	540 ± 127	532 ± 95	488 ± 110	449 ± 130
K (%)	0.41 ± 0.14	1.08 ± 0.12	4.17 ± 0.29	2.98 ± 0.22	3.73 ± 0.13	3.80 ± 0.17	3.58 ± 0.17	3.05 ± 0.18
Sc	18.0 ± 1.0	11.8 ± 0.6	1.10 ± 0.09	2.82 ± 0.05	2.67 ± 0.03	2.94 ± 0.05	3.30 ± 0.02	3.33 ± 0.10
Mn	1108 ± 47	967 ± 17	308 ± 5	525 ± 4	384 ± 6	451± 9	325 ± 5	385 ± 3
Fe (%)	7.22 ± 0.24	6.39 ± 0.23	1.08 ± 0.01	0.97 ± 0.17	0.80 ± 0.01	0.75 ± 0.02	0.73 ± 0.00	0.89 ± 0.03
Co	37.7. ± 1.3	30.8 ± 0.7	0.28 ± 0.07	1.39 ± 0.03	0.13 ± 0.01	0.08 ± 0.01	0.53 ± 0.04	0.47 ± 0.01
Zn	126 ± 21	125 ± 3	85 ± 18	32 ± 5	39 ± 4	36 ± 4	26 ± 2	37 ± 0
Rb	12 ± 3	29 ± 3	236 ± 8	102 ± 2	151 ± 2	175 ± 2	135 ± 1	99 ± 3
Sr	392 ± 93	470 ± 77	28 ± 6	250 ± 17	28 ± 4	—	67 ± 11	79 ± 37
Zr	97 ± 20	134 ± 14	252 ± 11	132 ± 3	90 ± 8	87 ± 8	116 ± 2	128 ± 0
Cs	0.24 ± 0.07	0.37 ± 0.06	3.89 ± 0.15	4.73 ± 0.09	9.64 ± 0.11	11.89 ± 0.16	6.80 ± 0.05	5.34 ± 0.07
Ba	122 ± 29	346 ± 55	106 ±35	533 ± 15	856 ± 7	189 ± 18	994 ± 14	722 ± 10
La	6.4 ± 1.1	18.1 ± 0.7	67.7. ± 1.5	19.7 ± 0.3	20.1 ± 0.3	13.3 ± 0.3	22.1 ± 0.3	21.0 ± 0.4
Ce	14.4 ± 2.1	36.4 ± 0.7	137 ± 4	36.9 ± 0.7	42.9 ± 0.7	31.5 ± 0.6	43.5 ± 0.2	41.8 ± 0.2
Nd	9.0 ± 2.0	18.6 ± 0.8	49.1 ± 5.4	12.0 ± 0.7	15.9 ± 1.2	11.5 ± 0.9	13.2 ± 0.8	15.5 ± 0.4
Sm	3.72 ± 0.29	5.13 ± 0.24	10.8 ± 0.4	2.46 ± 0.05	3.99 ± 0.06	3.83 ± 0.08	3.39 ± 0.05	3.24 ± 0.06
Eu	1.47 ± 0.07	1.61 ± 0.11	0.28 ± 0.06	0.48 ± 0.01	0.28 ± 0.01	0.13 ± 0.01	0.37 ± 0.01	0.54 ± 0.01
Tb	0.86 ± 0.27	0.64 ± 0.05	1.61 ± 0.12	0.31 ± 0.01	0.63 ± 0.02	0.72 ± 0.04	0.50 ± 0.03	0.50 ± 0.04
Dy	3.86 ± 0.40	3.51 ± 0.38	10.2 ± 0.8	1.88 ± 0.24	4.39 ± 0.25	5.14 ± 0.58	3.38 ± 0.23	3.35 ± 0.18
Yb	1.34 ± 0.10	1.14 ± 0.10	4.51 ± 0.31	1.43 ± 0.06	3.00 ± 0.09	3.66 ± 0.17	2.58 ± 0.07	2.64 ± 0.10
Lu	0.26 ± 0.05	0.16 ± 0.02	0.73 ± 0.06	0.26 ± 0.02	0.46 ± 0.02	0.53 ± 0.01	0.42 ± 0.01	0.39 ± 0.01
Hf	2.29 ± 0.17	3.46 ± 0.33	10.0 ± 0.2	3.45 ± 0.05	2.80 ± 0.06	2.72 ± 0.10	3.17 ± 0.01	3.66 ± 0.13
Ta	0.29 ± 0.08	0.65 ± 0.17	6.75 ± 0.41	0.81 ± 0.02	0.54 ± 0.01	0.65 ± 0.01	0.57 ± 0.02	0.52 ± 0.01
Th	0.77 ± 0.19	1.48 ± 0.26	27.5 ± 0.8	8.85 ± 0.17	11.10 ± 0.1	9.70 ± 0.1	11.9 ± 0.1	9.3 ± 0.2

*Paektusan Volcano-1 group (Kuzmin *et al.* 2002a:510).

of research, three major sources were identified: Paektusan [Baitoushan] Volcano, Basaltic Plateau, and Obluchie Plateau (Figure 1). The Paektusan Volcano in the northern part of the Korean Peninsula is the most abundant archaeologically among them; its obsidian is distributed in prehistoric complexes over vast distances, up to 800 km in a straight line (Figure 2). The earliest sites with the Paektusan obsidian are dated to ca. 24,000–25,500 BP on the Korean Peninsula (Popov *et al.* 2005; Kim *et al.* 2007), ca. 11,800 BP in Primorye [Maritime] Province of the Russian Far East (Warashina *et al.* 1998; Kuzmin 2006), and ca. 10,000–15,000 BP (approximate age) in Manchuria (Jilin and Heilongjiang provinces in Northeast China) (Jia *et al.* 2010).

The second most abundant source of obsidian is the Basaltic Plateau in southern Primorye Province (Figure 3). Previously, it was known from archaeological contexts only in Primorye (e.g. Kuzmin *et al.* 2002a), but it was subsequently identified at some sites in the neighbouring Amur River basin (Glascock *et al.* 2011) and Manchuria (Jia *et al.* 2010). The age of the earliest sites where this obsidian was utilised is ca. 10,000–12,000 BP in Primorye, ca. 10,800 BP in the Amur River basin, and ca. 10,000–15,000 BP (estimated age) in Manchuria. The maximal distance between source and sites is roughly 550 km (Figure 3).

The third source of obsidian is the Obluchie Plateau in the middle course of the Amur River, Russia (Figure 3). Archaeological sites with this kind of volcanic glass are widely distributed in the Amur River basin, with a distance of up to 750 km from the source. The age of utilisation sites ranges from ca. 12,000 BP to ca. 2000 BP.

Obsidian exchange networks in insular Northeast Asia

The Japanese Islands are definitely the ‘champion’ in terms of obsidian provenance studies in Northeast Asia (see, for example, review: Habu 2004:221–224). Numerous obsidian sources were identified on Hokkaido, Honshu, and Kyushu islands. Large exchange networks existed in the Upper Palaeolithic and the Jomon on Honshu Island (e.g. Yamamoto 1990; Sato and Tsutsumi 2007; Tsutsumi 2010). Two regions in Japan with the widest distribution of obsidian from sources to utilisation sites are: 1) Hokkaido Island (e.g. Izuho and Sato 2007; Kuzmin and Glascock 2007); and 2) Kyushu Island (Obata *et al.* 2004; Kim *et al.* 2007).

Hokkaido Island has at least 21 sources of obsidian (Izuho and Sato 2007). Two of them, Shirataki and Oketo,

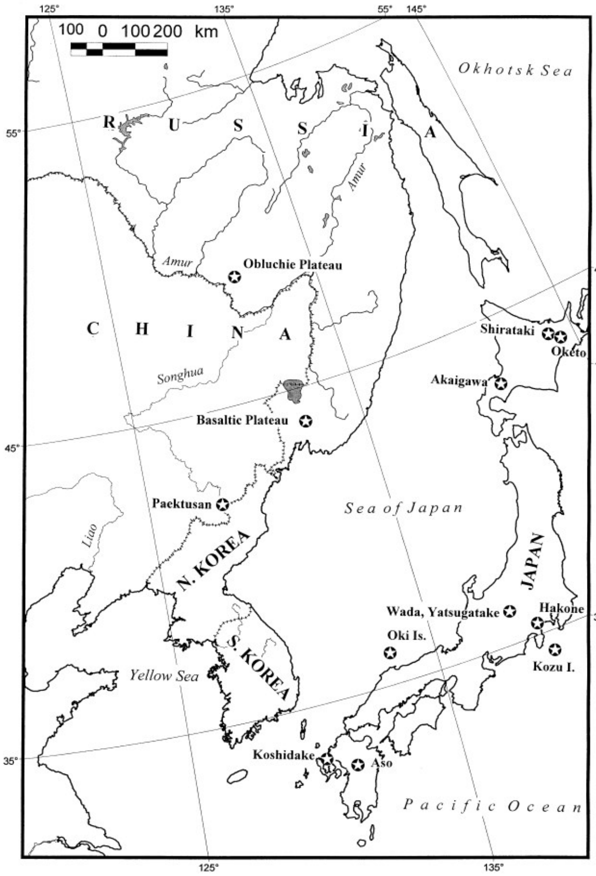


Figure. 1. Major obsidian sources in Northeast Asia (after Kuzmin 2006, 2010).

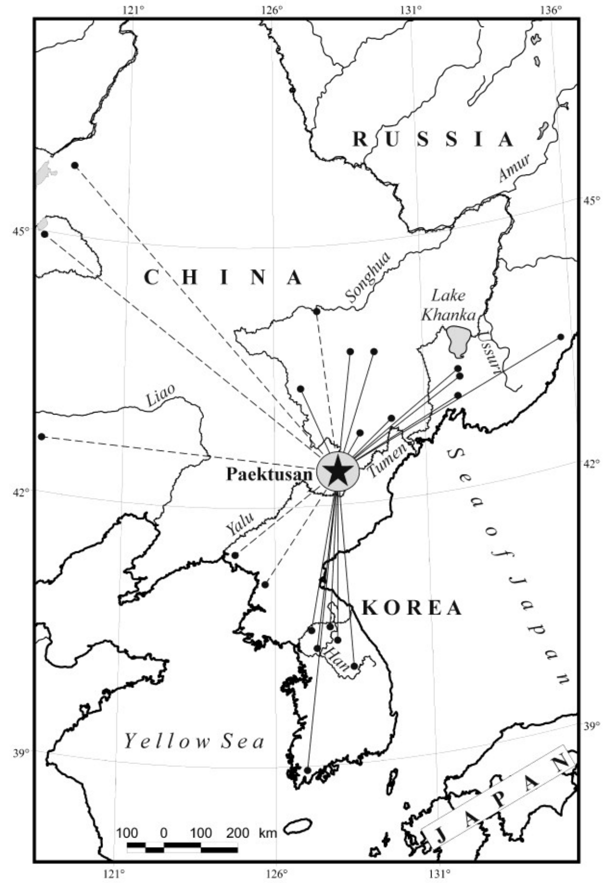


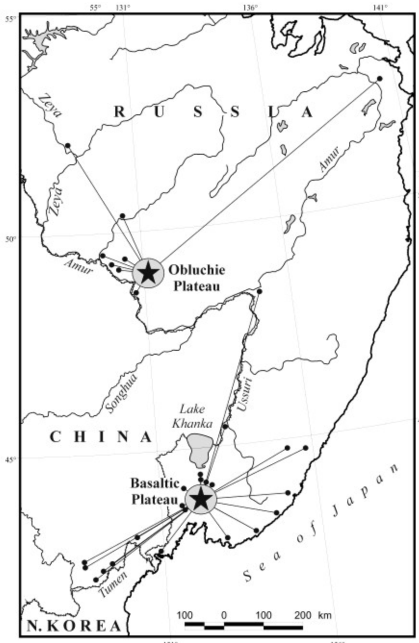
Figure. 2. The spread of obsidian in prehistory from the Paektusan source (after Kuzmin 2006, 2010; Kim et al. 2007; Jia et al. 2010). Solid lines show sites with the Paektusan obsidian confirmed by geochemical analyses; dashed lines show suggested spread of obsidian.

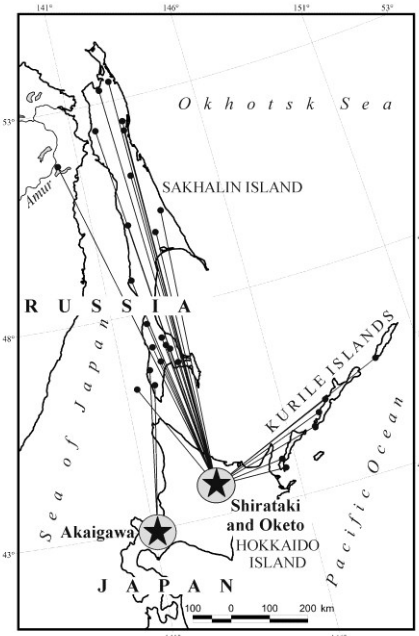
have very large distribution networks (Figure 4) covering Hokkaido and neighbouring islands north and west of it (Sakhalin and the Kuriles, Kuzmin and Glascock 2007; Phillips 2010), and regions east of it (Amur River basin) (Glascock *et al.* 2011). Around 18,000 BP, Hokkaido obsidian was transported to the southern part of neighbouring Sakhalin Island, about 250 km away from the sources. By ca. 9000 BP, this obsidian was transported to central Sakhalin with a distance of approximately 700 km, and at ca. 7500 BP (age estimate; see Vasilevski *et al.* 2010) Hokkaido obsidian is found in northern Sakhalin, about 1000 km from the sources (Kuzmin and Glascock 2007). In the Early–Late Jomon and Epi-Jomon (ca. 8000–2500 BP) on the Sakhalin and Kuril Islands, the obsidian traffic continued across the La Pérouse [Soya] Strait dividing Hokkaido from Sakhalin, and via the straits between Hokkaido and the Kurile Islands, reaching northernmost part of this archipelago (see Phillips 2010) (Figure 4).

Kyushu Island has several obsidian sources (e.g. Habu 2004:222), of which the Koshidake source in Saga Prefecture was most widely used in prehistory (Figure 1). In the early Upper Palaeolithic (ca. 25,500 BP), Koshidake obsidian was brought across the Korea [Tsushima] Strait to the southern part of the Korean Peninsula (Kim *et al.* 2007), a distance of ca. 350 km from the source (Figure 5). In later times, Kyushu obsidian (mainly from Koshidake source) was transported south to the Ryukyu Islands, beginning around 8000–6000 BP and most extensively since ca. 4000 BP (Obata *et al.* 2004, 2010). At the end of the Jomon Period (ca. 2500 BP), the distances between source (Koshidake) and utilisation sites were up to 1000 km (Figure 5).

Wider implications of obsidian exchange patterns in Northeast Asia

The existence of large-scale obsidian exchange networks in the prehistory of Northeast Asia (Figs. 2–5) undoubtedly testifies to long-distance migrations or contacts in the Upper Palaeolithic and Neolithic, beginning at least at ca. 25,500 BP. This is primary information which should be taken into account by any serious prehistorian. Another important feature is the use of several obsidian sources at the same site in the Upper Palaeolithic and Neolithic of Primorye, Korean Peninsula, and in the Upper Palaeolithic and Jomon of the Japanese Islands (e.g. Kim *et al.* 2007; Kuzmin and Glascock 2007; Kuzmin *et al.* 2002a:513; Obata *et al.* 2010; Tsutsumi 2010). The use of several obsidian sources at the same site was also recently





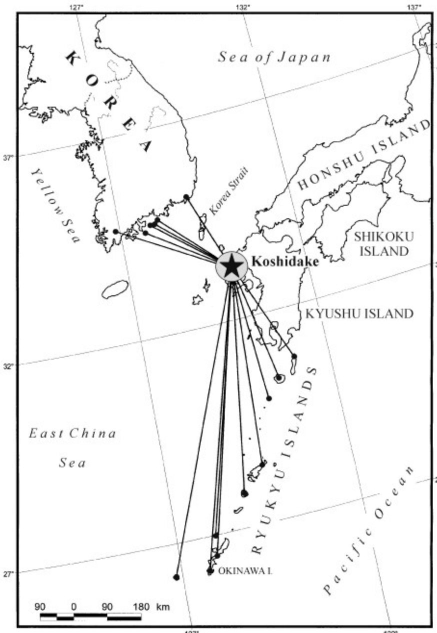


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Figure. 3. The spread of obsidian from the Basaltic Plateau and Obluchie Plateau sources in prehistory (after Kuzmin 2006, 2010; Jia et al. 2010; Glascock et al. 2011).

Figure. 4. The spread of obsidian from the Hokkaido Island sources in prehistory (after Kuzmin 2010; Kuzmin and Glascock 2007; Phillips 2010; Glascock et al. 2011).

Figure. 5. The spread of obsidian from the Koshidake source in prehistory (after Obata et al. 2004; Kim et al. 2007).

served in the neighbouring territories of Manchuria (Jia *et al.* 2010) and the Kamchatka Peninsula (Kuzmin *et al.* 2008). Therefore, the strategy of acquisition of high quality raw material in prehistory appears to have been quite complex.

CONCLUSIONS

This brief review of the current data on obsidian transportation in prehistoric Northeast Asia shows that human contacts and/or migrations were very active from the early-middle Upper Palaeolithic (ca. 25,500 BP) onwards, with distances between sources and utilisation sites in the order of hundreds of kilometres. The range of obsidian spread in the Upper Palaeolithic in Northeast Asia was generally ca. 200–300 km and in some cases up to ca. 800 km (Paektusan Volcano source and related sites), and in the Neolithic (Jomon) up to ca. 1000 km. It is clear that the obsidian provenance studies should continue in all parts of Northeast Asia with increasing pace. This gives us direct evidence of human movements and interactions.

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