CHAPTER 7

BRIDGING THE GAP BETWEEN TWO OBSIDIAN SOURCE AREAS IN NORTHEAST ASIA: LA-ICP-MS ANALYSIS OF OBSIDIAN ARTEFACTS FROM THE KURILE ISLANDS OF THE RUSSIAN FAR EAST

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Abstract: *Recent archaeological excavations in the Kurile Islands of the Russian Far East have recovered almost 2000 obsidian artefacts in the form of finished stone tools and flake debitage. While artefacts made of obsidian are present throughout the island chain, obsidian native to the Kurile Islands is not known to have been used prehistorically. An initial source provenance study of Kurile Island artefacts indicated that obsidian raw material was brought into the islands at least 2500 years ago from sources located on the Japanese island of Hokkaido and from the Kamchatka Peninsula (Russian Far East). This chapter reports on a larger provenance study using Laser Ablation Inductively-Coupled-Plasma Mass Spectrometry (LA-ICP-MS) that expands the initial research and provides the largest sample to date of obsidian artefacts from the Kurile Islands that can be assigned to obsidian source groups located in Northeast Asia. Identifying the sources used to produce obsidian artefacts is a key element necessary for reconstructing prehistoric Kurile Island migrations, colonisation events, and social network structures.*

Keywords: *Obsidian, Sourcing, Archaeology, Kurile Islands, Russian Far East, Kamchatka Peninsula, Hokkaido Island*

Introduction

Imported items found in archaeological sites are often seen as evidence for transport of materials via the movement/ migration of people or through trade/exchange networks (Pires-Ferreira 1978). The directions and distances associated with materials that have been transported, especially over long distances, can provide insight into the social as well as utilitarian nature of material exchange among hunter-gatherer groups that are essentially independent and economically self-sufficient (Eriksen 2002; Whallon 2006). Non-local lithic raw material used for the production of stone tools is one type of resource that can represent hunter-gatherer intergroup networks (Eriksen 2002).

Over the last decade, regional studies in the northeast Asian portion of the Pacific Rim have developed information and ideas about the prehistoric use of obsidian as an important raw material for the manufacture of stone tools. Research conducted specifically on Hokkaido Island (Japan) and the Primorye and Kamchatka regions of the Russian Far East, have provided detailed accounts of the location of primary and secondary obsidian sources, the movement of obsidian over long distances, and the differential use of various sources based on location and quality (see Table 7.1 for a list of relevant obsidian studies in Northeast Asia).

Until recently, the Kurile Islands of the Russian Far East (Figure 7.1) have represented an archaeological blank spot in terms of the use of obsidian as a raw material for manufacturing stone tools. While still relatively little is known about the overall culture history and technological adaptations of Kurile Island inhabitants, it recently was established that non-local obsidian was used prehistorically throughout the archipelago (Phillips and Speakman 2009). The Kurile Islands are a geographic bridge between northern Japan and the northern Russian Far East. The distribution of obsidian from these areas across the Kuriles has great potential to inform us about the migration movements and exchange relationships, and in turn the larger social organisational structure of the islands' inhabitants at different times in prehistory. This chapter provides a more in-depth view of the distribution of obsidian artefacts across the island chain through Laser Ablation Inductively-Coupled-Plasma Mass Spectrometry (hereafter – LA-ICP-MS) analysis of a larger sample of obsidian artefacts, with the goal of developing a higher-resolution data set from which studies of lithic technology, social organisation, and migration can be made.

Geographical and Geological Background

The Kurile Archipelago is a 1150km long chain of islands that spans the Okhotsk Sea – Pacific Ocean boundary, and is situated on the central portion of the Kurile–Kamchatka Island Arc which includes eastern Hokkaido, the Kurile Islands, and southern Kamchatka (Cook *et al.* 1986; Gorshkov 1970). The Kurile Islands vary in size from 5km^2 to 3200km^2, and the islands at the extreme southern and northern ends of the archipelago tend to be larger and more ecologically diverse than the more isolated central Kuriles (Pietsch *et al.* 2003).

Tectonically, Kurile Islands are associated with the subduction of the Pacific Plate under the Okhotsk Plate and consist of two island arc ridge systems, the Lesser Kurile Ridge and the Greater Kurile Ridge, located in between the oceanic Kurile Trench and the Kurile Basin of the Okhotsk Sea. The Lesser Kurile Ridge is an older, inactive arc that includes the Nemuro Peninsula of Hokkaido, the Habomai island group, and Shikotan Island, and then continues to the northeast as the submarine Vityaz Ridge (Gorshkov 1970; Ishizuka 2001). The Greater Kurile Ridge includes

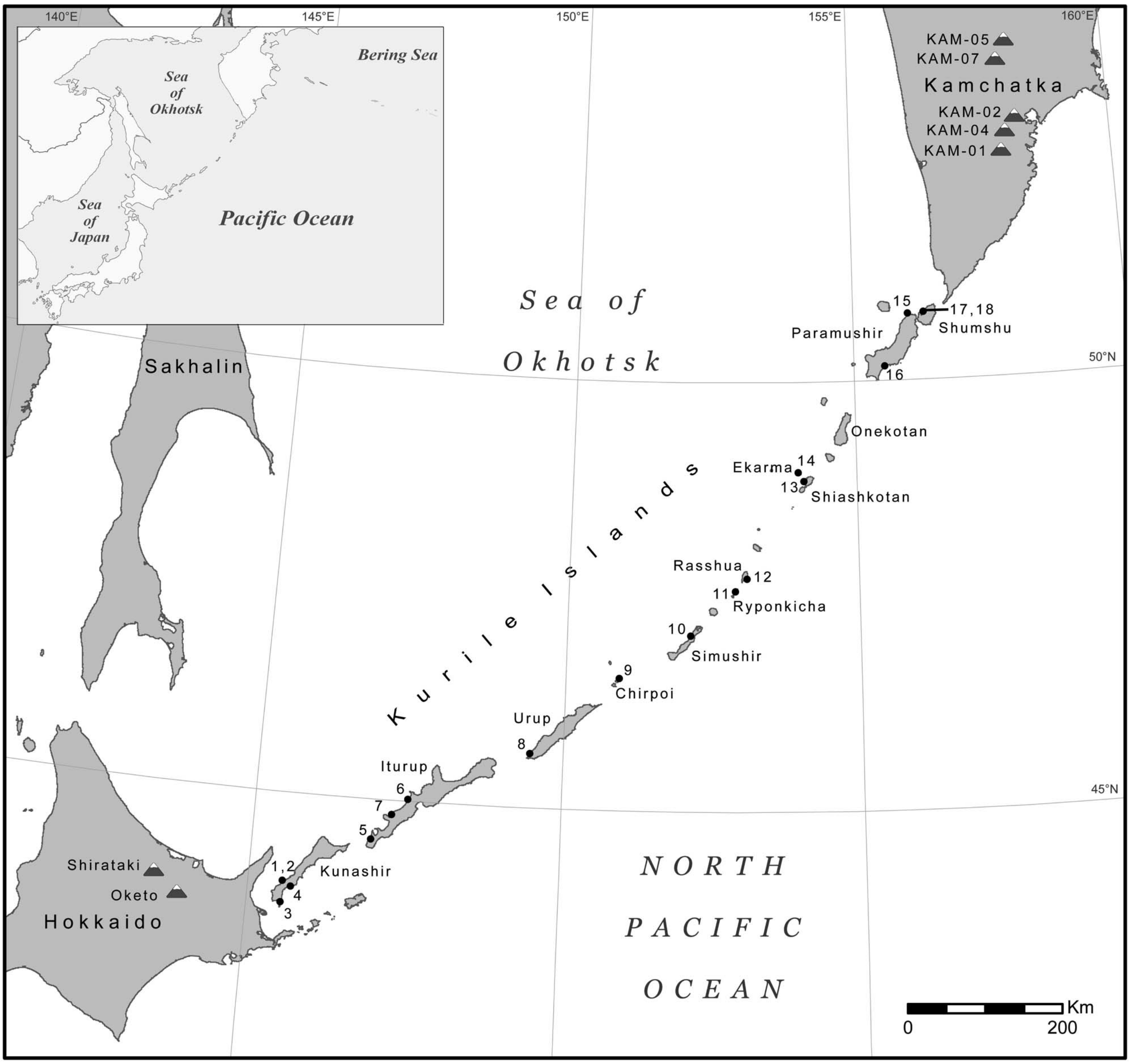

Figure 7.1. Map of Kurile Islands and surrounding region. Numbered points correspond to archaeological sites referenced in the text: 1) Alekhina; 2) Peschanaya 2; 3) Rikorda 1; 4) Sernovodsk 1; 5) Berezovka 1; 6) Kuibyushevskaya 1; 7) Tikhaya 1; 8) Ainu Creek 1; 9) Peschanaya Bay 1; 10) Vodopodnaya 2; 11) Ryponkicha 1; 12) Rasshua 1; 13) Drobnyye 1; 14) Ekarma 1; 15) Savushkina 1; 16) Tukharka River 1; 17) Baikova 1; 18) Bolshoi 1

the Shiretoko Peninsula of eastern Hokkaido, all of the remaining Kurile Islands from Kunashir north to Shumshu, and the southern tip of the Kamchatka Peninsula. The Greater Kurile Ridge was formed from submarine volcanic activity that began in the Miocene (about 23 million years ago) and is composed of 160 Quaternary terrestrial volcanoes and 89 submarine ones. The Greater Kurile Ridge is still tectonically and volcanically active, with 19 volcanoes that have erupted since AD 1945 (Gorshkov 1970; Simkin and Siebert 1994).

The Kurile chain is representative of the andesitic volcanism associated with most island arc systems, and is situated in between two centres of silicic volcanism, one located to the south in eastern Hokkaido and one to the north in southeastern Kamchatka (Erlich 1986). Since obsidian usually occurs in conjunction with silicic volcanism and is a product of magmas containing silicic melts with a SiO_2 content greater than 70% (Eichelberger 1995), Hokkaido and Kamchatka represent two potential areas with sources of obsidian that were used prehistorically as a raw material for stone tool production in the Kurile Islands.

Archaeological Background

Compared with Hokkaido, Kamchatka, and other parts of the larger Northeast Asia region, significantly less archaeological research has been conducted in the Kurile Islands in the last 50 years (Fitzhugh *et al.* 2002; Phillips and Speakman 2009; Vasilevsky and Shubina 2006; but see Prokofiev 2005 for a review of Japanese research in the Kuriles at the end of the 19th century and first half of the 20th century). More recently, the International Kurile Island Project (hereafter – IKIP) in 2000 and the

Table 7.1. Chronological listing of relevant obsidian studies in Northeast Asia

Year	***Author(s)***	***Title***
1995	Kimura, H.	Obsidian, Humans, and Technology
1996	Shackley, M. S., *et al.*	Geochemical Characterization of Archaeological Obsidian from the Russian Far East: A Pilot Study
1996	Glascock, M. D., *et al.*	Geochemical Characterization of Obsidian Artefacts from Prehistoric Sites in the Russian Far East: Initial Study
1999	Kuzmin, Y. V., *et al.*	Geochemical Source Analysis of Archaeological Obsidian in Primorye (Russian Far East)
2000	Glascock, M. D., *et al.*	Obsidian Geochemistry of the Archaeological Sites of the Sakhalin and its Sources
2000	Kuzmin, Y. V., *et al.*	The Sources of Archaeological Obsidian in Primorye and its Distribution in the Stone Age Cultures
2002	Hall, M., and Kimura, H.	Quantitative EDXRF Studies of Obsidian Sources in Northern Hokkaido
2002	Kimura, H.	A Prospect of the Obsidian Study in Hokkaido District
2002a	Kuzmin, Y. V., *et al.*	Sources of Archaeological Obsidian from Sakhalin Island
2002b	Kuzmin, Y. V., *et al.*	Sources of Archaeological Volcanic Glass in the Primorye (Maritime) Province, Russian Far East
2004	Doelman, T., *et al.*	Acquisition and Movement of Volcanic Glass in the Primorye Region of Far Eastern Russia
2004	Fitzhugh, B., *et al.*	Archaeological Paleobiogeography in the Russian Far East: The Kurile Islands and Sakhalin in Comparative Perspective
2004	Sato, H.	Prehistoric Obsidian Exploitation in the Russian Far East
2005	Naoe, Y., and Nagasaki, J.	Raw Material Consumption Strategy at Late Upper Paleolithic in Hokkaido
2005	Popov, V. K., *et al.*	Geochemistry of Volcanic Glasses of the Paektusan Volcano
2005	Speakman, R. J., *et al.*	Geochemistry of Volcanic Glasses and Sources of Archaeological Obsidian on the Kamchatka Peninsula (Russian Far East): First Results
2006	Glascock, M. D., *et al.*	Obsidian Sources and Prehistoric Obsidian Use on the Kamchatka Peninsula: Initial Results of Research
2006	Kimura, H.	The Shirataki Obsidian Mine Area and the Yubetsu–Horokazawa Technological Complex
2006b	Kuzmin, Y. V.	Recent Studies of Obsidian Exchange Networks in Prehistoric Northeast Asia
2006	Suzuki, H., and Naoe, Y.	The Shirataki Sites: An Overview of Upper Paleolithic Sites at an Obsidian Source in Hokkaido, Japan
2007	Izuho, M., and Sato, H.	Archaeological Obsidian Studies in Hokkaido, Japan: Retrospect and Prospects
2007	Kim, J. C., *et al.*	PIXE Provenancing of Obsidian Artefacts from Palaeolithic Sites in Korea
2007	Kluyev, N. A., and Slepstov, I. Y.	Late Pleistocene and Early Holocene Uses of Basaltic Glass in Primorye, Far East Russia: A New Perspective Based on Sites Near the Sources
2007	Kuzmin, Y. V., and Glascock, M. D.	Two Islands in the Ocean: Prehistoric Obsidian Exchange Between Sakhalin and Hokkaido, Northeast Asia
2007	Pantukhina, I.	The Role of Raw Material in Microblade Technology at Three Late Palaeolithic Sites, Russian Far East
2008	Doelman, T., *et al.*	Source Selectivity: An Assessment of Volcanic Glass in the Southern Primorye Region, Far Eastern Russia
2008	Kuzmin, Y. V., *et al.*	Obsidian Use at the Ushki Lake Complex, Kamchatka Peninsula (Northeastern Siberia): Implications for Terminal Pleistocene and Early Holocene Human Migrations in Beringia
2009	Phillips, S. C., and Speakman, R. J.	Initial Source Evaluation of Archaeological Obsidian from the Kurile Islands of the Russian Far East Using Portable XRF

Kurile Biocomplexity Project (hereafter – KBP) in 2006–7 have provided new data and the means to synthesise the archaeology of the island chain based on ceramic and lithic artefacts, faunal data, and radiocarbon (^{14}C) dating (Table 7.2).

During the Late Glacial period (ca. 18,000–15,000 BP) when global sea level is estimated to have been approximately 130m lower than today (e.g., Chappell and Shackleton 1986), the southern Kurile islands of Kunashir and Iturup and the northern islands of Paramushir and Shumshu were connected to Hokkaido and Kamchatka respectively. Confirmed early occupations in the southern Kurile Islands extend back to the Middle Jomon period, ca. 5000 BP, based on ^{14}C dates and pottery types from archaeological sites on Iturup Island (Golubev 1972; O. A. Shubina and I. A. Samarin, personal communication 2009), and people were potentially present in the southern

Kuriles as early as ca. 7000 BP (Zaitseva et al. 1993) [see also Yanshina and Kuzmin 2010 – *Editors*]. These earliest occupations probably represent Jomon hunter-gatherers who lived throughout Japan from ca. 12,000 to ca. 2500 BP (Imamura 1996; Kobayashi 2004; Yamaura and Ushiro 1999). Though little information currently exists for this period that some researchers have labeled the "Early Neolithic" of the southern Kurile Islands (Kuzmin *et al.* 1998; Vasilevsky and Shubina 2006; Zaitseva *et al.* 1993), the earliest occupants of the southern Kuriles likely lived as small and highly mobile populations subsisting primarily by terrestrial hunting and gathering, which was supplemented with fish and shellfish (Imamura 1996; Kikuchi 1999; Okada 1998), though direct evidence of subsistence activities at the earliest Kurile sites is currently lacking.

Consistent occupation in the southern Kurile Islands began ca. 4000 BP (Zaitseva *et al.* 1993), and at ca. 2500–1300 BP Epi-Jomon people with a developed maritime-adapted economy moved north out of Hokkaido and into the more

Table 7.2. Kurile Island culture history (after Fitzhugh and Dubreuil 1999; Fitzhugh et al. 2002, 2004; Kikuchi 1999; Ohnuki-Tierney 1976; Stephan 1976; Tezuka 1998; Vasilevsky and Shubina 2006; Zaitseva et al. 1993)

Culture period	***Dates (BP)***	***Presence in Kurile Islands***
Ainu	800–50	Southern to northern islands
Okhotsk	1400–800	Southern to northern islands
Epi-Jomon	2500–1400	Southern to north-central islands
Final Jomon	3200–2500	Southern islands
Late Jomon	4500–3200	?
Middle Jomon	5500–4500	Southern islands
Early Jomon	7300–5500	Southern islands?

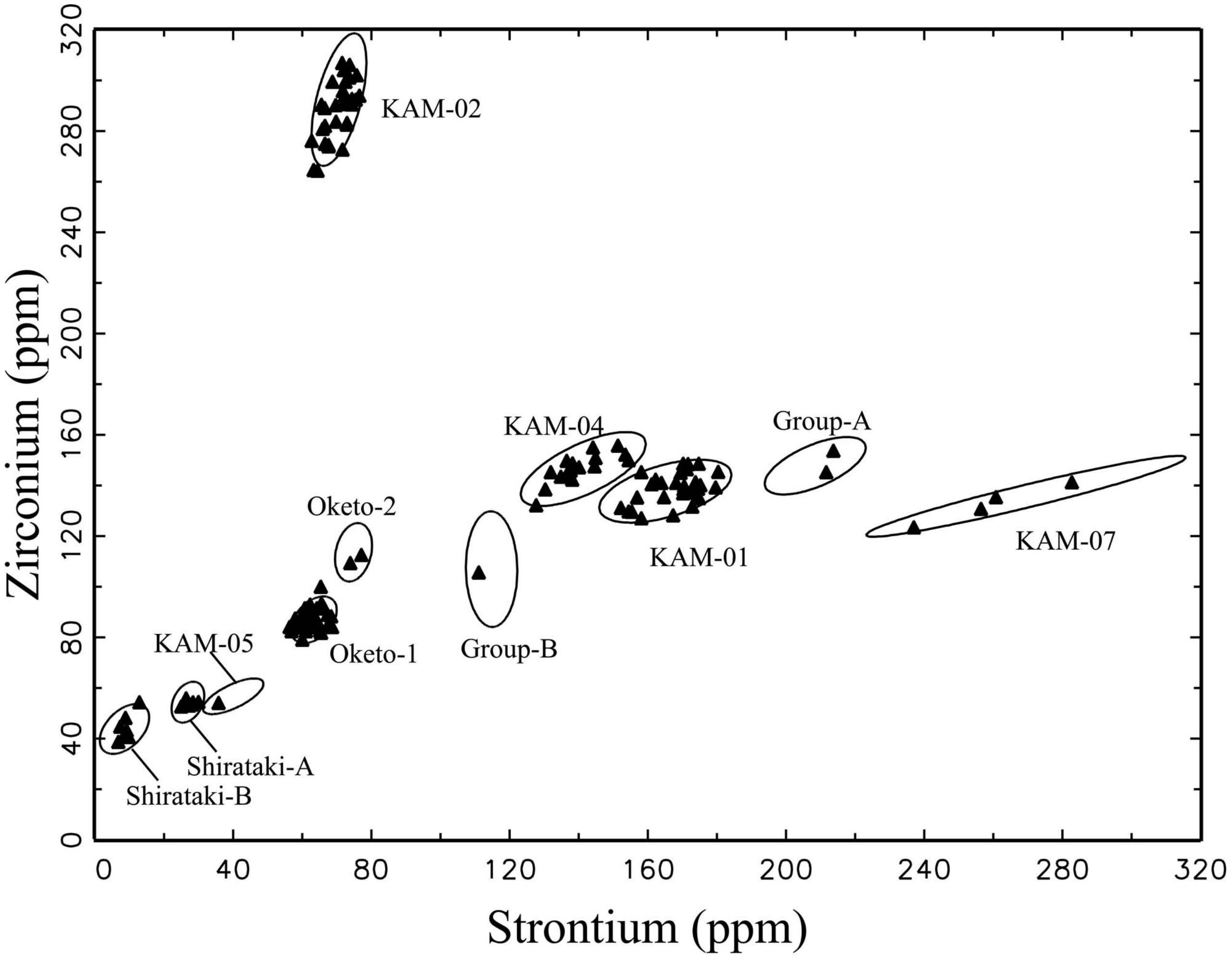

Figure 7.2. Sr vs. Zr plot of obsidian artefact compositions (n = 131) from the Kurile Islands using pXRF in the initial pilot study (Phillips and Speakman 2009). The ellipses surrounding each group are drawn at the 95% confidence level. Confidence ellipses were drawn using a minimum of four data points from a larger group of obsidian artefacts, though only the artefacts relevant to this paper are presented here

remote central Kuriles (Fitzhugh *et al.* 2002; Kikuchi 1999; Okada 1998; Vasilevsky and Shubina 2006; Yamaura 1998; Yamaura and Ushiro 1999). The Epi-Jomon period in the Kurile Islands represents a remnant continuation of the Jomon culture which had transitioned from a hunting and gathering economy to a more sedentary agriculture subsistence system in most of the Japanese Islands including southern Hokkaido. Epi-Jomon technology continued to rely on stone and bone tools with the introduction of a small amount of imported iron tools (Imamura 1996). Evidence of Epi-Jomon occupations based on recent ceramic identifications are found as far north as Shiashkotan Island in the north-central part of the Kurile chain (E. Gjesfjeld, personal communication 2009).

Around 1400 BP the intensively marine-oriented Okhotsk culture appeared on Sakhalin Island, potentially having migrated out of the Amur River basin on the Northeast Asian mainland (Okada 1998; Sato *et al.* 2007). Okhotsk people, identified by a complex mixture of ceramic styles from the Amur River basin and Sakhalin and Hokkaido islands, occupied the northern and eastern coasts of Hokkaido, and expanded throughout the entire Kurile Island chain and potentially into southern Kamchatka (Imamura 1996; Otaishi 1994; Yamaura 1998; Yamaura and Ushiro 1999). The Okhotsk reliance on marine resources is recognised through a technological tool kit that contained a variety of sea mammal hunting harpoon styles, composite fish hooks, and the predominance of bone tools made from sea mammal bones (Okada 1998).

After ca. 800 BP, the Okhotsk people were replaced on Hokkaido and in the Kurile Islands by the Ainu culture (Fitzhugh and Dubreuil 1999). The Ainu people are believed to be descendants of a combination of the Satsumon culture that established plant cultivation along with terrestrial hunting and riverine fishing in the interior of Hokkaido, and the remnant coastal Okhotsk culture (Okada 1998). In the Kurile Islands, the Ainu continued to employ a maritime-adapted resource economy, and also developed trade relationships with European and American explorers and trading companies (Ohnuki-Tierney 1976; Shubin 1994; Stephan 1974; Tezuka 1998; Vysokov 1994).

Based on previous analysis of small lithic assemblages from the Kuriles, it was proposed that the islands were sufficiently isolated to constrain the spread of non-local raw materials throughout the island chain via mobility or exchange (Fitzhugh *et al.* 2004). The limited surveys that have been conducted by the KBP for geological sources of obsidian in the Kurile Islands have only located sparse outcrops of fractured perlite (M. Nakagawa, personal communication 2007; A. V. Rybin, personal communication 2006). However, recent archaeological excavations by the KBP at sites in the southern, central, and northern parts of the island chain, and work by Russian archaeologist O. A. Shubina in the southern islands, have recovered obsidian artefacts from contexts associated with Epi-Jomon and Okhotsk site occupations spanning roughly 1750 years (ca. 2500–750 BP). An initial pilot project conducted by Phillips and Speakman (2009) analysed 131 obsidian flakes from 18 sites on eight islands using a portable X-ray Fluorescence (hereafter – pXRF) spectrometer. This study identified nine different source groups located in Hokkaido and Kamchatka (Figure 7.2) in this sample assemblage, indicating a long-term utilisation of non-local obsidian across the Kuriles. While this study provided a baseline of data for the region, only flakes approximately 5mm in diameter and larger and with one flat side were analysed due to the flake morphology and minimum size requirements inherent in pXRF instruments. The research presented here is an attempt to further refine these initial findings with a larger and more varied sample of Kurile obsidian artefacts.

Materials and Methods

More than 2000 obsidian artefacts, including formal tools, retouched flakes, and tool production debitage, were recovered from 26 archaeological sites across the southern, central, and northern Kurile Islands during the KBP 2006 and 2007 field seasons. Most of the archaeological sites investigated by the KBP were visited for only one or two days to conduct short surveys and small test excavations, and usually one to three 1 × 1 metre test pits were excavated at each site. The Ainu Creek, Vodopodnaya 2, and Drobnyye sites received more extensive investigation, with up to two weeks spent at the site, and the excavation of multiple 2 × 2m excavation units.

Because all formal lithic tools and retouched flakes are curated at the Sakhalin Regional Museum in Yuzhno-Sakhalinsk, Russia, only the flake debitage was available to analyse in the United States for the current study. The obsidian debitage assemblage is dominated by small flakes created through bifacial reduction and retouch with an average weight of 0.17g and average medial width of 4.14mm. The current study analysed 774 flakes from 18 sites (Figure 7.1) using LA-ICP-MS to build upon the previous study, and included flakes smaller than 5mm to potentially increase the diversity of the sources that occur in Kurile Island flake assemblages (Eerkens *et al.* 2007). Obsidian flake assemblages from six archaeological sites (Rikorda 1, Ainu Creek 1, Vodopodnaya 2, Drobnyye 1, Savushkina 1, and Baikova 1) distributed across the southern, central, and northern parts of the island chain make up 92.6% of the current study sample; the complete study sample represents all of the obsidian flakes in the Kurile assemblage that could not be analysed with pXRF.

In recent years, laser ablation (LA) systems used in tandem with inductively-coupled-plasma mass spectrometers (ICP-MS) have gained increasing popularity as a tool for chemical analyses of both organic and inorganic matrices. LA-ICP-MS offers several advantages over other analytical methods, including high accuracy and precision, low detection limits, rapid analytical time, low cost per sample, high sample throughput, and minimal damage to objects (Cochrane and Neff 2006; Speakman and Neff 2005; Speakman *et al.* 2002). Although LA-ICP-MS has been indispensable as a method of determining the chemical properties of cultural materials (Devos *et al.* 1999, 2000; Gratuze 1999; Gratuze *et al.* 2001; James and Dahlin 2005; Kennett *et al.* 2001;

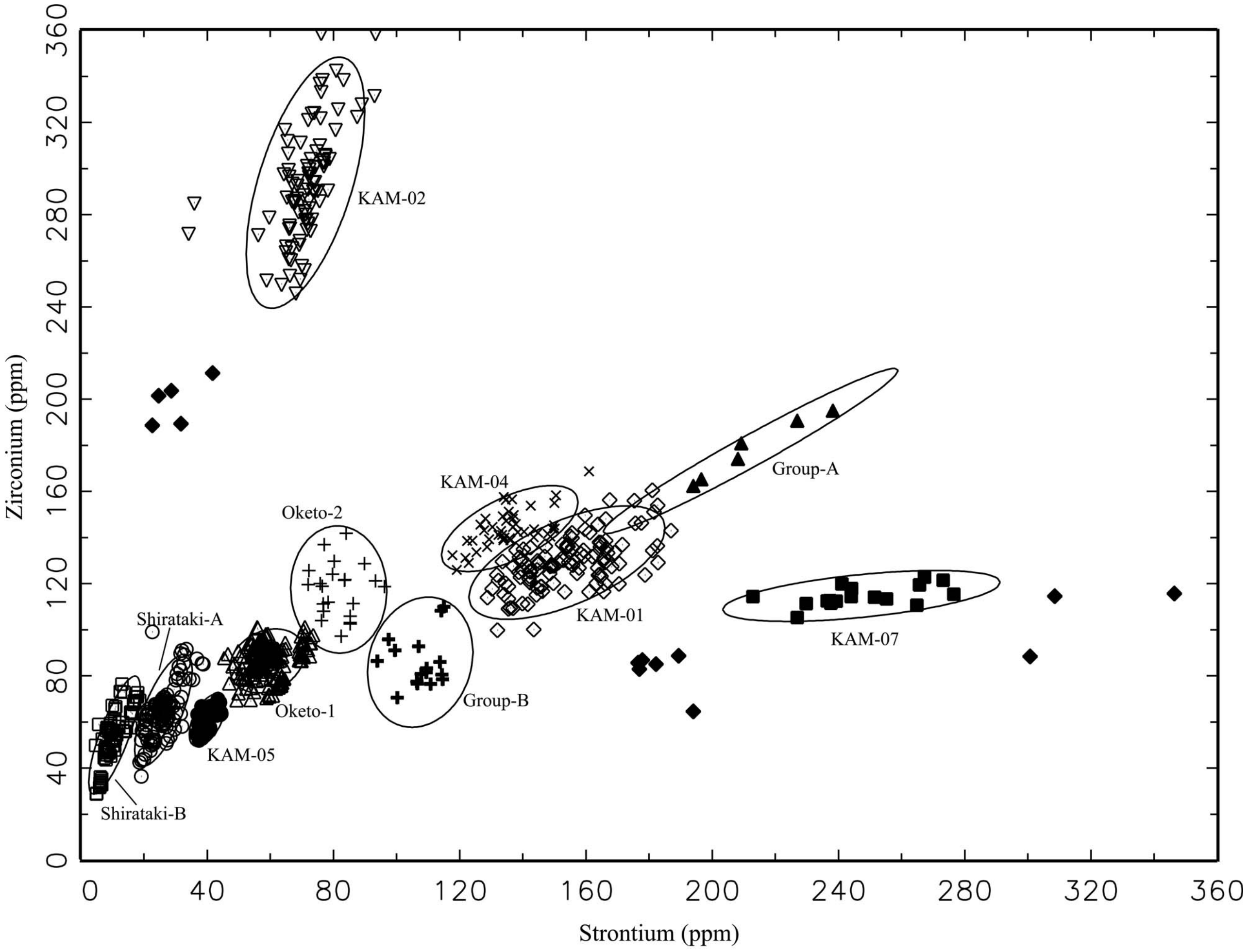

Figure 7.3. Sr vs. Zr plot of obsidian artefact compositions (n = 774) from the Kurile Islands using LA-ICP-MS. The ellipses surrounding each group are drawn at the 95% confidence level. Confidence ellipses were drawn using a minimum of four data points

Mallory-Greenough *et al.* 1999; Speakman and Neff 2005), its focus on small sample areas makes this technique ideally suited for the analysis of compositionally homogenous matrices, such as obsidian.

The current sample of obsidian flake debitage was analysed at the Smithsonian Institution's Museum Conservation Institute (Suitland, MD, USA) using a Perkin Elmer Elan 6000 ICP-MS and CETAC LSX 200nm laser ablation unit. Flakes were mounted so that the flattest face (dorsal or ventral) was exposed to the laser, and were pre-ablated to remove any surface contaminants with the laser operated at 70% power using a 200 micron diameter spot size running at a 20Hz pulse rate over a computer generated raster at a speed of 100 micron/sec. They were then ablated at 70% power using a 100 micron in diameter spot size operating at a 20Hz pulse rate over a computer generated raster at a speed of 30 micron/sec to generate elemental abundance data. Argon served as the transport gas from the laser ablation unit to the ICP-MS. At the beginning and end of each daily analysis session, a series of blanks, the NIST SRM 612 glass standard, and six well-characterised obsidian samples that previously had been analysed by Neutron Activation Analysis (NAA) were run to develop a set of calibration parameters and to monitor instrumental drift of the ICP-MS, which can affect count rates over several hours and/or days.

The ICP-MS analysis of obsidian artefacts generated data for 29 different elements; of these, Sr and Zr were used to discriminate between the primary Hokkaido and Kamchatkan sources and matched the elements used in the initial pilot project to differentiate obsidian source groups. Data generated from the analyses, expressed as counts per second, were ratioed to an internal standard (in this case Si) to normalise for different count rates between samples and standards. The normalisation approach used is modified from that suggested by Gratuze (1999) and others (e.g., Speakman and Neff 2005).

Results

The results of the LA-ICP-MS analysis of obsidian flakes indicate that 11 different source groups were identified (Figure 7.3) and which are in close agreement with the source groups determined in the original pXRF pilot study (Phillips and Speakman 2009). Although there are differences between pXRF and LA-ICP-MS in terms of their precision, specific source groups are accurately differentiated by each of the methods allowing for a comparison of the data sets created via both trace element analysis techniques.

Data for the source groups identified in the current artefact sample are summarised in Table 7.3. Four of the source groups are located in Hokkaido (Shirataki-A, Shirataki-B, Oketo-1 and Oketo-2), five are situated in Kamchatka (Kamchatka-1, Kamchatka-2, Kamchatka-4, Kamchatka-5, and Kamchatka-7 [named by primary investigators as KAM-01 through 07; see Kuzmin *et al.* (2008) – *Editors*]), while the locations of the Group-A and Group-B source groups are currently unknown. There were also 15 flakes that were not assigned to any source group. Obsidian from Hokkaido source groups represents 57.5% (n = 445) of the total Kurile Island sample assemblage that was analysed with LA-ICP-MS, with Kamchatkan source groups accounting for 37.7% (n = 292), Group-B – 2.1% (n = 16), flakes unassigned to any source group – 1.9% (n = 15), and Group-A – 0.8% (n = 6). The dominance of the Hokkaido source groups in the overall assemblage is less important due to the fact that most of those obsidian artefacts come from a single site, Ainu Creek 1, which had the largest volume of material excavated of any other archaeological site in the Kurile Islands during the KBP expeditions (Table 7.4). More interesting is the distribution of the different source groups across the island chain.

The initial study (Phillips and Speakman 2009) found that obsidian artefacts from the Hokkaido source groups were primarily distributed across the southern Kurile Islands, while Kamchatkan obsidian was concentrated in the central and northern islands, with very little crossover or mixing of Hokkaido and Kamchatkan sources. The current research found a similar pattern of distribution based on a sample size that is almost six times larger than the initial study.

The Hokkaido obsidian source groups are located in two major volcanic complexes in northeastern Hokkaido, the Shirataki (43º55´ N, 143º09´ E) and Oketo (43º42´ N, 143º32´ E) volcanoes (see Hall and Kimura 2002; Kuzmin *et al.* 2002a). Almost all of the obsidian from the Hokkaido source groups (97.9%; n = 436) is distributed across archaeological sites in the southern Kurile Islands, with only nine flakes from Hokkaido recovered from sites in the central and northern parts of the island chain (Table 7.5). Obsidian from the Oketo-1 source group represents 53% (n = 236) of the total Hokkaido obsidian-sourced artefact assemblage, and while the Oketo-1 source is the most abundant within all of the Hokkaido source groups, it is currently not necessarily the most widely distributed source in the southern islands. The Oketo-1 source is found in five archaeological sites across Kunashir, Iturup, and Urup islands, while the Shirataki-B source is found in seven sites, the Shirataki-A source in five sites, and the Oketo-2 source in four sites. However, the sites where Oketo-1 obsidian was not found suffer from small sample sizes ($n \leq 10$), and it might be expected that obsidian from this source would be found in larger assemblages.

Small amounts of the Oketo-1, Oketo-2, and Shirataki-A source groups were found in the central and northern Kurile Islands. Three obsidian flakes from Oketo-1 were recovered from the Vodopodnaya 2 site on the central island of Simushir, and one flake from the Baikova 1 site on the northern Shumshu Island. Two flakes from the Oketo-2 source were found in two northern sites, one each at Baikova 1 and the Savushkina 1 site on Paramushir Island. Three flakes from the Shirataki-A source were excavated from the Vodopodnaya 2 site.

The Kamchatkan obsidian sources include five different source groups, KAM-01, KAM-02, KAM-04, KAM-05, and KAM-07. Only the KAM-05 and KAM-07 source groups have been confidently located geographically in central Kamchatka, with the KAM-05 group representing the Maly Payalpan Volcano and the KAM-07 group representing the Ichinsky Volcano near the headwaters of the Belogolovaya Vtoraya River (Kuzmin *et al.* 2008). The location of the KAM-01, KAM-02, and KAM-04 source groups have been loosely estimated based on the distribution of artefacts in archaeological sites in the southern and eastern parts of the Kamchatka Peninsula (Glascock *et al.* 2006; Kuzmin *et al.* 2008; see also Grebennikov *et al.*, this volume).

In the entire sample of Kamchatka-sourced obsidian, the KAM-01 (38.7%; n = 113) and KAM-02 (30.5%; n = 89) source groups are represented in the highest frequency in this study. Sixty-nine percent of the KAM-01 obsidian artefacts were found in the northern sites of Savushkina 1, Tukharka River 1 (both on Paramushir Island) and Baikova 1 (on Shumshu Island). The KAM-02 assemblage is concentrated in central Kurile sites, with 90% (n = 80) of the obsidian flakes from that group found in the Vodopodnaya 2, Ryponkicha 1, and Drobnyye 1 sites. Interestingly, almost 20% (n = 16) of the obsidian artefacts from the Rikorda 1 site on the southern island of Kunashir were made from KAM-05 obsidian, while only three other flakes from any Kamchatkan sources were found in the southern Kuriles. All of the KAM-05 obsidian found in the Rikorda 1 site came from two adjoining stratigraphic levels in the same test pit excavation, and may be the result of a single reduction event of a larger piece of KAM-05 obsidian. Confirmation of this hypothesis will require further lithic technological analysis currently in progress. Aside from one flake recovered from the southern Ainu Creek 1 site, the rest of the KAM-05 obsidian assemblage (39.3%; n = 11) was spread across four sites in the central Kuriles.

A total of 22 artefacts plotted together in two different groups that did not fit with any of the Hokkaido or Kamchatkan source groups were identified in the original pilot study. Group-A consisted of six artefacts that were all excavated from the Baikova 1 site on Shumshu Island in the northern Kuriles. Of the 16 artefacts assigned to the Group-B source group, 14 of them were recovered from sites in the central and northern Kuriles. The geographic distribution of Group-A and Group-B artefacts follows a similar pattern seen in the distribution of the Kamchatkan source groups; it is hypothesised that the Group-A and Group-B sources are located somewhere on the Kamchatka Peninsula. Finally, 15 obsidian flakes could not be assigned

Table 7.3. Means and standard deviations for elemental concentrations from obsidian artefacts analysed in this study; after Glascock et al. (2000, 2006); Kuzmin (2006b); Kuzmin and Glascock (2007); Kuzmin et al. (1999, 2000, 2002a, 2008); and Speakman et al. (2005)) for original obsidian source geochemical characterisation data. Values in ppm except where noted; S.D. – standard deviation

Source	**Shirataki-A**		**Shirataki-B**		**Oketo-1**		**Oketo-2**		**KAM-1**		**KAM-2**		**KAM-4**		**KAM-5**		**KAM-7**		**Group-A**		**Group-B**	
	***n* = 108**		***n* = 79**		***n* = 236**		***n* = 22**		***n* = 113**		***n* = 89**		***n* = 45**		***n* = 28**		***n* = 17**		***n* = 6**		***n* = 16**	
Element	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
K, %	33.754	6.150	34.135	5.951	34.246	6.342	43.691	10.965	27.415	6.324	40.981	8.728	26.900	2.014	32.724	15.408	43.664	12.088	39.522	5.521	20.149	6.296
Mn	454	114	464	80	359	109	557	150	803	266	1224	430	596	192	343	102	892	253	1237	132	482	196
Fe, %	23.275	13.009	18.167	12.987	9.193	3.929	15.842	5.865	19.855	6.624	28.382	10.276	15.968	5.745	7.016	3.839	18.629	10.775	31.628	3.171	12.721	8.211
Zn	79	35	67	33	37	10	62	15	60	25	101	30	45	16	28	10	61	26	125	77	39	22
Ga	20	4	19	4	18	2	25	6	18	3	22	3	16	2	13	2	21	4	26	2	13	4
Rb	143	26	160	30	140	12	178	56	65	9	106	9	67	5	99	11	74	8	92	3	54	32
Sr	26	4	11	4	58	7	82	7	154	14	71	8	136	10	41	4	247	18	212	17	107	7
Y	29	6	33	6	24	3	32	7	18	4	62	9	21	3	16	4	11	2	22	2	14	8
Zr	64	10	54	12	86	6	117	11	129	11	294	25	144	8	61	6	115	4	178	13	86	11
Nb	5	1	5	1	4	1	6	2	2	0	7	1	2	1	6	4	7	1	2	0	2	1
Cs	9	2	11	2	7	1	9	2	4	1	5	0	4	0	4	1	1	0	5	0	3	2
Ba	1372	227	625	512	1590	180	2062	543	1131	165	1374	224	1218	130	890	388	1659	241	1516	173	812	232
La	21	3	16	6	22	2	28	7	13	2	35	5	14	1	19	4	20	2	18	1	10	5
Ce	43	6	35	9	45	4	58	15	28	5	79	10	29	2	36	6	37	3	38	2	21	9
Pr	5	1	4	2	5	1	6	2	4	1	11	3	4	1	4	1	4	1	5	1	3	1
Nd	17	3	14	5	17	2	23	6	12	2	33	5	13	2	12	2	13	2	16	2	8	5
Sm	4	1	4	1	4	0	5	1	3	1	12	2	4	0	3	0	3	0	4	0	2	1
Eu	0	0	0	0	0	0	1	0	1	0	2	1	1	0	0	0	1	0	1	0	0	0
Gd	4	1	4	1	3	1	4	1	3	1	10	2	3	1	2	0	2	0	3	1	2	1
Tb	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Dy	4	1	5	1	4	0	5	1	3	1	10	2	3	0	2	1	2	0	3	0	2	1
Ho	1	0	1	0	1	0	1	0	1	0	2	1	1	0	0	0	0	0	1	0	0	0
Er	3	1	3	1	2	1	3	1	2	1	6	2	2	0	1	0	1	0	2	1	1	1
Tm	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Yb	3	1	3	1	3	0	3	1	2	1	7	1	2	0	2	0	1	0	3	0	2	1
Lu	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hf	3	0	3	1	3	0	4	0	4	0	9	1	5	0	2	0	3	0	6	0	3	0
Ta	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0
Th	11	2	10	3	12	1	15	5	4	1	8	1	5	0	9	1	5	0	6	0	4	3

Table 7.4. Distribution of obsidian source groups across Kurile Island archaeological sites; names of sources are in bold. Columns under the names of sources are (from left to right): Site No. and Name; No. of samples; % in total assemblage

Shirataki-A			***Shirataki-B***			***Oketo-1***			***Oketo-2***		
2 Peschanaya 2	1	0.9	1 Alekhina 1	1	1.3	3 Rikorda 1	37	15.7	2 Peschanaya 2	1	4.5
3 Rikorda 1	8	7.4	2 Peschanaya 2	2	2.5	4 Sernovodsk 1	6	2.5	3 Rikorda 1	3	13.6
5 Berezovka 1	1	0.9	3 Rikorda 1	20	25.3	5 Berezovka 1	1	0.4	4 Sernovodsk 1	3	13.6
6 Kuibyushevskaya 1	3	2.8	4 Sernovodsk 1	1	1.3	7 Tikhaya 1	1	0.4	8 Ainu Creek 1	13	59.3
8 Ainu Creek 1	92	85.2	5 Berezovka 1	2	2.5	8 Ainu Creek 1	187	79.3	15 Savushkina 1	1	4.5
10 Vodopodnaya 2	3	2.8	6 Kuibyushevskaya 1	7	8.9	10 Vodopodnaya 2	3	1.3	17 Baikova 1	1	4.5
			8 Ainu Creek 1	46	58.2	17 Baikova 1	1	0.4			
Total	**108**	**100%**	**Total**	**79**	**100%**	**Total**	**236**	**100%**	**Total**	**22**	**100%**
KAM-01			***KAM-02***			***KAM-04***			***KAM-05***		
3 Rikorda 1	1	0.9	8 Ainu Creek 1	1	1.1	10 Vodopodnaya 2	15	33.3	3 Rikorda 1	16	57.1
9 Peschanaya Bay 1	4	3.6	10 Vodopodnaya 2	28	31.5	13 Drobnyye 1	2	4.4	8 Ainu Creek 1	1	3.6
10 Vodopodnaya 2	5	4.4	11 Ryponkicha 1	3	3.4	15 Savushkina 1	27	60.1	10 Vodopodnaya 2	7	25.0
13 Drobnyye 1	25	22.1	13 Drobnyye 1	49	55.1	17 Baikova 1	1	2.2	12 Rasshua 1	1	3.6
15 Savushkina 1	30	26.5	15 Savushkina 1	1	1.1				13 Drobnyye 1	2	7.1
16 Tukharka River 1	1	0.9	17 Baikova 1	5	5.6				14 Ekarma 1	1	3.6
17 Baikova 1	47	41.6	18 Bolshoi 1	2	2.2						
Total	**113**	**100%**	**Total**	**89**	**100%**	**Total**	**45**	**100%**	**Total**	**28**	**100%**
KAM-07			***Group-A***			***Group-B***			***Unknown***		
10 Vodopodnaya 2	16	94.1	17 Baikova	6	100	4 Sernovodsk 1	1	6.3	8 Ainu Creek	1	6.7
13 Drobnyye 1	1	5.9				8 Ainu Creek 1	1	6.3	9 Peschanaya Bay 1	1	6.7
						9 Peschanaya Bay 1	6	37.3	10 Vodopodnaya 2	8	53.2
						10 Vodopodnaya 2	4	25.0	11 Ryponkicha 1	3	20.0
						14 Ekarma 1	1	6.3	12 Rasshua 1	1	6.7
						15 Savushkina 1	1	6.3	14 Ekarma 1	1	6.7
						17 Baikova 1	2	12.5			
Total	**17**	**100%**	**Total**	**6**	**100%**	**Total**	**16**	**100%**	**Total**	**15**	**100%**

to any of the 11 source groups currently identified through pXRF and LA-ICP-MS analyses.

Discussion

The distribution of non-local obsidian across the Kurile Islands can be placed into the broader regional context of obsidian movement and usage in Northeast Asia. It has been demonstrated that obsidian from sources on the Japanese island of Hokkaido was transported on distances of up to 1000km to Sakhalin Island of the Russian Far East for almost 20,000 years (Glascock *et al.* 2000, 2006; Kuzmin 2006a, 2006b; Kuzmin and Glascock 2007; Kuzmin *et al.* 2000, 2002a, 2008). Given the geographic proximity of the southern Kuriles to Hokkaido, it could be expected that the Hokkaido–Sakhalin obsidian trade/transport network would be extended into the Kurile Islands. The initial movement of obsidian onto the islands of Kunashir, Iturup, and Urup may have coincided with early colonisation of those islands by Early or Middle Jomon people.

Although less is known about the trade and transport of obsidian from Kamchatkan source groups, several recent studies have shown that obsidian was transported from sources to sites around the Kamchatka Peninsula at distances of up to 400km (Glascock *et al.* 2006; Kuzmin *et al.* 2008; Speakman *et al.* 2005). Based on the current work it is clear that obsidian from Kamchatkan sources was used extensively in the central and northern Kuriles. Only 19 out of a total of 292 flakes made from Kamchatkan obsidian are found in southern Kurile archaeological sites, 16 of those from the same test pit on the Rikorda 1 site.

The nature of obsidian source group distribution within the Kurile Islands represents a data set of archaeological materials that can be leveraged to explore issues related to human migration and social networking. Personal relationships between and among human groups provide a social means for circumventing the local subsistence and material resource constraints that are inherent to geographically isolated environments (Mackie 2001). At

Table 7.5. Obsidian source groups represented in Kurile Island archaeological sites. Site Nos. and Names are in bold. Columns under sites' names are (from left to right): Source Name; No. of samples; % in total assemblage

1			***2***			***3***			***4***			***5***		
Alekhina			***Peschanaya 2***			***Rikorda 1***			***Sernovodsk 1***			***Berezovka 1***		
Shirataki-B	1	100.0	Oketo-2	1	25.0	KAM-01	1	1.2	Group-B	1	9.1	Oketo-1	1	25.0
			Shirataki-A	1	25.0	KAM-05	16	18.8	Oketo-1	6	54.5	Shirataki-A	1	25.0
			Shirataki-B	2	50.0	Oketo-1	37	43.6	Oketo-2	3	27.3	Shirataki-B	2	50.0
						Oketo-2	3	3.5	Shirataki-B	1	9.1			
						Shirataki-A	8	9.4						
						Shirataki-B	20	23.5						
Total	**1**	**100%**	**Total**	**4**	**100%**	**Total**	**85**	**100%**	**Total**	**11**	**100%**	**Total**	**4**	**100%**
6			***7***			***8***			***9***			***10***		
Kuibyushevskaya 1			***Tikhaya 1***			***Ainu Creek 1***			***Peschanaya Bay 1***			***Vodopodnaya 2***		
Shirataki-A	3	30.0	Oketo-1	1	100.0	Group-B	1	0.3	Group-B	6	54.5	Group-B	4	4.5
Shirataki-B	7	70.0				KAM-02	1	0.3	KAM-01	4	36.4	KAM-01	5	5.6
						KAM-05	1	0.3	Unknown	1	9.1	KAM-02	28	31.4
						Oketo-1	187	54.8				KAM-04	15	16.9
						Oketo-2	12	3.5				KAM-05	7	7.9
						Shirataki-A	92	27.0				KAM-07	16	17.9
						Shirataki-B	46	13.5				Oketo-1	3	3.4
						Unknown	1	0.3				Shirataki-A	3	3.4
												Unknown	8	9.0
Total	**10**	**100%**	**Total**	**1**	**100%**	**Total**	**341**	**100%**	**Total**	**11**	**100%**	**Total**	**89**	**100%**
11			***12***			***13***			***14***					
Ryponkicha 1			***Rasshua 1***			***Drobnyye 1***			***Ekarma 1***					
KAM-02	3	50.0	KAM-05	1	50.0	KAM-01	25	31.6	Group-B	1	33.3			
Unknown	3	50.0	Unknown	1	50.0	KAM-02	49	62.1	KAM-05	1	33.3			
						KAM-04	2	2.5	Unknown	1	33.4			
						KAM-05	2	2.5						
						KAM-07	1	1.3						
Total	**6**	**100%**	**Total**	**2**	**100%**	**Total**	**79**	**100%**	**Total**	**3**	**100%**			
15			***16***			***17***			***18***					
Savushkina 1			***Tukharka River 1***			***Baikova 1***			***Bolshoi 1***					
Group-B	1	1.7	KAM-01	1	100.0	Group-A	6	9.5	KAM-02	2	100.0			
KAM-01	30	50.0				Group-B	2	3.2						
KAM-02	1	1.7				KAM-01	47	74.6						
KAM-04	27	44.9				KAM-02	5	7.9						
Oketo-2	1	1.7				KAM-04	1	1.6						
						Oketo-1	1	1.6						
						Oketo-2	1	1.6						
Total	**60**	**100%**	**Total**	**1**	**100%**	**Total**	**63**	**100%**	**Total**	**2**	**100%**			

the local scale, social networks are a way to exchange information related to the day-to-day extraction of subsistence and material resources that are unevenly distributed (Cashdan 1983). Mobility is another way of lessening the potential negative impact on resource acquisition success, especially when territories are large (Cashdan 1987, 1992). At a regional level, social networks are cooperative strategies that often form a 'safety net' of support that can be critical in times of local resource scarcity or failure as a result of environmental variability (e.g., natural catastrophic events) (Bender 1978; Kennett and Kennett 2000; Rautman 1993; Rensink *et al.* 1991; Whallon 1989, 2006).

A relative measure of the access to obsidian sources that inhabitants of the southern Kurile Islands maintained would be through a degree of the richness of sources found in southern Kurile archaeological sites. Obsidian source richness in sites is simply the number of different obsidian source groups found in a site's obsidian artefact assemblage. Before a richness measure can be considered for a site assemblage however, the potential effects of

Table 7.6. Rank Order of southern Kurile archaeological site assemblage sample size and source richness (Spearman's r = 0.926; p = 0.72)

Site	***No. of samples***	***Rank (Samples)***	***Richness***	***Rank (Richness)***
Alekhina	1	1.5	1	1.5
Peschanaya 2	4	3.5	3	4.5
Rikorda 1	85	7	6	7
Sernovodsk 1	11	6	4	6
Berezovka 1	4	3.5	3	4.5
Kuibyushevskaya 1	10	5	2	3
Tikhaya 1	1	1.5	1	1.5
Ainu Creek 1	342	8	7	8

sample size on richness must be considered (Grayson 1984; Grayson and Cole 1998). Table 7.6 displays the Spearman's Rank Order of southern Kurile Island archaeological sites in terms of site obsidian artefact assemblage size and in terms of the number of different obsidian sources that are represented in the site (see Larson and Farber 2003, 573 for explanation of Spearman's Rank Order; for examples of usage in archaeological research see Grayson 1984, 1989). These two ranks are highly correlated (Spearman's *rho*, $r_s = 0.926$; $p = 0.72$), demonstrating that the larger the assemblage for a site, the greater number of sources found in that assemblage.

An alternative to measuring source richness in terms of the number of sources present in a site, is to reverse the analysis and measure site richness in terms of the number of sites in which each source is present. Table 7.7 focuses on the Hokkaido obsidian source group assemblages and their distribution in southern Kurile archaeological sites. A rank order correlation shows that these two ranks are not significantly correlated (Spearman's *rho*, $r_s = 0.316$; $p = 1$), allowing for further analysis of the evenness of the distribution of Hokkaido sources across the southern Kurile Islands as a whole.

Evenness measures are used to quantify the distribution of species in a community (Beck 2008; Bobrowsky and Ball 1989, 7; Grayson and Cole 1998). The measure of evenness is given as:

$$E = H / \ln S$$

where H is a measure of source-site diversity calculated by the Shannon diversity index and represented as $H = p_i \ln p_i$, with p_i the proportion of the eight southern Kurile sites in which each source group is present, and $\ln S$ is the natural logarithm of the number of different Hokkaido source groups. The values for evenness are constrained between 1 and 0, with values closer to 1 indicating a more even distribution of specimens across classes. An evenness value of 0.985 indicates that the four Hokkaido obsidian source groups were evenly distributed in regards to their presence in archaeological sites across the southern Kuriles.

Human groups that are highly mobile and able to procure lithic raw material on the landscape as part of their regularly scheduled resource extraction activities or planned logistical trips to raw material sources should have access to a higher number of different sources. Groups that are less mobile and rely on exchange relationships with other groups to obtain lithic raw material may have access to fewer different sources (Binford 1979; Morrow and Jeffries 1989; Pecora 2001).

Based on these measures of Hokkaido source group distribution, hypotheses can be developed to direct further study of these assemblages in the southern Kuriles. Access to different obsidian sources should be dependent upon the nature of group mobility and raw material procurement. Occupants of Kunashir, Iturup, and Urup islands may have had more direct access to primary and secondary obsidian deposits located in northern and eastern Hokkaido, leading to a wider and more even circulation of Hokkaido source groups in the southern Kuriles. The geographic nature of the southern Kuriles may have supported frequent travel and direct access since the straits between islands that must be crossed average roughly 25km in width (compared to straits in other parts of the archipelago that are over 80km wide). Additionally, the southern Kurile Islands are larger, more ecologically diverse, and less isolated than the central and northern Kuriles. Social networks formed by inhabitants there may have focused on localised information exchange for resource extraction rather than on forming long-distance lines of support that may have been necessary for survival in the central and northern parts of the island chain.

The measure of source richness for central and northern Kurile archaeological sites suffers from the same sample size effects as the southern Kurile sites. A Spearman's Rank Order correlation for central and northern Kurile site obsidian artefact assemblage size and the number of sources that are found in those sites (Table 7.8) shows a high correlation between the two variables (Spearman's *rho*, $r_s = 0.941$; $p = 0.65$). Based on the relative abundance of Kamchatkan sources present in archaeological sites, there appears to be a difference in the concentration of some source groups in the central Kuriles versus in the

Table 7.7. Rank Order of Hokkaido source group assemblage sample size and site richness (Spearman's r = 0.316; p = 1.0)

Obsidian source group/assemblage	***No. of samples***	***Rank (Samples)***	***Richness***	***Rank (Richness)***
Shirataki-A	105	2	5	4
Shirataki-B	79	3	7	1
Oketo-1	232	1	5	3
Oketo-2	20	4	4	2

Table 7.8. Rank Order of central and northern Kurile assemblage sample size and source richness (Spearman's r = 0.941; p = 0.65)

Site	***No. of samples***	***Rank (Samples)***	***Richness***	***Rank (Richness)***
Peschanaya Bay 1	11	6	2	5
Vodopodnaya 2	89	10	8	10
Ryponkicha 1	6	5	2	5
Rasshua 1	1	1.5	1	2
Drobnyye 1	79	9	5	7.5
Ekarma 1	2	3.5	2	5
Savushkina 1	60	7	5	7.5
Tukharka River 1	1	1.5	1	2
Baikova 1	63	8	7	9
Bolshoi 1	2	3.5	1	2

Table 7.9. Rank Order of Kamchatka, Group-A, and Group-B source group assemblage sample size and site richness (Spearman's r = 0.873; p = 0.78)

Obsidian source group/assemblage	***No. of samples***	***Rank (Samples)***	***Richness***	***Rank (Richness)***
KAM-01	112	1	6	1.5
KAM-02	88	2	6	1.5
KAM-04	45	3	4	4.5
KAM-05	11	6	4	4.5
KAM-07	17	5	2	6
Group-A	6	7	1	7
Group-B	19	4	5	3

northern islands. However, a rank order correlation between Kamchatkan source group assemblage size and site richness (Table 7.9) shows a similar correlation (Spearman's *rho*, $r_s = 0.873$; $p = 0.78$), precluding any further quantification of the evenness of the distribution of Kamchatkan source groups at this time.

Though further analysis of a larger sample will be required to make comparisons between the distributions of Hokkaido and Kamchatkan obsidian source groups, it appears that the Bussol Strait separating the southern and central Kuriles may have been a significant barrier to the transport of obsidian from both source areas. This strait is the widest one in the Kurile island chain, a combined 109km wide between Urup and Simushir islands (79km between Urup and Chirpoi islands and 30km between Chirpoi and Simushir islands). The Bussol Strait has a strong current flowing between the Pacific Ocean and the Sea of Okhotsk, and it is recognised as a biogeographic barrier to the movement of plants and animals from the southern to central part of the island chain (Pietsch *et al.* 2003). Human groups who moved from Hokkaido and the southern Kuriles into the central and northern part of the Kurile Archipelago may have found it too costly in terms of time, energy, and risk to maintain access to Hokkaido obsidian sources across this strait. Securing access to Kamchatka, obsidian sources would have provided a less costly alternative to Hokkaido obsidian, which may have been achieved by re-orienting seasonal or annual migration patterns towards the north and allowing for the direct procurement of Kamchatkan obsidian, or by developing trade and exchange relationships with the inhabitants of the southern Kamchatka Peninsula.

While a comprehensive ^{14}C chronology for the Kurile Islands is still being developed by the KBP and is currently unpublished, preliminary findings show that in the southern Kuriles obsidian from Hokkaido sources was accessed for over 1700 years beginning ca. 2500 BP, indicating long-term use of those sources. In the central and northern Kuriles, obsidian from Kamchatkan sources was used consistently for over 700 years spanning the Epi-Jomon and Okhotsk culture periods. Interestingly, small amounts of Hokkaido obsidian recovered from sites on Paramushir and Shumshu islands seem to come from Epi-Jomon contexts, which may indicate an early expansion by Epi-Jomon people throughout the entire length of the island chain (B. Fitzhugh, personal communication 2009).

Conclusions

Research on obsidian artefacts from the Kurile Islands demonstrates that the prehistoric inhabitants of the Kurile Archipelago had access to multiple sources of obsidian located on Hokkaido and the Kamchatka Peninsula. More interesting are the patterns of obsidian use in the southern, central, and northern Kurile Islands, which indicate that source access may have been influenced by geographic and social factors. In the Kuriles, changing patterns of obsidian distribution can be used to characterise hunter-gatherer social networks that were dynamic through time (Hofman *et al.* 2007), and to infer the role that the networks played in the overall organisation of small social groups living in unpredictable environments (Kirch 1988). Additional research on the provenance of obsidian artefacts found in Kurile archaeological sites, as well as the technological analysis of how obsidian was utilised vis-à-vis other lithic raw material types, will further explore these and other issues related to the human occupation of this region.

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