

The Geysers of 'The Valley of Geysers'
Kronotsky National Biosphere Preserve, Kamchatka Peninsula, USSR

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A Preliminary Report by the GOSA Expedition
of June 28 - July 9, 1991



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Cover Photograph:

A major eruption of the geyser Grot Yubileinyi as viewed from the vicinity of the helicopter pad and house in the Valley of Geysers, Kronotsky Nature Preserve, Kamchatka. This picture also conveys some aspects of the beautiful ruggedness of the valley. Photo by John Rinehart.

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For And With Editorial and Data Corrections By
"The 1991 GOSA Kamchatka Expedition"

Jack Hobart, Bill Warnock, John Rinehart, Martha Fenimore and Bob Colvin



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How It Came To Happen— The Development of the GOSA Tour to Kronotsky Nature Preserve

by T. Scott Bryan

This business of arranging a trip to the Valley of Geysers came up suddenly and, in most respects, efficiently. It all began one otherwise ordinary January 11, 1991 when, in seeking geyser activity information for a new issue of *The Geyser Gazer SPUT*, I made a casual telephone call to the Old Faithful Visitor Center. It is most fortunate, perhaps, that the person on duty was Dan Ng, the Old Faithful Area Naturalist, the one most familiar with the then-current events.

After discussing the geysers for a few minutes, Dan made a simple off-hand comment—inside the Visitor Center at that moment was Sergei Alekseev, the 32-year-old Director of the Kronotsky Nature Preserve. He was accompanied by Frith Maler, the U.S.S.R. Operations Coordinator for REI Adventures.

Alekseev was visiting the United States in order to learn more about American (e.g., National Park Service) management and interpretive techniques because of the pending opening of Kronotsky to visitors during 1991. REI Adventures had been granted an exclusive concession to conduct such tours for Americans.

What I did not realize at the time was that Alekseev had already been presented with copies of my two books and had seen an issue of *The Geyser Gazer SPUT* (GOSA's bimonthly newsletter), and in those ways had become acquainted with the existence of The Geyser Observation and Study Association. He was enthralled with the idea of a group of "geyser gazers" who sought to learn more about geysers, on their own without any government assistance or funding. Given our interest in geysers and his desire to promote his area, Alekseev instructed REI Adventures to develop a special trip for members of GOSA.

So, despite the Middle East war against Iraq, which had begun just a few days before, and some poor relations between the USA and USSR, mostly because of Baltic Republic independence moves, on January 29 Frith Maler sent by fax an itinerary for a "Friends of the Geysers" tour. Proposed date of departure: June 28, 1991.

The new issue of *The SPUT* was at the printers by that time. I managed to get a brief announcement prepared for insertion, mailed the issue within a day or two, and sat back to wait for responses. I didn't have to wait long... at first. The first to call was Jack Hobart, just the day after the mailing. I heard from John Rinehart the next day, and Martha Fenimore the next. That gave us four of the minimum six needed for the tour, and made it look as though the trip would fill (at 10) very quickly. But then the phone fell silent. There were a couple of queries; a couple of people tentatively signed on, but then had to cancel due to other commitments. Some called wondering if the dates could be changed, because of the conflict with the July 11 total solar eclipse in Mexico. For more than three weeks, we were stuck at four trip members. February became the longest month of the year. It wasn't until March that, in part due to some cajoling, Bill Warnock and Bob Colvin finally came aboard, giving us the six needed participants.

That left a long time for further planning—and for all sorts of things to go wrong. The fact that Bill was in Israel did not help. With the Iraqi war, mail service to Israel was totally disrupted. Yet I had to receive application papers and a cash deposit in short order. Often, things barely arrived on time. Although we had been told that our visa applications needed to be in the hands of Zierer's Visa Service by April 28, the Soviets wanted the information by April 8. Three of the group did not even have passports yet.

As group leader for an endeavor unlike anything I'd been involved in before, it was a tremendous hassle, a time of many headaches and heartaches. We got upset with REI Adventures, and they got upset with us, even suggesting at one point that it might be better to simply cancel the entire excursion. But in the end, all worked out.

Our airline schedules and tickets for getting to Anchorage were arranged individually, while Heather at REI Adventures booked our lodging in Anchorage (all but Hobart and Warnock staying at the Barrett Inn the night before leaving for Russia) and sent the airline tickets to Magadan in the middle of May.

For all the changes that have been happening in the Soviet Union recently, though, that society is still close and closed in many respects. In spite of our personal invitation from Alekseev, our visa applications had to be approved by the Soviet KGB from Kamchatka, then by the KGB and Foreign Ministry in Moscow before approvals could be sent to the embassy in Washington, DC; they then had to go to the consulate in San Francisco for the actual issuance via Zierer's Visa Service. We had been forewarned—visas sometimes arrive as little as just two days before departure. That could have produced some real problems, given our need to first get to Anchorage. But success. My visa arrived on June 19, more than a week before the big day.

And it all began with a simple phone call.

A Look Back in Perspective The view from August 20, 1991

In retrospect, we were very lucky travellers. The trip came off smoothly. On every occasion when we were to be met at an airport, transported by helicopter, driven by car, or whatever, the people were there. There were no hitches and no hassles. All six gazers agreed that this had been the best trip of their lives.

But in fact, it almost didn't happen. Only weeks after we were home did we learn that our visas were incorrect. Petropavlovsk-Kamchatskii should have been listed as an allowed destination. It was not. It was probably only because of the inexperience of Russian customs officials at the then-new international terminal in Magadan that we were allowed to board the Aeroflot flight to Kamchatka. It is doubtful that they simply let us pass by virtue of being a "special group."

In further retrospect, of course, were the events of August 19 and beyond—the overthrow of Gorbachev with its consequent cancellation of American tours into the Soviet Union, and then the failure of the coup two days later. This report had been intended as a preliminary discussion of the geysers in Dolina Geizerov. We were invited to return in 1992, when we had hoped to spend more time examining the geysers instead of exploring the area.

It stands to reason that Soviet policies regarding American tourism might quickly return to "normal." But there will undoubtedly be changes, too. Our future must be considered as questionable.

Therefore, this journal has been expanded in the anticipation that it might have to serve as a final report, the first and only non-Soviet description of the second largest geyser field on Earth.

Part I

In any case, no tourist had ever been allowed to spend more than two days in the Valley, and even Soviet researchers have generally been restricted to a few days at the most. Our eight full days made the 1991 GOSA Expedition an historic group, indeed.

Part I

The Valley of Geysers Access, Geography, Weather, and People

Transportation

Until very recently, any travel to the Soviet Far East (these coastal areas are not part of Siberia) was long and difficult, all routes being via Moscow. Starting on June 17, 1991, Alaska Airlines began three flights per week from Anchorage to Khabarovsk and return, via Magadan. Magadan is the take-off point to Petropavlovsk-Kamchatskii, and isn't all that far from Anchorage—the flight time is less than four hours, but it also crosses five time zones and the International Date Line. (Figure 1 shows the flight routes.)

The Magadan air terminal is about 50 kilometers from the city itself. Most tours have to spend some time in the terminal or, if several hours are available, on a tour into the city. The terminal is old and junky by American standards, its open spaces lined with ticket counters, food stands and lounge areas. For Americans, a special private lounge area had been established near the Alaska Airlines end of the terminal complex (separate from the Aeroflot remainder), and the Bar Video was reserved for our exclusive use each time we were there.

The travel from Magadan to Petropavlovsk is via Aeroflot and, depending on the arrangements, can be either commercial jetliner or chartered turboprop. The flight between Magadan and Petropavlovsk is short, taking only about 1 1/2 hours.

The Petropavlovsk air terminal is close to Yelizovo, the headquarters town for Sakzhoy, the Kamchatkan tourist agency, the site of Dom Okhotnika, the lodge used by the REI Adventures tours, and the Aeroflot heliport used by Kronotsky Nature Preserve.

The helicopter flights to and from the Valley of Geysers are certainly the most interesting travel aspect of the trip. Somebody said that when the Soviets find a design that works, they stick with it. Every helicopter we saw was identical in design and color. Though old and somewhat rickety (or so they seem), they worked and could cover the 200 kilometers between town and Valley in little more than an hour. Figure 2 shows the southern portion of the Kamchatka Peninsula, with the boundary of Kronotsky Nature Preserve and the helicopter flight routes identified.

All in all, every aspect of the travel went smoothly. It seems remarkable that it took less than

General Introduction

The Kronotsky Nature Preserve (as it is commonly called; the official name is Kronotsky National Biosphere Preserve) was established as a wildlife refuge in 1982, primarily because of its concentration of sable, then the highest quality Russian fur reserved for the use of the royal family. The area was expanded and became a full national park in 1934. Even so, there was no knowledge of its geysers until 1941.

Kronotsky is a very rugged place. Many of its rivers are fishless because of their high temperatures in the winter—winter, because it is then that the flow is almost entirely geothermal; the Geysernaya, for example, has been recorded as warm as 27°C in January. The lack of a fishery and the apparent absence of any valuable mineral deposits among the volcanic terrain precluded exploration and settlement. The Valley of Geysers was discovered quite by accident by T.I. Ustinova in August, 1941, and it was not until 1951 that it was thoroughly explored and studied for the first time.

The Valley of Geysers remains a remote place. The nearest poor road ends some 110 kilometers away. Although a few people have illegally hiked to the Valley, legal entry is by invitation only and the only practical access is via Aeroflot helicopters. They fly a charter service for the park, to and from Yelizovo 200 kilometers to the south; there is no regular or on-demand commercial service.

With that, the Valley has been visited very infrequently, even by Soviet citizens. We were told that only about 50 foreign visitors had been there in the five years of 1986-1990. None of the employees of Sakzhoy, the Kamchatkan tourist agency, had been there before our trip. "Foreign" includes all non-Soviet east Europeans. It was reported to us that only six Americans had ever been into the Valley prior to 1991, three of whom were representatives of REI Adventures doing the groundwork for their tours during 1990. We now know that that is not quite correct, but liberally considered, the total of American visitors cannot have been greater than 30.

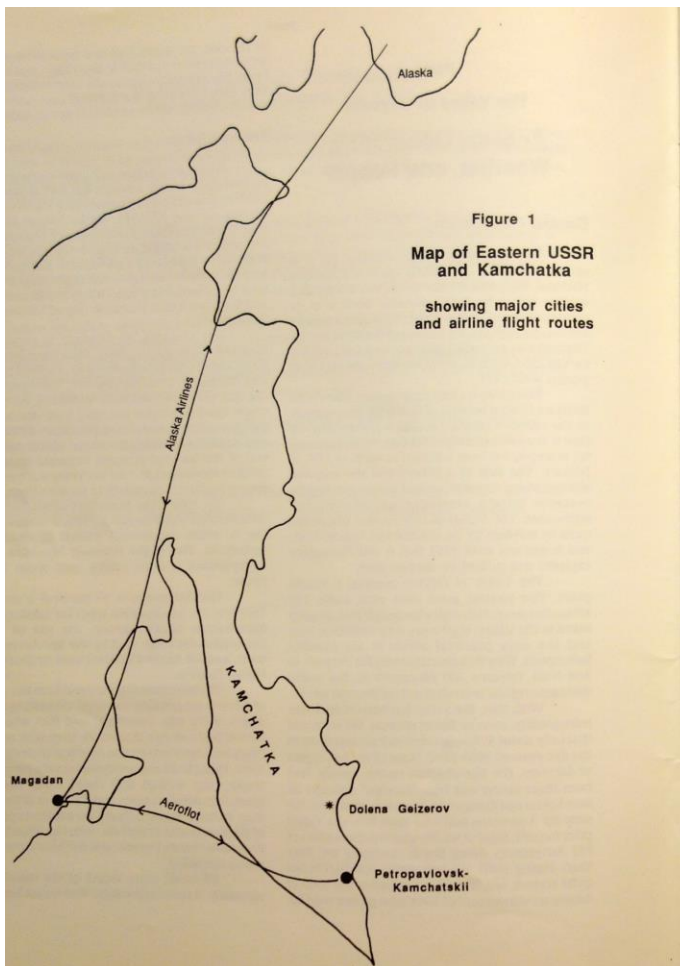


Figure 1
Map of Eastern USSR
and Kamchatka
showing major cities
and airline flight routes

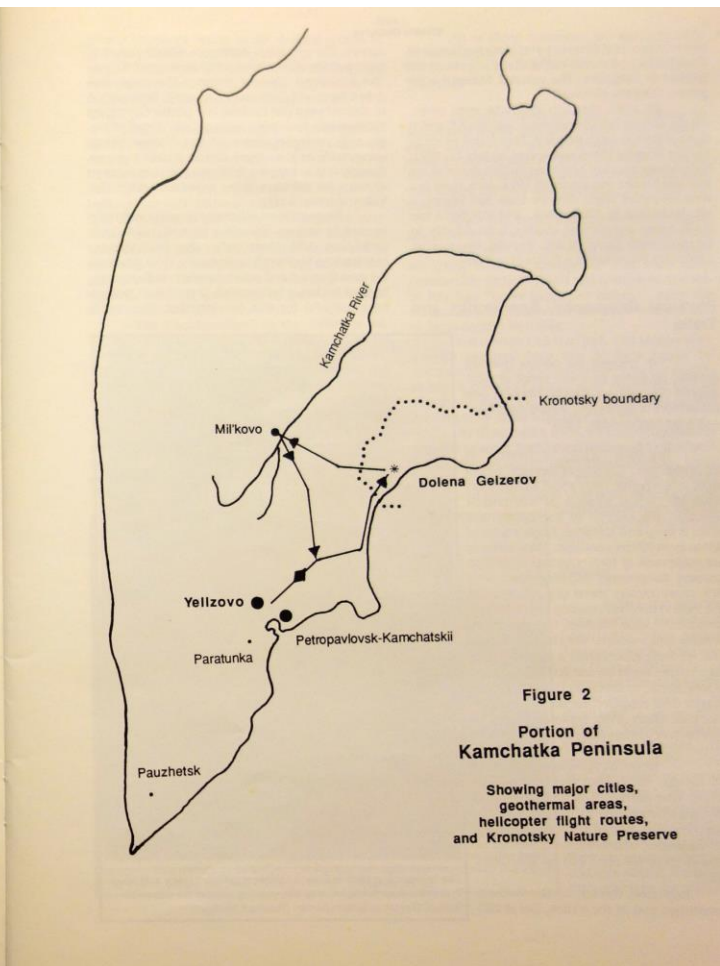


Figure 2
Portion of
Kamchatka Peninsula
Showing major cities,
geothermal areas,
helicopter flight routes,
and Kronotsky Nature Preserve

Dolina Geizerov

eleven hours (real time) to travel from Anchorage to Kamchatka, and almost half of that was spent on the ground in Magadan. The cultural distance is far greater than the physical!

By 1992, this trip might be even easier. Alaska Airlines has the option to add more flights if there is great enough demand. Per a travel article in the Los Angeles Times newspaper on July 14, 1991, the package tours in Magadan and Khabarovsk are sold out for the remainder of 1991. Also, there is a weekly Aeroflot flight directly from San Francisco via Anchorage to Khabarovsk, and this flight has made some commercial charter stops directly in Petropavlovsk-Kamchatskii. Regular commercial service on that route is a future possibility.

Physical Geography, Boardwalks and Trails

"We followed the narrow riverbed, covered up to our ears with lumps of multi-colored clay and wet through climbing over the barriers of stones and skirting waterfalls."
— Vadim Gippereiter, 1969

The term "Valley of Geysers" is inappropriate. "Canyon of Geysers" would work much better. Only about 8 kilometers from the actual summit of Kikhpynch Volcano, the canyon of the Geysernaya River is deep and tortuous. Slope angles of 45° to even 70° are common. Their surfaces are composed of hydrothermal clays that become dangerously slippery when wet. Any cross-country travel (e.g., in most of the Valley) involves crossing not only long stretches of such hillsides, but also many streams and swamps. We thought it odd that we were each issued a pair of thigh-high rubber boots on our arrival. We grew to love them, so much so that some even bought and returned to the States with their pair. Many of our explorations would have been extremely difficult without those boots.

The elevation at the house is exactly 500 meters. At Vellikan Geysers it is 445 meters. This difference of 65 meters (210 feet) is accomplished in only one-half a linear kilometer. By trail, the route is perhaps 0.75 kilometer, which means hundreds of stairway steps (in fact, 440 by Rinehart's count).

Pervnets Geysers, at the farthest downstream end of the Valley, lies at 280

meters. The elevation difference within just this main portion of the Valley is 165 meters, or 540 feet. The horizontal distance between Pervnets and Arka is barely 1 1/2 kilometers, roughly comparable to that between Old Faithful and Grotto Geysers in Yellowstone. Such great relief quickly dispelled our pre-trip interpretations of the Valley being comparable to the Upper Geysers Basin, and any thoughts about tripping from one geyser to another in just a few minutes; going anywhere within the Valley involves a hike.

Because Dolina Geizerov is being cautiously opened to visitors (the 1991 limit is 1,000 total including 100 "foreign"), the Park began constructing boardwalk trails during 1990. Much of the management and administration of Kronotsky harkens back to a Yellowstone of the 1800s, but we were thankful for this development. The walks



The boardwalk system in Dolina Geizerov contains many stairways. This is the drop through Group Via, passing around the alcove of Sichel Geysers at bottom center. (Rinehart photo).

greatly improved access to the thermal groups of greatest interest while doing much to protect the fragile botanical ecology of the Valley. No construction is performed before a botanical survey for rare and endangered species has been conducted first.

These trails are restricted to a small portion of the Valley. The system is being slightly expanded during 1991, but there are no plans to route boardwalks throughout the Valley—the cost of hauling in all lumber, work crews and supplies via helicopter is prohibitive in any case, but the intent is to keep most of the Valley "off limits" to most visitors in order to better preserve it. Excepting special groups such as ours, all future visitors will be restricted to the boardwalks. (To our surprise and great pleasure, we were free to wander anywhere we wanted, and were conducted to some strictly off-limits places as well.)

The "headquarters" in the Valley is the house constructed by Vitalii Nikolayenko (see below) starting in 1972. Multi-story and with many rooms, it serves as his summer residence and office, the tourist's kitchen and dining room, a weather shelter, the heliport and communication center, and the general gathering place. It is the ultimate "ranger station." All trails begin at the house. One leads to pit toilets and a community dump across a meadow; another ends at a bathroom, complete with porcelain tub; all the rest drop directly into the Valley itself.



The house that Vitalii built, starting in 1972, and which now serves as the Valley headquarters. This photo was taken from the Aeroflot helicopter upon our arrival. The top of "Hill 516" is behind the trees above the house. (Rinehart photo)

Part I

All of these constructs are approximately shown on Plate I.

Weather

Historical literature makes the weather on Kamchatka sound decidedly uninviting. Virtually every description talks at length of the dense summertime fog and rain along the Pacific coast; of the sun seldom shining. On the other hand, we were told before the trip that pleasant, 80°F days are common.

Therefore, we do not know if we were blessed or cursed by the weather we experienced between July 1 and 8, 1991. Sunshine was brief and rare. Rain fell daily, often as downpours. Wet snow blew horizontally on both July 4 and 6; snow on the 4th of July had "never happened before." After the thousands of miles of travel, we often were content to (impatiently) sit inside.

But it wasn't all that bad. The temperature usually reached into the 55-65°F range by midafternoon, and the conditions kept the insects at bay. A couple of briefly mild moments proved that the mosquitos could have been terrible (as was confirmed by other trips later in 1991).

By all accounts, then, we suffered extremely unusual weather. Some areas we hoped to visit were inaccessible because of the slippery conditions. Some geysers were temporarily inundated by flooding runoff, and the mud pots were pools of tepid water.

Such conditions should not be expected by any future trips.

People

Before the trip we had a slight but impersonal familiarity with Sergei Alexandrovitch Alekseev. He is the Director of Kronotsky Nature Preserve. At the age of only 32, he might be a progressive within Soviet administrative agencies. He recognizes that Kronotsky and its Valley of Geysers are world-class. He knows that they must be preserved at all costs, but that they must also be accessible if they are to be understood and appreciated. It is largely through his personal efforts



The Russian people of the Valley of Geysers. (Left) Kronotsky Director Sergei A. Alekseev. (Byran photo). (Center Left) Vitalii A. Nikolayenko. (Rinehart photo). (Top Right) Volodia, Misha, and Oksana. (Warnock photo). (Bottom Right) Tanya. (Byran photo)

that Kronotsky—perhaps even Kamchatka in general—has been opened to outsiders.

It was Alekseev who demanded a restriction on the number of visitors, but it was also he who made the special invitation to GOSA at the end of his January 1991 trip to the United States. He has hopes of organizing a similar group of geyser gazers on Kamchatka, openly expressed his wish to maintain close ties with GOSA, and invited us to return in 1992. Sergei is now an honorary member of GOSA.

The other person of high note is Vitalii Alexandrovitch Nikolayenko. There isn't enough room in this volume to describe him. Vitalii has a long history of many jobs here and there throughout the Soviet Union. He has a wife and two children and maintains an apartment in Petropavlovsk-Kamchatskii, but he is seldom there between April and November, when he works in Kronotsky, as he has since 1970.

Perhaps it is best to describe Vitalii as some sort of combined caretaker-foreman-chief ranger-chief naturalist-bear researcher-handyman-host. He is the only resident of the Valley of Geysers. He built the ramshackle but comfortable house starting in 1972, shortly after he was shot and nearly crippled by a poacher. He has more stories than you can count; OK, some might be stretched just a bit. He's a ham who loves to get into your photograph. He has an unquenchable thirst for knowledge. He's delightful.

Vitalii's main interest is the *medved*, the Kamchatka bear. Sometimes described as a brown bear similar to the Alaskan or Kodiak, it is actually a *gizly* and is by some given the exact same species name (*Ursus arctos bryanhills*) as those in Yellowstone. He has studied them since his arrival in the park. Having tracked some individuals and families for

weeks at a stretch, he feels he knows many of the animals on a personal basis, and they he. His photos are amazing, taken with nothing more extreme than a 120mm lens. More stories.

American geyser gazers he did not know. Our arrival took him away from one of his bear studies, and he frankly was not thrilled. The prospect of having to host a bunch of American "tourists" for a week left him frustrated and nervous; remember, we were the first. A full week? Surely we'd be bored stiff in a day or two, and he'd have to find something for us to do. Nobody could spend days watching geysers, could they?

Of course, we could. So could he. Vitalii was already a geyser gazer, but perhaps he didn't realize it. He actually ended up following us around the Valley. Vitalii is now also an honorary member of GOSA.

All of the services we were provided with were arranged through the new Kamchatka tourist agency, Sakzhoy (Саэкжой). Several people have been hired for the 1991 summer. They were all nervous when they met us; they all cried when we left.

Oksana Klimenko teaches English at a middle school in Yelizovo. She served as one translator for us and the others, and helped with the cooking and serving. Often embarrassed by our actions and hers, her English improved markedly during our visit.

Tatyana (Tanya) Kolegovoy works as a secretary at Sakzhoy. For us she was the cook, and what a cook she is. She constantly turned out massive amounts of fantastic food using primitive facilities. You never liked the idea of fish soup? Guess again. The French toast we taught her how to fix was mighty good, too.

Mikhail (Misha) Selefonov has a degree in geology from a Moscow university, but like many in

the States he is unable to find a job in his field. Serving as a general helper with Sakzhoy has given him new experiences and the opportunity to expand his already decent grasp of English.

Vladimir (Volodia) Petrushen served us as the other roustabout. Somewhat quieter than the others, I somehow never learned much of his background, but his wife is a volcanologist in Petropavlovsk. He was always there, always attentive to our every need, and the giver of the greatest number of gifts at the end of our trip.

Last and first is Katie Sauter, the REI Adventures representative and guide on Kamchatka in 1991. Ours was her first trip to the Valley of Geysers, too. Katie literally became exhausted from all the translations asked of her (on both sides), and she really came through. Every bit of our trip, from initial arrival to final departure in Magadan, happened smoothly and on schedule, thanks to her. She made a wonderful adventure into a perfect trip. Katie is now a paid member of GOSA.

Katie wrote a song. Sing it to the tune of "America, The Beautiful"—

Kamchatka, The Wonderful

Oh, beautiful for cloudy skies,
For craters full of steam;
For muddy hillsides filled with bears,
This place is just a dream.

Kamchatka,
Kamchatka,
The geyser paradise.
Just wait until next year and
We'll be back at any price.

The Future

Several times while we were in Dolena Geizerov and again on our last evening in Yelizovo, Sergei Alekseev invited our return in 1992. It was clear that he meant both as individuals and as GOSA. But as of this writing, this is an invitation in word only. It takes much more.

Even in these days of glasnost and perestroika, the Soviet system is a difficult one to deal with. Here, it is made still worse by the remoteness of Kamchatka. In order for any group to actually go to Kamchatka, the following must happen: 1) the initial invitation must be made in writing by the proper authority, in this case, Alekseev, to the tourist agency (here Sakzhoy, sometimes Intourist); 2) the agency must then provide the names and passport numbers of all individuals

involved to the KGB; 3) if the KGB finds no fault with any one person, it gives its approval to the Soviet Ministry of Foreign Affairs, which actually issues the authorizations for the visas; 4) the authorization is sent to the Soviet Embassy in Washington, DC, which further forwards it to the Consulate in San Francisco; 5) the visas are processed there and sent on to Zierer's Visa Service, also in San Francisco, which acts as something of an intermediary through the whole process; 6) finally, Zierer's sends the visas to all the individuals who will be travelling.

All this is supposed to happen within five weeks. It usually works, but not always. We were perhaps somewhat fortunate, in that as a specially invited group the tourist agency and Foreign Affairs were both by-passed. Even then, we were lucky, it turns out. Our visas noted Magadan as one authorized stop. Petropavlovsk-Kamchatskii was not listed. It should have been. We actually should not have been allowed on Kamchatka!

So, our return has been invited. It is fortunate that we have many months in which to prepare. But after all is said and done, this "Preliminary Report" might also be a final report. We hope not, but...



Katie Sauter, Bob Colvin and Jack Hobart (top to bottom) working their way down "Trapinka Martha". This is the main trail to Groups I and II. (Byran photo)

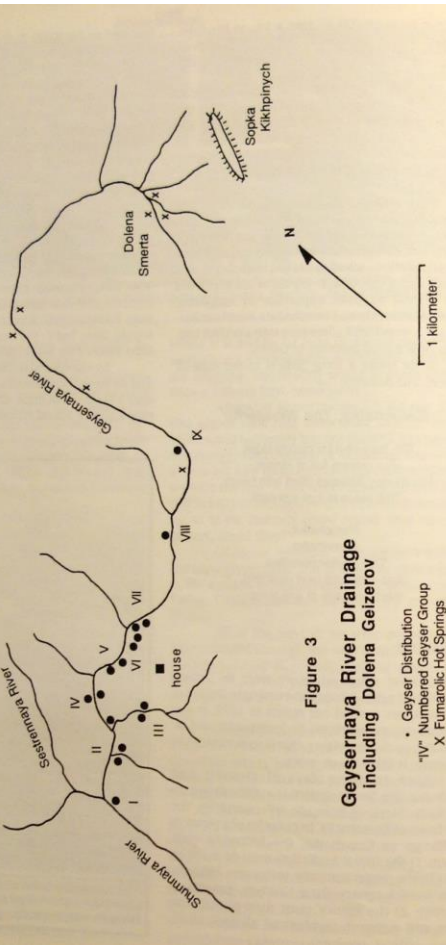


Figure 3
Geysernaya River Drainage
Including Dolena Geizerov

* Geyser Distribution
"V" Numbered Geyser Group
X Fumarolic Hot Springs

Part II
The Valley of Geysers
General Geology and
Geyser Regime

Regional Geology and Geothermal Setting

All of Kronotsky Nature Preserve is volcanic except for a narrow strand along the Pacific Ocean shoreline. The park encompasses several volcanoes that have had historic eruptions—Semyatsky and Karimsky erupt frequently, and even Kikhpinych at the headwaters of the Geysernaya River was active during the 1890s. These are subduction zone volcanoes. Their lava chemistry is usually too poor in silica to support geysers but, as is also the case at El Tatío, Chile, there are exceptions. The Valley of Geysers is adjacent to the Uzon Caldera, a large (15 kilometer diameter) rhyolitic explosion and collapse feature which developed something less than one million years ago and which had continuing activity in post-glacial times (that is, less than 10,000 years ago).

A general plan of the Geysernaya River drainage, showing the location of the numbered geyser groups, is shown on Figure 3.

Based on the thickness and extent of sinter deposits, which are often perched high on the canyon walls, and some other physical considerations, it has been estimated that hot spring activity has been taking place within the Valley of Geysers for at least 100,000 years. The modern, existing springs are quite young, however, forming as the Geysernaya River rapidly cuts its channel downwards. Most of the geysers and other flowing springs are near the river level while the older, higher thermal units are dominated by muddy pools and steam vents. The geyserite deposits of these modern springs are actually quite sparse and are usually little more than thin coatings on boulders. Even the relatively extensive terrace at Geizer Velikan is this way, altered bedrock being exposed in eroded areas beneath only a few centimeters of sinter.

The fluid circulating through most geothermal systems is relatively "old" meteoric water. Any input of magmatic water is usually slight. The Valley of Geysers fits this model. Per a study published in 1989, Sugrubova and others used tritium analyses to estimate a water age of 600 years. While the tritium technique can provide little more

than an educated guess, this result compares quite favorably with the 500-year age determined by the U.S. Geological Survey for the waters in Yellowstone's Upper Geyser Basin.

Geyserite rock and water chloride contents also compare favorably. The most notable difference is in the iron content of the sinter. At least 0.2% is present in every sample analyzed in 1951, and one sample contained 3.7%. The presence of this much iron (as oxide) obviously accounts for the brilliant coloration of most geyserite in the Valley, which is seldom of the ordinary gray-white color.

The results of a 1986 survey of chloride analyses showed every spring tested to contain between 425 and 837 milligrams per liter (ppm). This is again quite typical of "alkaline" deep circulation waters. Acid, high sulfate waters are restricted to the springs at higher elevations along the canyon rims and near the headwaters of the Geysernaya River.

The Valley of Geysers would seem to have a much greater thermal flux vs. volume of water than does Yellowstone. Perhaps this should be no great surprise, given the very close physical relationship between the hot springs and recently active volcanoes. But it is important to note that virtually every spring in the Valley is boiling and erupting as either a geyser or as a perpetual spouter. True geysers comprise a very large proportion (perhaps over 40%) of the total number of discrete hot springs that lie at or near river level. Only one example of a clear quiet pool was seen, the mud pots are restricted to a few small areas, and steam vents lie only on high slopes and in the upper reaches of the Geysernaya drainage (matching the water chemistry distributions).

The Number of Geysers

Dolena Geizerov is the second largest geyser field on Earth.

That, as any geyser gazer will recognize, is a very big statement. While the number of geysers within the Valley does not closely match Yellowstone's total, it does equal that of the Upper Geyser Basin and easily surpasses that of any other existing area in the world. Indeed, its geysers might surpass the sum of all other non-Yellowstone areas combined. This finding alone was worth the trip.

"How many geysers are there?" was the first question we asked of Vitalii not long after our arrival. His initial answer was "Five hundred," but it quickly became clear that that figure was for all erupting springs, including perpetual spouters. Once we restated the question emphasizing distinct periodicity, Vitalii pondered for a few moments and

pronounced:

"Two hundred geysers." At the time, that seemed excessive. Now we know that it is entirely reasonable. We were in the Valley for only eight days. Three major thermal areas were not visited at all, three others only once, and we had to spend a fair number of daylight hours indoors because of severe weather. Yet per the best conservative count that we can generate from memory, still photographs and video tapes, we actually watched no fewer than 116 geysers actually in eruption. Those that we came to understand well enough to tabulate number 85 (Table 1).

To be sure, many of the geysers are very small, but there is absolutely no question as to their identity. Yellowstone does not host any "thermal walls" of the sort commonly seen in the Valley of Geysers. Places like Calcite Springs and portions of the Grand Canyon of the Yellowstone are only similar. These nearly vertical, sinter-covered slopes which drop precipitously to the river are studied with springs, and often a dozen or more of them proved to be geysers upon only casual observation. Only for a few of these did we do more than note



A portion of the Pipovekaya Wall, including the formations of Boroda and Bezgoloviy Geysers. Virtually every white spot is the vent of a small geyser. Thermal walls of this sort are rare elsewhere around the world but common in Dolena Geizerov. (Bryan photo)

their existence. Certainly there are many geysers that we never saw.

How many more geysers might there be? A lot. How many might prove to be of significant size? Quite a few. How many infrequent geysers such as Krepost (Part III, No. 6a-3) have never been recorded? Probably, several. How many geysers might exist within the unvisited Groups IIIa, VIII, and IX? Very likely, a bunch.

Are there really 200 geysers within the Valley of Geysers? Unquestionably!

"Pulsating Springs"

The Russians frequently use the term "pulsating spring" in their reports. Prior to our trip we were very uncertain as to what this really meant. Probably the best definition is that a "pulsating spring" is any erupting feature, regardless of size or intermittency. In other words, "pulsating spring" includes both geysers and perpetual spouters.

As noted above, the vast majority of springs in the Valley of Geysers erupt; quiet pools and gently flowing springs are very uncommon. It is likely that many of the pulsating springs we saw as perpetual spouters are true geysers. Our itinerary did not allow most areas to be intensely studied enough to make such determinations.

The Intensity of Geyser Activity

"Only the unemployed could love [and spend the time waiting for] a geyser like Fan and Mortar. In Russia there are no unemployed people, so no geysers with intervals of days."
— Vitalii Nikolayenko, 1991

As just noted, the proportion of erupting vs. the total number of springs within the Valley of Geysers is very high, at least as compared to Yellowstone. That might be taken as a function of the relatively high heat flow to the springs. Entirely in addition to that, though, is the intensity—that is, the frequency and duration vs. the size—of the geysers.

For years, I had read the descriptions of the Valley of Geysers and its geysers with some disbelief. As a "Yellowstone-ite", I could hardly believe that so many geysers of such size could be so active. They are.

Statistics for many are given in Part III and won't be repeated here. But just imagine: a geyser the size of Daisy erupting every 38 minutes within

a few feet of another the size of Echinus repeating hourly, both with double the duration of their Yellowstone cousins. Imagine a geyser erupting upwards as high as 30 meters and outwards more than 60 meters, its water arcing over another geyser itself fully 20 meters high. Imagine Fan starting every 2 1/2 hours... It really is amazing.

The Names of the Geysers

The Valley of Geysers was not discovered until 1941. T.I. Ustinova simply encountered the springs in the course of a general geological survey of the region. It was she who first applied names.

Ustinova named 22 features on the basis of their location or physical appearance. These names are the only ones that might be taken as "official," even though a few have been dropped from modern usage. These names are noted within the text of Part III.

Virtually all other names have been applied by Vitalii Nikolayenko during his twenty years of living in the valley. He has generally continued the tradition of naming features on the basis of physical appearance. There are a few exceptions, and some of the thermal walls have been named after various geologists.

Twice in the course of the 1991 GOSA Expedition, Vitalii suggested that we name some geysers. We wanted to be extremely cautious in doing so and generally declined the opportunity. In our presence, though, Vitalii did invent some names. More informally, we used some names for otherwise unnamed small geysers; although I do use them in this report, there is no guarantee that they will find any future use. Any name first applied during the course of our visit, whether by Vitalii or ourselves, is so noted in Part III.

Quite a few other names have been used by researchers during the past four decades, but relatively few of them have survived beyond one or two published reports. As often as not, they appeared only within some table of features so that exactly which spring they referred to is now unknown; no such name is used here.

Transliterations of names from the Russian cyrillic to the English roman alphabet can be done in a number of different ways. I have found, for example, that the American Department of State and Library of Congress use two very different standards. In this report, I have adopted that of the Library: 'wi' becomes 'ii' instead of the often-seen 'y'; 'wi' becomes 'yi'; 'w' standing alone at the end of a word is 'y' and takes a long 'e' sound. Some of these transliterations might be incorrect or

questionable. If so, I apologize. Having virtually no Russian language ability myself, I have done my best to be accurate, and I sincerely appreciate the help of others.

Translations that were not obtained while on Kamchatka have been taken mostly from Romano's Russian-English Dictionary, and are again subject to future corrections.

About Plate I

Included with this report is a large-scale fold-out map of the Valley of Geysers. The original was produced by Vitalii Nikolayenko on July 4, 1991. The streams and positions of most major geysers were traced from a volcanological survey topographic 1:2,000 scale base map. Some of the downstream areas (Groups I and II) did not appear on the topo and were added by Vitalii from his memory (which from my perspective was quite good for scale but shows the course of the Geysernaya River overly simplified per a map published at small scale in 1978). Features not shown on the topographic base were added to fill out the groups. Vitalii then wrote the name of each feature shown onto the map, using Cyrillic script (see transliteration note above).

Vitalii's original was re-traced onto vellum paper and the features and names added using rub-on transfers and laser printer labels after my return to the States. I added the routes of the trails from memory. Finally, this new original was duplicated using a large format Xerox machine.

So far as can be determined, this is the most complete and most detailed map of Dolena Geizerov ever seen within the United States. While it might not be precisely accurate in some respects (especially the trails), it most assuredly does give a good feeling for the Valley of Geysers and the distribution of its thermal features. Its linear scale (1 cm = 20m) is precise.



Vitalii working on the Plate I map. (Rinehart photo)

Part III

The Valley of Geysers

The Geyser Activity — Observations and Descriptions

Introduction

The following descriptions of the individual geysers and other hot springs of the Valley of Geysers follow a geographical order, from downstream upwards. The springs quite naturally divide themselves into groups, which have been designated with Roman numerals by Russian volcanologists. These designations are indicated on Plate I, but in this report the Roman numerals have been shortened to Arabic numbers for convenience. Within each group the individual springs are then serially numbered. For example, the fifth described spring within Group IV is indicated as 4-5. Most but not quite all of the springs are shown on Plate I. This map, at a scale of 1:2,000, is the largest and most detailed ever imported into the United States.

Each of the springs is also identified by name, if a name has been given. The names are first given in an English transliteration, then parenthetically in Russian cyrillic and English translation. The sources of the names are several, but primarily were given by T.I. Ustinova, the discoverer of the Valley of Geysers in 1941, by V.A. Nikolayenko at any time between 1970 and 1991, and by this GOSA expedition in 1991. Names certainly have been applied by various Soviet researchers, but these have almost invariably been altered in more recent use. With few exceptions, only the current usage is applied here. In a handful of cases the only name given is in English and within quote marks; these names were used and suggested during the GOSA expedition, but have not necessarily been accepted for future use.

In any case where a significant amount of data about the geyser activity is available, it is included as a table at the end of this report, separate from the written description. In the majority of cases, only some basic statistical information based on historical knowledge or our own brief observations is given. Whichever may be the case, though, at least some information is given for every observed feature of significance.

Specific statistical data is presented in an abbreviated format where hours, minutes, and seconds are abbreviated as "h", "m", and "s". In any other case, where the values are more general or approximate, the measurement units are spelled in full.

A summary of all known eruptive data is shown in Table I. It must be emphasized that this table and indeed the entire text is only a summary. It is all based on only eight days within the Valley of Geysers, during which we gained little more than an acquaintance with the geysers. It is to the future to truly understand them.

Group I

Group I is a small cluster of springs which includes just one geyser (Pervenets), a handful of small perpetual spouters, and some thermal seeps. It is the downstream most of all the thermal seeps, at an elevation of only about 280 meters. Our only brief visit to this group was on July 02.



Pervenets Geyser, here at nearly full force about 10 meters high. (Bryan photo)

1-1 Pervenets (Первенец; First)

Pervenets is the downstream most of all geysers, lowest in elevation of virtually all thermal features. Located just below the nearly mutual confluences of the Geysernaya and Sestrennaya Rivers with the Shumnaya River, Pervenets is the only geyser within Group I.

Pervenets is one of the 22 features named by Ustinova in 1941. Through the years it has shown some significant changes in its intervals. Once they were as short as 12 minutes. By the late 1970s they had increased to as much as 2 1/2 hours. Again they shortened to 15 to 20 minutes during the mid-1980s, and then lengthened again to about an hour in 1990.

The activity of Pervenets begins with a period of filling. Water gradually rises within the cavern-like vent, and boiling and surging increase as the level rises. Both of the observed overflow periods were of almost exactly 24 minutes. The eruptions begin when the surging suddenly and quickly builds into a combined bursting-jetting action, which sends sprays of water arching out over the Shumnaya River.

The eruption reaches both a height and lateral distance of fully 15 meters, although most bursts are considerably smaller. It is only near the end of the duration (two of which were timed at ~2 1/2m and 2m 37s) that the force declines into a concluding minor bursting and weak steam phase. The two observed intervals were ~42m and 43m 50s. A third interval based on a distant steam cloud was less than 45 minutes long.

Group II

Group II includes a small number of springs at and near the confluence of Ruchy Troynoy (Troynoy Creek) with the Geysernaya River. Several of its members are significant geysers, including Troynoy, which most of the Russians take to be the most beautiful of all in Dolena Geizerov.

2-1. Troynoy (Тройной; Triple or Trio)

Troynoy has been famed because of the large size of its main jet and the beauty of its three cone-



The three main vents of Troynoy Geyser are at the top of its massive cone formation, just beyond Troynoy Creek. Sosad Geyser (lower left) erupts from a reddish geyserite at the base of Sakharnyi Geyser's cone (portion at bottom right). (Bryan photo)

type columns of water, each of which is erupted at an angle considerably other than vertical. We were all tremendously impressed by our first view of Troynoy's massive cone complex and beautiful setting. Unfortunately, because of a combination of location and weather considerations, we were able to witness only one eruption, and that under rather poor conditions.

The cone is a large geyserite mound, built upward and outward from the hillside rather than free-standing. The three vents that give Troynoy its name are all near the summit. All three participate in preplay activity.

Troynoy's eruption is preceded by a period of overflow, said to normally last 1 to 1 1/2 hours. During this time there is a very gradual increase in volume and, near the time of eruption, occasional surges which might well be called "minor eruptions," reaching 1 to 2 meters high. The eruption begins with a massive surge from all three vents, and resembles nothing less than the initial take-off of Yellowstone's Fan Geyser. There is a tremendous initial discharge of water which floods all parts of the cone.

The tallest of the three jets is that from the central vent. It reaches fully 20 meters high at an angle (largely towards our position of observation to the north) of about 40° from the vertical. The most massive jet is from the northern vent; it spews huge volumes of water outwards as far as 30 meters toward the river, but at the very low angle of 75° from the vertical so that its actual height is only 2 to

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4 meters. The third, southern vent is the smallest and most vertical of the three, reaching 6 to 7 meters at 20° from the vertical.

The entire eruption has a duration of about 8 minutes. The full force of the play is maintained only for a few moments (perhaps 1 minute), after which a pulsing action leads to pauses and final minor jetting. Here again, the activity is reminiscent of Fan Geysers. The action concludes with a weak but extended steam phase.

All historic listings give Troynoy's interval as between 2 1/2 and 3 hours. Vitalli stated that it was just about 2 1/2 hours during 1990. The overflow of 1h 13m we observed probably indicates little change.

2-2. Sosed (Сосед; Neighbor)

Sosed erupts from a small vent partially covered by an overhanging cliff of geyserite, which is actually part of Sakharnyi Geysers' (#2-3) cone. The geyserite is distinctly red in color. Much of the erupted water drains from an uphill catchment area and back into the crater. The eruption, however, does not seem to be stifled by this backflow.

Sosed is directly connected with Troynoy in such a way that its eruptive cycles directly relate to the cycles of Troynoy. To a lesser extent, the inverse is true, too.

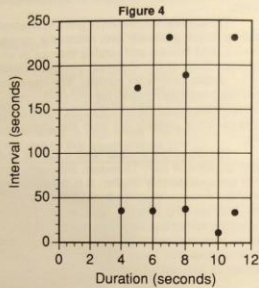
Following an eruption of Troynoy, Sosed normally goes nearly an hour without erupting, and it is only uncommonly seen before Troynoy begins its overflow. The first eruptions are quite weak and on relatively long intervals, but the intensity of the action then increases as the time for Troynoy nears. Intervals can grow as short as 5 minutes. The corollary is that "too much" action by Sosed will delay Troynoy. We seemed to witness the ideal situation in which Sosed did not erupt at all during the last 29 minutes of Troynoy's cycle (see Table 2).

Sosed, when at full force, erupts at an angle of about 30° from the vertical and in an oblique uphill direction. The height is around 5 meters. Durations range from less than 1 minute to more than 2 1/2 minutes and, especially during the later portions of a series, may virtually cease before regaining full force several times during the course of a single eruption. There is no concluding steam phase.

2-3. Sakharnyi (Сахарный; Sugary)

Sakharnyi was named after the geyserite of its cone, which includes all textures from fine spines to large nodules to long "stalactites" of sinter in a variety of colors dominated by pink. The interior of the open cone is richer red and comparatively smooth. Sakharnyi is an extremely vigorous geyser.

Despite its proximity to Sosed, Sakharnyi evidently is not affected by the Troynoy-Sosed cycles; per our records, it appeared to be identically active before, during, and after Troynoy. The activity recorded during one short span of time is shown in Table 3. It indicates significant bimodality to the intervals; e.g., either 11 to 37 seconds or 2m 54s and greater. There does not appear to be any correspondence between the interval and its succeeding duration (Figure 4, as an example), or the opposite. Neither is there any related variation in height, which ranges from below the rim of the cone (but still 40 to 60 centimeters above full pool)



to as much as 2 meters above the rim. Whatever the statistics, every eruption begins with an abrupt rise of the water within the vent. Splashing starts well before overflow is reached. The bursting is play somewhat reminiscent of Yellowstone's Anemone Geysers, except that it rises from a confining cone rather than an open pool.

2-4. Nerazvodinnyyi (Неразводный; Undiluted)

The name of this perpetual spouter is somewhat in jest. The water temperature is a "constant" 96°C, omitting the "C" for Celsius, that is the same as "96", the alcoholic proof of undiluted vodka (note, however, that all the vodka we saw was 80°). There was some indication that this has been known to act as a geyser, but apparently not in several years. The steady play we observed reached up to 30 centimeters high.

2-5. Dvoynyye (Двойник; Twins)

No eruption by this geyser was observed by

Jack Hobart, the only member of our group to visit its site. It is said to erupt from two small vents separated by about 1 meter and, when active, to have very small bursting eruptions.

2-6. Unnamed ("Surprise")

Vitali was not familiar with this geyser, which was seen and described by Hobart, who suggested the name "Surprise" because its brief eruptions squirt droplets of water outward as far as 2 meters from a nondescript hole in the bank of Troynoy Creek. Intervals are of a few minutes, and durations a few seconds of occasional spurts. A comparison of Hobart's description with Vitali's of Bilznitsil seems to confirm their separate identities.

Group III

Group III extends along most of the length of Ruchy Vodopodaya (Waterfall Creek), so named because of three waterfalls along its course. [The falls are Bolshoi Vodopod (25 meters), Stupienka (2 meters), and Malaya Vodopod (9 meters).] Group III is, by area, the single most extensive numbered group of springs within Dolena Geizerov. It is also somewhat awkward as a group. Because there is a clear separation between the springs above and below Bolshoi Vodopod (Big Waterfall), I have arbitrarily divided the group into two parts.

Group IIIa consists of the few springs just below the Bolshoi Vodopod; because of treacherously slippery trails and a lack of time, it was not visited by our group.

Group IIIb contains all the hot springs above Bolshoi Vodopod, and includes the bathhouse for the Valley community.

3a-1. Parovoy (Паровой; Steamer)

Parovoy is something of a mystery. It is evidently one of Ustinov's 1941 names and appears in all known early references, which typically list intervals of 35 to 50 minutes and heights of 1 1/2 meters. The more recent literature always fails to give any data for Parovoy. In addition, Vitali failed to include it on his map. Steam was visible rising above Parovoy's reported site, but nothing more is known about it.



Bill Warnock (left) and Jack Hobart examining the deposits at Drevnyi Geysers. Note the light-colored, new deposits of geyserite which imply considerable eruptive activity even though most of the formation is old and decayed. (Bryan photo)

(Note that the name of #7b-2, Pariyatshii also translates as "Steamer.")

3a-2. Skritnyy (Скрытый; Hidden)

Skritnyy is reported to be a small, frequently active geyser nearly hidden from view within a crater high on the canyon wall a few meters downstream from Bolshoi Vodopod. There is no data to report.

3a-3. Shilo (Шило; Awl)

This geyser, which is in active eruption far more than it is quiet, was named because of the spike-like jets it plays in an almost totally horizontal direction over the Waterfall Creek. Immediately at the base of Bolshoi Vodopod, Shilo is the feature shown playing among the bathes on the PBS Adventure Series program, "Yankee in Kamchatka," first broadcast in June 1991.

3b-1. Utuzhok (Утужок; Little Iron)

Virtually a perpetual spouter, in eruption every time it was seen, Utuzhok is said to have quiet intervals which are progressively becoming longer and more frequent. The steamy eruption jets as much as 1 meter high from several vents located along a fracture. The name is descriptive of the geyserite deposits.

3b-2. Drevnyi (Древный; Ancient)

Another near perpetual spouter, I will state that Drevnyi is a true geyser, albeit small and perhaps

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infrequent. Vitali claimed this to be a perpetual spouter, despite our contentions to the contrary which are based on obviously fresh, pale yellow geyserite deposits well above and beyond the observed splash zones and complete inactivity in the "main vent" during our observations.

Nevertheless, it is clear that Drevnyi is past its prime. Once a large cone-like complex, it is now in a state of severely weathered decay. The eruption rises from several different openings located here and there along the stream-side base of the formation, reaching as much as 60 centimeters high. The extent of fresh geyserite implies occasional activity as high as perhaps 2 meters from at least one of the vents.



Shutnik Geysers erupts from a small cone which rises directly from the bed of Ruchy Vodopoda. It now serves as the hot water source for the bathhouse (right foreground). (Bryan photo)

3b-3. Fakel (Факел; Torch)

Located just downstream from Malyi Vodopod (Little Waterfall), this feature showed all the signs of being a perpetual spouter but is listed as a geyser on Vitali's thermal map. As is common to so many of these springs, the eruption jets from the cliff and over the stream at an angle of 30° from the vertical. The height is perhaps 2 meters.

3b-4. Teremok (Теремок; Small Fairy-Tale House)

Teremok has spasmodic splashing eruptions about 1 meter high. Only one eruption was seen, and that from a distance. The duration was several minutes. The interval is unknown but probably short.

3b-5. Teremkovyyi (Теремковый; Little Attic?)

The name of this geyser is apparently a diminutive relation to "Teremok," which is immediately adjacent. Nothing at all is known about the activity of Teremkovyyi.

3b-6. Unnamed

Again, virtually nothing beyond the location of this geyser at the base of the Sklon Kartennyyi (Vivid Slope) thermal wall is known. It is unclear shown and named as a geyser on Vitali's thermal map.

3b-7. Shutnik (Шутник; Joker)

At the end of a rather long and very muddy trail is a bathhouse, a small building containing a plumbing system and a deep, enameled bathtub. The original intention was that the tub could be supplied with hot water from a small geyser just upstream (see #3b-9) and cooled to the appropriate bathing temperature by the addition of stream water. The plumbing is presently inoperable, so the hot water source has become Shutnik. It erupts from a small cone which rises about 1 1/2 meters high directly from the bed of Ruchy Vodopodaya.

Shutnik is a geyser. How often its natural eruptions take place is uncertain. The interval is at least 40 minutes long, but probably not much longer than that— activity was seen on each of three observational visits by our group. Preplay consists of intermittent overflow starting a few minutes before the eruption; each subsequent overflow is a little more voluminous, longer lasting, and accompanied by a greater degree of boiling than the one before. The eruption begins when the boiling becomes a bursting which may reach as much as 1 meter high. The duration, not including the subterranean bursts which extend into visible refilling, is about 1 minute.

The name "Joker" evidently arises because this geyser is extremely easy to induce into eruption and may thus surprise the unwary bather. Such happened to Katie Sauter— moments after she dipped a pailful of water from the crater, an eruption began with little (no observed) warning.

3b-8. Vorota (Ворота; Gate)

Located a few feet upstream from Shutneek, this like Geizerovyyi (next) and several others appeared to play as a perpetual spouter although it is clearly indicated as a geyser on the thermal map. Durations longer than intervals are quite common in the Valley of Geysers, in which cases observations involving far more time than was available during this trip would be needed in order to obtain any realistic data.

3b-9. Geizerovyyi (Гейзерный; Little Geysers)

At the head of the now-defunct plumbing leading into the bathhouse, Geizerovyyi was in eruption each time it was observed, reaching a height of 30 to 50 centimeters. Nevertheless, it is clearly indicated and named as a geyser on Vitali's thermal map as well as on a 1975 tourist map.

Group IV

With the possible exception of Group IIIa and the far upstream Groups VIII and IX, Group IV is the least accessible of all the thermal units within the Valley of Geysers. No distinct trail leads into it, and our access was via a very steep, slippery route more-or-less directly down the slope from the group camp on Hill 516. The only alternative is to walk downstream from Group V, a poor choice as it involves crossing the delicate geyserites of Bolshoi and Malyi Geysers in addition to the hillsides. Accordingly, we visited the area only once, and then rather briefly.

4-1. Zhalo (Жало; Serpent's Tongue)

The name Zhalo was given to this impressive geyser/spouter by Vitali during our visit; meaning Serpent's Tongue, it could also translate as "Bee Stinger." Zhalo has reportedly become both stronger and more periodic over the course of the past year or two. The intervals are presently only a few seconds long and are difficult to distinguish from mere hesitations in the eruption. Zhalo's nature, however, would be as difficult to describe as "perpetual spouter." The eruption is jetted at a very low angle (about 70° from the vertical) from a cavern and into the river to a total length of 1 to 3 meters; frequent pulses reach fully 4 meters or more.

4-2. Skalistyy (Скалистый; Rocky)

It is unfortunate that we found Skalistyy to be dormant. Among the larger of the Valley's geysers when active, this condition was apparently due to extraordinarily high groundwater levels because of both the early season and the heavy rains during our visit. Whenever drowned in this fashion, Skalistyy

overflows a large, steady stream of water at a temperature well below boiling. That, with only a hint of periodicity, is what we saw cascading from the cone perched four meters above the river.

When operating normally, Skalistyy produces intervals of around 1 hour, the 1 to 3 minute eruptions reaching heights as great as 15 meters.

4-3. Lafet (Лает; Gun Carriage)

Lafet is a geyser, largely subterranean but truly periodic as more than a quiet intermittent spring. The spring includes two vents, one which flows a strong stream of water during the eruptions and another higher on the slope which steams vigorously and, according to Hobart, at least once showed droplets of water as high as 30 centimeters above the opening. Judging by the sound, the actual eruption is quite strong, and Lafet might well develop an open crater in time.

Three intervals of Lafet were recorded; these were of 23, 11, and 16 minutes with the admitted possibility that the first of these was a double interval. The observed durations were between 2 1/2 and 4



Though of relatively small true size, the geyserite cone of Conus Khrustalnyy Geysers is among the largest distinct, free-standing cones in the Valley of Geysers. (Bryan photo)

minutes of heavy overflow followed by another ~2 minutes of intermittent and progressively weaker overflow.

4-4. Conus Khrustalnyi (Конус Хрустальный; Crystal Cone)

Simply named Conus by Ustinova, the name has been appended in order to distinguish it from Conus Rozovyyi, upstream in Group VIIc. It is marked by a small symmetrical cone of geyserite, exquisitely ornamented with beaded and fluted geyserite. The vent at the top is about 10 centimeters in diameter.

Conus Khrustalnyi is a highly regular geyser. We were only able to observe two complete cycles of activity, but they showed almost no variation. The intervals were 24 1/2 and 25 minutes. The geyser overflows for 4 1/2 to 5 minutes before the eruption, which only gradually develops full force. The play is a pulsating cone-type jet reaching a height of 1 to 1 1/2 meters, and is maintained for most of the water phase. Two durations were timed at 2m 23s and 2m 19s. The eruption concludes with a short steam phase.

4-5. Bolshaya Pechka (Большая Печка; Big Oven)

Bolshaya Pechka is no more, except as a small steamy opening near the river level. On October 4, 1984, Kamchatka was hit by the remnants of Typhoon Elza. Rains produced a tremendous flood which did extensive damage. Bolshaya Pechka's crater was completely filled with debris. Sometime later the vent blew out in what was apparently a single powerful eruption. No additional activity has been observed, and the spring currently shows little potential. Historically, it was one of the more vigorous geysers in the Valley, with intervals of 10 minutes, durations of 3 minutes and angled heights as great as 10 meters.

4-6. Novaya Pechka (Новая Печка; New Oven)

In time, the demise of Bolshaya Pechka gave birth to Novaya Pechka, just a few feet upstream. Novaya Pechka is presently active as a perpetual spouter, largely roofed-over and so only a few centimeters high, but given that it is

apparently a (partial) expression of Bolshaya Pechka's thermal energy, it could well evolve into something more.

4-7. Kamenka (Каменка; Small Stones or Little Sauna (both quoted))

Kamenka is borderline between a geyser and a perpetual spouter. Without the eruptive activity ever entirely stopping, its discharge is distinctly periodic. It is only at the time of peak flow that there is any significant jetting. This can easily reach 1 meter high from one opening and about 1/2 meter from several others. Geyser or not, one complete cycle of Kamenka's activity requires only about 15 seconds.

4-8. Malenkii Prints (Маленький Принц; Little Prince)

Under the name "Prince Buratino," this geyser was subject to the technique of "hydrosounding" by Steinberg, et al. [1978], in which a precisely known volume and temperature of water is poured into the vent of a geyser in an attempt to better decipher the volume, heat flow, etc. of its plumbing system. At that time, the natural intervals averaged 9m 20s with durations of 1m 45s. The vent is a small opening among some boulders which are coated by a thin layer of spiny pinkish geyserite.

Malenkii Prints is apparently subject to considerable variations over short time spans. During 1990, the spring began its overflow 24 minutes after



Under the name "Prince Buratino," Malenkii Prints Geyser was the subject of hydrosounding experiments by Steinberg and others during the 1970s. Now it is a frequent and highly regular performer. (Bryan photo)

the previous eruption and several minutes prior to the succeeding play; the average interval was near 30 minutes. Thus, upon seeing the start of overflow, we sat back to wait a while. But the overflow lasted only a few seconds (perhaps as long as 20 seconds) before the eruption began very abruptly. The height was between 1 1/2 and 3 meters to the top of an angled (45°) water jet. The duration was 1m 05s. A second eruption began after an interval of just 7m 28s (duration 1m 12s), and a third was seen after another 5m 52s (duration 1m 06s).

4-9. Unnamed geysers

The Stenka Kartikov (Dwarves' Little Wall) thermal wall directly across the river from Malenkii Prints includes numerous hot springs, at least four of which are geysers. None are named.

I suggest "Zontik" (Зонтик) or "Parasol" for the largest of these geysers, because of its formation's similarity to the parasol variety of limestone cavern speleothem. During a brief observation, it showed highly regular intervals of 12 to 15 seconds, durations of 3 to 5 seconds, and heights of roughly 20 to 30 centimeters. Overflow occurred only during the eruptions. (It should be noted that Dolena Geizerov includes a great many geysers of this sort—small, but unquestionably true geysers. Most were only noted to exist, with no attempt made to obtain data on them.)

4-10. Ustevoy (Устьево; Small Mouth)

That Ustevoy is a geyser is made clear by the thermal map. The route of our hike took us up slope, over a hill, and through tall shrubbery so that we saw only this spring's steam cloud. Nothing beyond its existence is known.

Group V

With Group V we consider that portion of Dolena Geizerov which is not only accessible via developed trails and boardwalks, but also more-or-less directly visible from the vicinity of the house. Accordingly, very much more time was spent observing these (and the Group VI and VII) features than the others.

Group V is dominated by Malyi and Bolshoi Geysers, but it contains another five named and documented, four unnamed and documented, and twelve unnamed, undocumented but observed geysers. Note that this is a total of 23 geysers, a number greater than that commonly cited by the literature as the total existing within the entire Valley of Geysers!

5-1 and 5-2. Unnamed geysers.

For the same reason that #4-10 Ustevoy was unobserved, so were these two geysers. All that is known about them is that they are shown as geysers on Vitalii's thermal map.

5-3. Unnamed geyser.

Vitalii verbally denied that this could be a geyser when we visited it, but he later added it to his thermal map. A single eruption was seen at close hand, but it was probably not representative of what the spring is capable of. The pool, only about 40 centimeters in diameter, occupies a pinkish, stony basin. When seen, it sat quietly just below overflow. The one eruption witnessed on site began abruptly and consisted of just a few splashes a few centimeters high. There was practically no discharge down the rather large runoff channel.

On other occasions, the "third spring downstream from Malyi", as viewed from the boardwalk viewing platform above Bolshoi, was noted as a geyser. It is believed to be this spring, in which case the eruptions can reach at least 1 meter high over durations of more than 1 minute.



Smuglyi Geyser is one of the many small and vigorously frequent and regular geysers that have never been previously described in the literature. (Bryan photo)

5-4. Raskritiyi Kamen (Раскрытый Камень; Split Rock)

Raskritiyi Kamen erupts from two openings, located above left and below right of one large boulder. An eruption begins with a gush of water from the lower hole, which forms a large stream and the majority of the discharge. The actual vent lies beneath/behind the boulder. As its force increases, puffs of steam emanate from the upper holes. Eventually, these puffs are accompanied by bursts of water which squirt through the rock pile. Some of the spray may reach a height of 60 centimeters. Each of the five recorded intervals was between 3 1/2 and 4 1/2 minutes, and the durations were all about 2 minutes.

5-5. Smuglyi (Смуглый; Swarthy)

This geyser is frequent, regular, pretty, and in plain sight of the boardwalk at Bolshoi, from which it was seen many times. The only occasion on which data about it was collected, however, was during our walk past it.

This geyser was seen in eruption four times, with a fifth eruption probably missed in the middle of the series. The data indicates intervals of almost exactly 10 minutes; eruptions were recorded at 12:16, 12:26, 12:36, and 12:56. The duration is about 1m 20s, again with little variation. The play consists of vigorous fountain-type bursts from a small, rock-bound crater, the water spraying in all directions and to a height of as much as 1.3 meters.

5-6. Ritii (Ритий; Rhythmic)

Vitalii identified this spring as "Yellow Spouter" as we walked past it, but Ritii is the name he put on the thermal map. Either name is fitting, as this is a rhythmically pulsing perpetual spouter, 1 to 2 meters high, whose vent is lined with pale yellow geyserite.

5-7. Malyi (Малый; Small)

Malyi is among the most significant of the Valley's geysers. Its eruption is large, frequent, and pretty. The name, by Ustinova, is in reference to the size of the crater, which is less than half as big as that of nearby Bolshoi, not the size of the eruption. Somewhat reminiscent of the form and size of Daisy or Riverside Geysers in Yellowstone, it would be a favorite anywhere.

With only a little more effort, we could have collected far more interval data for Malyi than we did, but this probably does not matter much. Malyi has always been a highly regular geyser, and it has shown little variation over the years, except for a recent slight increase: the average interval in 1941 was 31m 30s; in 1945, 32m 20s; 1951, 31m 06s;



Malyi Geyser, shown here near the end of its water phase, is justly one of the most famous of the geysers in Dolena Geizerov, sending its water jet fully 15 meters above its vent every 38 minutes. (Rinehart photo)

1954, 31m 26s; 1960, 32m 14s; 1978, ~32m; 1984, 32m 34s; and 1990, ~35m (verbal, per Vitalii).

We actually recorded only 21 closed intervals. This data shows an interval range from 33 to 42 minutes plus one of 49 minutes. The average of the 21 intervals was 38m 37s, standard deviation 3m 06s. This data is shown in Table 4. There were, in addition, dozens of open, multiple intervals noted; although not recorded here, their analysis would produce insignificant statistical changes.

Malyi is described by Russian researchers as passing through four distinct stages during its cycle: fill, overflow, water eruption, and steam phase. During the fill there is a constant rolling and bursting of the water within the crater. This becomes occasionally but briefly violent near the time of first overflow. Once the overflow has started, it may briefly cease a few times, even within a minute or two of an eruption's start. In general, though, both it and the surging get progressively stronger. The eruption begins after roughly five minutes of overflow when the surging develops into bursting, and the bursting quickly progresses into strong cone-type jetting.

The water jet plays at an angle of about 25° from the vertical, towards and occasionally over and into the river. The maximum height has typically been listed as 12 meters. Perhaps that is so, and if so it puts the top of the jet fully 20 meters above the river (it is a steep slope down-eruption toward the river). Our impression was that Malyi's from-the-vent height was more like 15 to 20 meters, and its peak above-the-river height as great as 30 meters. But such quibbles do not really matter. Malyi is a very impressive geyser!

The water phase lasts about 4 minutes and gradually merges into the steam phase, which has a duration of an additional 3 to 4 minutes. By that time Malyi is already within half an hour of another eruption, and it will be only a few minutes before surging water is again visible within the vent.

Malyi's yellow geyserite formations appear at first glance very large. In reality, and as is common to most of Dolena Geizerov's features, the sinter is little more than a thin coating a few centimeters thick on boulders.

5-8. Sekretar (Секретарь; [Malyi's] Secretary)

Located near the northern base of Malyi's



Sekretar Geyser (bottom) and Sekretar Bolshovo are typical of the small geysers and perpetual spouters that are scattered throughout Dolena Geizerov. (Bryan photo)

formations, Sekretar erupts nearly continuously from a shallow crater nearly surrounded by large boulders. The play reaches fully 1 meter high. No distinct pauses to the eruption were seen by our group, but Vitalii stated that quiet intervals occur on irregular intervals.

5-9. Bolshoi (Большой; Large)

Bolshoi was named for the contrast between the size of its crater versus that of Malyi—Bolshoi's is fully 2 1/2 times the diameter but otherwise appears quite similar.

The geysers, however, are very different from one another, and while Malyi is among the larger of the cone-type geysers in the Valley, Bolshoi is one of the largest of the fountain-type geysers. Bolshoi's eruptions bear a strong resemblance to Yellowstone's Echinus Geyser.

Bolshoi's activity has changed through the years. Per the literature, the intervals remained fairly constant at about 1 1/2 hours, while the durations varied from 15 minutes to 6 minutes (generally becoming shorter as the years passed). We were told that every eruption was preceded by fully one hour of overflow, and that most intervals in recent years (including 1990) had exceeded 2 hours. By contrast, our studies revealed the shortest average overflows and intervals, and the greatest heights ever recorded.

As is the case with several other geysers in the Valley, the crater begins to refill while the concluding bursts of the previous eruption are still taking place. As the water level rises, the bursting declines into mere bubbling and weak surging until about the time of the next overflow. As the trickle quickly grows to a flood, intermittent bursting is renewed. There is no distinct start to the new eruption. For statistical purposes, we generally recorded the time of the first large, vigorously jetting bursts or (from a distance) the first billowing steam clouds; the two events nicely coincide.

The limited number of overflow and closed interval data points we recorded is given in Table 5. The average overflow was only 14 1/2 minutes. The average of eleven intervals was only 1h 16m, with a tiny standard deviation of just 3.38 minutes.

Most of Bolshoi's bursts reach no more than 5 to 7 meters high, but some near the start of the eruption reach far greater heights. Per the historic literature, the tallest bursts have reached 15 meters. Nearly every eruption we observed, however, sent a few vertical jets well above the ridge line. Via crude triangulations, we concluded that these reached between 20 and 25 meters high, and very possibly more.

When combined with nearby Malyi, Bolshoi is a showcase: nowhere else are there large geysers of



Bolshoi Geyser in one of its calmer moods. Near the start of an eruption some of the explosively rocketing jets reach at least 20 meters high; their peaks would be far above the top of this picture. (Bryan photo)

the two classic eruption styles that are so frequent and so close together.

5-10. Sekretar Bolshovo (Секретарь Большого; Bolshoi's Secretary)

Very similar in appearance and setting to (Malyi's) Sekretar, this spring is a perpetual spouter. Invisible at the base of the nearly vertical slope below the boardwalk, its play was about 60 centimeters high whenever it was viewed from off-trail. The erupting vent is surrounded by the most extensive "frying pan" ground seen in the Valley.

5-11. Norka (Норка; Little Mink's Burrow)

Perched high on the Pipovekoyaya Wall across the river from Bolshoi, Norka is a good example of the many small, seldom-noticed geysers of the Valley which have apparently never been previously described in any literature. It plays from a small silt-like vent skirted by a spreading geyserite formation on the wall. Eruptions recur about every 5 minutes. Lasting just 10 to 20 seconds, the squirting water jets reach perhaps 1 meter high.

5-12. Malaya Pechka (Малая Печка Little Oven)

Shown on early maps as a perpetual spouter, Malaya Pechka was listed as a geyser by Steinberg in 1984, when both the intervals and durations were said to be short and erratic. It has now regressed to perpetual spouter, constantly bursting up to 1 meter high from its small crater at the base of the Pipovekoyaya Wall.

5-13. Boroda (Борода; Beard or Bearded)

Another geyser on the Pipovekoyaya Wall and similar in its formations to Norka, Boroda was seen in eruption only a few times so that interval data could not be obtained; it probably plays every few tens of minutes. The eruptions seen reached 1 to 2 meters high for durations of up to 2 minutes. The name comes from the beard-like sinter formation which extends down the wall below the vent.

5-14. Bezgolovyyi (Безголовый; Headless)

The last of the named geysers on the Pipovekoyaya Wall, Bezgolovyyi has the most massive geyserite formation there, somewhat resembling a decapitated body. Although apparently quite frequent in its activity, Bezgolovyyi was seen erupting just one noted time, when a brief but rather voluminous jet reached 2 to 3 meters high.

Along with these four named features, there are at least 10 additional small, unnamed geysers on the Pipovekoyaya Wall. These all tend to play with intervals of a few minutes, durations of a few seconds, and to heights of a few centimeters. Though small, they are true geysers.

5-15. Seryi Tsyulpan (Серый Тюльпан Gray Tulip)

Somewhat upstream from the rest of the Group V features, Seryi Tsyulpan is a neat perpetual spouter that was seen quiet just one brief time. Playing from a flat-topped cone near the river level, the highest bursts seen reached only 60 centimeters. The spring was named after the shape of the vent, which we did not view closely.

Group VI

Group VI is a somewhat hybrid group, in that it contains two distinctly separate concentrations of springs. Here, 12 are described, all but one of which have been given names. As is the case elsewhere, numerous additional small geysers and perpetual spouters also occur in this area. Because of natural geographic divisions, Group VI has been divided into two subunits.

Group VIa includes only a few springs near their river in the downstream area. Group VIb involves

ground level to the visible bottoms of the craters, to both of which then angle downward to the southwest. (Per Vitalli, the two craters are the Socialist and Capitalist Hells, somewhat different in appearance but leading to the same place!) Located in a verdant area dotted with muddy springs (mud pots in drier seasons), at least one of the Vorota Ada vents is periodic in its noise and steam emission, and is probably a subterranean geyser. The intervals and durations are both a few minutes long. From the surface, though, no activity is visible.

6b-3. Vanna (Ванна; Bath)

A geyser dormant at the time of our visit, Vanna sometimes undergoes bursting eruptions 2 meters high accompanied by a large volume of discharge. Possibly seasonal, dependent on low groundwater levels for eruptions, the growth of green algae in the splash zone indicated a long dormancy. The crater is oval and lined with reddish geyserite, and contained one of the larger open pools of the entire Valley.

6b-4. Unnamed

Just up slope from Vanna is a reddish, muddy pool. A secondary vent to one side is said to erupt 1 meter high during the dry season, when it lies above the pool level. Nothing further is known about this geyser, which was flooded during our visit.

6b-5. Pystriy (Пестрый; Variegated)

Exactly which spring is Pystriy is uncertain. It is shown on Vitalli's thermal map as lying within an area dominated by colorfully muddy springs. It might be any one of them, the single clear water spouter nearby, or even an intermittent steam vent seen next to one pool. Per our observations, it is only a name on the map.

6b-6. Kovarnyyi (Коварный; Insidious; Treacherous)

The name is fitting. The vent of Kovarnyyi lies below a large boulder which overhangs the crater. During the winter it is common for a snow cornice to form here, and a few years ago a bear made the mistake of walking on it. The animal fell into the pool and gouged claw marks in the muddy bank as it burned to death.

In some ways, Kovarnyyi is one of the most "Yellowstone-like" springs in the Valley. A pool of clear water occupies a shallow, sinter basin with the vent offset to the south edge beneath the boulder. Eruptions consist of frequent bursts which glance off the rock and spray outwards over the pool as far as 2 meters; without the rock in the way, they would be fully as tall. Observed intervals ranged from only a few to as many as 30 seconds long. Typical durations were of 10 to 20 seconds.

6a-Sa. Sorok Dva (Сорок Два; Forty-two)

This tiny spring is included only for completeness. Lying a few feet above Shchell and within its alcove, Sorok Dva is a perpetual spouter which reaches perhaps 10 centimeters high.

6b-1. Eskalator (Эскалатор; Escalator)

Ruchy Goryachii (Warm Creek) drops to river level down a beautiful cascade known as "The Escalator." This small geyser/perpetual spouter lies near the brink of the fall, and was actually called by Vitalli simply "the spring at the top of the Escalator." This is possibly a perpetual spouter rather than a geyser. No location provides a good view of it. From afar, there were episodes when a series of bursts were visible, rising above the surrounding plants. These bursts of perhaps 1 meter might have been nothing more than fluctuations larger than ordinary.

6b-2. Vorota Ada (Ворота Ада; Gates of Hell)

Also identified as "Dante's Gates" and "Dante's Hell," Vorota Ada consists of two deep vents within one large crater. It is 3 to 4 meters from

those on flatter ground high above the river, along and near the banks of Ruchy Goryachii (Warm Creek). It contains both the Valley's most extensive mud pot area (during dry weather) and its only deep, clear pools as well as several geysers. One of springs, Goluboy Kotel (Голубой Котел), the Sky-Blue Cauldron, was the only clear blue pool we saw.

6a-1. Tramplichnik (Трампличник; Trampoline)

The dominant one of three observed geysers on the Trampoline Wall, Tramplichnik was named because of the "bouncing" action of its eruptions, which let small bursts of water from a tiny vent high on the wall. Observed intervals were typically 30 to 60 seconds long, each play lasting some 10 seconds and reaching 30 to 60 centimeters high. A few meters away is a second, very similar geyser which plays only slightly less often.

6a-2. Kogichka (Когичка; Little Claw)

Near the base of the Trampoline Wall, Kogichka plays about 1 meter high for durations of a few seconds. The intervals of this typically small geyser are probably only a few minutes long, but none were recorded in the presence of other, more spectacular geysers in the opposite viewing direction. In fact, it is not certain if Vitalli intended this map name to apply to the geyser or a nearby waterfall.

6a-3. Krepost (Крепость; Fortress)

Once called Bastion (which name has been moved to some other, unidentified spot, but which has the same English meaning), Vitalli claimed that Krepost acted only as a small perpetual spouter, at best. Our group witnessed two very significant eruptions, possibly the first ever seen.

When first observed on July 01, the small (1 meter diameter) pool was visited only because it lies near Primernyyi (#6a-4). It was full of clear, gently bubbling water and had only light, steady overflow through a narrow geyserite channel. The crater is partially filled with rocks, and the vent at the bottom is only a few centimeters across. For these reasons plus history, Vitalli completely discounted John Rinehart's description of the first observed eruption.

That eruption was seen on July 05. John was recording a series of intervals for Primernyyi, so he was looking almost directly at Krepost when it started playing. The eruption began abruptly and jetted a steady column of distinctly muddy water to a height of at least 6 meters; a few small rocks were thrown from the crater. After 1 1/2 minutes of play, a brief but initially noisy steam phase set in. Krepost then required something less than 3 hours to refill its crater, at which time the re-cleared water was boiling vigorously.

The next day was extremely rainy. A stream of rainfall runoff from the terrace above flowed directly into Krepost's crater. As if to prove that it could not have erupted, Vitalli actually stood in the crater, knee deep in his rubber boots. Yet there were clear signs of eruptions on the surroundings—areas of grass and moss were dead, flattened and washed. These signs had not been noted on July 01.

Additional eruptions might have occurred at any time late on July 06 or on July 07, when the rains had diminished and the spring was again clear and hot. But it was on July 08 that the second eruption was seen by Scott Bryan, viewed from the helicopter pad near the house. Even at that great a distance it was obvious that the play was again a steady column of muddy water reaching a height of at least 6 meters. A closer view probably would have shown 10 meter jets within the steam cloud. This eruption also ended with a strong steam phase.

Krepost, then, can be a very significant geyser, which might erupt with fair frequency under drier conditions. However, 1991 has seen a general increase in geyser activity throughout the Valley of Geysers. Krepost is apparently one of the more remarkable but possibly only temporary recipients of this greater thermal flux.

6a-4. Primernyyi (Примерный; Example)

Primernyyi was named because it serves as a good example of typical geyser activity. During the mid-1980s, it was called Pyatmerutka (Five Minute) because of its highly regular intervals; the present name was apparently given by Vitalli. Eruptions now recur every 4 1/2 minutes, when it fills, overflows for a few seconds, erupts to 50 centimeters for some 30 seconds, and then drains. The only time Primernyyi failed was when it was drowned by rainfall runoff, like nearby Krepost. Even then, it behaved as a surging intermittent spring.

6a-5. Shchell (Щель; Crack)

Though relatively small (reaching "only" 3 meters high), Shchell is a very regular and pretty geyser well placed for statistical observations. The data obtained during our visit is shown in Table 6; in this case, a number of inferred multiple intervals are included in order to show how little variation there is to the intervals. The observed range was 34 to 38 minutes, with an average interval of 35m 53s. Shchell constantly gurgles and steams.

Impending eruptions are indicated by increased noise and a very brief overflow. Water is jetted from several vents, the largest reaching the 3 meter height at a sharp uphill angle. In keeping with the regular intervals, the durations vary little from 1m 20s, not including the brief steam phase which has an indistinct end.



Kovarnyy Geyser is actually one of the few in the Valley of Geysers to erupt from an open crater containing a pool of water. (Bryan photo)

Fontan among many other geysers. Group VIIb encompasses the fairly small area near and including Velikan. Group VIIc, the location of Gorizontalny and Conus Rozovyyi, is further upstream, hidden from direct sight by a low ridge.

7a-1. Malakhitovyyi Grot (Малахитовый Грот; Malachite Grotto)

Malakhitovyyi Grot is a very large perpetual spouter, erupting from a massive cone at the edge of the Geysernaya River. Playing at a sharp angle, the steamy spray reaches outward as far as 4 meters. My impression is that it became steamier and weaker during the eruptive

episodes of Grot Yubileyniy (#7a-9), which would not be a surprise, lying as it does near the base of the Grot Yubileyniy end of the Vitrazh.

Malakhitovyyi Grot was named because of the green algae growing on the yellow geyserite. The formation was severely undercut by the floods of Typhoon Elza in October, 1984, which produced

Group VII

Group VII is the last large group of geysers in the Valley, encompassing all those within the main basin to the north of Group VI.

Group VII contains several notable features.

Velikan is the tallest of the Valley's geysers, but Grot Yubileyniy is larger. Overall, Group VII contains at least 45 observed geysers. The greater proportion of these geysers are virtually unknown, never previously described by any known literature.

Because Group VII is so extensive, it is here divided into three sub-groups. Group VIIa includes the features on and in the immediate vicinity of the Vitrazh (Витразж), the famous "Mosaic Wall" which is the largest of all the thermal wall complexes in the Valley and which boasts Grot Yubileyniy and



Among the largest and most physically appealing perpetual spouters in Dolena Geizerov is Malakhitovyyi Grot. Vitalli Nikolayenko provides scale. The undercutting erosion at the bottom of the cone was caused by the Typhoon Elza flooding in October, 1984. (Bryan photo)

the cavernous openings at its base.

7a-2. Leshii (Леший; Leshy)

Leshii is a character in a Russian folk tale who, if I understood it right, can be both good and bad, especially towards children. This naming probably reflects the activity of the geyser. The vent lies within the river and is fully exposed only at times of low water. Then the geyser may erupt as high as 2 to 3 meters at an angle over the water. As we saw it, still under several centimeters of water, it could do no more than burst through the river, seldom if ever reaching higher than 1 meter. The activity recurs every few seconds and usually consists of a few quick bursts.

7a-3. Unnamed

Vitalii suggested that we name this geyser, but somehow that never happened. Low on the southern edge of the Vitrazh, it had small, irregular eruptions when first observed, but had become rather infrequent by the end of our visit. The suspected cause is the protracted eruptive activity by Grot Yubileinyi.

7a-4. Gosha (Госа; GOSA)

Named by Vitalii on July 03 in honor of GOSA's visit, Gosha is a small but frequent geyser low on the Vitrazh whose activity is related to that of Grot Yubileinyi. Perhaps somewhat cyclic (in that some observed intervals, Grot or no, were as long as 10 minutes or so), it generally erupts every 1 to 2 minutes. Each play lasts just a few seconds, sending bursts of water as high as 1 meter. Following major eruptions by Grot, the first few eruptions are as high as 2 meters and involve discharge much greater than the usual trickle.

7a-5. Kuznechik (Кузнечик; Grasshopper)

Also named on July 03, Kuznechik erupts in opposite directions from a pair of vents at the lower center of the Vitrazh. One short data series was obtained on July 04, and indicates a high degree of regularity when Grot Yubileinyi is inactive. Twelve consecutive intervals showed the small range of 1m 04s to 1m 19s (average 1m 12s), while the 13 consecutive durations ranged between 13 and 23 seconds (average 17 seconds). Most eruptions reach about 1 meter high from the left, more vertical vent.

7a-6. Unnamed ("Golden" or "Smoking Monkey")

This small geyser is almost impossible to see except when it is erupting, and that generally is not often. The first English name was suggested by Bill Warnock from the geyserite's color, then modified by Katie Sauter because the formation resembles a monkey's face puffing steam as if it was a cigarette

smoker. The vent lies in a raised sinter area between runoff streams from Grot Yubileinyi. It was normally observed only when we were otherwise tracking the Grot overflow episodes, but whether there is an activity relationship there is unknown. The largest bursts of the brief eruptions reached perhaps 50 centimeters high.

7a-7. Vitalii (Виталий; Vitalii)

Vitalii named this geyser for himself on July 03, shortly after seeing a major eruption by Grot Yubileinyi with us for the first time. Near the top of the Vitrazh and within Grot's runoff, the geyser consists of two parts (apparently). Most eruptions are jetted at an angle, upwards and outwards as far as 1 meter from an invisible vent. At times, however, either this vent with different force or a second vent plays at a downward angle, reaching only a short distance before striking the sinter of the wall. Another vent perhaps 1 meter away plays less frequently, and is vertical to 1 meter; this is probably a separate geyser, but not enough activity was seen to be certain. One never knew quite what to expect from Vitalii (just as with the person!), nor when it would be active. Vitalii chose a good one to name for himself.

7a-8. Zastenok (Застенок; On-the-Wall)

This feature proved to actually be three springs within one geyserite formation. Zastenok itself is a perpetual spouter playing from a fairly large and obvious cone a few meters to the right (south) of the Vitrazh. Few of its bursts reached higher than 50 centimeters.

The same cone includes a geyser. It was observed only twice, on different dates, each time playing with a series of brief but frequent eruptions. These occurred about every 2 minutes, lasted some 20 to 40 seconds, and reached vertically to about 1 meter. This activity could well be related to that in Grot Yubileinyi, whose actual vent cannot be more than a few feet away, since this geyser was seen in action only during and immediately after Grot's series.

7a-8a. Unnamed ("Zastenok's Hole")

Some 3 meters lower on the geyserite shield formed by Zastenok is a small hole that also proved to be a geyser. We came to call it "Zastenok's Hole." It was infrequently and briefly seen to play a few centimeters high.

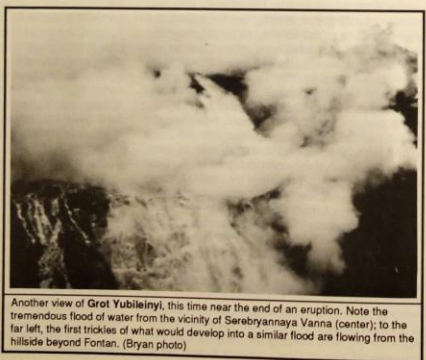
As usual, this thermal wall includes a great many features. Besides the Zastenoks, at least five were believed by us to be active as geysers.

result of minor eruptions strong enough to visibly jet water from the grotto. It was one of these that eventually triggered the full eruption, at 14:07, 3h 08m after the first overflow surge was recorded.

With rather little warning (although we quickly became better at understanding the indications), Grot burst outward. The play, at roughly a 55° from vertical angle, reached outward some 30 meters and hit a peak height of perhaps 15 meters above the platform. The volume of discharge was tremendous and produced a deep flood of water muddied by erosion nearly the full width of the Vitrazh. Eruptions recurred at 14:12, 14:15, 14:17 and 14:19. This series of five eruptions was remarkable, for Vitalii had never seen more than two in a series.

After a few more minutes of observation, it appeared that the series was finished, and our group departed to Zhemchuzhnyi and Velikan (in Group VIIb). While there, a large steam cloud implied another eruption. Then after having seen both Zhemchuzhnyi and Velikan, we witnessed three more eruptions by Grot as we were returning toward the house. The first two of these were stronger than any seen before, reaching beyond Fontan and easily 40 meters from the grotto.

All this proved to merely be an introduction to Grot. Although it was not seen on July 04 (a day of great celebration but miserable weather), eruptions were recorded on each day of July 05-08. In total, we directly observed a total of 44 major eruptions by Grot (see Table 7), each of which had a duration of 20 to 30 seconds. Using a surveyed topographic map as a base (the same as served as the base map for Plate 1), it was easy enough to closely estimate the most powerful eruptions to reach outward fully 65 meters (210 feet) before striking ground elevated well higher than the vent; the peak height of these strongest eruptions was figured as 25 to 30 meters. In general but with exceptions, it was either the second or third eruption of a series that was of greatest force. Each eruption series also included a number of "minor" eruptions. These typically consisted of only a few quick jets of "only" 10 meters or so, and came either before or after (but not within) the major series.



Another view of Grot Yubileinyi, this time near the end of an eruption. Note the tremendous flood of water from the vicinity of Serebryannaya Vanna (center); to the far left, the first trickles of what would develop into a similar flood are flowing from the hillside beyond Fontan. (Bryan photo)

The larger the eruption, the greater the discharge and more severe the erosion. This is a great worry to Sergei Alekseev. The geysers atop and on the Vitrazh are among the most famous and most revered in the Valley of Geysers. Continuing major activity by Grot could well alter or destroy these features, and the loss of Fontan would be a great one indeed. But, as Sergei said: "What can you do? It's nature!"

Our GOSA party and all the Russians (who all managed to see Grot at least once) agree: While there might be a few larger geysers elsewhere in the world, none can match Grot Yubileinyi for size, discharge, effect and affect, or sheer beauty of setting.

The Vitrazh is unique among the thermal walls in that it is topped by a flat platform which is surrounded by a large erosional alcove. When considering this setting, we concluded that it had resulted from prehistoric eruptions by Grot—the platform lies at the same level as Grot's vent, and the slopes of all parts of the alcove were washed by the eruptions. It seems very logical. However, Vitalii countered this suggestion by noting that the eroded alcove lies within a soft, thermally altered volcanic tuff while the platform is at the contact between the tuff and more resistant lavas beneath. Also, he contended that the eruptions since 1988 have enlarged Grot's cavern, especially its roof, and that eruptions such as we saw would have been impossible at any previous time. In respect, Vitalii's thoughts are probably correct. The line of the platform surface closely matches the location of springs to both the

north and south of the Vitrazh, and the geyserite platform surrounding Velikan might have a similar cause.

7a-10. Serebryannaya Vanna (Серебрянная Ванна; Silver Bath)

Serebryannaya Vanna is not a hot spring, *per se*. Rather, it is a catch basin for the overflow directly out of Grot Yubileinyi. Several meters long, about 1 1/2 meters wide and perhaps 1/2 meter deep, it lies on the open Vitrazh platform immediately in front of the cavern of Grot and at the lip of the Vitrazh slope. The crater is lined with a fine-grained, silvery-gray geyserite.

Within the Serebryannaya Vanna is a fracture along which are several perpetual spouters. These, or at least some of them, might prove to be geysers upon better observation, for they were actually seen to play strongly only during the overflows shortly before Grot eruptions. From above, however, they were visibly bubbling during every observation.

7a-11. Novii Fontan (Новый Фонтан; New Fountain)

The history of Novii Fontan is shrouded. It appears in the literature as early as 1951, but at that time it is listed as having average intervals of both 131 minutes and 24.36 minutes! More recent records give its intervals as 2 to 2 1/2 hours, each eruption lasting between 3 and 5 minutes and reaching 5 meters high. Further, Novii Fontan's eruption was said to cause nearby Fontan to "skip" one interval.

Novii Fontan has therefore changed. It was difficult to find it not in eruption. The only significant time spans when it was quiet were for short periods during and immediately following eruptions by Fontan. The rest of the time it was highly frequent, probably in eruption more than it was not. The highest jets reached not more than 3 or 4 meters. Novii Fontan often played in concert with Fontan. While no detailed records were kept, there was simply no clear pattern to Novii Fontan's activity.

7a-12. Unnamed ("Novii's Geyser")

Located a few meters in front of Novii Fontan, right at the brink of the Vitrazh, this unnamed geyser is frequently active and might be directly related to Fontan. On many occasions the eruptions were observed only within a minute or two of the start of Fontan. While there were exceptions to this, the relationship seems strong enough to merit future attention. The height of the eruption was 50 centimeters.

7a-13. Fontan (Фонтан; Fountain)

If any geyser in the Valley has shown



Words cannot adequately describe the eruptions of Grot Yubileinyi. This picture shows the initial jets of the play. Note that the horizontal distance from the mouth of the grotto to Fontan Geyser, directly above the sinter "X" on the face of the Vitrazh, is 32 meters. (Bryan photo)

7a-9. Grot Yubileinyi (Грот Юбилейный; Jubilee Grotto)

GROT!!! What a geyser! Had we seen nothing else during our eight days in the Valley of Geysers, Grot would have been worth the trip. It is currently the largest active geyser on Kamchatka and ranks among the top ten or so on Earth!

Grot was named by Ustinova in 1941, not because of any geyser activity but because of the large cavern, or grotto, in which it lies. Through the years it has been listed as a geyser, but to my knowledge never with any statistics being given. We were told that at best it was a boiling spring, perhaps periodic at times, but never given to forceful eruptions prior to 1988. From then through 1990 it had occasional powerful eruptions but generally only monthly. The shortest known intervals, seen during June 1991 before our arrival, were of about one week. It was these eruptions that led to Grot being renamed Grot Yubileinyi by Vitalii, because of the Jubilee—the 50th Anniversary—of Ustinova's 1941 discovery of the Valley. To this point, Vitalii was the only person known to have seen a major eruption.

On July 02, the day before we saw our first eruptions, Vitalii pointed out Grot's overflow and noted that it did sometimes have big eruptions. It was clear that we should not expect to see any. That evening, however, it was suggested that watching Grot might prove to be a good GOSA project, if such was what we were looking for. Nobody had ever documented any of Grot's activity before, so we

accepted the challenge. On the morning of July 03 we headed that way. First, Vitalii took myself and Jack onto the Vitrazh platform. What we saw was a huge cavernous opening mostly filled with boiling, surging water. At that moment the water was 1 meter below the overflow level into the associated Serebryannaya Vanna (Silver Bath; see #7a-10 below). The surroundings were wrought with erosion, which had cut fully 1 1/2 meters into the old formations of the platform atop the Vitrazh and severely washed the hillside above. We looked only briefly and quickly returned to the boardwalk viewing platform across the river

below the Vitrazh. (Vitalii said that we should never reveal that we had been onto the platform, but Sergei later said that there was no problem to this).

Only 39 minutes later (at 10:59), Grot had filled and the first overflow from Serebryannaya Vanna commenced. Although this overflow episode lasted longer than most we eventually witnessed, it was otherwise typical. Flow would begin rather gently at first and then increase to a steady stream. At times, almost always around one minute after the start of each overflow period, there would be a very heavy surge of overflow. Steam billowing from Grot itself indicated that these surges were because of minor eruptions confined to the cavern. The wave action took a few seconds to wash across the Serebryannaya Vanna, over its rim, and down the slope; only then was it visible to be recorded as an overflow surge. These heavy surges did not occur during every overflow period, but seemed to happen in groups of three or four with occasional singles. After the surge, overflow continued at a lesser volume and gradually decreased to a trickle. Usually it never quite entirely before another overflow period began. Each of these "hot periods" of overflow lasted 2 to 5 minutes (one 7 minute period was recorded), and recommenced every 6 to 8 minutes throughout the overflow period. After each eruption series by Grot ended, overflow ceased completely for a time, until both Grot itself and the Serebryannaya Vanna had refilled.

As the time for an eruption approached, some of the overflow surges became very heavy, the

consistent activity throughout the years, then it is Fontan. Prior to the advent of Grot Yubileinyi, it was incomparably the largest geyser on the Vitrazh. Fontan was observed and named by Ustinova in 1941, when it had average intervals of 15m 30s, exactly the same value as was determined in 1945. By 1951, the average interval had increased to 23 1/2 minutes, but it had again dropped to just over 16 minutes by 1960. Lists from the 1970s and 1980s continued to give it as 15 to 20 minutes.

Given our extensive observations of Grot Yubileinyi, considerable data about Fontan was recorded (Table 8). Of these 67 closed intervals, the average within a range of 8 to 28 minutes was 15m 21s; the standard deviation was 4m 17s. From that average, one can be quite confident that Fontan is unchanged. The height of the strongest eruptions is as great as 20 meters. Using that as a guide to the maximum, some eruptions do not exceed 10 meters, and the average height is probably on the order of 15 meters. Because Fontan only gradually builds into full eruption and ends with protracted concluding bursts, durations were not timed; generally, however, they were of 3 to 4 minutes.



Lying on the far northern edge of the Vitrazh are three significant geysers. Nepotoyannyi Geyser is in eruption. To the lower left is the cone complex of Dvovnyy Sedlo (cones) and Dvovnyy Stremya (fracture). (Hinehart photo)

Fontan (Фонтан; Fountain) has shown

7a-14. Nepostoyannyi (Непостоянный; Inconstant)

Nepostoyannyi erupts from a long fracture through the sinter of an orange-brown geyserite mound near the left (north) top of the Vitrazh. In keeping with its name, it is highly erratic in its activity. Intervals range from seconds to minutes, durations from 1 or 2 to perhaps 10 seconds, and heights from much less than 1 to more than 3 meters. In time it is responsible for very significant net discharge.

7a-15a. Dvoynoy Sedlo (Двойной Седло; Double's Saddle)

Dvoynoy is common to most lists of the Valley's geysers published since the mid-1960s, but always with the implication that it erupted from two vents simultaneously. In fact, there are two vent complexes within the geyserite cone, but they act as completely independent geysers. The uppermost of these, playing from two yellow-lined vents, is Sedlo. From all outward appearances, Sedlo could be a fairly big geyser, but we never saw more than minor splashing from its vents. A liberal guess might put the maximum height at 2 meters. Most activity was much smaller, and the eruptions never lasted more than a few seconds.

7a-15b. Dvoynoy Stremya (Двойной Стреля ; Double's Stirrup)

Lower on the cone topped by Sedlo, Stremya erupts a fan-shaped jet of water from a long horizontal fracture about halfway down the formation. The play here is as brief as that by Sedlo (i.e., seconds), but consists of both major and minor eruptions. A few major intervals were recorded. These ranged anywhere from 19 to 42 minutes (with another of 68 minutes possible) without any observable pattern. They jetted water as high as 3 meters. Minor eruptions were more common, but often reached heights of only a few centimeters.

7a-16. Unnamed ("Red Geyser")

On the slope above Nepostoyannyi, in an area washed by the eruptions of Grot Yubileinyi, is a vent which was always observed to steam steadily and gently except shortly after eruptions by Grot. Then it was seen to have frequent eruptions of red muddy water. The implication is that this is really nothing more than a drowned steam vent, yet when active the play was strongly periodic (intervals as long as 1 1/2 minutes, durations of 20 to 30 seconds) and the discharge from the 50 centimeter eruptions was notable. It is possible that this is a cyclic geyser that was only noticed because of watching Grot's discharge.

7a-17. Zamknutyi (Замкнутый; Enclosed)

Zamknutyi is a vent on the hillside above #7a-18, Averii. It is a perpetual spouter playing perhaps 1 meter high.

7a-18. Averii (Аверий; Averii)

Averii is named for Russian volcanologist V.V. Averii, who was killed in an Aeroflot plane crash in 1964. It is a very large perpetual spouter, reaching fully 4 meters high with some bursts. This activity began several years ago when a break in the sinter rim lowered the level of a previously quiet pool by about 20 centimeters.

7a-19. Quathegey (from the English "Quantum Theory of Geysers")

The same hydrosounding studies that involved Malenkii Printz (#4-8), also involved this spring, just a few feet from Averii. In the 1970s it had cone-type eruptions up to 1.5 meters high. When not altered by the hydrosounding, its natural eruptions recurred on intervals averaging 12m 35s; the mean duration was 1m 50s. Quathegey has now been dormant for several years, perhaps because of the action in nearby Averii. Steaming gently, the decaying vent contains wooden trash and is closely surrounded by plants. Without renewed activity, it will soon disappear.

7b-1. Velikan (Великан; Giant)

Velikan is, of course, the most famous of the Valley's geysers. Historically it has been the largest under any consideration, and eruptions as high as a measured 65 meters are known from it. That, however, is extreme. Most eruptions reach little more than 30 meters high, and that for only part of the brief, 1 minute duration. The play is at a distinct southward angle, about 20° from the vertical.

Between 1941 and the late 1970s, Velikan grew less active as the intervals showed a gradual progression from 2h 52m to 7h 30m. In a paper published in 1980 (data from 1977), Steinberg inferred that this lengthening was because of a slow erosional enlargement of the asymmetrical crater. This, he said, allowed a greater degree of convective cooling, which in turn forced longer intervals. Construction of an artificial dam so as to eliminate the shallow part of the crater from the convection produced consistently shorter intervals. Steinberg additionally noted that wind affected the intervals, and that even moderate winds could yield infinite intervals; that is, no eruption until the wind died down.

However, those inferences might have been incorrect, at least in part. Although Velikan's discharge is producing severe erosion on part of its

observations and the photograph in *The Geysers of Yellowstone* both indicate a more realistic maximum of 8 or 9 meters. It is nevertheless a lovely geyser and, remarkably, the only one of size to have a truly vertical eruption.

Zhemchuzhnyi plays from a bluish-gray geyserite cone exquisitely beaded with pearly geyserite nodules. The cone itself looks as if it is actually made of rocks cemented together, as if of masonry, and it is a gap between these rocks that most easily allows one to peer into the vent in order to judge the water level.

Despite their near proximity, there is no evidence of a connection between Velikan and Zhemchuzhnyi (nor, in fact, with any other feature).

7b-4. Unnamed

On the slope above Zhemchuzhnyi and toward Velikan are several small geysers and perpetual spouters. One of these showed intervals and durations of roughly 2 minutes, the bursting play sometimes reaching up to 1 meter high.



We were surprised to learn that **Platchenitza Geyser** was named because of its beautiful formation's resemblance to Christ's Shroud. (Bryan photo)



Zhemchuzhnyi Geyser has the most vertical eruption of any geyser of significant size in Dolena Geizerov. The large rock of the cone is close to 1 meter high. (Bryan photo)

7b-3. Zhemchuzhnyi (Жемчужный; Pearl)

Zhemchuzhnyi is a highly regular geyser, as shown by the data in Table 10. The data is sparse simply because rather little time was spent watching the Zhemchuzhnyi area. The average interval of 3h 16m (standard deviation only 5.72 minutes) is substantially shorter than the 4+ hours given by all previous reports, including Vitalii for 1990. It appears to be another geyser benefitted by the 1991 increase in thermal flux.

Zhemchuzhnyi undergoes little discharge until very shortly before an eruption; however, episodes of strong boiling within the vent are visible fully an hour before the play, and it is one of these that builds into the cone-type jetting of the eruption. The geyser reaches its full height very quickly (and quietly; although we were standing only 20 meters away, one eruption was well underway before we were aware of it) and maintains it for 4+ minutes, nearly into the steam phase which continues for another several minutes.

Although most references give Zhemchuzhnyi's height as 12 to 15 meters, our



Velikan Geyser, as viewed from a distance of more than 100 meters. This photo shows the maximum height of a typical eruption. (Bryan photo)

geyserite platform, the crater itself appears solid. Since 1978, Velikan's average interval has remained constant at just about 5 hours. Statements made earlier this year following Sergei Alekseev's visit to Yellowstone to the range being 5 to 18 hours were misquoted; in 1990, they were 4 to 8 hours regardless of wind or weather conditions.

Velikan did not bless our group with many eruptions, and we were able to obtain only three closed intervals. These average 5h 02m. Taking the entire series of reasonable multiple intervals, the average of 33 inferences is 5h 05m (Table 9). This small difference from the closed data, with a standard deviation of only 22 minutes, agrees well with Vitalii's assessment that Velikan "almost always plays after 5 hours" except that it sometimes "remembers its past and erupts after 3 hours." He was outstandingly good at predicting it.

After one eruption, Velikan slowly fills its crater. The first boiling action takes place at about the same time as the first overflow. From afar it is possible to see Velikan "peeking over the edge of the rim to see if we are watching." If we are, we should be in position an hour later. The intermittent boiling

becomes larger and involves more of the pool until one final boil domes the water over the vent. Velikan bursts forth. The full height is not reached until about 30 seconds have passed (i.e., fully half the eruption). Velikan then regresses into a strong but short steam phase barely a minute after the onset. Written reports about powerful intermittent steam phases during the first few minutes after an eruption are not correct, at least not at the present time. Velikan's is an impressive but amazingly short eruption.

7b-1a. Unnamed geysers/springs in Velikan area

The vicinity of Velikan includes numerous other springs, several of which are unquestionably geysers.

One of the more prominent developed a few years ago at the base of a large, old stone birch tree: it is now fallen, and a vigorous and highly variable perpetual spouter (possibly a geyser) occupies a jagged crater penetrated by silicified roots.

Along the southwest edge of Velikan's platform is a series of geyserite cones as much as 1 meter tall. Similar in appearance to the cones at Yellowstone's Monument Geyser Basin, they all contained small spouters, one of which is probably a geyser.

Historically notable is a cluster of springs on the hillside immediately above (east) of Velikan. These were collectively named by Ustinova as the **Karlek (Dwarfs)**—Upper, Central, Lower, Left, and Right—and all five were described as geysers as high as 3 meters as recently as 1960. Presently, however, they all appear to act as perpetual spouters of small size. The name "Karlek" has become a generic term, transferred to the numerous small geysers of the thermal walls where its use is similar to our "sput."

7b-2. Paryashchii (Парящий; Steamer)

Playing from a rocky vent amid a pile of boulders next to the river, Paryashchii is a relatively new feature. There is almost no sinter on the rocks and unless it is in eruption there is nothing to guide one to its site. For a time, though, this was a perpetual spouter and it is only recently that Paryashchii began to have distinct intervals. Now both the intervals and durations are so long as to be indeterminate. We saw Paryashchii both active and inactive, both modes lasting at least as long as 8 and typically in excess of 12 hours. The start of one eruption was seen, though, and it went from nothing to full force in an instant. The maximum height would be much greater than 1 meter were it not for the boulders above the vent.

7c-1. Platchenitza (Плащеница; Christ's Shroud)

Platchenitza is an intriguing geyser on the Rainbow Wall, just over a low ridge and a short distance upstream from Zhemchuzhnyi. The shroud is a thick geyserite shield of an even and dark silvery-gray color which extends almost vertically down the wall from the vents to the river. At the top is the vent complex, consisting of several yellowish openings along an evident fracture. The uppermost few centimeters form a low free-standing cone. The entire formation is about 2 1/2 meters tall. All in all, Platchenitza is one of the most beautiful thermal wall features.

Because of its location, hidden from any downstream viewing position, only a little data was obtained. This indicates a high degree of regularity. Three consecutive intervals obtained on July 06 were of 26, 26, and 25 minutes. The eruptions begin abruptly, water spurting to a height of up to 1 meter above the cone. After about 1m 15s, the force of the play abruptly declines to little more than weak, intermittent splashing which continues for another 1 minute or more.

On the thermal wall slope a few feet above Platchenitza is the smallest true geyser we observed. It played every 10 to 20 seconds, reaching all of 4 centimeters high during the 5 second duration.

7c-2. Gorizontálny (Горизонтальный; Horizontal)

Gorizontálny is another of those large but brief geysers which plays its water over the river. In this case, the major eruption jet is massive and virtually horizontal while a second is nearly as strong at 45°. The duration is much less than 1 minute.

Gorizontálny was named by Ustinova in 1941, but no eruptive data was cited then or in 1945, 1951, or 1954. A 1960 report finally listed intervals of 1 1/2 hours, durations of seconds, and "heights" of 12 meters. Since authors failed to give data prior to 1960, since I had been unable to locate any reference to Gorizontálny dating more recently than 1960, and since Steinberg failed to mention it in his map and table of 1984, I had concluded that it was commonly dormant. I know now that the lack of records is because of the geyser's position. Like Platchenitza and all the others in Group VII, it is all but invisible from any downstream position. That combined with the exceptionally short duration makes data very difficult to obtain unless Gorizontálny is a specific goal.

In fact, Gorizontálny is a highly regular geyser. We obtained closed intervals on different dates of: 1h 33m, 1h 31m, [3h 07m double = 2 X 1h 33.5m inferred], and 1h 31m. Preplay consisting of

brief intermittent overflow begins several minutes before an eruption; recurring on intervals of 1 to 2 minutes, each has a duration of a few seconds. The later overflows are accompanied by boiling, and it is one of these that abruptly bursts outward with the eruption. The play leaves the vent at an angle of about 75° from the vertical. It is forceful enough that some of the initial jets completely span the river, thus reaching outward as far as about 8 meters. (None of the eruptions we saw closely matched the 12 meter figure cited in 1960.) The time from the initial jets to the concluding bursts is not more than about 50 seconds.

7c-3. Moidadir (Мойдир; Squeaky Clean)

This small geyser/spouter lies immediately upstream from Gorizontálny. Its name reflects an increase in activity a few years ago (circa 1980), when the vent was enlarged and cleaned of debris by unseen eruptions. Activity here is continuous but with distinct variations in force. At times the play virtually ceases, while at others a quick surge sends spray over 1 meter high.



This particular photograph of **Gorizontálny Geyser** hardly varies a trace of the practically horizontal jet that gives it its name. The height from this secondary vent is about 6 meters. (Bryan photo)

7c-4. Unnamed ("Black Mouth")

This name was suggested by Vitalii after the shape of the crater's opening, which is of a perfect heart shape coated inside with dark algae. The shallow spring within is probably a geyser, but no eruption was seen.

7c-5. Unnamed

This geyser is more significant than numerous others and deserves a name. The southwesternmost on Ustinova's Wall, it plays from a black, slit-like vent surrounded by orange geyserite low on the wall. Its intervals are about 5 minutes. The play is a pulsing-jetting action which sends water as high as 1 meter throughout the 1 to 1 1/2 minute duration.

7c-6. Ustiney (Устиней; Ustiney)

Named in honor of Ustinova, this could be translated as "Ustinova's Little Geyser." The brief observation we made of it indicates fair regularity and possible major and minor durations. The observed consecutive intervals were of 19, 20, and 18 minutes. The respective durations were ~1m, 1m 17s, >2 1/2m, and ~1m. All of the eruptions were similar in that water was squirted from the small vent to some 50 centimeters throughout the first minute or so of play; the longer eruption then underwent several weak "restarts" through its remaining 1+ minute.

7c-7. Conus Rozovyyi (Конус Розовый; Pink Cone)

Conus Rozovyyi erupts from a large pinkish geyserite cone perched high on Ustinova's Wall. Its brief, cone-type eruptions reach 2 to 3 meters high. The five consecutive intervals recorded on July 06 were 14, 14, 15, 15, and 14 minutes. The eruptions last less than 1 minute. Although the eruption is larger and briefer, Conus Rozovyyi's formation and play strongly resemble those of Conus Krustalnyi.

7c-8. Unnamed

This is another geyser strongly deserving of a name. It erupts from a break at the base of Conus Rozovyyi, sending a steady, 2 meter jet at a 45° angle in the down slope direction. One closed interval was 39 minutes. The duration was greater than 2 minutes.

7c-9 to 7c-12. Unnamed

Actually, the largest of these geysers (#7b-10), located at and below the north end of Ustinova's Wall, does have a name, but I failed to record it and Vitalii neglected to include it on his thermal map. It plays frequently (intervals around 20 minutes) to 1 1/2 meters. The other geysers are smaller and were not consistently observed.

7c-13. Unnamed ("Black Heart")

This name was suggested by Vitalii after the shape of the crater's opening, which is of a perfect heart shape coated inside with dark algae. The shallow spring within is probably a geyser, but no eruption was seen.

7c-14 and 14a. Unnamed geysers ("Pink Stone")

Located up slope from Black Heart, these two pools were acting as intermittent springs on July 06, when we were in their immediate vicinity. At that time, I thought of this name for the southwesternmost of the two because of the numerous small stones coated with pink, spiny geyserite within the runoff channel. On succeeding days, both of these springs were seen from the viewing platform below the Vetrozh tube in eruption every time they were looked at. Evidently then, they may have both intervals and durations in terms of hours.

7c-15. Unnamed

Around the ridge from #7b-14 are several small geysers perched on another steep thermal



A face-on view of the geyserite formation created by the runoff from Arka Geyser. (There is a double meaning here in "face-on": how many stone faces can you see in the rocks?) (Bryan photo)

Part III
wall, apparently unnamed. I suggest "Arch Wall" after its most unusual feature (#7c-16).

This geyser is the southernmost on the wall, erupting to 50 centimeters from a beautiful shallow, cup-like basin decorated with yellow geyserite pearls. The single eruption watched lasted around 1 1/2 minutes.

7c-16. Arka (Арка; Arch)

When I pointed out this sinter arch to Vitalii, he used the word as if it was an established name. It is an intriguing feature. When viewed straight on, the runoff of this small geyser appears to flow down a slight sinter ridge on the wall. From the side, though, it is seen to actually be flowing along the top of a natural arch whose opening is fully 1 1/2 meters long and 1/2 meter high—absolutely unique. The geyser has frequent eruptions some 30 centimeters high.



This is the same geyserite formation as is shown on the previous page. (Bryan photo)

Group VIII

Group VIII lies well upstream from the others, fully a kilometer from the upper part of Group VIIc. We reached only the lower reaches of this group during a hike on our first day in the Valley, and we now regret that we did not go to the effort to push on a little farther to see the geysers.

8-1. Raduzhnyi (Раду́жный; Iridescent)

This feature is probably a perpetual spouter. Its spray supports multicolored algae upon multicolored geyserite; surrounded by dense plants and adjacent to the river, it is a well-named beauty. The play is not more than a meter high.

Only a few minutes were spent viewing Raduzhnyi and other springs a few feet away at the base of a small thermal wall. Some (at least three) of these features are short-interval geysers, but no data was obtained.

8-2. Vosmorka (Восмерка; 8-Shaped)

The two round openings of this vent give Vosmorka its name. It is said to erupt every 20 to 30 minutes and reach up to 3 meters high.

8-3. Burlishchii (Бурлищий; Seething)

This geyser near Vosmorka was previously unknown to me, and no data was reported during our trip.

8-4. Plachushchii (Плачущий; Weeping)

The existence of this geyser has been known for several years, but nothing is known about its activity except that the play reaches about 2 meters high.

Group IX

At least three additional geysers lie still further upstream, about another kilometer from Plachushchii. Almost nothing is known about the Group IX geysers. Just one has been named.

9-1. Verkhnei (Верхний; Uppermost)

Verkhnei, we were told, erupts often and as high as 4 meters. Nothing more is known about it.

Dolena Smerta

Another five kilometers up the Geysernaya River from Group IX is the confluence of the several small streams which form the river at the base of the volcano Kikhpinych. In this area are numerous steam vents and extensive deposits of native sulfur. At times, fumarolic gasses, such as carbon dioxide

and hydrogen sulfide, are able to collect in low and sheltered places. Numerous animals have been killed in these spots, everything from small mice to full-grown bears. This barren region is Dolena Smerta, the Valley of Death.

Also someplace upstream from Group IX is a feature or place called Monetnyi Dvor, the "Money-making Mint", because the rocks or geyserite of the area resemble the printing plates used for printing bills.



The downstream-most portion of Group VIII is marked by a small thermal wall. Its largest feature, Raduzhnyi, is probably a perpetual spouter rather than a geyser, but several small geysers are present. (Bryan photo)

Concluding Note—

Although this volume was expanded because of the late summer, 1991 political situation in the Soviet Union, most of the activity is still described in general terms only. Greater details about many observations may be published in future issues of the GOSA Transactions.

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Production:

This volume was produced on a Macintosh IIfx computer using PageMaker 4.01, MacWrite II 1.1v1, Microsoft Works 2.00e, and DeltaGraph 1.5d under System 7.0. The text is set in Stone Serif, photo captions and titles in Helvetica, and the Russian in Cyrillio Gothic. Final copy was printed with an Apple Personal Laser Writer NT. The pictures were halftoned photographically.

Table 1 — Summary

Group #, Spring Name	Interval	Duration	Max Height, m	Playback	Notes
Group I					
1. Pervenets	42 - 45 min	2 - 2 1/2 min	15	24 min	Concludes with weak steam phase
Group II					
1. Troynoy	2 - 2 1/2 hrs	8 min	20, 30, 6"	1-1 1/2 hr	One eruption observed; 3 vents, "see text"
2. Sobed	min - 1 hr	sec - 2 1/2 min	5	sec - 2 1/2 min	Activity related to Troynoy cycle
3. Sakharnyi	11-38s > 2	1/2m	6 - 11 sec	2	Bimodal interval
4. Nerazrodinnyi	(steady)	unknown	.3	.3	Previously a geyser?
5. Dvoynook	unknown	unknown	1	1	Not observed in 1991; thermal map reference
6. Unnamed geyser	minutes	seconds	2	2	"Surprise G." of Hobart
Group IIIa					
1. Parovoy	35 - 50 min	minutes	1.5	minutes	Group IIIa not visited in 1991
2. Skritnyi	brief	near steady	2 - 3 horizontal	near steady	Historic data
3. Shilo					No data available
Group IIIb					Shown on "Yankee in Kamchatka"; PBS 1991
1. Ulyuzhok	short	near steady	1	1	Intervals reportedly becoming longer; more frequent
2. Drevnyi	unknown	unknown	1	1	Full eruption not seen; otherwise acts as p.s.
3. Fakel	seconds	near steady	2	2	Steamy jets at 30° from vertical
4. Teremok	unknown	minutes	1	1	Not observed in 1991; thermal map reference
5. Teremkovnyi	unknown	unknown	1	1	Not observed in 1991; thermal map reference
6. Unnamed geyser	unknown	unknown	1	1	Hot water source at bathhouse
7. Shutnik	-40 min	1 min	5	5	
8. Vorota	near steady	long	1	1	
9. Geizernuyu	near steady	long	.5	.5	
Group IV					
1. Zhalo	seconds	sec - min	3 - 4 (horizontal)	3 - 4	Increasing intermittency; named 7/05/91
2. Sklastnyi	1 - 1 1/2 hrs	1 - 3 min	15	15	Historic data, dormant 1991
3. Lel'ri	11 - 23 min	2 1/2 - 4 min	•	•	Eruption largely subterranean
4. Conus Khrustalnyi	24 - 25 min	2 - 2 1/2 min	1.5	1.5	Conus of Ustinova [1941]

Group #.	Spring Name	Interval	Duration	Max Height: m	Prevaly	Notes
Group V						
1.	Unnamed geyser	unknown	unknown			Not observed in 1991; thermal map reference
2.	Unnamed geyser	unknown	unknown			Not observed in 1991; thermal map reference
3.	Unnamed geyser	3 1/2 - 4 1/2 m 2 min	1			"Third geyser from Malyi" of Hobart & Warnock
4.	Raskriyly Kamen	10 min	1.3			Extremely regular
5.	Smuglyi	(steady?)	brief			Rhythmic pulsations; a near geyser
6.	Milyi	35 - 42 min	1-2			1991 Average I = 38m 37s; ends with steam phase
7.	Secretar	seconds	5 min			Erratic, infrequent quiet intervals
8.	Bolehol	1 - 1 1/3 hrs	1			Tall bursts zero to many/eruption
9.	Sakretar Bolshovo	(steady)	10 - 25			
10.	Norka	5 min	.6			Active as geyser in early 1980s
11.	Malaya Pechka	(steady)	1			
12.	Boroda	10s of min	1-2			
13.	Bergolovoyi	minutes	2-3			Thermal map shows as perpetual spouter
14.	Seryi Tyulpan	seconds	.6			
Group Via						
1.	Tramplichik	30 - 60 sec	10 sec			
2.	Koglichka	minutes	seconds	.6		
3.	Krepost	unrecorded	1 1/2 min	6 - 7 (710)		2 muddy eruptions seen were first ever recorded
4.	Primernyi	4 1/2 min	30 - 40 sec	.5		Extremely regular
5.	Shchell	34 - 38 min	1 - 1 1/2 min	3		1991 Average I = 35m 53s
5a.	Sorok Dva	(steady)	(steady)	.1		

Group #.	Spring Name	Interval	Duration	Max Height: m	Prevaly	Notes
Group V						
1.	Ekvelator	frequent	seconds	1		Possibly a fluctuating perpetual spouter
2.	Vorota Ada	irregular	minutes	...		Subterranean activity
3.	Vanna	unknown	minutes	2	yes	Dormant in 1991
4.	Unnamed geyser	unknown	unknown	1		Muddy pool active only in dry season
5.	Pyostriy	unknown	unknown	1		identity uncertain
6.	Kovernyi	5 - 30 sec	10 - 20 sec	2	constant	
Group Vila						
1.	Malakhitovyi Grot	(steady)	(steady)	1-4		Fluctuating perpetual spouter
2.	Leshii	frequent	seconds	2-3		Height < 1 when drowned by river, as in 1991
3.	Unnamed geyser	sec. many min	seconds	1		
4.	Gosha	1 - 10 min	seconds	1-2		Named 7/03/91 in honor of GOSA
5.	Kuznetchik	13 - 23 sec	1			Two vents; named 7/03/91
6.	Unnamed geyser	sec. - 1 min	.5			"Smoking Monkey G" of Warnock
7.	Vitalii	minutes	10 - 40 sec	1		Named by Vitalii 7/03/91
8a.	Zastenok Geyser	2 min	20 - 40 sec	1		Cyclic, data for active series
9.	Unnamed geyser	infrequent	seconds	.3		Low on Zastenok's formation
10.	Grot Yubileinyi	2 - 9 min	10 - 25 sec	to 65 (horizontal)	min - hrs	Cyclic, data for active series; see text
11.	Novii Fontan	frequent	sec. - min	1-4		Catchment for Grot Yubileinyi overflow
12.	Unnamed geyser	before Fontan?	30 sec	.5		More active but weaker than historically
13.	Fontan	8 - 28 min	3 - 5 min	10 - 20		"Novii's G" of Warnock
14.	Nepostoyennyi	sec. - min	seconds	1-3		1991 Average I = 15m 21s
15a.	Dvoynoy Sedo	irregular	seconds	1-2		Highly erratic
15b.	Dvoynoy Siremya	19 - 42 min	seconds	3		Major eruptions only; minors common
16.	Unnamed geyser	1 1/2 min	20 - 30 sec	.5		"Red G" of Bryan; seen only after Grot; see text
17.	Averii	(steady)	(steady)	4		Large perpetual spouter since mid-1980s
19.	Quathegy	9 - 10 min	1 1/2 - 2 min	3		Dormant in 1991, historic data

Group #.	Spring Name	Interval	Duration	Max Height: m	Prevaly	Notes
Group V						
1.	Velkan	(3) 4 - 8 hrs	1 min	30 - 40	1+ hr	1991 Average I = 5h 05m
2.	Peyashchii	hours	hours	1	little	Both interval and duration ~8 hours
3.	Zhanchushchii	3 - 3 1/2 hrs	4 - 5 min	8 - 15		Significantly more frequent in 1991 vs. historic
4.	Unnamed geyser	2 - 3 min	2 - 3 min	1		
Group VII						
1.	Plichanitsa	26 - 36 min	1 - 2 1/2 min	1		Weaker than historic listings
2.	Gorizontnyi	1 1/2 hrs	45 - 50 sec	8 (horizontal)		Became geyser c.1980
3.	Moldir	frequent	seconds	3		"Black Mouth" of Vitalii
4.	Unnamed spouter	(steady)	(steady)	1		
5.	Unnamed geyser	5 min	1 - 1 1/2 min	7		
6.	Udinyi	19 - 20 min	1 - 2 1/2 min	2 - 3		
7.	Conus Rozovyi	39 min	2 1/2 min	2		Erupts at 45° angle; one closed interval
8.	Unnamed geyser	20 min	1 - 3 min	1.5		"Black Heart"; erupts within cavern
10.	Name unrecorded	unknown	minutes?	1*		"Pink Stone G" of Bryan
13.	Unnamed geyser	unknown	hours	.5		Near and activity related to "Pink Stone"
14.	Unnamed geyser	hours	hours	1		Runoff crosses natural arch of sinter
15.	Unnamed geyser	hours	1 1/2 min	.5		
16.	Aha	frequent	1 min	.3		
Group VIII						
1.	Reduzhnyi	short	minutes	1		Possibly a perpetual spouter
2.	Vosmorka	20 - 30 min	unknown	3		Not observed in 1991; historic data
3.	Burilichii	unknown	unknown	2		Thermal map reference only
4.	Plachushchii	unknown	unknown	2		Not observed in 1991
Group IX						
1.	Verkhnei	unknown	unknown	4		Far upstream group, not visited in 1991

Date	Interval	Duration	Height
July 02	----	30s	splash
	-19m	1m	1.3m
	-14 1/2m	1 1/2m	1m
	11m 06s	---	3m
	6m 09s	1m 40s	4m
	6m 19s	2m 09s	5m
	-29m	long	5m

Date	Interval	Duration
July 02	----	6
	188	8
	35	4
	11	10
	230	7
	230	11
	33	11
	35	6
	174	5
	37	8

Date	Time	Interval
July 02	1355	
	1433	38
	1515	42
	1553	38
	2026	
	2104	38
July 03	0446	
	0523	37
	1110	
	1147	37
	1226	39
	1304	38
	1344	40
	1433	49
	1514	41
	1553	39
July 05	1325	
	1405	40
	1438	33
July 06	1901	
	1940	39
July 08	0937	
	1016	39
	1051	35
	1131	40
	1207	36
	1245	38
	1320	35

Table 5 — Bolshoi Geyser

Date	Time	Interval	Overflow
July 02	1408		26
	1519	1h 11m	08
July 03	1100		
	1222	1h 22m	14
	1343	1h 21m	
	1519	1h 36m	
July 05	1202		
	1315	1h 13m	
	1549	[2h 34m]	
	1704	1h 15m	
July 07	1024ns	>1h 20m	10
	1144	~1h 20m	
	1257	1h 13m	
July 08	1035ns		
	1154	~1h 19m	
	1310	1h 16m	

Table 6 — Shcheli Geyser

Date	Time	Interval	Overflow
July 03	1224		
	1300		36
	1338		38
	1415		37
		
July 04	1605		[110]
		
July 05	1649		
		
	1759		[70]
July 06	1833		34
		
	1920		[108]
July 07	1528		
		
	1747		[139]
July 08	1821		34
		
	1812		[69]
July 09	1037		
	1113		36
	1148		35
		
	1301		[73]

Table 7 — Grot Yubileyni Geyser

Date	Time	Interval	Series	Eruption Interval	Lateral Throw	Comments
July 03	1059		unknown		30	1st eruption seen
	1407		unknown	5	major	
	1412		unknown	3	35	
	1415		unknown	2	15	
	1417		unknown	2	major	At Veikian
July 05	1546		unknown	...	40	
	1554		unknown	6	35	Seen from near house
	1618		unknown	24	major	
	1634		>3h 29m	8	35	
July 06	1642		unknown	9	50	
	1651		unknown	9	25	
		unknown			
July 08	0845		unknown	4	major	Seen from house
	0849		unknown	2	"big" major	do
	0851		unknown	4	major	do
	0855		unknown	4	major	do
July 09	1620		>7 1/2 h?		10 minor	
	1746		9h 01m?	17	30	
	1803			8	50+	
	1811			9	55	
	1820			3	25	
	1823			3	15 minor	

Table 8 — Fontan Geyser

Date	Time	Interval	Series	Eruption Interval	Lateral Throw	Comments
July 07	0802					
	1015		major	9		
	1024		50	8		
	1032		55	3		
	1035		30	3		
	1226		major	2h 11m	5	
	1231		major		13	
	1244		major			
	1507		10 minor	2h 41m	6	
	1513		30		6	
July 08	1522		60+	9		
	1531		50	9		
	1534		40	3		
	1536		15 minor		3	
	1706		3h 11m	2h 23m	5	
	1730		60		6	
	1735		50		6	
	1741		40		6	
	2023		<10 minor	2h 53m	7	
	2030		40		11	
July 09	2041		<10 minor			
	2233		30	4		Seen from steps
	2237		major	2h 10m	3	Seen from steps
	2240		major			

Table 8 — Fontan Geyser

Date	Time	Interval	Date	Time	Interval	
July 03	1109		0720		12	
	1126		0741		21	
	1139		0801		20	
	1150		0818		17	
	1202				
	1222		0955			
	1238		1008		13	
		1017		9	
	1334		1036		19	
	1357		1049		13	
	July 04	1607		1100		11
		1627		1112		12
		1639		1122		10
		1658		1133		11
.....			1144		11	
1733			1159		15	
1741			1211		12	
1803			1223		12	
1817			1247		24	
1830			1301		14	
July 05		1656		1310		9
		1716		1323		13
		1730		1351		28
		1751		1611		
	1812		1629		18	
	1830		1647		18	
	1842		1705		18	
	1900		1724		19	
	1913		1743		19	
	1926		1752		9	
	July 06	1642		1810		18
		1657		1656		20
		1709		1716		20
		1725		1730		14
1747			1751		21	
1800			1812		21	
1819			1830		18	
1836			1842		12	
1854			1900		18	
July 07		0700a		1913		13
		0708		1926		13
		[>8]		1642		15
				1657		15
				1709		12
			1725		16	
			1747		22	
			1800		13	
			1819		19	
			1836		17	
			1854		18	
	July 08	1038		1038		15
		1053		1106		13
		1106		1117		11
1117			1131		14	
1140			1140		9	
1154			1154		14	
1203			1203		11	
1217			1217		14	

Table 9 — Velikan Geysers

Date	Time	Closed	Inferred
		Interval	Interval
July 01	0953		
July 02	1220		5h 17m X5
July 03	1004ies 1528	-5h 28m	5h 26m X4
July 04	1753		5h 17m X 5
July 05	1750		4h 47m X5
July 06	1646		4h 35m X5
July 07	1240 1802 2219	5h 22m 4h 17m	4h 58m X4
July 08	0943		5h 42m X2

Table 10 — Zhemchuzhnyi Geysers

Date	Time	Interval
July 03	1155	
	1527	3h 28m
	1843	3h 16m
July 06	1708	
	2020	3h 12m
July 07	1030	
	1345	3h 15m
	1655	3h 10m
	2015ies	3h 16m

Name in Russian	Name in English	Page
Arka	Arch	35
Averii	Averii	30
Bezgolovyyi	Headless	22
Bolshaya Pechka	Large Oven	18
Bolshoi	Large	21
Boroda	Bearded	22
Burlishchii	Seething	35
Conus Khrustalnyi	Crystal Cone	18
Conus Rozovyyi	Pink Cone	34
Dolena Smerta	Valley of Death	35
Drevnyi	Ancient	15
Dvoynook	Twins	14
Dvoynoy	Double	30
Eskalator	Escalator	24
Fakel	Torch	16
Fontan	Fountain	29
Geizernuyu	Little Geysers	17
Gorizontalnyi	Horizontal	33
Gosha	GOSA	26
Grot Yubileinyi	Jubilee Grotto	27
Kamenka	Small Stones	18
Karleka	Dwarfs	31
Kogichka	Clawlike	23
Kovarnyi	Insidious	24
Krepost	Fortress	23
Kuznechik	Grasshopper	26
Lafet	Gun Carriage	17
Leshii	Leshy	26
Malakhitovyyi Grot	Malachite Grotto	25
Malaya Pechka	Little Oven	22
Malenkii Prints	Little Prince	18
Malyi	Small	20
Moidadir	Squeaky Clean	33
Monetnyi Dvor	Money Mint	36
Nepostoyannyi	Inconstant	30
Nerazvodinnyyi	Undiluted	14
Norka	Little Burrow	22
Novaya Pechka	New Oven	18
Novii Fontan	New Fountain	29
Parovoy	Steamer	15
Paryashchii	Steamer	31
Pervenets	First	12
Plachushchii	Weeping	35
Platchenitza	Shroud	33
Primernyi	Example	23

Name in Russian	Name in English	Page
Pyostriy	Variegated	24
Quathegey	Quantum Theory of Geysers	30
Raduzhnyi	Iridescent	35
Raskritiyi Kamen	Split Rock	20
Ritii	Rhythmic	20
Sakharnyi	Sugary	14
Sedlo, Dvoynoy	Saddle (Double's)	30
Sekretar	Secretary	21
Sekretar Bolshovo	Bolshoi's Secretary	22
Serebryannaya Vanna	Silver Bath	29
Seryi Tyulpan	Gray Tulip	22
Shchell	Crack	23
Shilo	Awl	15
Shutnik	Joker	16
Skalistyi	Rocky	17
Skritnyi	Hidden	15
Smuglyi	Swarthy	20
Sorok Dva	Forty-two	24
Sosed	Neighbor	14
Stremya, Dvoynoy	Stirrup (Double's)	30
Teremkovyyi	Small Fairy-Tale House	16
Teremok	Fairy-Tale House	16
Tramplichik	Trampoline	23
Troynoy	Triple	13
Ustevoy	Small Mouth	19
Ustiney	Ustiny	34
Utyuzhok	Little Iron	15
Vanna	Bath	24
Velikan	Giant	30
Verkhenii	Uppermost	35
Vitalii	Vitalii	26
Vorota	Gate	17
Vorota Ada	Gates of Hell	24
Vosmorka	Eight-shaped	35
Zamknutyi	Enclosed	30
Zastenok	On The Wall	26
Zhalo	Serpent's Tongue	17
Zhemchuzhnyi	Pearl	32
Unnamed geysers	Black Heart	34
	Black Mouth	34
	Novii's Geysers	29
	Parosol	19
	Pink Stone	34
	Red	30
	Smoking Monkey	26

Name in Russian	Name in English	Page
	Surprise	15
	Zastenok's Hole	26
	Unnamed	16
	Unnamed	19
	Unnamed	24
	Unnamed	26
	Unnamed	31
	Unnamed	32
	Unnamed	34



Errata
Corrections and Amendments to
GOSA Transactions Special Report #1 (Kamchatka)

This errata will not correct an occasional but “minor” typographical error in the English text. It does, however, make a number of Russian spelling and name corrections and includes a few additional comments. My greatest of thanks go to Dr. Tatyana Ustinova, the discoverer of the Valley of Geysers, for providing most of these corrections.

Front Cover and Title Page— The second word in the Russian cyrillic form of Kronotsky’s name should read “государственный ”.

Page 1— Dr. Ustinova wishes it to be absolutely clear that her 1941 discovery of the Valley of Geysers was *not* accidental at all, as will be described in her narrative which will appear in *The GOSA Transactions*, Volume IV (1993).

Page 9— The volcano given as Semyatsky should be transliterated as Semyatchik.

Page 13, #1-1— The name Pervenets translates to English as “First-born”, not simply as “First.”

Page 13, Group II and elsewhere— The Russian word for “Creek” should be spelled “Ruchay.”

Page 14, #2-4— The Russian version of this name should read “Неразведенный ”, producing a transliteration of “Nerazvedennyi.” The English meaning remains “Undiluted.”

Page 15, #2-6— The name which starts the last line of this description should read “Dvoyneek”. My error here came about because Vitalii had originally verbally used Bliznitsii, but then placed Dvoyneek onto his map.

Page 15, Group III— The Russian name for Waterfall Creek should read “Ruchay Vodopadnii.”

Page 15, #3a-1— In the next to the last line, correct “Pariyatshii” to “Paryashchii.”

Page 15, #3a-2— The Cyrillic for “Skritnyi” should be “Скрытый ”. (Boy, page 15 was terrible!)

Page 17, #3b-9— The word form of “Geizernuyu” is an adjective which should not stand alone and cannot be a name. So, on the map it was perhaps intended to indicate a number of small geysers.

Page 20, #5-6— Both the English “Ritii” and the Cyrillic “Ритий ” were questioned by Ustinova, but she made no additional comment. However, I do not have a Russian for for the alternate name, “Yellow Spouter.”

Page 28, ¶1, line 4— The angle of the eruption should read “35° from the vertical”.

Page 32, top left photo— Ustinova states emphatically that this photo cannot be of Zhemchuzhnyi, and suggests that it is of Fontan instead. She also states that Zhemchuzhnyi does not have a vertical eruption as the photo shows and the text states. However, the picture *is* of Zhemchuzhnyi and the text *is* correct. In fact, we were never on the Vitrazh platform for long enough a time to have obtained such a photo of Fontan. Having seen a photo Ustinova showed before a GOSA gathering in July, 1992, it can be concluded that Zhemchuzhnyi has changed the form of its eruption considerably over the course of the years, probably by blowing out a piece of its cone so that its eruption is now more vertical but less powerful than it once was (note that in the text I state that the modern eruptions are weaker than those of the past).

Page 33, #7c-3— The Cyrillic for “Moidadir” should be “Мойдодыр ”.

Page 34, #7c-6— Ustiney, the name given to us by Nikolayenko is, in fact, not given in a Russian form at all. We now believe that he invented the name on-site for our benefit and in honor of Ustinova, who had been a dinner table topic of conversation the previous evening. Ustinova agrees with the convention against naming thermal features after actual persons, so this geyser should probably revert to “Unnamed.”

Page 35, #8-3— The Cyrillic form for this geyser should be “Бурлаший ”, resulting in an English “Burlashchii”.

Page 35, Group IX— At the end of the second line, the name should be altered to “Plachushchii”.

Page 35, Dolena Smerta— Ustinova corrected the second word to “Smerte”. Although she did not make this correction, other authorities have argued that “Dolena” should be “Dolina”.

Plate I
 Map Showing
 Major Thermal Features
 of
DOLENA GEYSERS
 The Valley of Geysers
 Kronotsky Nature Preserve
 Kamchatka Oblast, Russia

Compiled by
 T. Scott Bryan, July and September, 1991
 Based on an original prepared by
 Victor A. Kuznetsov, July 8, 1991
 Names of geysers are given in both Cyrillic
 and Latin alphabets, and phonetic
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