70604

We invite you to join us on a trip to Murmansk, the world's biggest city within the Polar circle and an ice-free port in the Kola Gulf of the Barents Sea. Watch the upcoming number of our mag!

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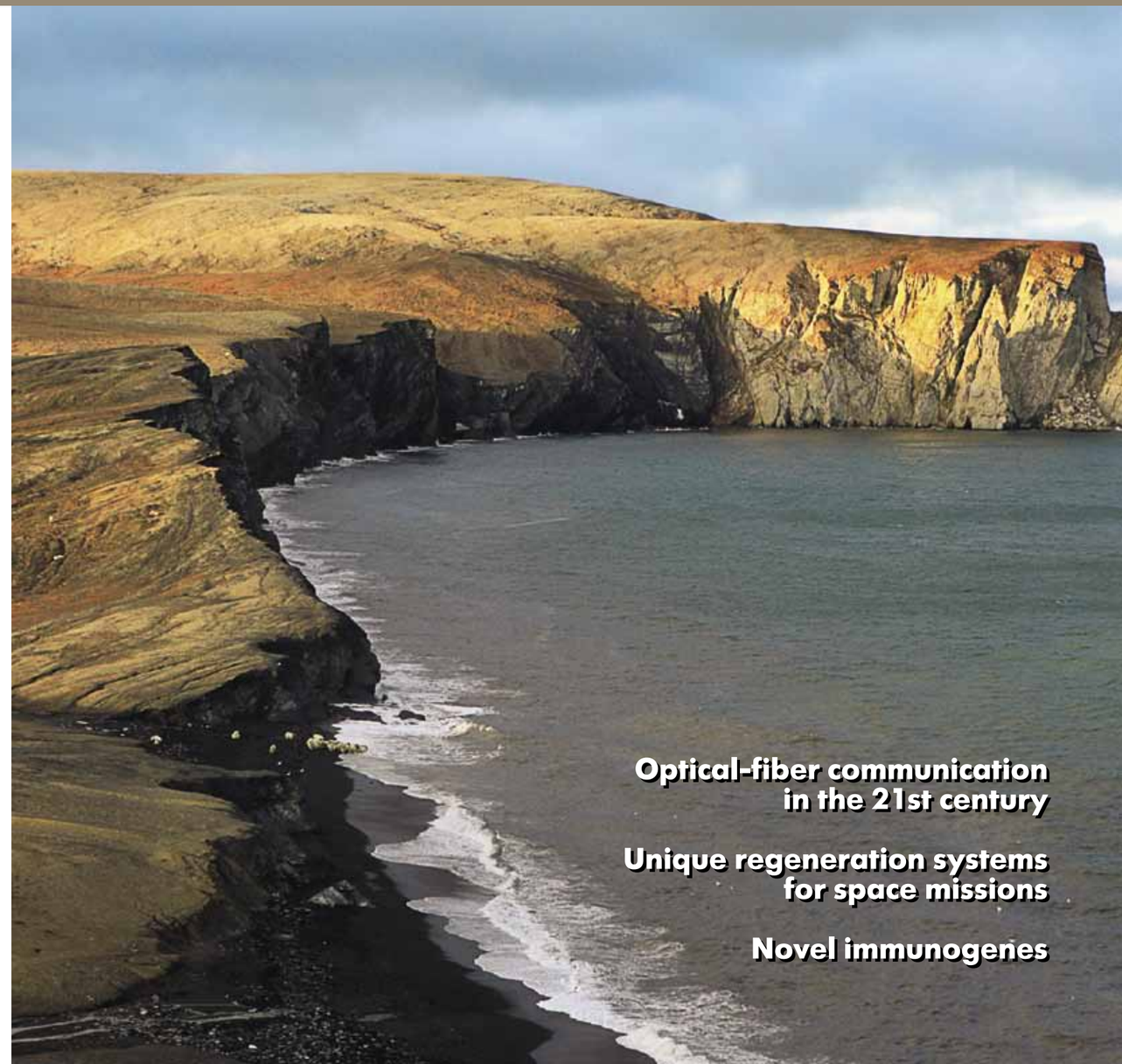

Optical-fiber communication in the 21st century

Unique regeneration systems for space missions

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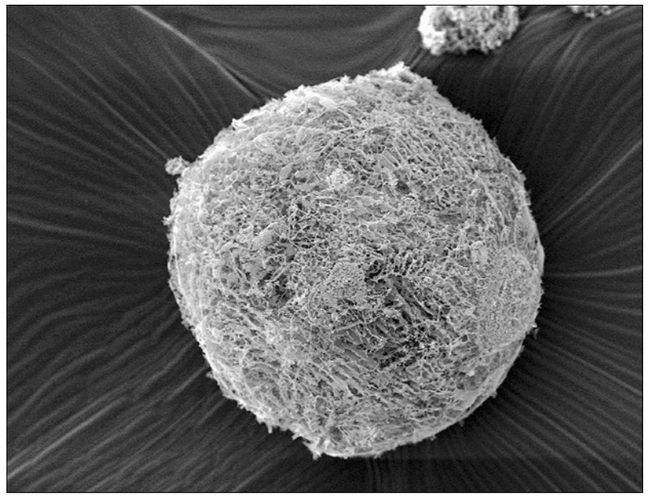
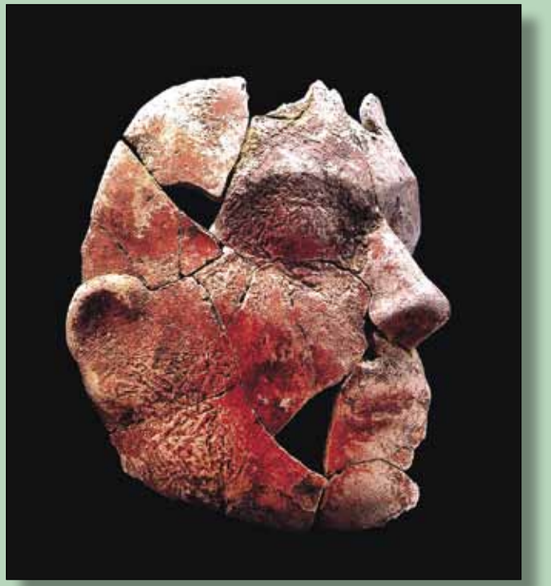
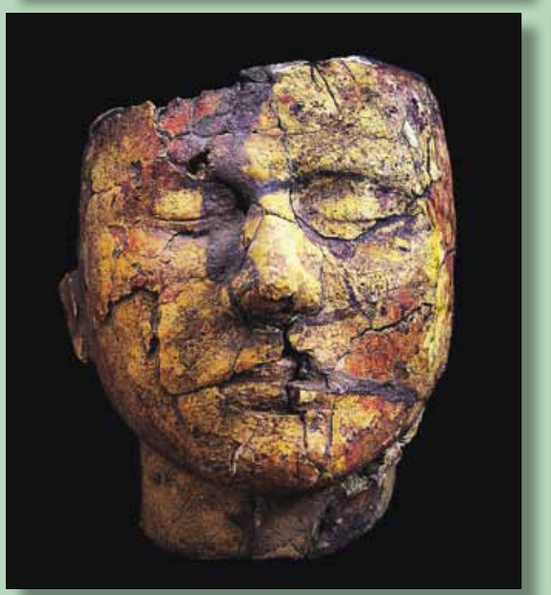


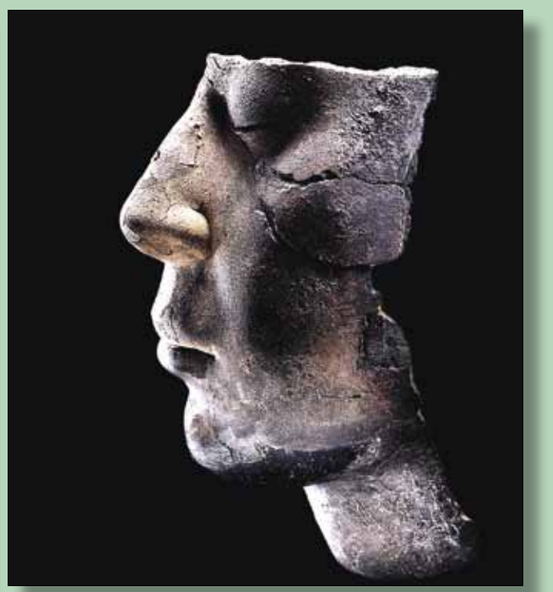
26 New pharmaceuticals involve both chemistry and physics: medical drugs are designed in the form of miniscule particles either of fine crystalline structure, or else amorphous. This is the job of formative pharmaceutical physics.

72 “His works are always a true expression of what he has lived through and felt, they are always an innermost urge...” This is what Alexander Herzen, a 19th-century Russian philosopher and prose-writer, said about Mikhail Lermontov whose birth bicentennial falls on 2014.



New crafts emerged in the land of Khakasia early in the Common Era. Its people saw dramatic changes in their mode of life. During the first six centuries A.D. most different cultural traditions merged together to give birth to a new civilization known as the Tashtyk Archeological Culture. What did they look like, the Tashtyk people? The old burial masks tell the story. You’ll get to know particulars in the next issue of our mag.





36 December 2013: the Russian Navy got a welcome addition—the *Severodvinsk*, a new submarine of the fourth generation, went into service. Designed and built in St. Petersburg, it is the last word in our shipbuilding.

45 Obsidian, a volcanic glass variety, occurs wherever there are old volcanoes. In this country it is found in the Far East for the most part. The mining and the working of this valuable material as well as its uses attest to the level of ancient stone crafts.

64 H.A. Académie des Beaux-Arts was associated with the Romanov ruling dynasty even before its official founding in the mid-18th century. The idea was incubated by Peter the Great, also a great reformer. His heirs to the throne were likewise active in promoting the Académie's progress.

In 2004 the "Wrangel Island" preserve was entered into the UNESCO World Heritage list as a model example of evolution taking in most different arctic complexes all through the Cenozoic—now in complete isolation, now in periodic contacts between the two continents, Eurasia and America. The area on and around Wrangel Island is the habitat of rare and endangered fauna and flora species. The Wrangel sanctuary furnishes good conditions for their protection and conservation. It is the first arctic object in this list of honor that does Russia credit for her contribution in the exploration and protection of the precious environment in its primordial state yet.

On the first page of the cover—the Waring Cape. Photo, N. Ovsyanikov

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GEOLOGY AND ARCHEOLOGY OF THE MARITIME OBSIDIAN

by Vladimir POPOV, Cand. Sc. (Geol. & Miner.),
leading scientist, Laboratory of Volcanic Petrology,
Far Eastern Geological Institute, RAS Far Eastern Branch,
Vladivostok

Volcanic glass (obsidian) is a most interesting rock formation shedding light on eruptive rock formative processes. On the other hand, it helps to trace the migratory paths of ancient man using this mineral in tool making. Thus we are able to access the territorial scales and periods of prehistoric events. In our country the main deposits of obsidian are found in the Maritime Region of the Far East. An international think tank representing the RAS Far Eastern and Siberian Divisions and universities of the USA, Australia and New Zealand working in this region since the 1990s has laid a groundwork for detailed studies of the local volcanic glass. The findings of geologists, archeologists, paleogeographers and physical chemists have been published in 28 articles in journals and collection of works in Russian and English, and also in two joint monographs.

Maritime obsidian.

Pillow basalt lava fragment with chilled volcanic glass. Chernyatinsky volcano, Primorye.

Just a few words about the subject-matter of research. Depending on its chemical composition, volcanic glass can be called obsidian, hyalomelane, perlite or pitchstone. The first two varieties of rhyolite and basalt composition are remarkable for their high technological properties, which makes them suitable for tool manufacture. Rhyolite volcanic glass usually occurs in archeological monuments of the Mediterranean, Caucasus, Japan, Kamchatka, the western coast of North and South America and other regions of the young and present volcanism. However, basalt volcanic glass (hyalomelane) and instruments made of it are found much less often. As a rule, volcanic glass originates in lava outflows to water and ice when a quenching of magmatic melt and crust formation take place. Mass volcanic eruptions which occurred 13-11 mln years ago in the territory of southern Primorye (Maritime Region) and eastern Sikhote Alin were accompanied by the formation of pillow lavas and hyaloclastites (fragmental rock of volcanic origin) as the main sources of basalt obsidians.

Cleavable, volcanic glass forms plates and microplates with thin and sharp edges. Such chips can be

Stream branching out as a lava tongue is formed of blue hyalomelane.

handworked, and that is why this material was much in use in the Stone Age. The methods of production, processing and use of this high-quality raw material are indicative of the development level of ancient industries. The use of obsidian in primitive cultures allows to trace the migration paths of people and the nature of their contacts, exchanges and trade in the Paleolithic, Neolithic and Paleometallic Ages (the last 20-30 thous. years). Therefore volcanic glass studies are important in geological and archeological problem solving.

In 1992 Andrei Tabarev, a member of the Institute of Archeology and Ethnography of the RAS Siberian Branch and Yaroslav Kuzmin, his colleague from the Pacific Institute of Geography of the RAS Far Eastern Branch in cooperation with the American scientists Michael Glascock (University of Missouri, Columbia) and Steven Shackley (University of California, Berkeley) made a geochemical analysis of 45 obsidian artifacts in 14 archeological monuments of the Primorski Krai (Maritime Region) and the Amur River Basin, and presented their findings at the conference "Archeology of the North Pacific" (Vladivostok, 1993). Their research work was joined later by a large team of archeologists and geologists from Novosibirsk, Western Siberia, and the Far East who by the 2000s had discovered on the Asian continental margin three main sources of archeological obsidian, i.e. on the Pektusan volcano, in the Gladkaya River basin and within the Shkotovsky basalt plateau covering an immense territory (~1,500 km^2) of the southern Primorski Krai. The latter finding was of the utmost interest in geological and historical aspects. The scientists discovered a considerable spread of obsidian in local paleolithic complexes sometimes off from a primary outbreak of rock material to 300 km (Ustinovsky monuments in the Zerkalnaya River basin) and 660 km (Osinovaya River and Novotroitskoye-10 monuments in the Amur River basin). The geologists discovered an unusual geochemical type of volcanic glass in the area of ancient settlements and pebble forelands of large rivers, such as the Razdolnaya, Borisovka, Partizanskaya, Muraveika, Arsenyevka, Ilistaya and Shkotovka which cut through the Borisovskoye and Shkotovskoye basalt uplands. The findings obtained in field research parties of 1995-1997 and published in 2000 in a joint monograph served a basis for further geological and archeological studies in the region.

Subsequent research studies were connected with the name of Nina Kononenko, a doctoral candidate and an archeologist well known in the Far East. As early as 1992-1997 she, conducting archeological excavations in the Mikhailovsky and Anuchinsky Districts of Primorsky Krai, detected numerous obsidian tools; in 1999 she studied in detail experiments dealing with the cleavage and processing of volcanic glass at Santa Barbara Univer-

Obsidian tools made by Igor Sleptsov in experiments with volcanic glass fluvial pebbles. 2004.

sity (USA) under the Fulbright Program*. Therefore in 2002 Nina Kononenko organized an international field party (apart from Russian scientists it included those of Japan and USA) to the headstreams of the Ilistaya and the Arsenyevka. The party discovered a large primary outbreak of volcanic glass on the Ilistaya and two archeological monuments on a basement terrace cusp of this river.

In 2004 Nina Kononenko, then a postgraduate of Australian National University (Canberra), initiated another field party which included Nikolai Klyuev, Igor Sleptsov and Irina Pantyukhina (Institute of History, Archeology and Ethnography), Vladimir Popov (Far Eastern Geological Institute), Robin Torrence (Australian Museum, Sydney), Trudy Doelman and Peter Wait (University of Sydney). Having surveyed the Khasansky, Oktyabrsky, Anuchinsky and Shkotovsky districts of Primorsky Krai, this party examined the primary outbreaks of volcanic glass on the Krabbe Peninsula (Posyet Bay)**, in the Gladkaya River basin, on the northwest margin of the Borisovskoye upland, opposite the Chernyatino settlement, in the Shkotovka River mouth (Obryvisty Cape) and in the Pravaya Ilistaya River headwaters. Moreover, the field workers described in detail the obsidian source first discovered in 2002. It was a tall rocky cliff (the former river hold-down) formed by pillow lavas of andesite-basalts and associated hyaloclastites which stretched in the form of a steep wall along the valley right side. Accumulations of fragments and pebbles of volcanic glass processed by water streams were found on river shoals, and at prehistoric man encampments on flat scarps of adjacent pediment terraces. One monument called Tigrovy-8 appeared to be directly on a primary source which formed a scarp of an ancient terrace. Its height above the valley bottom reached 80 m. The adjacent steep slopes of the Pravaya Ilistaya and the left tributary of the Ilistaya could be seen from the terrace level ground where a Paleolithic encampment lay.

The findings of the explorers impressed immensely not only the Australian members of the field party. For the first time the Russian archeologists could observe the primary outbreaks of obsidian, they obtained first-hand information on the subsurface geology of hyaloclastites and pillow lavas, and tempered glass formative conditions at eruption places of paleobasalts; they prepared a large collection of samples as well. They also carried out field experiments on stone tools making.

Evenings, after their hours, the explorers compared notes on what they had seen; they incubated the idea of a large-scale project for volcanic glass research. There was good reason for that: primary outbreaks (sources) of this mineral and the adjacent camping sites of primitive man were out there. Thus a model research object was chose.

Back from their field work the outfit filed their first joint article for the *Russia and the Asia-Pacific Region* journal published by the Institute of History, Archeology and Ethnography; and in December of 2004, on the international project "Reconstruction of the system of obsidian exchanges in the Russian Far East" with the financial support of the Australian Discovery Research Foundation and the Australian Institute of Nuclear Sciences and Engineering. It was headed by Nikolai Klyuev and Vladimir Popov of Russia and by Trudy Doelman and Robin Torrence of Australia.

In 2005 a small international team visited the Ilistaya river region where it discovered several ancient camping sites and three primary sources of obsidian. Collecting rich materials we went to Australia to sum up our field data and discuss plans for the next year. In Sydney we met the management of the Australian Museum and signed an agreement on scientific cooperation with the Far Eastern Geological Institute.

We familiarized ourselves with working conditions of Australian geologists and archeologists, and how sample collections, exhibits and archive documents were kept

*Fulbright Program is the largest international education exchange program financed by the US government and instituted in 1946 by Senator James Fulbright aimed at strengthening cultural and academic relations between the USA and other countries.—*Ed.*

** *See*: V. Popov, "'Live' Stones of Krabbe Peninsula", *Science in Russia,* No. 6, 2013.—*Ed.*

Explorations in the Khasansky region. Left to right: Robin Torrence, Igor Sleptsov, Trudy Doelman and Peter Wait. 2004.

Members of the Joint Russian-Australian expedition. 2004.

there, in Australia. We also visited the University of Sydney founded in 1850. In Canberra we visited the Australian National Museum and Australian National University where we were received by Professor Peter Bellwood, head of the department of archeology and anthropology, well known in the scientific community. Of particular interest was our visit to the Australian Nuclear Center in Sydney where samples of volcanic glass were analyzed by the PIXE-PIGME method (method of analyzing artifacts by X-ray radiation produced by the proton bombardment of samples with the use of an ion beam, a routine technique in archeology).

In Sydney, next to the university buildings, is the William Macleay Museum bearing the name of its founder Sir William Macleay, Australian scientist, colleague and friend of our great compatriot Nicholas Miklouho-Maclay. A bronze bust to this Russian ethnographer, anthropologist, biologist and traveler stands at the front door. The museum exhibits collections of insects, birds, plants and also instruments, outfit, documents and photos of the first Australian researchers including those belonging to Miklouho-Maclay. Implements and household utensils of the Papuans collected during expeditions to New Guinea are kept in the museum. We had a

Vladimir Popov (left) and Nikolai Klyuev at a primary outbreak of basalt obsidian on the Pravaya Ilistaya. 2007.

Bust of Nicholas Miklouho-Maclay at the entrance of the William Macleay Museum Sydney, Australia.

rare opportunity to examine everything. Some documents, letters and photos are kept at the State Library of New South Wales. The houses in which Miklouho-Maclay lived and worked are still there in Sydney. Just for his 165th birth anniversary in 2011 Alla Khlebakova published her article, "The Known and Unknown Miklouho-Maclay", in the Australian Russian-language weekly "Unity" which offered interesting facts of his biography. We are glad that the memory of our outstanding pathfinder lives on out there, "deep under".

Our working visit ended with a seminar where members of the Primorski field party presented updates on the Russia Maritime Region, so far little known to the Australians but highly interesting in its geology and archeology.

In 2006 an international expedition of twenty specialists started out for Primorski Krai, a mecca for volcanic glass researchers, who continued geological and archeological studies in the Ilistaya river basin and began to dig out the Tigrovy-2 and Tigrovy-8 monuments. A small field party conducting explorations in the Arsenyevka

Primary outbreak of pillow lavas and hyaloclastites in the upper reaches of the Pravaya Ilistaya.

Hyaloclastite is composed of volcanic glass fragments enclosed in a ground mass formed by palagonite.

river channel and on the Poperechka, the river's tributary, found new sources of obsidian and more archeological monuments. Their findings were presented at the 18th international congress of the Indo-Pacific Prehistoric Association in November of 2006 in Manila, Philippines.

In 2007 within the framework of the project the international team continued archeological excavations and field studies in the Poperechka and Pravaya Ilistaya rivers basins. A powerful cyclone hitting the region's southeast during the field work caused high water in the Ilistaya river basin, thus creating favorable opportunities for collecting obsidian pebbles on river shoals, the main places of its mining in the prehistoric time. Since there had been no heavy rain in this region for several years, we were unable to collect pebbles for assessing the amount of obsidian in them. Then, during a dry season pebble shoals were covered with river mud, thick grass and osiery. The flood changed the river channel, and the outwashed shoals took on an erstwhile look they had

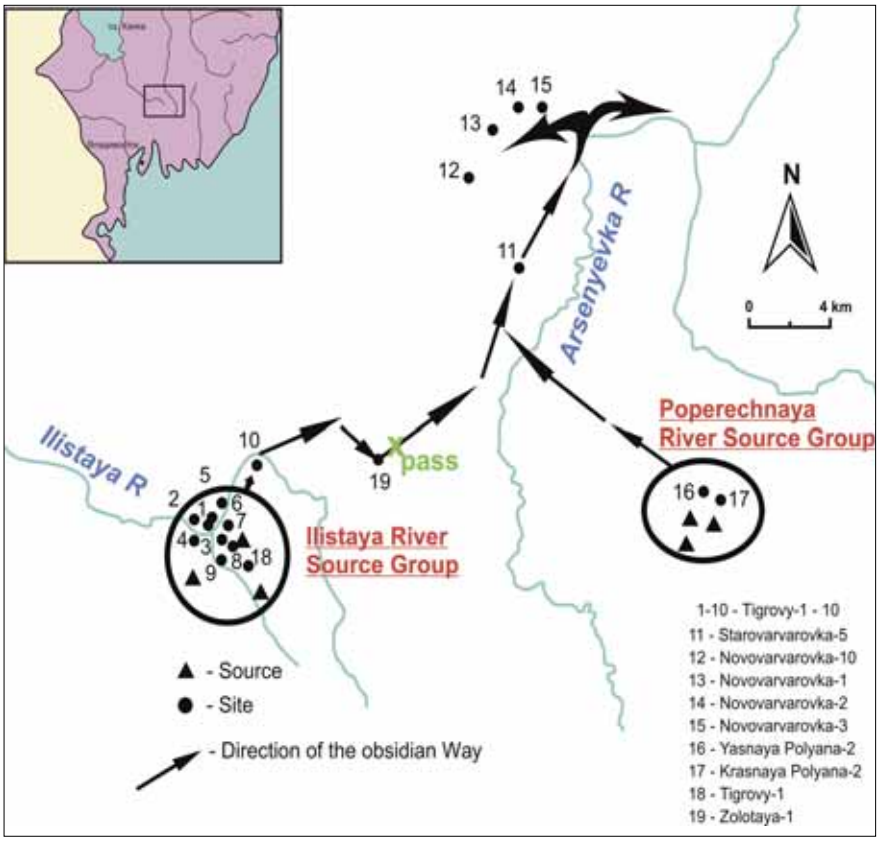
Central part of pillow lava may be formed entirely by volcanic glass.

Washing of the habitation layer material in the Ilistaya by Hugh Watt (left) and Robin Torrence of Australia.

during ancient encampments. We managed to prepare a large collection of volcanic glass samples for experimental work and college practicals. At the seminar in the Institute of History, Archeology and Ethnography Australian scientists headed by Robin Torrens summed up their field results in 2005-2007 and discussed immediate plans. Then our foreign colleagues visited the Far Eastern Geological Institute where they met Dr. Oleg Chudayev, Deputy Director for Scientific Work, and inspected our Geological and Mineralogical Museum*, laboratories of the Analytical Center, and the Science Library.

The Russian-Australian project "Reconstruction of the system of ancient exchanges of obsidian in the Russian Far East" offered a typological description and a technological analysis of artifacts; it systematized data on the geochemical composition of samples and identified genetic types of volcanic glass. The typological analysis of tools in combination with the results of the biostratigraphic analysis and radiocarbon dating of habitation levels made it possible to pinpoint chronological boundaries of the monuments under study, from the

* *See*: V. Solyanik, "Golden Fund" of Geological Science of Primorski Krai", *Science in Russia*, No. 5, 2013.—*Ed.*



Location of volcanic glass sources and archeological monuments in the Ilistaya and Arsenyevka river basins. Arrows, the probable transportation routes of stone raws from the mining and preprocessing places.

Upper Paleolithic to the Paleometallic Age. Studies of obsidian implements at encampents lying as far from the obsidian sources as 25-30 km and more (Novovarvarovka-1, 10, Risovoye-1, in the Arsenyevka river basin) showed that for a long time they played an important role as shipping points as volcanic glass traveled eastward to the Amur (Osinovaya Rechka and Novotroitskoye-10) and to the coast of the Sea of Japan from the Kievka river mouth to the Zerkalnaya river basin. Thus the results of work in this key region of Primorye allowed to reconstruct processes implicated in the young (Miocene) basalt volcanism and in formative conditions of associated hyaloclastites, and see the pattern of their uses by stone Age man, including the collection of raw material, its preprocessing and further hauling to camping sites. The results of this teamwork discussed at international conferences and meetings were published in international journals.

Lately the Australian scientists continued their research work in China. In archeological monuments of Manchuria they found basalt glass which showed that hyaloclastites of the Shkotovsky upland are a major source of obsidian on the eastern edge of the Asian continent.

At the same time the team of Russian and American researchers (Yaroslav Kuzmin, Andrei Grebennikov, Margarita Dikova, Andrei Ptashinsky, Michael Glascock, Jeff Speakman and the author of this paper) expanded the geography of their work to the Russian northeast, i.e. the Sea of Okhotsk, Kamchatka and Chukotka. Out there the explorers discovered above 20 geochemical types of volcanic glass, and this attested to different geotectonic conditions and periods of persilicic volcanism in the Cainosoic. We need to study the most important primary sources of stone raws in the north of the Sredinny Ridge of Kamchatka and in the lower reaches of the Anadyr (Lake Krasnoye). The preliminary data on obsidian spreading in the archeological monuments in northern Kamchatka, Kolyma and Chukotka show that obsidian was carried rather far from its sources (above 500 km) and in different directions. According to American archeologist John Cook about 3-5 thous. years ago Lake Krasnoye obsidian was taken to Alaska through the Bering Strait already in existence then. Therefore using the well-tested geoarcheological approach we can trace the possible migration paths of man from Asia to America: the problem of its original settlement continues to attract attention in different countries.

Illustrations supplied by the author