DID THE JAPANESE OBSIDIAN REACH THE CONTINENTAL RUSSIAN FAR EAST IN THE UPPER PALEOLITHIC?

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Introduction

Obsidian, a kind of volcanic glass, is usually produced by some volcanic activity around the orogenic belt, related to the active plate tectonics movement. In the Northern hemisphere, obsidian has been widely exploited since prehistoric times in the coastal and archipelagic areas on the Pacific Rim and the plateau and mountain areas from Southeast Asia, Oceania to the Aegean Sea, including the Himalayas, Caucasia and Anatolia. In East and Northeast Asia, obsidian was mainly produced in Primorye (Russian Far East), the North Korean, and the archipelagic area from the Kamchatka Peninsula to the Japanese archipelago.

Obsidian was extremely high quality for production and utilization of stone tools in prehistory, so in circum Japan Sea area, including Japanese Archipelago, Sakhalin Island, Continental Russian Far East and Korean Peninsula, obsidian was much used. Although, sources of obsidian are so limited in this area, that obsidian was transported in long distance, more than 1,000 km. This paper addresses the prehistoric obsidian exploitation in the Russian Far East, and which did the Japanese obsidian exploited the Continental Russian Far East or not.

It has been well known that obsidian was used in the prehistoric Russian Far East, it is only recently, however, that archaeometric source analysis has not been conducted. Organized research carried out by many researchers, including the author of this paper, has done much to clarify the actual condition of obsidian exploitation[1]. It has also been said that obsidian from the Kamchatka Peninsula was widely used: however, since results of the archaeometric source analysis do not yet clarify the relationship with archaeological material in the Palaeolithic and Neolithic, it will not be discussed in this paper.

Obsidian exploitation in the Russian Maritime Province, or Primorye, and Sakhalin Island is discussed in these articles that contain the results of source analysis of obsidian stone implements from prehistoric sites in Primorye and Sakhalin Island. The source analysis is based on the Instrumental Neutron Activation Analysis on obsidian raw material from local obsidian sources in Primorye, Paektusan on the Korean Peninsula, and obsidian sources in Hokkaido (Oketo, Shirataki, Tokachi-mitsumata and Akaigawa)[2].

Obsidian exploitation in Primorye

Obsidian sources

Four main obsidian sources are known in Primorye: three local sources and one exotic source. Most of the plenteous obsidian products, found in

[1] КУЗМИН И ПОПОВ 2000; KUZMIN et al. 2002a; 2002b; SATO et al. 2002; SATO 2004b; КУЗМИН et al. 2005; KUZMIN 2006; KUZMIN-GLASCOCK 2007; DOELMAN et al. 2008; DOELMAN et al. 2009; PHILLIPS-SPEAKMAN 2009; KLUEV-SLEPTSOV 2007; 2010.

[2] KUZMIN et al. 2002a; 2002b; SATO et al. 2002; SATO 2004b.

sites from Palaeolithic to Early Iron Age and Middle Age in this area, are brought from three of these four sources[3].

Three local obsidian sources (including perlites) are (A) poor quality rhyolitic perlites in the eastern Sikhote-Alin Mountains, (B) several outcrops on the Shkotovo basaltic plateau and Shufan basaltic plateau in the north of Vladivostok[4], and (C) the Gladkaya River basin near the border with North Korea. Rhyolitic perlites from (A) the eastern Sikhote-Alin Mountains have not been found from archaeological sites; it seems that they were not used to make stone implements, probably because of its poor quality. As exotic lithic raw material, (D) obsidian from Paektusan on the border between North Korea and China is utilized (*Fig. 1*). In addition, since obsidian from an unknown source was used at the sites in the Samarga River basin on northern Primorye, an unknown obsidian source may exist in this region.

Obsidian exploitation in Upper Palaeolithic period

In Primorye, obsidian seems not to have been utilized in the sites dating back to Upper Palaeolithic period, such as the Ustinovka sites and sites neighbouring Usrrisk. The beginning of obsidian exploitation in this area is estimated to be at the end of Upper Palaeolithic period (*Table 1.*). At the end of Upper Palaeolithic period, obsidian exploitation started at the Ustinovka sites and Suvorovo sites in the Zerkalnaya River basin, the Ilistaya sites in the Ilistaya River basin, and sites in the Razdolnaya River basin. In the Ustinovka sites and Suvorovo sites in the Zerkalnaya River basin, they used the obsidian from (B) the Shkotovo basaltic plateau and Shufan basaltic plateau, which is more than 200km away, instead of the obsidian from a nearby source, (A) eastern Sikhote-Alin Mountains. In the sites in the Ilistaya River basin and the Razdolnaya River basin, obsidian from a local source, (B) the Shkotovo basaltic plateau and Shufan basaltic plateau is mainly used[5]. At the Razdolnoye site, however, obsidian from (C) the Gladkaya River basin 150km away was used. It is noteworthy that, at the sites in the Ilistaya River basin, the utilization of obsidian from (D) Paektusan started at this time period.

While obsidian exploitation, which started at the end of Upper Palaeolithic period, was based on obsidian from local sources in principle, it is to be noted that obsidian from Paektusan at a distance of 400 to 500km has been used from the beginning. In addition, we must pay attention to the fact that the so-called local obsidian often contains obsidian from sources at a distance of 150 to 200km. According to the author's observation of the microblade industries from the Ilistaya River basin including the Ilistaya sites and the Gorbatka sites, while they produce microblade cores by a technique adapted to the raw material condition of the local obsidian, which consists mainly of small rounded pebbles with a diameter of approximately no more than 5cm, they are likely to have used obsidian from Paektusan to produce the stone tools made from blanks of large blades, because the necessary size and quality of obsidian were not available locally[6]. It may be assumed that the lithic reduction strategy adapted to the manner of obsidian production resulted as the two phases of obsidian exploitation in Primorye, exploiting local and distant sources. This feature is also observed in the obsidian exploitation on the Korean Peninsula[7].

Obsidian exploitation in the Neolithic period, Early Iron Age, and Middle Age

In the Neolithic period, obsidian is homogeneously used throughout Primorye. While obsidian from (B) the Shkotovo basaltic plateau and Shufan basaltic plateau is widely used, the utilization of obsidian from (C) the Gladkaya River basin is also widely observed, though small in quantity. We must pay attention to the heavy use of (D) obsidian from Paektusan, which developed in the Zaisanovka culture period (*Table 1.*). The heavy use of obsidian in the Zaisanovka culture has already been recognized. Because this obsidian is different from the obsidian used for the microblade industry, Onuki[8] concluded this was a result of the establishment of a trading network including obsidian from Paektusan[9]. The result of the source analysis supports this view.

[3] Кузмин–Попов 2000; KUZMIN et al. 2002a; 2002b; SATO et al. 2002; Кузмин et al. 2005; KUZMIN–GLASCOCK 2007; DOELMAN et al. 2008.
[4] KLUEV–SLEPTSOV 2009; 2010
[5] DOELMAN et al. 2009; KLUEV–SLEPTSOV 2007; 2010
[6] SATO 2002; 2004a.
[7] OBATA 2003.
[8] ONUKI 1998.
[9] OBATA 2003.

Data on the obsidian exploitation in the Early Iron age and Middle Age are insufficient to draw any conclusions. It may be assumed that the utilization of (B) obsidian from the Shkotovo basaltic plateau and Shufan basaltic plateau and (D) obsidian from Paektusan continued from the previous time period, while (C) obsidian from the Gladkaya River basin is not observed.

Exploitation of obsidian from Paektusan

As mentioned above, obsidian from Paektusan was used in Primorye since the beginning of the obsidian exploitation. Therefore, expansion of its exploiting range through the ages cannot be observed in Primorye as obviously as on Sakhalin Island. The distance of the obsidian yielding sites in Primorye from the farthest obsidian source, Paektusan, was 400 to 500km in the Palaeolithic period, a little over 600km in the Neolithic period, and 700km in the Early Iron age and Middle Age. This seems to show that obsidian exploiting range was expanding albeit slightly (*Fig. 2.*).

In Korean Peninsula Paektusan obsidian distributed till the border area between South and North Korea, and much used in prehistory, Upper Palaeolithic and Neolithic[10].

A small quantity of obsidian was used at the Xhumi site near across the river from Komsomolisk-na-Amur City on the lower Amur, which belongs to the Osipovka culture period (Incipient Neolithic, 13-10 ka). The result of the X-ray fluorescence analysis on the obsidian from Xhumi site, conducted by a group including the author, indicates that it is very likely to be from Paektusan[11]. This result is not quite certain because we used the archaeological materials collected from a site outside *Kainei-jo* near Paektusan for correlation[12], instead of obsidian directly from Paektusan. If the assumption that the material from outside *Kainei-jo* is from the Paektusan source is correct, there existed obsidian movement (exchange) over a distance of 1,500km in a straight line (*Fig. 3.*). This distance of 1,500km is not entirely fantastic, because if obsidian from Shirataki was really exploited in Primorye, which will be mentioned later, more than 2,000km-long distance distribution area would have existed in this time period.

Obsidian exploitation on Sakhalin Island

Obsidian sources

It has been widely known that many stone tools made of obsidian are excavated from prehistoric sites in Sakhalin Island, though there exist no obsidian source on the island. To identify the source and study the distribution of obsidian on prehistoric Sakhalin Island, we collected 79 samples of obsidian products from 35 sites of the Upper Palaeolithic period (20-13ka), Neolithic period (13-2ka), and Early Iron age (2-0.8ka), and conducted the source identification by the Instrumental Neutron Activation Analysis in 1999, using the obsidian raw material from four major obsidian sources in Hokkaido, which are archaeologically most likely[13]. Among the four analyzed sources of Hokkaido, Akaigawa, Tokachi-Mitsumata, Shirataki, and Oketo, obsidian from the former two sources were not identified on Sakhalin Island. It became clear that obsidian on Sakhalin Island is dominated by obsidian from Shirataki (A) (B) and obsidian from Oketo (C) (*Fig. 4.*). Since no obsidian sources are known in the lower Amur River basin, which faces Sakhalin Island across the Mamiya strait, the nearest obsidian sources, except for the Hokkaido ones, are those in Primorye. Obsidian samples from Sakhalin, however, do not correspond with the chemical composition of the obsidian from sources in Primorye.

In addition, the result we obtained showed that the chemical composition of the obsidian from Shirataki source is largely divided into two groups, which was already reported by another research group[14]. It may be assumed that while the outcrops of (A) Shirataki 1 group are located on the mountain top of Mt. Akaishi in Shirataki, the outcrops of (B) Shirataki 2 group are distributed around the mountain top just below and in the mountain mass to the south (*Table 2.*, *Fig. 5.*). Obsidian samples from Shirataki were collected from the top of Mt. Akaishi, Horoka-zawa, Hachigo-zawa, and Ajisai-no-taki. At Horoka-zawa, as both obsidian (A) Shirataki 1 group from the mountain top and obsidian (B) Shirataki 2 group

[10] OBATA 2003; KIM 2006.
[11] WARASHINA et al. 1998.
[12] MATSUSHITA 1998.
[13] KUZMIN et al. 2002b; SATO et al. 2002; КУЗМИН et al. 2005.
[14] INOUE 2003.

from directly below the mountain top were collected, both groups were identified by analysis[15].

Obsidian from Shirataki has been classified into several kinds according to their appearance: reddish *Hanatokachi*, rough *Nashihada*, etc. Such classification by outward appearance, however, does not correspond to the classification by chemical analysis, (A) Shirataki 1 group and (B) Shirataki 2 group.

Obsidian exploitation in Upper Palaeolithic period

The source of obsidian from Hokkaido in Upper Palaeolithic was limited to Shirataki. Both (A) Shirataki 1 group and (B) Shirataki 2 group are exploited; while the former (A) reaches the middle Sakhalin, the latter (B) is limited to south Sakhalin. This distributional feature is not certain because it is based on data from a small number of sites. In the cases of the Neolithic period and after, however, the distribution of (B) Shirataki 2 group is rather small compared to (A) Shirataki 1 group and (C) Oketo group. In Upper Palaeolithic, the maximum distance reaches 600km for (A) the Shirataki 1 group and 340km for (B) the Shirataki 2 group. In both groups utilization dates back to Layer 2 of the Ogonki 5 site (19ka), and both groups have been exploited throughout Upper Palaeolithic period.

Obsidian exploitation in the Neolithic period and Early Iron Age

The exploitation of obsidian from (C) Oketo source started in the Neolithic period. This phenomenon matches the analysis of Koshimizu and Nomura[16]. Obsidian from (A) (B) Shirataki is heavily exploited as in the previous time period. In the Neolithic period, the exploiting range of obsidian from Hokkaido covered all Sakhalin Island: Obsidian from (C) Oketo and (A) Shirataki 1 group reached the northern end of Sakhalin Island. The maximum distance from the source reaches 1,000 km. This situation basically continued in the Early Iron age. These phenomena support the possibility that obsidian from Hokkaido was transported mainly by a land route until the early Neolithic period, through the Mamiya strait, between the Cintinent and Sakhalin, and Soya strait, between Sakhalin and Hokkaido, which formed land bridges in Pleistocene or shallow and narrow straits in Holocene, since there are reports on the possible use of obsidian from Shirataki at the Malaya Gavani site in the lower Amur River basin[17] and the Osinovka site in the suburbs of Usrrisk in Primorye[18]. This means that an obsidian procurement network over 2,000km may have existed.

Obsidian distribution route on Sakhalin Island

While Sakhalin is now an island, from the Pleistocene to early Holocene, it formed the northern half of the Palaeo-Sakhalin/Hokkaido/Southern Kuril peninsula connected to the Continent and Hokkaido. But, the formation process of the Soya strait is not fixed clearly. When a view is considered, however, the formation is thought to have started at approximately 12ka, and at 8-7ka, the topographic landscape became what we know today[19]. On the other hand, the Mamiya strait is known to be so shallow that it was almost impossible to find any route large sail boats could cruise, though many expedition teams were send by the Imperial Russia to find out whether Sakhalin is an island or not. In the Pleistocene, the Amur River flew south to the Japan Sea between Sakhalin and the Continent. Large-size ships could sail along this river valley after it sank under the sea. At the north end of the south-flowing Amur River, however, it is assumed that a narrow land bridge existed between Sakhalin and the Continent, and the strait became established at approximately the same time as or later than the Soya strait.

As seen above, from the Pleistocene to the beginning of Holocene, Hokkaido with southern Kuril Islands was the end of a peninsula projecting south from the Continent. Therefore, it may naturally be assumed that obsidian from Hokkaido was transported by land route[20] (*Fig. 6.*). After this time period, they would have had to cross the newly formed strait. However, probably because the obsidian procurement route was firmly established, no particular change is observed on the obsidian procurement network.

[15] SATO et al. 2002; SATO 2004b.
[16] KOSHIMIZU–NOMURA 1990.
[17] KIMURA 1992; 1998; 1999; KANAYAMA 1992.
[18] MORI 1989; KASHIHARA–KOUKOGAKU–KENKYUJO 1994.
[19] OHSHIMA 1990.
[20] SATO 2000.

The question of the "obsidian that crossed the sea"

Background

Many introductory and technical books or articles in Japanese archaeology state that obsidian was transported from Japan to the Continental Russian Far East in prehistoric times[21]. Most of the books, however, do not cite official results of analysis; some of them even seem to depend on second-hand quotations. Here I will examine this issue, following the recent study by Onuki[22].

According to Onuki, the statement that obsidian from Oki (small island in the Sea of Japan near the seashore of Shimane Prefecture, southwest Japan), Akaigawa, Shirataki, Oga (small peninsula from the seaside of Sea of Japan in Akita Prefecture, northeast Honshu), etc. crossed the Sea of Japan to Primorye, which is now widely found in archaeological books, can be traced to the words of Prof. S. Kato at two symposiums[23]. While the details are unclear because the author did not attend either of the meetings, the book[24] seems to give a more or less accurate overview.

In this book, Prof. Kato makes the following announcement based on information from Prof. M. Suzuki, who was in charge of the analysis; in Primorye, they identified obsidian from Oki in the Ustinovka site and Ilystaya site, obsidian from Oki and Akaigawa in the Neolithic sites of Troitsa and Karebara, obsidian from Akaigawa in the Neolithic sites of Ryba 2 and Rybak ; in the middle and lower Amur River basin, they identified obsidian from Shirataki in the Neolithic sites of Gromatykha (Middle Amur) and Malaya Gavani (Lower Amur). Citing the resume of this lecture distributed at the time, Prof. M. Yamada states that obsidian from Oga is also identified in the Neolithic Primorye[25].

Did the Japanese obsidian cross the sea?

The recent obsidian source research in the Continental Russian Far East by Kuzmin et al. analyzed material from most of the sites listed above. However, they could not identify any obsidian from the Japanese archipelago, except for one example from Osinovka[26]. In the research by another group including the author, no obsidian from the Japanese archipelago was found either[27]. On November 2 and 3, 2003, the Meiji University Academic Frontier Promoting Project, "Research of obsidian mine in the stone age," was held at the Meiji University Obsidian Research Center in Nagano Prefecture. In response to the author's paper given there at a general discussion meeting for the year 2003 titled "Human history and obsidian exploitation in East Asia," Prof. M. Suzuki commented that he had not made an official announcement of the analysis results, except for the Malaya Gavani example, because there were some problems about the reliability of the analysis.

Recent data shown above indicate that, except for the example in Osinovka, suggested by Kuzmin et al., and obsidian from Shirataki in Malaya Gavani, analyzed by Prof. M. Suzuki, obsidian from the Japanese archipelago was not distributed in the Continental Russian Far East[28]. As mentioned above, the examples from Osinovka and Malaya Gavani may be probably transported by a land route from Hokkaido, where had barely become a peninsula at the time. It is natural to assume that obsidian from Shirataki was brought into the Continent through Sakhalin, because an obsidian procurement network had already existed between Sakhalin and Shirataki since the Pleistocene. Therefore, "obsidian that crossed the sea" in the strict sense did not exist in the Russian Far East. The Japanese obsidian did not exploited in the Continental Russian Far East in Upper Palaeolithic except for a only few uncertain reports.

Obsidian exploitation on the Continent

As we have seen, heavy exploitation of obsidian started by the end of the Upper Palaeolithic period, especially around the obsidian sources. The exploitation range of obsidian expanded in the Neolithic period. Obsidian exploitation range on the Continent is characterized by its relatively wide, compared to that on the Japanese archipelago. A long-distance transportation extending more than 1,000km is not an exception on the Continent. This difference was probably caused by the difference in geographic

[21] OKAMURA 2000a; b; 2002; YAMADA 1990, etc.
[22] ONUKI 2003.
[23] MORI 1989.
[24] KASHIHARA KOUKOGAKU KENKYUJO 1994
[25] YAMADA 1990.
[26] KUZMIN et al. 2002a
[27] WARASHINA et al. 1998.
[28] ONUKI 2003.

and geological landscape and lithic environment; while on the Japanese archipelago many obsidian sources are scattered within a small and complex landform, on the Continent good obsidian sources are limited and far apart in a huge and simple landform.

It may be assumed from this status of obsidian distribution that cultural formation and change took place on a more dynamic scale on the Continent than on the Japanese archipelago.

Number	*Site name*	*Basaltic plateau*	*Gladkaya River*	*Paektusan*
Upper Palaeolithic				
1	Ustinovka 1	+		
2	Ustinovka 4	+		
3	Suvorovo 3	+		
4	Kentsukhe	+		
5	Ivanovka	+		
6	Gorelaya Sopka	+		+
7	Firsanova Sopka	+		+
8	Ilistaya 1	+		
9	Lesozavodsk	+		
10	Osinovka	+		
11	Gadychya Sopka	+		
12	Borisovka	+		
13	Razdolnoye		+	
14	Timofeevka 1	+		+
Neolithic				
15	Ustinovka 3	+		
16	Sinie Skaly†	+	+	
17	Eustaphy†			+
18	Phusun†	+		+
19	Valentin-peresheek†	+		
20	Kievka†	+		
21	Pereval			+
22	Senkina Shapka	+		
23	Maikhe†			+
24	Chernaya Sopka†		+	+
25	Boisman 2			+
26	Troitsa†	+		+
27	Gladkaya†			+
28	Khansi			+
Early Iron Age and Middle Ages				
29	Monastyrka 3			+
30	Lebyazhye	+		
31	Bulochka	+		
32	Anuchino 1	+		
33	Rybak			+

* The sites of Ust-Svetlaya, Samarga 2A and Samarga 5 (all of Early Iron Age), correspond to an unknown source and are not included.

† Zaisanovka culture site.

Table 1.: Archaeological sites found obsidian in Primorye (after KUZMIN et al. 2002a)

1. táblázat: Primorye környéki régészeti lelőhelyek obszidiánnal (KUZMIN et al. 2002a nyomán)

No.	Sites	Oketo	ShiratakiA	ShiratakiB
Paleolithic				
1	Ogonki 5, 6, and 7		+	+
2	Sennaya 2		+	
3	Olimpiya 1			+
4	Ostantsevaya Cave		+	
5	Sokol		+	+
Neolithic				
6	Odoptu	+	+	
7	Slavnaya 2		+	
8	Novoalesandrovsk 2, 3, and 6		+	+
9	Pugachevo 4 and 5		+	
10	Dolinsk 1		+	+
11	Starodubskoye		+	
12	Porechye 4		+	
13	Lugovka			+
14	Yuzhnaya 2	+		+
15	Sedykh 1			+
16	Bogataya 1	+	+	
17	Moneron 5	+		+
18	Vostochny 2		+	+
19	Yasnoye 3			+
20	Shebunino 1			+
21	Kirpichny 9	+		
22	Naiba 6		+	
23	Ado-Tymovo 4			+
24	Puzi 4			+
25	Blagodatny 3		+	
Early Iron Age				
26	Beregovoye	+		
27	Zarechye 2	+		
28	Vostochny 1	+		
29	Lovetskoye 5	+		
30	Razmolovka	+		
31	Sadovniki 1	+	+	+
32	Yasnomoskoye 3			+
33	Stary Nabil 5	+		
34	Bakhura		+	+

Table 2.: Archaeological sites found obsidian in Sakhalin (after SATO et al. 2002)

2. táblázat: Szahalin környéki régészeti lelőhelyek obszidiánnal (SATO et al. 2002 nyomán)

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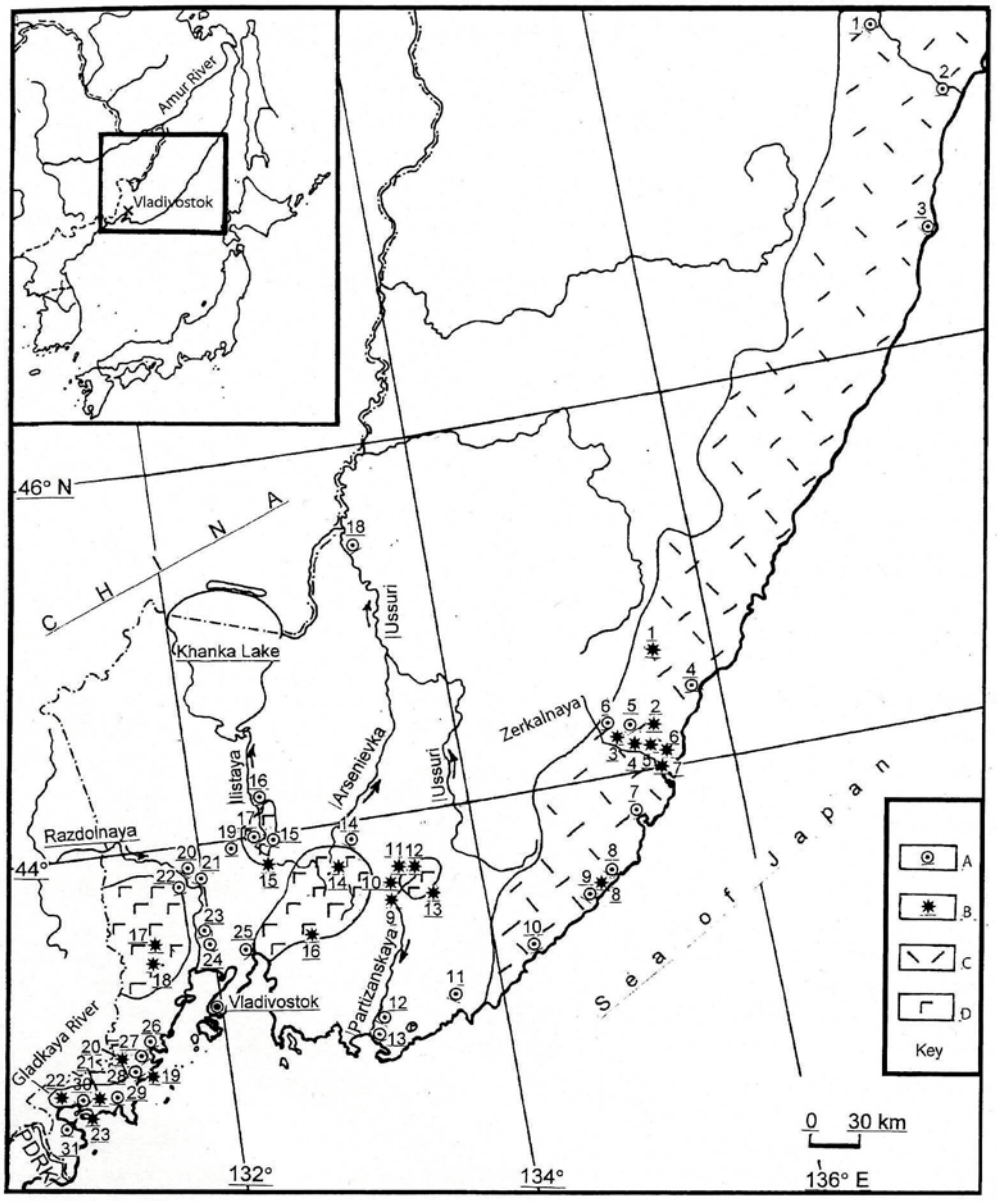
ELÉRTE-E A JAPÁN OBSZIDIÁN AZ OROSZ TÁVOLKELETI TERÜLETEKET A FELSŐ-PALEOLITIKUMBAN?

HIROYUKI SATO

Kulcsszavak: *obszidián kitermelés, Orosz Távolkelet, paleolitikum, neolitikum, távolsági nyersanyag, Hokkaido, Paektusan*

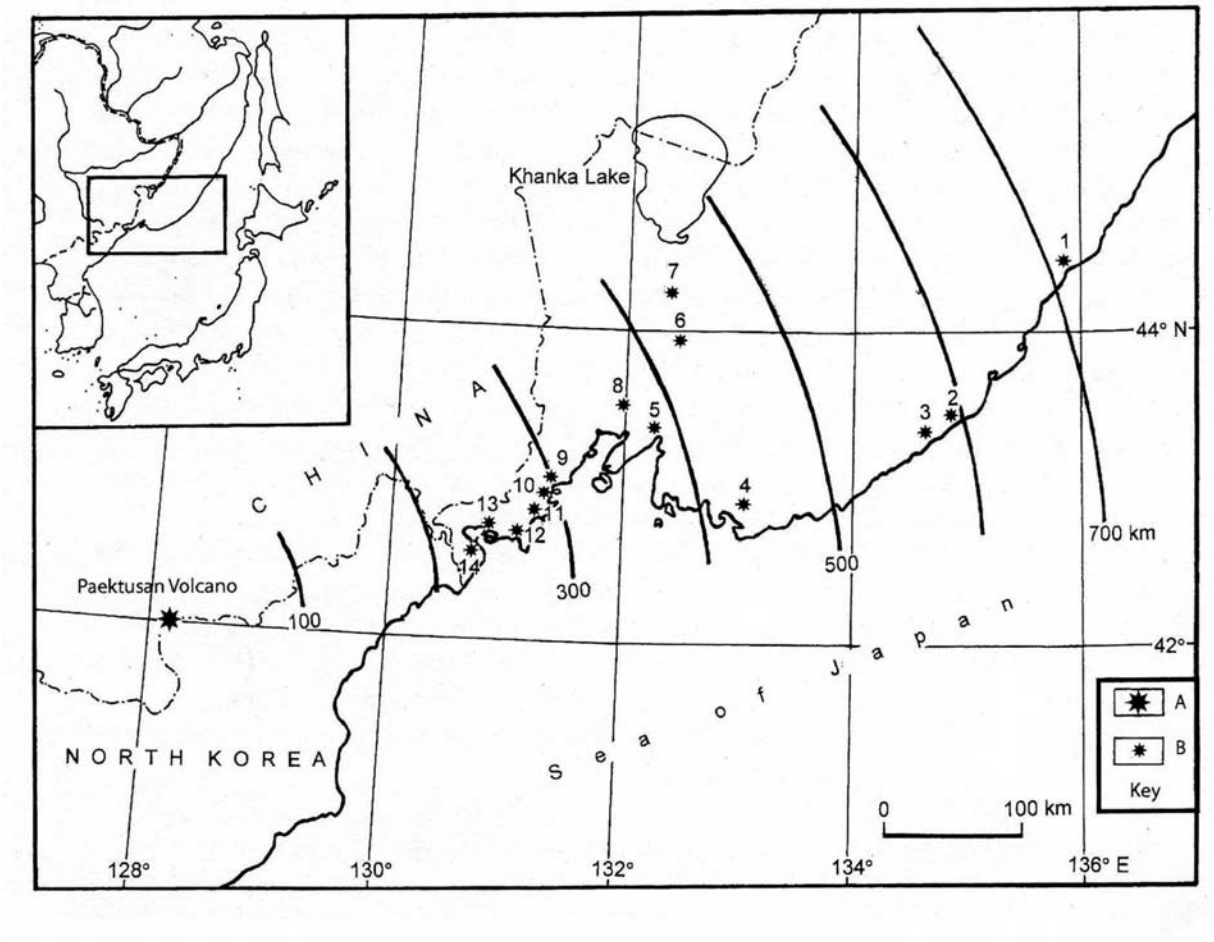
Az obszidián kiváló minőségű nyersanyag, ezért előszeretettel használták széles körben. A felhasználás kiterjedt a Japán Tenger környezetére is, beleértve a Japán szigetvilágot, a Szahalin szigeteket, az orosz Távolkeletet és a Koreai Félszigetet. Az obszidián korlátozott területen fordul elő, ezért a nyersanyagot nagy távolságra szállították. Kitermelése nagy mennyiségben kezdődott az orosz Távolkeleten a kései felső paleolitikum idején és további nagy obszidián források környékén, mint Paektusan (Észak-Korea), Shirataki és Oketo (Hokkaido, Japán). Az obszidián régészeti elterjedése jelentősen megnőtt a neolitikum idején. A kontinentális obszidián kitermelést, a Japán szigetvilághoz képest, nagy távolsági elterjedés jellemzi. Nem ritka a több, mint 1000 km-es elterjedési távolság az újkőkorban ezen a területen. A különbség oka valószínűleg a földrajzi és földtani tényezők együttes hatására vezethető viszza. A Hokkaido-i japán obszidiánt eddigi ismereteink szerint nem használták a kontinentális területen a felső-paleolitikumban és a neolitikumban, annak ellenére, hogy az egykori Szahalin-Hokkaido-Dél-Kuril félsziget területe összefüggött a Pleisztocén időszakban a kontinenssel.



A, archaeological sites; B, geological outcrops; C, eastern Sikhote–Alin volcanic belt; D, Basalt Plateau sources. Archaeological sites: (1) Samarga 5; (2) Samarga 2A; (3) Ust-Svetlaya; (4) Monastyrka 3; (5) Ustinovka 1, 3 and 4, Suvorovo 3; (6) Kentsukhe; (7) Sinie Skaly; (8) Eustaphy; (9) Phusun; (10) Valentin-peresheek; (11) Kievka; (12) Pereval; (13) Lebyazhya, Bulochka; (14) Anuchino 1; (15) Ivanovka, Gorelaya Sopka; (16) Firsanova Sopka; (17) Ilistaya 1; (18) Lesozavodsk; (19) Osinovka; (20) Gadychya Sopka; (21) Senkina Shapka; (22) Borisovka; (23) Razdolnoye; (24) Timofeevka 1; (25) Maikhe; (26) Chernaya Sopka; (27) Rybak; (28) Boisman 2; (29) Troitsa; (30) Gladkaya; (31) Khansi. Geological outcrops: (1) Nezhdanka, Yakut-Gora; (2) Bogopol; (3) Sadovaya River; (4–6) Brusilovka River basin—(4) Pad' Pryamaya, (5) Pad' Bogopolskaya Tropa and (6) Pad' Schmeidegir; (7) Sea of Japan coastal outcrops south of the Brusilovka River mouth; (8) Pad' Arsamasovskaya; (9–13) Partizanskaya River basin—(9) Sadovy Stream, (10) Kazenny Stream, (11) Chernaya Rechka, (12) Partizanskaya River headwaters and (13) Sergeevka River; (14) Arsenievka River basin; (15) Ilistaya River basin; (16) Steklyanukha River basin; (17) Nezhinka River basin; (18) Analievka River basin; (19) Klerk Peninsula (Ryazanovskoye Lake); (20) Ryazanovka River basin; (21) Vinogradnaya River basin; (22) Kraskino; (23) Krabbe Peninsula.

Figure 1.: Obsidian sources and their archaeological sites in Russian Far East (after KUZMIN et al. 2002a)

1. ábra: Obszidián források és kapcsolódó régészeti lelőhelyek az Orosz Távolkeleten (KUZMIN et al. 2002a nyomán)



Key: A, Paektusan Volcano; B, Paektusan Volcano-related sites—(1) Monastyrka 3, (2) Eustaphy, (3) Phusun, (4) Pereval, (5) Maikhe, (6) Gorelaya Sopka, (7) Firsanova Sopka, (8) Timofeevka, (9) Chernaya Sopka, (10) Rybak, (11) Boisman 2, (12) Troitsa, (13) Gladkaya and (14) Khansi.

Figure 2.: The Paektusan Volcano source and remote archaeological sites with made from Paektusan obsidian (after KUZMIN et al. 2002a)

2. ábra: A Paektusan vulkán obszidián forrás és a hozzá kapcsolható régészeti lelőhelyek (KUZMIN et al. 2002a nyomán)

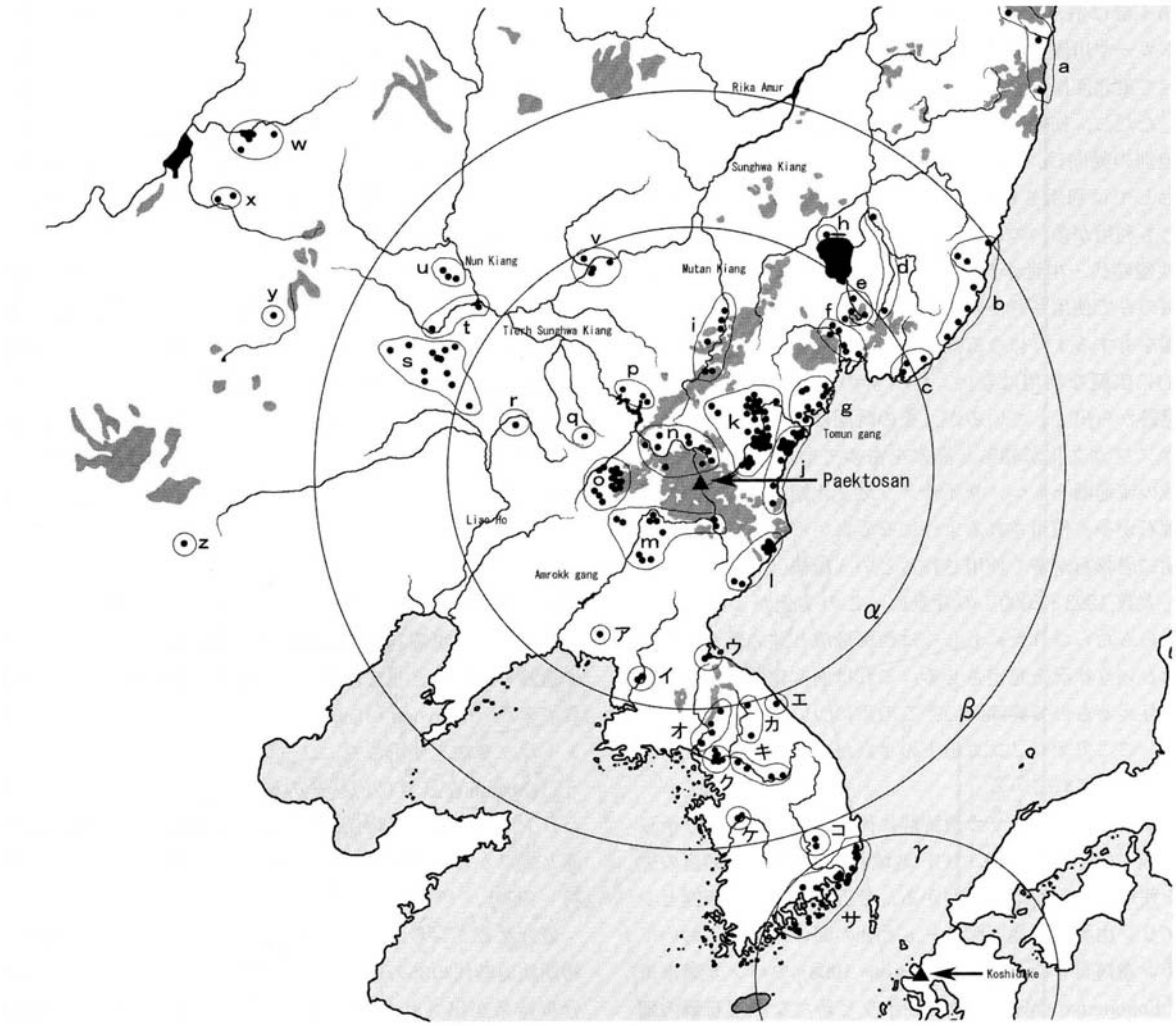


Figure 3.: Distribution of sites with obsidian in Far East and Korea (after OBATA 2003)

3. ábra: Obszidián régészeti elterjedése a Távolkeleten ésKoreában (OBATA 2003 nyomán)

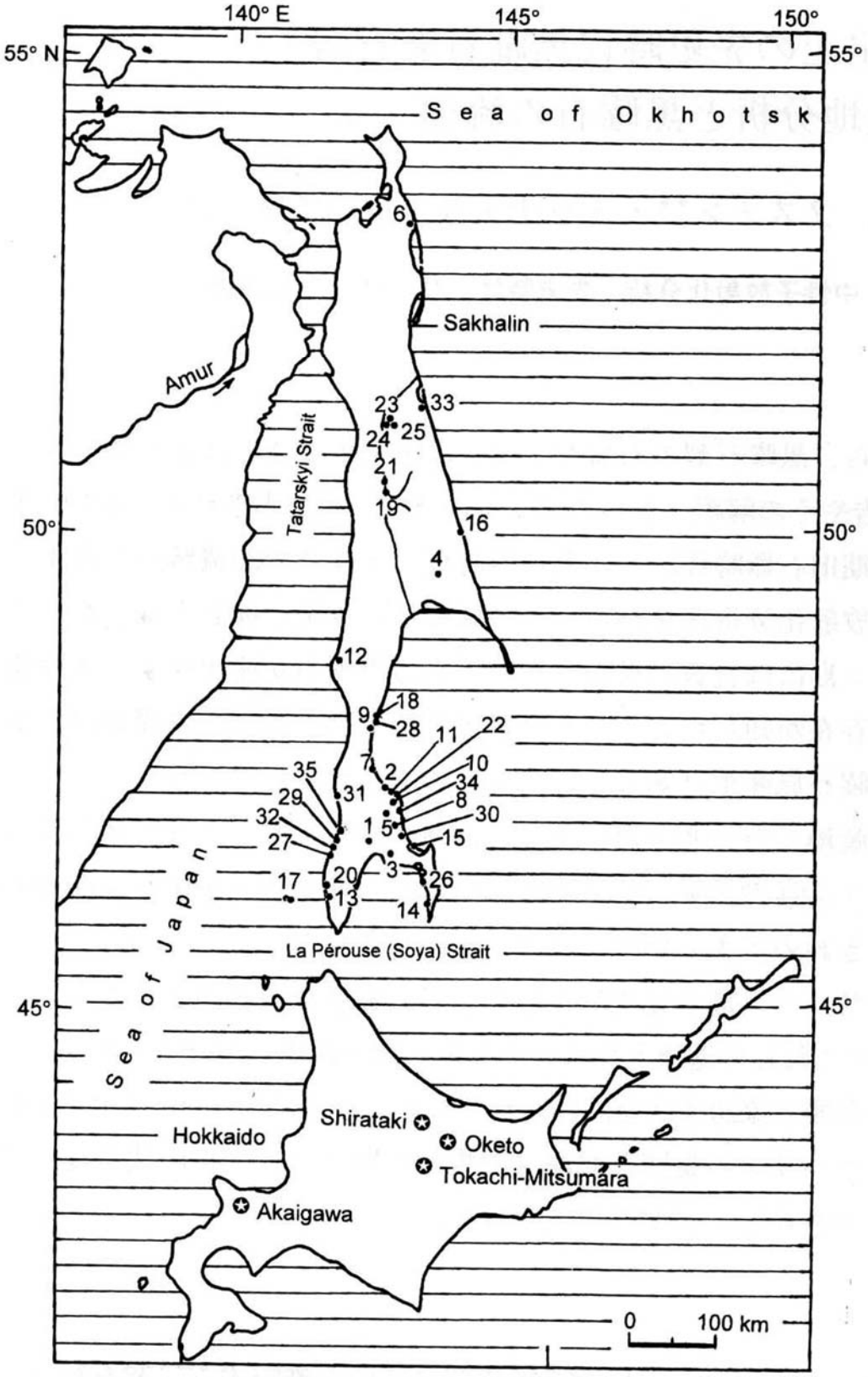


Figure 4.: The location of archaeological sites with associated obsidian artifacts on Sakhalin, and obsidian sources on Hokkaido (after KUZMIN et al. 2002b). Site number correspond to those listed in *Table 2.*

4. ábra: A régészeti lelőhelyek eloszlása Szahalin szigetén és a hokkaido-i obszidián források (KUZMIN et al. 2002b nyomán)

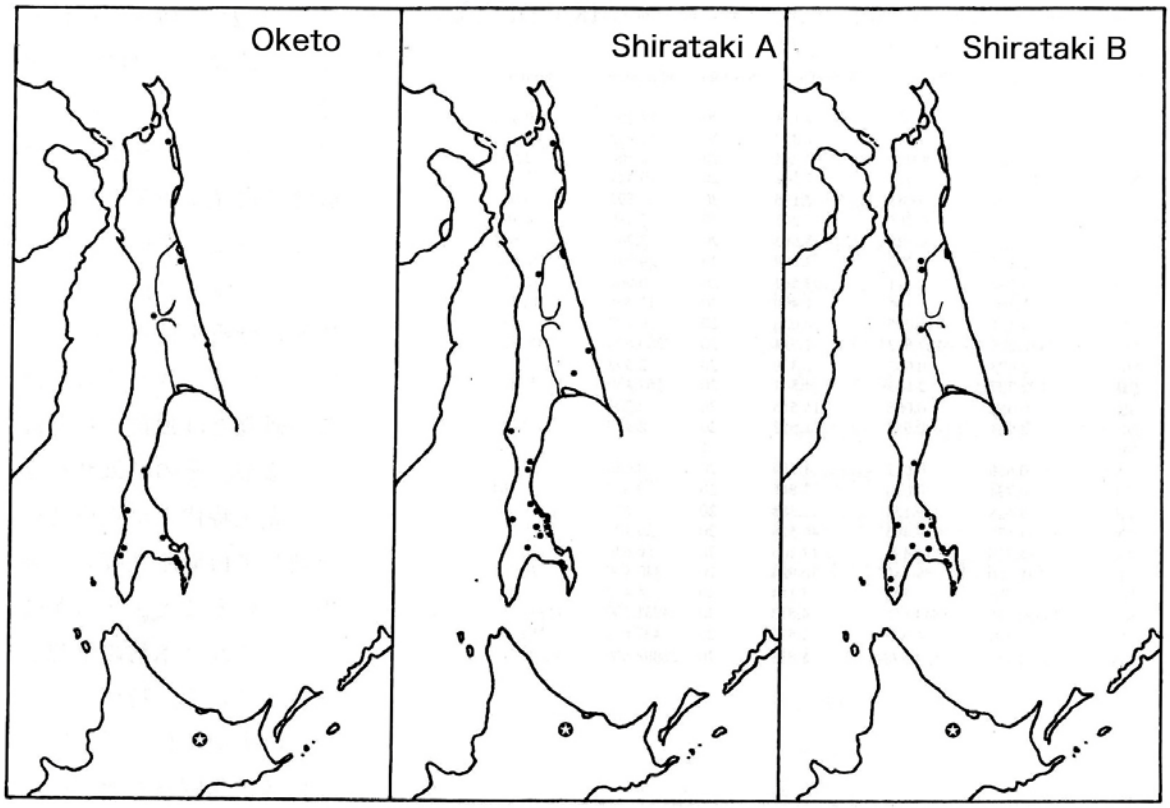


Figure 5.: Geographic distribution of the obsidian sources from Hokkaido (after KUZMIN et al. 2002b)

5. ábra: A Hokkaido-i obszdián források elterjedése (after KUZMIN et al. 2002b)

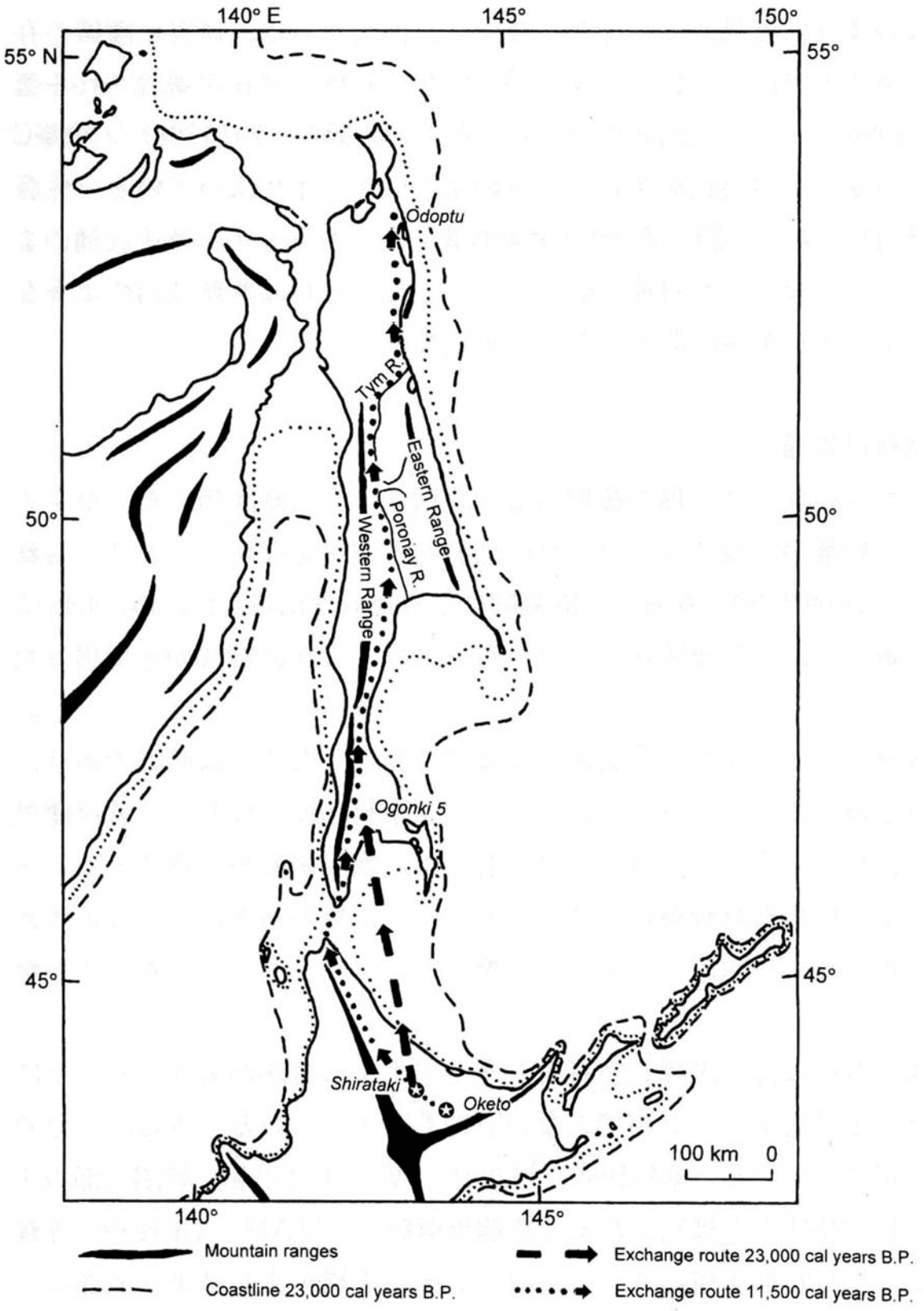


Figure 6.: Probable obsidian exchange routes between Hokkaido and Sakhalin, c. 23,000 – 11,500 cal BP (after KUZMIN et al. 2002b)

6. ábra: Feltételezhető obszidián kereskedelmi utak Hokkaido és Szahalin között, c. 23,000 – 11,500 cal BP (after KUZMIN et al. 2002b)