Shirataki obsidian exploitation and circulation in prehistoric northern Japan

Miyuki Yakushige and Hiroyuki Sato

Department of Archaeology, Graduate School of Humanities and Sociology, The University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan.
Email: Yakushige: nostalgiaporelpa@yahoo.co.jp; Sato: hsato@1.u-tokyo.ac.jp

Abstract:
Presently, the total number of archaeological obsidian sources in Japan is more than 80, and among them, 21 are in Hokkaido, northern part of the Japanese archipelago (Izuho and Sato 2007). Obsidian was the dominant of lithic raw material in the Upper Paleolithic Hokkaido (35-10 ka cal BP). Out of 21 archaeological obsidian sources in Hokkaido, 4 sources: Shirataki, Oketo, Tokachi, and Akaigawa are the major obsidian sources and the others are minor sources. Shirataki is one of the largest obsidian sources in Northeast Asia and it is well known that Shirataki obsidian was transported outside Hokkaido to Sakhalin and the Paleo-Honshu Island from the Late Upper Paleolithic period.

We compiled data of obsidian source analyses conducted to artefacts from Paleolithic sites in Hokkaido, and it became clear that the ratio of Shirataki obsidian in all analyzed materials is more than half (Sato and Yakushige in press).

We examined how far Shirataki obsidian was transported in each period: the Early Upper Paleolithic (35-25 ka cal BP) and the Late Upper Paleolithic (25-10 ka cal BP). The Late Upper Paleolithic is divided into three stage, the early Early Microblade Industry (Stage 1: 25-21 ka cal BP), the late Early Microblade Industry (Stage 2: 19-16 ka cal BP), and the Late Microblade Industry (Stage 3: 16-10 ka cal BP). As a result, it is revealed that the distribution areas of Shirataki obsidian did not expand gradually over time, but are different in different lithic industries. In the background of this situation lay the difference of ecological adaptation strategies adopted by the prehistoric people of the time and their movement behavioral strategies.

Keywords: Hokkaido, Sakhalin, Paleo-Honshu Island, Upper Paleolithic, obsidian, microblade industry, Lithic raw material, seafaring

1. Introduction
In the Japan Sea Rim Area, multiple obsidian sources have been discovered in the Russian Maritime Provinces, the middle Amur River, the border area between China and North Korea, and Hokkaido in the northern part of the Japanese archipelago (Kuzmin & Glascock 2010). The Shirataki obsidian source is located in the eastern part of Hokkaido, and one of the largest obsidian sources in this Japan Sea Rim area. In this area, the subsistence
strategies of modern humans displaying long distance mobility were supported by lithic technologies such as blade and microblade technology, the obsidian having been adopted as the raw material of these technologies. Therefore, obsidian source analysis data is an important clue in revealing population interaction and movement in this area.

Data from obsidian source analyses has recently been accumulated in the Japan Sea Rim area (Kuzmin & Popov 2000; Kuzmin & Glascock 2010), and progress has been made in the geographical/archaeological research of obsidian sources (Hall & Kimura 2002, Izuho & Sato 2007, Izuho et al. 2008, Izuho & Higashino 2010, Sato 2011a, b). This has enabled us to discuss the process of human adaptation to regional environments and the circulation network of lithic raw materials by showing there was indeed utilization of each obsidian source. For example, microblade industries in Hokkaido are characterized by their use of obsidian as the main raw material and their standardization of microblade core types when compared with industries in the surrounding areas (Sato 2010). For the first step in considering the background for this difference, we compiled data from obsidian source analyses in Hokkaido and examined the quality and size of obsidian from each source, the distance between sources and sites, and the relationship between sources and industries (Sato & Yakushige, in press). As a result, we were able to clarify that each industry in Upper Paleolithic Hokkaido had a specific tendency towards obsidian use and achieved a new understanding of the importance of the Shirataki obsidian source, that is, about half of the obsidian found in Upper Paleolithic sites in Hokkaido were from the Shirataki obsidian source. Therefore, we thought it necessary to investigate the diachronic and synchronic change of the Shirataki obsidian distribution area, and reveal how Shirataki obsidian was used in each industry and how far Shirataki obsidian was transported in prehistoric Hokkaido and surrounding areas.

2. Geographical settings, lithic raw material resources and chronology of Upper Paleolithic Hokkaido

2.1 Geographical settings

Hokkaido is located in the northern part of the Japanese archipelago. Due to a drop in sea level during the glacial period, geographical and ecological environments of the Japanese archipelago in the Upper Paleolithic were different from those of today (Figure 1). There was one large landmass named the Paleo-Honshu Island. On the contrary, the Mamiya Strait and the Soya Strait formed a land bridge, therefore Hokkaido was connected to the continent and formed the Paleo-Hokkaido Peninsula with Sakhalin and the Kuril Islands. Even more significant is that the Tsugaru Strait never had a land bridge, and Hokkaido and the Paleo-Honshu Island were separated throughout the Upper Paleolithic Period.

2.2 Lithic raw material resources

Presently, the total number of archaeological obsidian sources in the Japanese Archipelago is more than 80, and of those, 21 are in Hokkaido (Izuho et al. 2008) (Figure 2). Within them, Shirataki, Oketo (Figure 2-a), Tokachi (Figure 2-b), and Akaigawa (Figure 2-c) are major obsidian sources. Even though siliceous shale, agate and andesite were also used, obsidian was used by far the most in Paleolithic Hokkaido. The distance between the Oketo source and the Akaigawa source is the longest, reaching about 230 km. The Shirataki source is located on Akaishiyama Mountain in the northeastern part of Hokkaido. This source is one of the largest obsidian sources in Northeast Asia and characterized by several huge outcrops. There are many sites of various periods and industries on the fluvial terrace at the foot of the mountain, and about 100 sites around this source have been recognized so far (Naoe 2009). Since the chemical composition and characteristics of obsidian differ according to the
outcrop, we can identify outcrops by source analysis (Wada & Sano 2011). Obsidian cobbles in various shape and size are distributed from outcrops to creeks, and the slope and river at the foot of the mountain.

Figure 1. Geographical settings of the Japanese archipelago in the Upper Paleolithic period

2.3 Chronology

The chronology of Upper Paleolithic Hokkaido is largely divided into 2 periods: the Early Upper Paleolithic and the Late Upper Paleolithic (Table 1). The Late Upper Paleolithic begins with the emergence of microblade industries after 25ka cal BP. The Early Upper Paleolithic includes blade and trapezoid industries. The late Upper Paleolithic is divided into 3 stages (Yamada 2006) (Figure 3). Stage 1 is the early Early Microblade industry, 25-21ka cal BP, Stage 2 is the late Early microblade industry, 19-16ka cal BP, and Stage 3 is the Late microblade industry, 16-10ka cal BP. Stage 3 is characterized by the coexistence of various microblade industries.

Stage 1 includes the Pirika type, Tougeshita1 type and Rankoshi type microblade industries. Stage 2 includes the Sakkotsu type and Tougeshita2 type microblade industries, and stage 3 includes the Shirataki type, Oshorokko1, 2 type microblade industries, small boat-shaped tool 1, 2 type industries and the point and stemmed point industries. The Sakkotsu type of Stage 2 and Shirataki type of Stage 3 share the same technological feature, that being the real Yubetsu method. This method is characterized by the preparing of a biface as the blank of a microblade core and a spalling of the elongated edge for the creation of a platform. Because a cultural and social boundary was formed between the Paleo-Hokkaido Peninsula and the Paleo-Honshu Island throughout the Upper Paleolithic Period by the Tsugaru Strait, microblade industries in the Paleo-Hokkaido Peninsula and the Paleo-Honshu Island are significantly different. However, among microblade industries in Hokkaido, only the Sakkotsu type and the Shirataki type were distributed into the Paleo-Honshu Island beyond the Tsugaru Strait. Meanwhile, stemmed points appeared almost at the end of the Upper
Paleolithic Period and are often accompanied with microblade industries. They were not accompanied by pottery in Hokkaido, but at the same time in Paleo Honshu Island, they were accompanied by the earliest pottery and belong to the Initial Jomon period.

Figure 2. Obsidian sources in Hokkaido and Upper Paleolithic sites in which Shirataki obsidian was found
Table 1. Chronology of Upper Paleolithic Hokkaido.

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3. Materials and methods

The number of Upper Paleolithic sites in Hokkaido is 861 as of 2010 (Japanese Paleolithic Research Association 2010). We compiled the obsidian source analysis data of the Upper Paleolithic in and around Hokkaido reported thus far, including data from several laboratory analysis methods such as XRF and INAA. As a result, the number of sites where obsidian source analysis was done is 84, yielding 5,461 artifacts. This means only 9.8% of all Upper Paleolithic sites in Hokkaido have been analyzed. From this data, we extracted sites in which Shirataki obsidian was found in each period and industry (Table 2). Out of 5,461 artifacts from 84 sites, 2,720 artifacts (49.8%) from 56 sites are made from Shirataki obsidian. Then, we examined the change of Shirataki obsidian distribution areas in each industry. Paying careful attention to detail was important in analyzing this data. Because a few samples for analysis were chosen from thousands of artifacts in a random manner in some analyses, the results of these analyses do not necessarily show complete or actual tendency of obsidian use. However, we think we can at least recognize the tendency in transportation of Shirataki obsidian from these data.
Figure 3. Microblade industries in the Upper Paleolithic Hokkaido
### Table 2. Compiled data of sites in which Shirataki obsidian was found in Hokkaido and surrounding areas.

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**Legend**

1 Early Upper Paleolithic
2 Late Upper Paleolithic
2-A Early Microblade Industry
2-A-1 Rankoshi type microblade industry
2-A-2 Tougeshita 1 type microblade industry
2-A-3 Pirka microblade industry
2-B late Early Microblade Industry
2-B-1 Sakkotsu type microblade industry
2-B-2 Tougeshita 2 type microblade industry
2-C Late Microblade Industry
2-C-1 Shiratsuki type microblade industry
2-C-2 Hirusato type microblade industry
2-C-3 Small boat-shaped tool type industry
2-C-4 Oshorokko type microblade industry
2-C-5 bifacial point or stemmed point industry
4. Results

4.1 The Early Upper Paleolithic (35-25 ka cal BP)

We focus first on sites of the Early Upper Paleolithic, 35-25 ka cal BP (Figure 4). This stage includes trapezoid industry and blade tool industry. Figure 5 shows sites using Shirataki obsidian in the Early Upper Paleolithic. In this period, Shirataki obsidian was not transported outside of Hokkaido, but transported over a relatively wide area. The longest distance of transportation is 170 km.

![Figure 4. Distribution of Shirataki Obsidian in the Early Upper Paleolithic](image)

4.2 The Late Upper Paleolithic (25-10 ka cal BP)

4.2.1 Stage1 (early Early microblade industry) (25-21 ka cal BP)

Stage1 industries include the Pirika type, Tougeshita type, and Rankoshi type microblade industries (Figure 5). From this stage, people with microblade technology came into Hokkaido via Sakhalin, and this migration might signify refuge to the south caused by the
severe cold climate of the Last Glacial Maximum. The characteristics of this stage are not only the small number of sites but also the scarcity of tools yielded from each site. The distribution of Shirataki obsidian was limited to the near vicinity of the Shirataki source and greatly reducing the distribution area. The longest distance of transportation is 60 km.

**Figure 5. Distribution of Shirataki obsidian in the early Early microblade industries**

4.2.2 **Stage 2 (late Early microblade industry) (19-16ka cal BP)**

Stage 2 industries include the Sakkotsu type and Tougeshita 2 type microblade industries (Figure 6). The Sakkotsu type microblade industry belongs to the real Yubetsu method, and is widely distributed in Northeast Asian (Sato 2010). In this stage, the number of sites dramatically increased, and Shirataki obsidian was transported to distant areas. In particular, the transportation of Shirataki obsidian outside of Hokkaido started around this time. The longest distance of transportation is 380 km.

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doi:10.2218/jls.v1i1.768
4.2.3 Stage 3 (Late microblade industry) (16-10ka cal BP)

In Stage 3, we focus on each of the microblade industries separately, because they have different tendencies of obsidian usage.

Figure 6. Distribution of Shirataki obsidian in the late Early microblade industries

4.2.3.1 Shirataki type microblade industry

The Shirataki type microblade industry (Figure 7) is included in the real Yubetsu method and widely distributed beyond Hokkaido, similar to the Sakkotsu type microblade industry of the previous stage. In this stage, Shirataki obsidian was found from the Yunohana site (Tateishi et al. 2012) in the Tohoku region, in the northern part of Honshu Island. This is the only example of Shirataki obsidian transported onto Paleo-Honshu Island in the Upper
Paleolithic Period. This is important, because they transported Shirataki obsidian from Hokkaido to Paleo-Honshu Island across the Tsugaru Strait, and this implies the existence of seafaring in the Paleolithic period. The longest distance of transportation is about 700 km.

Figure 7. Distribution of Shirataki obsidian in the late microblade industry: Shirataki microblade industry

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doi:10.2218/jls.v1i1.768
4.2.3.2 Oshorokko type microblade industry

In the Oshorokko type microblade industry (Figure 8), Shirataki obsidian was not transported outside Hokkaido, and the distribution range is relatively smaller than other industries. The longest distance of transportation is 120 km.

![Figure 8. Distribution of Shirataki obsidian in the late microblade industry: Oshorokko type microblade industry](image)

4.2.3.3 Small boat shaped tool industry

This industry (Figure 9) is characterized by wide distribution of Shirataki obsidian, unlike the Oshorokko type microblade industry. Ogonki 5 site, in southern Sakhalin is included in this industry, and artifacts made by Shirataki obsidian have been found from this site (Kuzmin et al. 2002, Vasilevsky 2003). The longest distance of transportation is 320 km.
4.2.3.4 **Point and stemmed point industry**

The point and stemmed point industry (Figure 10) dates to the end of the Late Upper Paleolithic period. In that same period, pottery use commenced in Honshu and the south, signaling the beginning of the Jomon Period. In this industry, Shirataki obsidian was transported more widely than in the other stages. For example, Shirataki obsidian has been found from the Kosegasawa site (Warashina & Oguma 2003), an Initial Jomon Period site on Honshu Island. The longest distance of transportation is 750 km.

Hereafter, obsidian from Hokkaido was widely transported into both the northern part of Honshu Island and onto Sakhalin Island.
5. Discussion

We point out three results from our analysis.

First, the longest distance of Shirataki obsidian transportation differs in each period and industry.

Secondly, the Sakkotsu type and Shirataki type of the real Yubetsu method are characterized by dramatic expansion of distribution areas. This tendency implies that the change of obsidian distribution did not coincide with the start of Stage 1, when microblade...
technology first emerged. Moreover, the transportation of Shirataki obsidian beyond the Tsugaru Strait implies the existence of seafaring.

Thirdly, in Stage 3, not all industries show wide distribution. At the end of Stage 3 in the point and stemmed point industry, the distribution area of Shirataki obsidian expanded again. After that, Shirataki obsidian came to be regularly transported to the northern end of Honshu Island in the Jomon Period as well as Sakhalin Island and the northeastern part of the continent (Kuzmin et al. 2002).

Since Naoe’s (2009) argument on the procurement and the distribution of Shirataki obsidian, obsidian source analysis data was compiled, and we were able to confirm that our analysis results did not contradict his results.

We focus on the second point, the problem of the real Yubetsu industry.

Figure 11 shows obsidian source composition of Sakkotsu type microblade cores and Tougeshita type microblade cores. This graph implies that Sakkotsu type microblade cores are usually made from Shirataki obsidian. Tougeshita 2 type microblade cores, however, were made from obsidian of various sources. Consequently, real Yubetsu microblade cores had strong ties with Shirataki obsidian. Most of the Sakkotsu type microblade cores and the entire Sakkotsu type microblade industry requires large nodules of high quality, therefore Shirataki was the most suitable source for such raw materials (Yamada 2006). On the other hand, in the Tougeshita 2 type microblade industry, they used round pebbles and small debris or angular nodules in addition to large raw materials, thus we can presume that they used a variety of local raw materials in areas where high quality large obsidian nodules were relatively scarce. Furthermore, our results are consistent with the hypothesis of Kimura (1995) that Sakkotsu type microblade cores were transported over a long distance, uniting them with the Shirataki obsidian, whereas the Tougeshita type microblade cores were made of obsidian available in the vicinity of the sites. The background of this expansion is behaviorally considered to be one characterized with a long distance mobility strategy of the real Yubetsu microblade industry supported by the abundance and the large size of Shirataki obsidian. In addition, transportation of over 700 km cannot be explained thoroughly enough by direct procurement, so we would expect the existence of some sort of exchange network.

![Figure 11. Ratio of obsidian sources in Sakkotsu type and Tougeshita2 type microblade cores](image)

6. Conclusion

To conclude, we summarize with three points:

First, the distribution area of Shirataki obsidian basically expanded through the Upper Paleolithic Period, but it shows complex episodes of expansion and reduction in each stage and industry.
Second, the drastic expansion of the Shirataki obsidian distribution area did not coincide with the introduction of microblade technology. Rather, the drastic expansion of the Shirataki obsidian distribution area coincided with the next stage of the introduction of microblade technology, that is, the adoption of real Yubetsu industry began in the beginning of Stage 2.

Third, at the end of Stage 3, the distribution area of Shirataki obsidian expanded again in the point and stemmed point industry, and subsequently, Shirataki obsidian came to be regularly transported to the northern end of Honshu Island in the Jomon Period.

Acknowledgement

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Notes

1. More materials made from Shirataki obsidian were reported in Sakhalin (Kuzmin et al. 2002), but we did not deal with them in this paper as we are not yet aware of which were analyzed or what industry they belong to apart from the Sokol and Ogonki 5 sites.

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