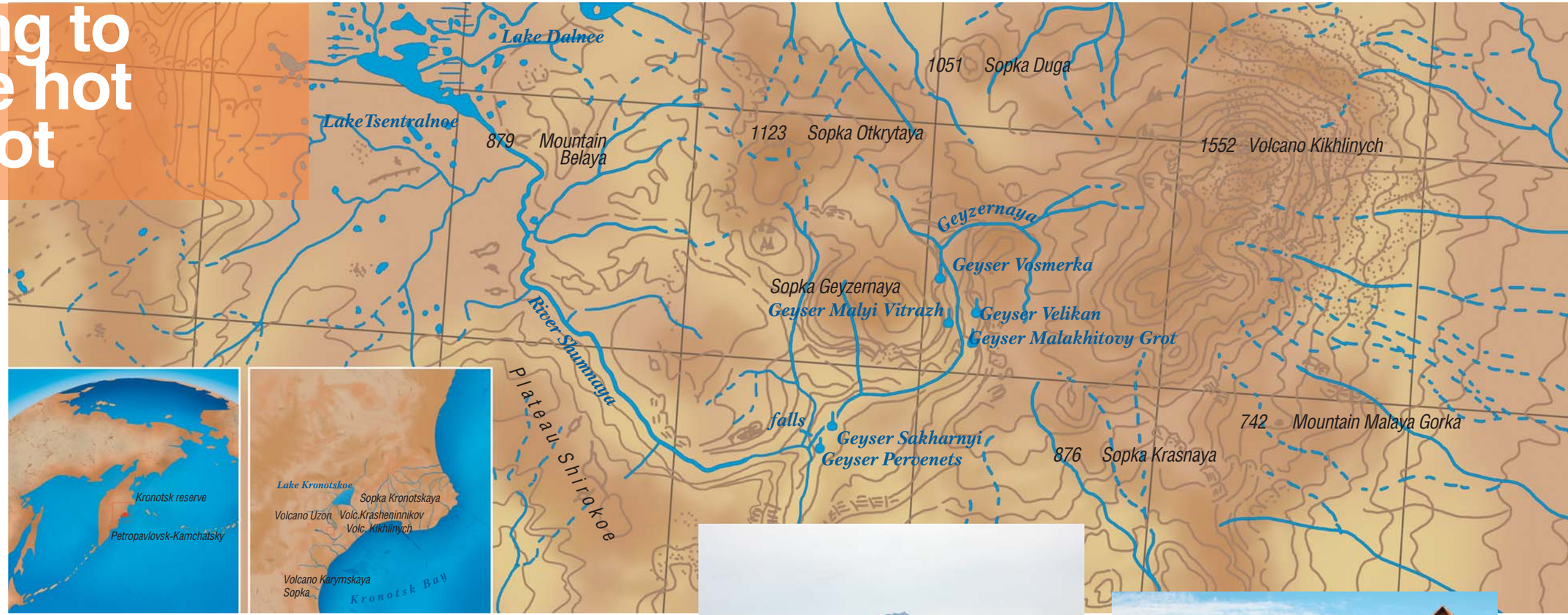
Going to the hot spot

V. YE. REPIN,
YE. V. DEINEKA,
A. N. SIMONOV,
O. P. PESTUNOVA,
N. A. KOLCHANOV,
V. V. VLASOV,
I. G. PROKOPKIN



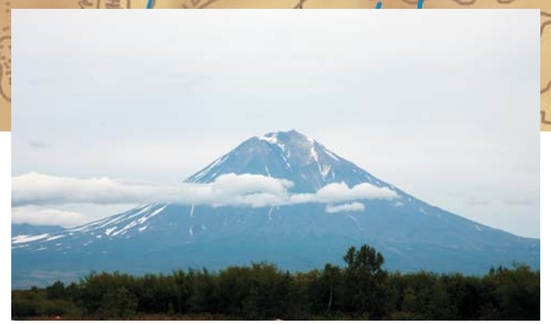
The pages of *Science First Hand* have been dedicated more than once to the problems of origin and evolution of the primitive life forms under the extreme conditions of the ancient Earth. And now, do similar conditions exist anywhere on the planet? Experts believe they do: they arise and are maintained for a long time near underwater volcanoes as well as in *hydrotherms* — hot springs appearing on the surface as a result of volcanic activity. Gas and water coming there from the interior of the Earth bring with them the same set of chemical agents as billions of years ago on the yet lifeless planet. It is there that unusual communities of primitive microorganisms able to assimilate inorganic compounds and to evolve with the changing conditions are formed.

The list of problems suggests that such a project can be accomplished only by a group of experts with various skills and knowledge. Indeed, there are several Institutes of the Siberian Branch, Russian Academy of Science (SB RAS) that take part in the project: the Institute of Cytology and Genetics, Institute of Chemical Biology and Fundamental Medicine, Institute of Biophysics, Boreskov Institute of Catalysis, Institute of Geology and Mineralogy, Trofimuk Institute of Oil and Gas Geology and Geophysics.

The first step in the project was a complex scientific expedition to the famous Valley of Geysers in Kamchatka.

We're off to Kamchatka!

One August evening, in cold rain, the team of our complex scientific expedition got on the bus going to Tolmachevo airport of Novosibirsk. On our way we heard the weather forecast — Kamchatka was about to meet us with rain and cold. We arrived in Petropavlovsk-Kamchatsky nearly on time: as promised, it was raining there, and the city was covered with mist. Gennady Karpov, a geologist



Members of the complex scientific expedition of the Siberian Branch, Russian Academy of Sciences, on the helicopter landing ground in the Geyser Valley, Kamchatka
On the stairs of the wooden airport of Petropavlovsk-Kamchatsky: waiting for the helicopter and anticipating the trip to Valley

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and deputy director of the Institute of Volcanology and Seismology of the Far-East Branch of RAS, met us at the airport and took to the hotel and then to the Institute. Its director, Corresponding Member of RAS Yevgeny Gordeev, told us regretfully that the weather was unfit for flying and we would have to stay in the city until the mist lifted up and helicopters were allowed to fly. In the drizzling rain we went to the hotel to order sauna for the evening to get warm. This is how we got stuck in Petropavlovsk ...

Stuck in Petropavlovsk

Day after day we hoped to leave the gray city, but every morning greeted us with mist and rain. The huge black ravens perched sadly on the wet trees and shook raindrops off their heads with their claws. We felt sad, and so did other residents of the hotel. The only possible occupation was sitting at the bar and staring, despondently, out of the window at the gray sky. There seemed to be no way out...

We remembered, however, that this was not a vacation but an expedition. On the first day we bought a map and made a tour of the city. In less than three hours, we managed to visit all local places of interest: the monuments to Saint Peter and Paul, Bering, and Laperouse; the Alley of Naval Glory; Kamchatka fishing port; the central square...

In the downpour we went to the bay to look at the famous black beach of Khalaktyr. The cold, the rain and the wind made the prospect of bathing quite unattractive. The only seasoned traveler among us, Volodya Repin, jumped into the unfriendly waters, the rest of us watching the process without a trace of envy from under the sunshades.

We were worried about the expedition — there were fewer and fewer days left for work. We conducted seminars, read about volcanoes and Kamchatka, studied the maps... This unwanted pause was not completely futile: we learned a lot about Kamchatka and volcanoes.

About volcanoes and bears

When they speak about Kamchatka, they always mention volcanoes and bears. Indeed, both are plentiful there.

One tenth of all volcanoes existing on the Earth are located on Kamchatka. They meet you right at the airfield. In the center of the peninsula there is a large group of enormous active volcanoes. Adventure lovers from Novosibirsk Akademgorodok come here every summer. They climb higher than ice, about 4 km, and admire unbelievably blue lakes of sulfuric acid and smoky stony terraces. They say that these chemical views capture one's eye immediately and forever.

From time to time, powerful explosions happen in the big active volcanoes, lava streams out, volcanic bombs fly... Since this is the time when scientists go to volcanoes, they are liable to losses: we saw the opening of a memorial to perished volcanologists. We happened to talk with some representatives of this heroic profession, and they named many of their colleagues who had died in different parts of the world.

There are lots of bears on Kamchatka, and they are big. The local instructions for tourists concerning the animals is quite an interesting document. Here it is in brief, rendered in our own words.

"You should not bother the animals. Last year a tourist from Japan sat for hours under cover and took pictures of the fishing bears, and evidently they grew tired of him. Once he did not show up for dinner. They searched for him, but found only his camera.

Bears do not like surprises, this is why it is necessary to let them know somehow that you are there (make noise, sing, etc.). It is better to be in a group, not by oneself. One should not get close to a bear lest it take it as a threat. If you meet a bear, step aside.

There is no generally shared opinion as to whether it is dangerous to look the bear in the eye. Some say that one should never do it, others believe that it does not affect the beast. If the bear is irritated, one should talk to it in a quiet calm voice, and if it does not approach you, leave. Never run! It will catch you anyway, for the bears can reach a speed of up to 70 km per hour!

If you started to move away, and the bear comes up to you, you should stop. Sometimes the bear can come very close before deciding what to do. If it comes too close, scream and wave your hands. A group of people must stand together and scream. Also, they say that it is useful to imitate tall height by lifting up long things — bears respect the big...

It is a bad sign if a bear comes up to you with its head down and its mouth open. It is a threat. If a bear begins to grab you with its teeth and paws, lie down on your stomach and protect your head. If it tries to turn you over, take the same position. The point is that bears can attack out of fear. If this is the case, you are lucky: it will just bite you a little and step away from a lying person. So you need to lie quiet and motionless, until the bear feels it is the winner. And if a bear does not stop to have fun and continues to bite you, it must be hungry. In this case you should protect yourself. It is a delicate matter to understand whether you are just being bitten (and then keep silent) or you are already being eaten (and then protect yourself)."

Most frequently, bears that attack people have previously managed to get some food from them. A friend of ours from a family of volcanologists told us how she was attacked by a bear. It was a young female who took to picking garbage next to the tourist camp. When our friend went to the dump to throw away fish entrails, the bear jumped out of the bush and attacked. The woman ran and fell down, and the bear took her behind with its teeth, lifted her up and began to shake her, just as dogs shake small animals. She was saved by brave tourists, who approached the animal in a group, screaming and waving different objects. The bear let the woman go and ran away. There were no serious consequences except scars.

On warm days the famous huge Khalaktyr black beach in Petropavlovsk-Kamchatsky is a splendid place for rest

On the way to the Geyser Valley

At last, three days after our arrival, the fog lifted and the mountains showed. We packed up swiftly and, after several hours of tedious waiting, we were in the air, flying amid the volcanoes! We were flying low, right next to the snow slopes, sometimes in the milk of clouds. We were flying over a deserted plateau covered with blue lakes and saw a bear going about its business. Having flown over volcano

The history of Kamchatka

In the ancient times different tribes lived in Kamchatka, but only the Itelmen have survived up to now. When the Cossacks came there, the land became Russian. Then the expeditions of Semen Dezhnev and Vitus Bering came to Kamchatka. On October 6 (17), 1740, the expedition ruled by Bering and Chirikov arrived at Avachinskaya bay. The day is believed to be the day of foundation of the city of Petropavlovsk, named after the expedition's packet-boats St. Peter and St. Paul.

Many well-known travelers visited the bay. In 1779 the ill-famed expedition of James Cook was there. After the death of the captain, the second-in-command Clark took over the expedition, but he was not luckier: soon he was buried in Petropavlovsk.

When in 1787 the expedition of G.-F. Laperouse came to Petropavlovsk, there were only one hundred people in the city, but for the guests they organized a ball with the ladies, who were only thirteen in number… Forty-seven years later there were already 600 people in the city. Today, 370,000 people live on the peninsula (less that one person for 1 km^2), and 250,000 out of them live in Petropavlovsk.

During the Crimean war the city was governed by V.S. Zavoyko. His detachment of one thousand people — soldiers, sailors and local hunters — successfully repulsed an attack of the English-French squadron of six ships which hosted 212 cannons and 2,500 troopers! Two attempts by the interventionists to make a landing failed, and the greater part of the first landing party of Zavoyko's soldiers were shot right on the shore. The English and French boarded the ships and sailed away from the cold hostile shores saving their lives. It was one of the very few victories won by Russian troops in that war.

After Alaska was sold, Kamchatka was forgotten for a long time. The Revolution brought some excitement, but the city stayed neglected. The Kamchadals took part in World War II, they cleared the Kuril Islands from the Japanese. After the war the fishing trawlers came from the GDR, and the fishing industry began to develop. Also, development of the city was triggered by the construction of a submarine base. However, after perestroika the navy on Kamchatka ceased to exist, and the fish caught was being taken away in unknown directions. Today, inhabitants of the faraway peninsula put all their hopes on the development of civilized fishing and tourism.

There are no large trees in the caldera of Uzon volcano; just a few dwarf birches grow on the green islands among lifeless thermal fields

craters and fast rivers, we landed in the interim point of our trip — caldera Uzon.

Here is a brief geographic reference. The Geyser Valley is a 4 km wide fracture between the active volcanoes Uzon and Kikhpinych. The structure named Uzon-Geyser is in the East Volcanic Zone of Kamchatka, about 180 km north from Petropavlovsk and 40 km west from the Pacific.

The 1,552 meter high Kikhpinych volcano is a complex massif with several peaks, the foot of one of them is cut by the river Geysernaya. In contrast, the volcano Uzon does not have a peak. Some time ago, it was about 3,000 meters high, but as a result of two powerful explosive eruptions the cone was thrown about the nearby mountains. Another eruption resulted in the formation of a caldera in the shape of a cup with a diameter of 12 kilometers, which today displays calm volcanic activity: the fumarolas are smoking, the hot springs are steaming, the mud cauldrons are boiling. A true Lost World...

The water-pressure system of the Geyser Valley is formed from the hydraulically connected floors of the ground and artesian water and fissure water of the tectonic fractures. More than 200 pulsating springs have been studied here, and more than 90 out of them are of the geyser type.

Chemical composition of the high-temperature water of the Geyser Valley and Uzon caldera represents sodium chloride solutions with high concentrations of silicate and alkali such as lithium, rubidium, caesium, and boron. However, water of the thermal springs of the Geyser Valley is only half as mineralized as that of the therms of the volcano Uzon. It is explained by the fact that the basic heat carrier in the interior of the Geyser Valley is superheated steam, whilst in the caldera of the volcano Uzon it is superheated solutions.

...Roaring, the helicopter lands on a dry square surrounded by swamps and brooks of fantastic colors. A flat surface with smokes and low plants spreads for kilometers on end, with a bank of mountain rocks behind it, around the caldera Uzon. By the edges of the caldera, ordinary tundra can be seen with its marshes and low bushes; closer to the center there are areas with emerald green grass alternated by lifeless clay fields covered with bubbling hot colored pools and smoking holes surrounded by bright yellow sulfur sediments. The swamps and geysers are belching out steam clouds.

In the center there are lakes, springs with colored shores, and smoking fumarola fields. On hot areas of the ground, little mud volcanoes work at their best: some let out big bubbles, others boil, still others periodically spit out mud. They are surrounded by wonderfully green plants. The place looks wild and strange...

On a flat dry patch, close to a brook, volcanologists built a cabin and were building another one... We ran around the smoking swamps; took pictures of the mud volcanoes, small geysers and colored pools; picked up bilberries and crowberries. The place is rich in bilberries, which attracts numerous bears. Some members of our team took a bath in the warm bottomless Bannoe lake that smells of sulphuretted hydrogen.

Thermal fields of the caldera of Uzon volcano, where the fumarolas are smoking, hot springs steaming, and mud cauldrons boiling, is a true Lost World

Fumarola is what the volcanologists call a source of hot gas in craters, on volcanoes' slopes as well as in the crust of cooling lava streams. Fumarolas let out gases dissolved in magma: carbonic gas, sulfur oxides, sulphuretted hydrogen, halogenohydrogenes and other chemicals, which makes the emanation dangerous for humans. As a rule, a thick steam is swirling over large fumarolas, for magma contains some water, too. The fumarola smoke saturated with water is a nutrient medium for certain bacteria. Many minerals formed here (for example, brimstone) are of biologic nature.

The famous Avachinskaya sopka near Petropavlovsk-Kamchatsky is a volcano with fumarolas, whose smokes can be seen on a clear day a few dozens kilometers away.

Caldera, a large round hollow with round walls, is formed as a result of a volcano top (and adjacent area) collapsing into an empty volcanic camera. One of the manifestations of the late stages of volcanism spread in the zones of modern volcanic activity is geysers, the springs periodically ejaculating hot thermal water and steam.

Geyser wells are several meters to dozens of kilometers deep. Exposed to hot gases and superheated steam coming from the interior by cracks, water on the bottom of the geyser well is heated to the temperatures significantly exceeding the boiling-point. At a certain point it boils up violently, and the well mouth shoots out a mixture of steam and water. Books on volcanoes usually say that to form a geyser a special geometry of underground well is needed. But let us recall the school lessons of handling solutions: if we try to boil water in a long tube placing its bottom in the flame of the burner, an eruption is guaranteed!

On the exterior geysers can look as small truncated cones, slightly sloping domes, small hollows and pits, on the bottom or in the walls of which there are outlets of pipelike or slitlike channels. There are regular and irregular geysers, and with different geysers the length of certain stages varies from minutes and dozens of minutes to several hours or even days.

Geyser activity depends on arrival of surface water, which, in its turn, depends on atmospheric precipitation. For example, Velikan, the largest geyser of the Geyser Valley, can stop working during strong downpours, when it is filled with cold water.

The brown, gray and blue mud bubbling baths and hot bottom streams making the little lakes boil... This is what the surface of the ancient Earth must have looked like when it witnessed the life begin. *The caldera of Uzon volcano, Kamchatka*

The caldera of Uzon volcano strikes with its contrasts — the hot areas of soil with mud baths and boiling lakes are surrounded with robust green plants

In the lost world

In an hour, we are in the helicopter again. A bit more of exciting flying along the canyons, and we are in the Geyser Valley. What an astounding, extraordinary beauty... A meandering quick river surrounded by high mountains, a lot of geysers and springs on its banks, and smokes everywhere. In some places it smells of sulphurette hydrogen. Snow lies on the peaks along the river banks, even though it is summer. In early spring, mother bears bring their offspring here to slide down the snowy slopes. And later, bear families go down to the river, where the earth thaws early and they can find delicious roots and juicy grass.

There are only three houses in the Valley, including a big two-storied one, made from light logs, with all facilities — this was where we lodged. In the evening, we turned on the heating system for some time to make it more pleasant to fall asleep. The house was surrounded by grasses taller than a man. The place is designed to protect nature from tourists: one must take wooden sidewalks and stairs to get from the houses to the most beautiful nearby geysers.

The Geyser Valley is located on the territory of the Kronotsky biosphere reserve, organized in 1934 to protect the local population of sable. The reserve is known by a most beautiful Kronotskoe lake and wonderful silver fir forests. Bears live here, you can also come across flame-red foxes and wolves.

The reserve also hosts twelve active volcanoes. The Geyser Valley itself was discovered only seven years after the reserve was organized. At that time the territory of Kamchatka was not fully studied, and the valley of the Geysernaya river in the narrow gorge with steep slopes was always hard to reach. Of course, hunters were bound to see steam clouds of the geysers but, first, it is very hard to surprise anybody in Kamchatka by smokes and steam clouds; and second, the local people were sure that the place was inhabited by evil spirits one should stay away from. The Itelmen were always a bit afraid of the volcanoes and hot springs, and not without reason: nothing good awaited a hunter in the smelly fumarolas, hot springs, and mud baths so easy to fall into.

This is how the Valley was discovered: first, geologists noted that water in one of the small rivers was of higher temperature. In early spring 1941, T. I. Ustinova, a hydrologist, and her local guide went up the river on a husky sled. The travelers camped on the bank to rest, and their camp turned out to be right in front of quite a powerful geyser, later called Pervenets (the First-born). The geyser shot almost at the people and scared them, for geysers were unknown in this country. In the summer of the same year, the explorers found a steeply sloped valley with hundreds of hot springs, geysers and lakes. The Geyser Valley now belongs to the highly protected territories: in 1977 the access was restricted, and now all visits are controlled. It is a reasonable measure — otherwise, the small valley would have been long trampled down, and geyserite taken away for souvenirs. Even though your freedom is restricted, you can see practically everything of interest and not to damage the unique nature.

In reality, the Geyser Valley is not a valley but a narrow canyon with steep yellow slopes, on the bottom of which the meandering quick river Geysernaya streams down. On the river banks, there are steaming fields with pulsating springs and bubbling mud cauldrons, white splashes of geysers. In the lower reaches, the river cuts deeply through the volcanic rocks and forms two high rock towers-gates. The river banks are colored due to leakage of mineralized streams, colors in which are added by both chemical processes and thermophilic organisms. The most interesting part of the valley is not big, no more than 5 km^2; it can be seen in a day.

Upstream the river Geysernaya is the Death Valley, where within a small (100 m to 150 m), low area they find numerous corpses of animals and birds. It is natural to suppose that poisonous gases from the fumarolas are accumulated here, which can become dangerous in windless weather. It is small mammals that are likely die first, trapped in the folds of the valley. Attracted by the corpses, crows and big birds of prey fly here and add to the list of victims. Their bodies attract foxes and gluttons, and then it is the turn of bears. Bending over the victims, the big animals get the mortal doze of the gases.

Once G. A. Karpov, a volcanologist, and Academician G. A. Zavarzin, a well-known microbiologist, went to the Death Valley to take air samples. The scientists took gasmasks, but they did not put them on at once, which almost

The Geyser Valley is home to numerous bears. The footprints of the local masters can be seen everywhere. Next to one of them a tourist boot of size 13 is put to show the scale

The trail along the Geysernaya river follows the steep ridge and turns around the rock gates carved by the stream.
The Geyser Valley, Kamchatka

brought them to the brink of death. Zavarzin lagged behind and, while picking something, bent over and breathed in the air from the near-ground level. Bending lower and lower, he began to move without coordination. The volcanologist looked back, and just in time: he noticed the odd behavior of his partner, understood the reason, ran up to him and put the gas-mask on him. The analysis of the air samples from the valley showed that beside high concentration of carbonic acid and sulphuretted hydrogen it contained prussic acid!

At work

We did not have enough time, so we started working at daybreak and stopped only when it got dark. Fortunately, our life was perfectly organized — no canned food to spoil our mood and digestion. A professional cook made us happy with hearty meals, inexhaustible supplies of caviar and fish, and a good choice of drinks. In no other trip did we have so many pleasures at our disposal: a completely wild, beautiful place; and a savory lunch after which you can sit on a comfortable bench, watch the Valley and contemplate about life origin and evolution... Pity we did not have enough time for that: afraid of bad weather, we could not afford to lose a minute.

On the very first day, we went down the river to the geyser Pervenets. We were told that it was quite a difficult route, but the path turned out to be rather good, and on the steep clay slopes there were ropes, absolutely indispensable in the rain. The hills that we walked over were not high but steep, and the crests were very narrow, with their slopes covered with bushes. If you stumbled and went down, the chances to get off with nothing more than a fright were not high. We were lucky — it was dry, and the ropes served only as a source of fun for Tarzan fans.

As we were going along the river, we had to move amid boiling pools in motley frames of stones and grass. Here and there, we saw big bear footprints imprinted in the soft ground. In some places, everything was burning and bubbling, as if these were infernal cauldrons with boiling water; streams of gas hissed from under the stones; and

the air was filled with sulfur gases. We were instructed not to walk over the glades covered with deceivingly low, bright green grass and shallow brooks that looked very safe to cross. As we were told, the thin crust of soil often hid burning quaking bogs, where you could fall and, if you were not wearing boots, injure yourself badly. Experienced people explained that you could step without fear only on the stones and on the ground where you could see wormwood — for some reason, this bitter plant does not like to grow over the hot swamps.

Chemical composition of the water samples from the pools and boiling geysers turned out to be quite versatile. Probably, this is the reason for versatility of the microorganisms that live here.

When at the end of our route we came up to Pervenets, it began erupting. We took the samples of water, zeolite, and montmorillonite, bathed in the river and went back.

After lunch we went up the stream Vodopadny to take new samples and to bathe in the famous warm waterfall Jakuzzi. It was named so for a reason: its low (about 2 meters) streams form a smooth cup 1 meter in diameter, where you can enjoy a better massage than in an ordinary Jacuzzi. Below, right after the cup, there is a large creek where about eight people can comfortably sit.

As we were approaching the waterfall, we saw a heap of water moccasins on the bank, which was a sure sign of the presence of geologists: when experienced travelers undress, they take off their moccasins in the last place. Indeed, in the warm creek under the waterfall geologists from Saint Petersburg with their local colleagues were soaking in perfect bliss. They were equipped with a mouth-organ and a khomus (a buzzing plate) and gave us concerts playing these miniature instruments. On the second day, we went to the geyser Velikan (the Giant). Its name speaks for itself: when erupting, the gush of water reaches thirty, sometimes forty meters! During our stay in the Valley, Velikan erupted every eight hours, almost to the minute. The water escaping from the geyser's mouth flows down to the river, where in the old times some kind people built a bathing hut out of boulders and called it "the royal bath". When the geyser erupts, tons of boiling water flow down the area, wash the emerald algae on the stones and cool down to the comfortable temperature, coming into the bath. The women in our expedition tried not to miss the rare chance to bathe there, for the green algae, living in colonies on its walls, rejuvenate the skin, they say.

Having reached Velikan, we took samples from the geyser's mouth and out of numerous springs and pools nearby. Brave Repin crossed the rough river Geysernaya on foot and took some more samples from the slope of the river called the Maly Vitrazh (a Small Stained-Glass) because of its multi-color look: thermal sediments colored strips of the river bed in various colors. After that we returned to the camp, brimming over with excitement and bending under the load of samples.

Of great help in analyzing the samples was the portable laboratory designed for express-analysis of natural water. The laboratory called "Ob" was designed and produced in Novosibirsk. Every sample was taken in two separate vessels: the solution from the first was analyzed on the spot; and the liquid from the second, hermetically sealed, was to be analysized later, when we were back to Akademgorodok.

To define the degree and the factors that affect chemical composition of the samples during shipping and handling, a separate experiment was conducted. The fact is that water composition can change both as a result of contact with air and as a result of vital activity of microorganisms that live in water. This is why we took several samples of water from different sources (from acidic to alkali) and filtered half of them with a sterile filter in order to remove the greatest part of the microorganisms. Then, for two months after the expedition, we several times measured the acidity of the medium. We discovered that most samples turned acid while being stored. It was thus not in vain that we took the trouble to carry the laboratory with us!

In the torchlight

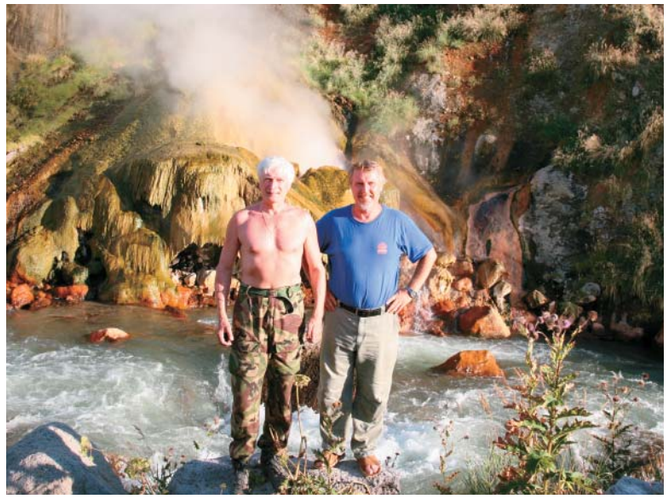
It is necessary to say that every spring in the valley, as well as each mud bath, is unique. On the surface of some mud baths, we found an oil film. Some scientists believe that this oil is synthesized by the local thermophilic microorganisms from gases leaking to the surface. Analysis of the samples taken from the baths, which was made later, showed that they contained a lot of organic carbon and dozens of various organic substances, which are being studied in detail now.

Field work stopped only when it grew dark. Chemical analysis of the samples was conducted in the torchlight — unfortunately, there was no light in the improvised laboratory set up in the hall of the house. Since the acidity and degree of oxidation of the samples, as well as concentrations of sulphides and carbonates in them, could change during storage, these characteristics had to be defined on the spot.

Bathing in the streams of a 30-meter-high waterfall on the Vodopadny brook. An unforgettable feeling: cold water coming from above, steam coming from under the stones aside, and biting hot streams of underground springs burning our heels from below. *The Geyser Valley, Kamchatka*

In the stone cup of the famous warm waterfall Jakuzzi on the Vodopadny brook you can get massaged better than in a real spa

▲ The huge mud baths of the Geyser Valley, natural traps with a boiling liquid create a danger for a careless traveler



The Malachite Grot is the most beautiful geyser in the Valley: in the evening in certain hours a rainbow flares over it. Virtually everybody wants to have his picture taken next to this natural wonder.
The Geyser Valley, Kamchatka

The evening of our third day in the valley was the last one for us. All members of the expedition were filled with mixed feelings: we delighted in the unbelievable beauty and uniqueness of the Geyser Valley and felt we had spent too little time in this gorgeous corner of the Earth. We did not want to leave...

The results of the expedition

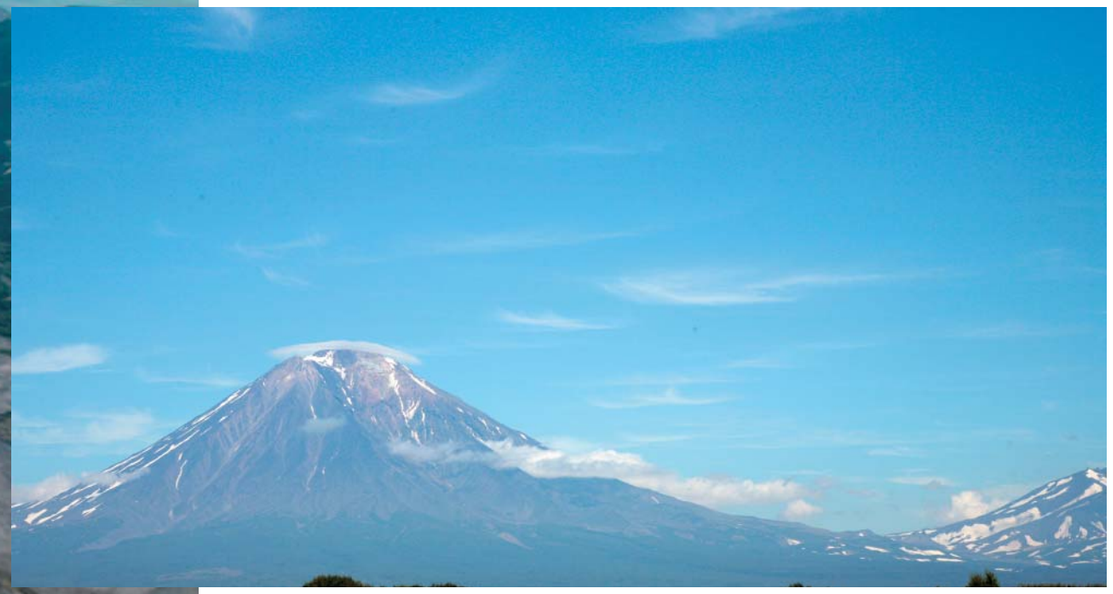
The way back was easy. The kind helicopter pilots took us quickly to Petropavlovsk, flying on purpose over extremely beautiful places: very high black volcanoes. The crater of one of them was whistling deafeningly, bright flame sparkled out of a small hole on the interior wall of the cone, the volcano was smoking...

Looking back, we realized that we had been lucky. Even the weather was to our favor, as we were told sometimes people had to wait for weeks on end and to no avail. We collected more than 200 samples, which are being analyzed now.

One of the purposes of the expedition was to reveal the diversity of microorganisms adapted to the extreme conditions of hot springs, fumarolas and geysers of the Geyser Valley. Scientists are especially interested in studying the extrathermophils of the ancient Archaea group, which are able to synthesize various proteins under high temperatures, including enzymes needed for biotechnology (for example, for biodegradation of polymers under high temperatures). Also, such microorganisms can serve as a source for cloning the genes that code these proteins.

Today, we educed out of our samples more than 300 cultures of microorganisms including the endemic ones, characteristic only of the hot springs.

A usual method of revealing biodiversity is analysis of composition of microorganism communities in a sample by seeding it on the artificial nutrient medium. However, the research method based on the analysis of characteristic conservative sections of a genome, which can be used as



The volcano in the cloud cap near the airport of Petropavlovsk-Kamchatsky is the last souvenir of Kamchatka that we will take with us

Photographs used in the article were made by the members of the expedition

We are leaving the unforgettable Geyser Valley. One of the volcanoes, over which we are flying in the helicopter, is whistling deafeningly and belching smoke after us

The farewell concert of the geologists masterfully performed on the miniature musical instruments — mouth organ and khomus

genetic markers, is more effective. Among universal markers are the genes coding the RNA of a ribosome — a cellular microbody, in which proteins are synthesized.

The results of our research using these genetic markers proved once again that microflora is hundreds of times more diverse as compared with what it looks when determined by the classical methods.

We also employed methods of DNA extraction out of various samples (microbiological mats, soil of mud baths, sediments of water samples) and the method of additional purification of the extracted DNA from the admixtures. As a result, presence of the previously unknown bacteria and archaea was discovered.

When you are back home after an expedition (especially if it was a success) and think back about its results, you realize that the success is attributed to the coordinated work not only of the members of the expedition, but also of the people who are connected with it indirectly. We are infinitely grateful to G. A. Karpov, our guide and curator, E. I. Gordeev for his colorful tales of Kamchatka, to the administration of the Kronotsky natural reserve and especially its director V. V. Komarov.

And finally, we would like to say that we are very sorry for those who have never been in the Geyser Valley. We are going to visit it once again to study in detail the remote part of the geothermal region, to reveal the secrets of the Death Valley and, of course, to check the instructions on how to behave around bears...