



VALLEY OF GEYSERS, KRONOTSKY RESERVE, KAMCHATKA: FEATURES SEEN BY THE 1991 GOSA EXPEDITION AND CHANGED BY THE 2007 LANDSLIDE, 2013 CYCLONE AND 2014 LANDSLIDE

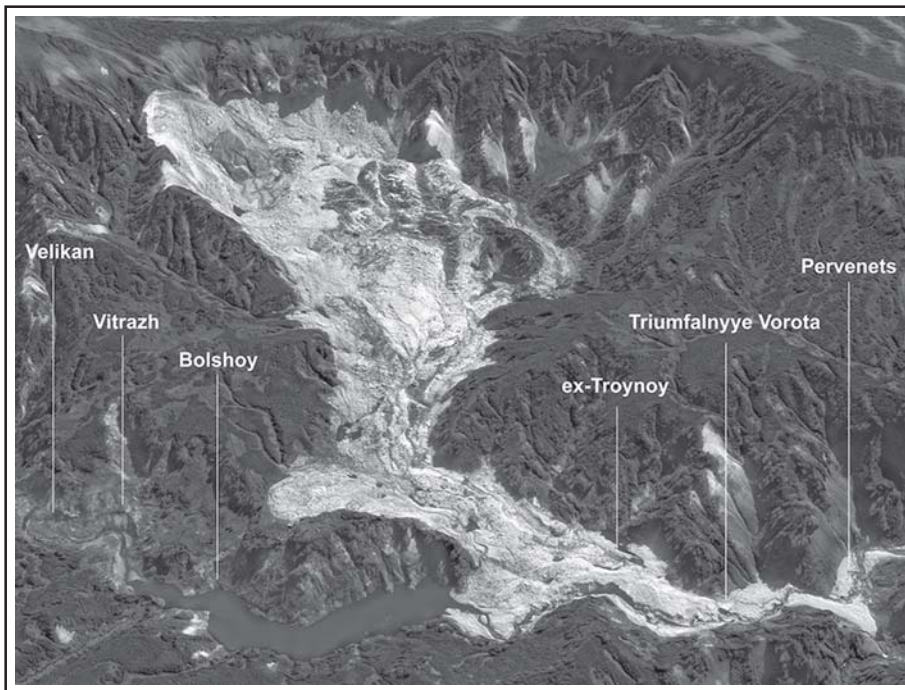
by Andrey and Vladimir Leonov; edited by Jack Hobart with additional information from the 1991 GOSA Expedition;
with recent photographs and reports courtesy of Kronotsky Reserve

by ScanEx and GeoEye Foundation

[Editors' Note: In 1991 several GOSA associates traveled to the Kamchatka Peninsula of Russia and visited the Valley of Geysers in the Kronotsky Reserve shortly after it opened to tourists in early 1991. T. Scott Bryan, Bob Colvin, Martha Fenimore, Jack Hobart, John Rinehart, and Bill Warnock toured from June 29 through July 9, 1991 and published a 50-page Special Report of *GOSA Transactions* with their observations. Vitaly A. Nikolaenko served as a guide while they explored the Valley of Geysers.

In the February 2012 Sput, Andrey Leonov introduced us to the Virtual Valley of Geysers (<http://valleyofgeysers.com>) with several photos of active features. In the February 2013 Sput, he also wrote an article presenting a Catalog of Current Geysers cross-referenced to his Catalogue of 127 geysers and features as of 2012 (<http://valleyofgeysers.com/catalogue-2012.pdf>) and to the GOSA report.

This article will present the story and photos of the 2007 Landslide with maps and a chart of Lost Geysers and Springs. Photos from the GOSA expedition will provide portraits of some of those lost features.



A 3D Model of the 2007 Landslide
(See February 2012 Sput, page 13, for details.)

In September 2013 a cyclone hit the Kamchatka Peninsula causing more changes, then a landslide in January 2014 added additional changes to the Valley of Geysers. Brief information and photos of these recent events will also be included. More information

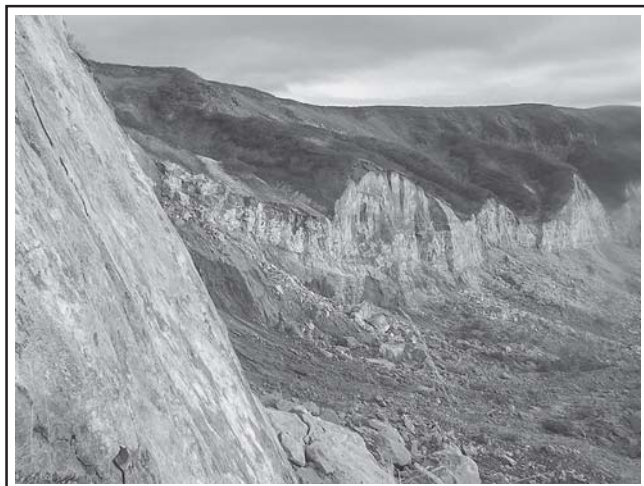
from the January 2014 landslide will be provided in a later article once a full scientific assessment is completed.]

The 2007 Landslide

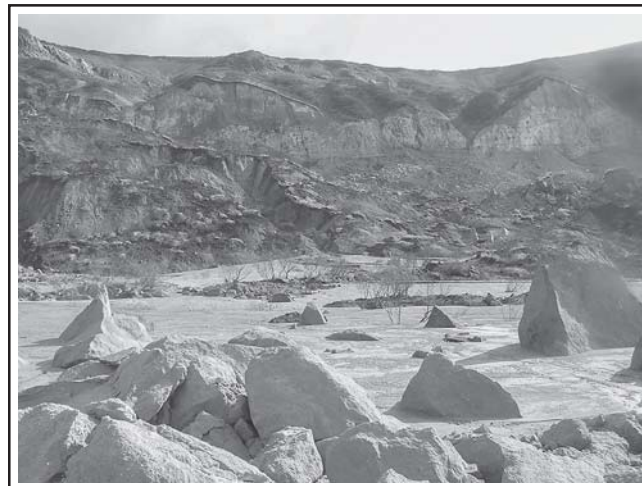
A huge landslide damaged the Valley of Geysers severely on June 3, 2007 (14:20 local time). Mass-media

by Vladimir Leonov

by Vladimir Leonov



Separation Wall of the Landslide, 2008



Separation Wall of the Landslide, 2008

by Vladimir Leonov



The Landslide-Formed Dam on the Geyzernaya River, 2008

reported contradictory news during the first few days, up to “a mudslide has destroyed the Valley of Geysers.” Fortunately the situation indeed was not so tragic as media reported. The most popular group of geysers on the Vitrazh (stained glass) Wall as well as the largest regular geyser, Velikan, were unaffected. At the same time, several beautiful geysers have been lost forever, including Troynoy, Sakharnyy, Sosed, Skalistyy, and Konus. Pervenets suffered but partially restored in 2011. Malyy was flooded, but stayed active underwater. [Editors’ Note: See pictures in the *Sput* v26n1, Feb 2012.]

The landslide formed in the upper reaches of Vodopadnyy Creek. Its direct cause is still unclear, because the Kamchatka network of seismic stations had not registered any seismic event in this region at that time. It is agreed now that the main factor of the landslide was a common geological process of gradual erosion of hillsides, probably intensified with the underground thermal water activity and local seismicity. The volume of the landslide is incredible: 21 million cubic meters. It is no doubt the largest landslide in Kamchatka on record and one of the largest in Russia. [Editors’ Note: The 7.3 Magnitude 1959 Hebgen Lake earthquake brought down an estimated 28 - 33 million cubic meters of soil and rocks.]

The fallen rock and mud went down the Vodopadnyy Creek, reached

Geyzernaya River and moved along it down to its confluence with the Shumnaya River. [See the Valley of Geysers Maps on page 7 and the Lost

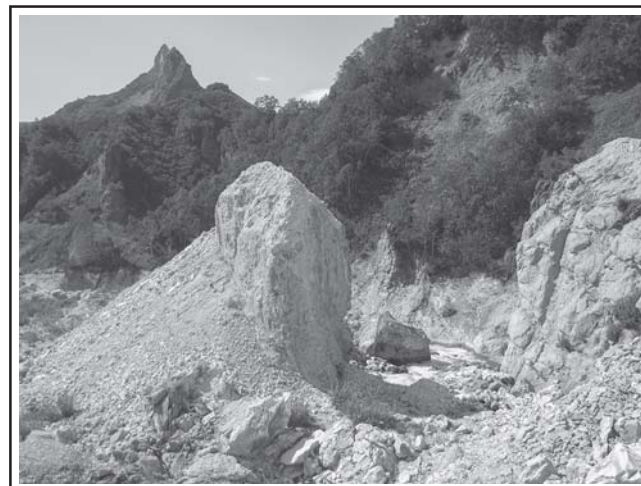
Features Map on page 8.] All geysers, springs, waterfalls and other features within Thermal Areas II and III were directly destroyed by the landslide [See Lost Geysers and Lost Springs Charts on page 9 and 10.] A dam was formed on the Geyzernaya River with a height of up to 60 meters. The length of the landslide reached approximately 2 kilometers. The Triumphalyye Vorota rock narrows in the lower course of the Geyzernaya River significantly decreased the landslide thickness, but were also partially buried. Their current height is 10-15 meters instead of 30-35 meters before the landslide. [Editors’ Note: This was called “The Gate of Triumph” in the GOSA Report.]

Pervenets Geyser, the only one located in Thermal Area I, was not buried immediately. The tip of the landslide partially obstructed its vent,

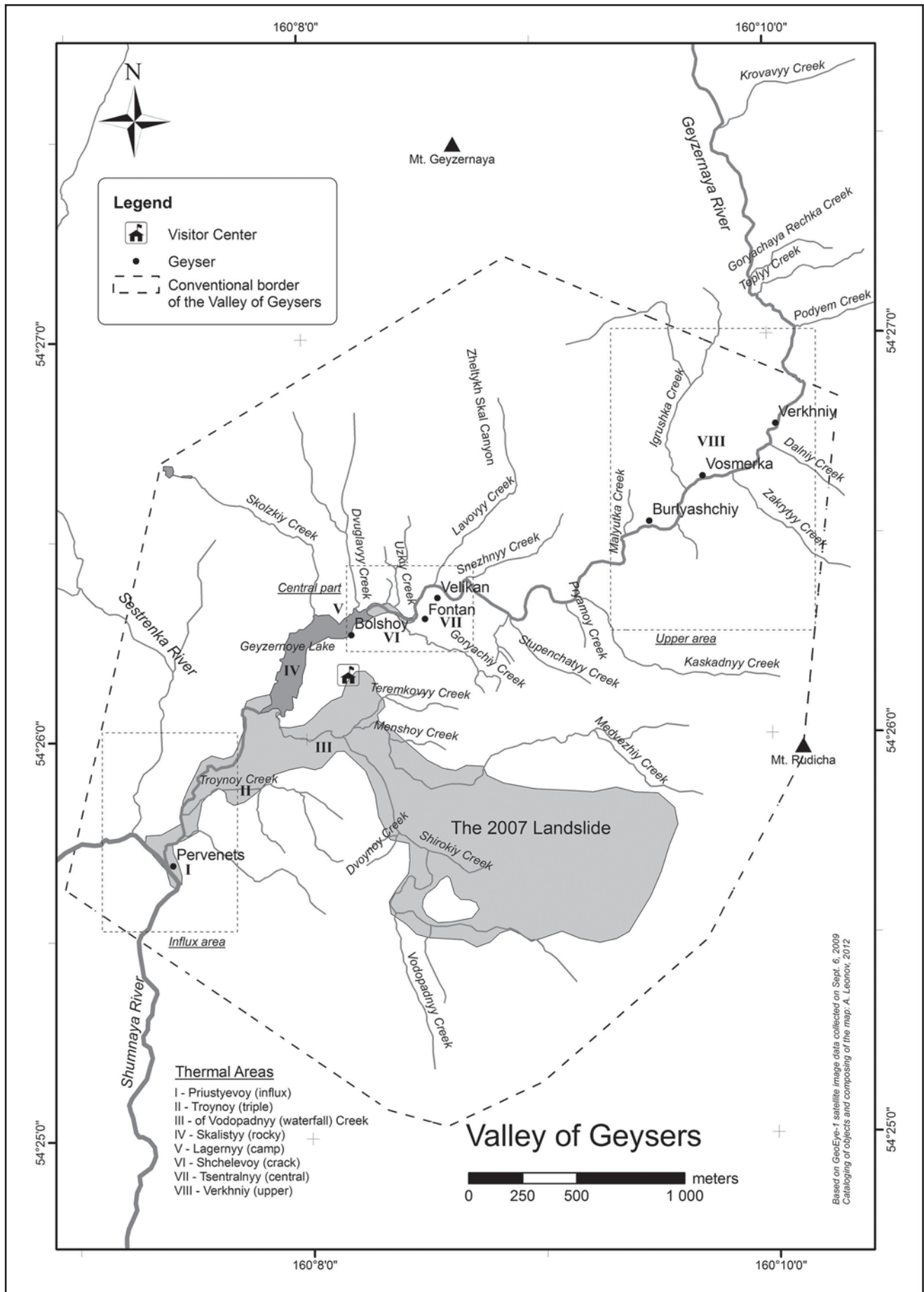
by Vladimir Leonov

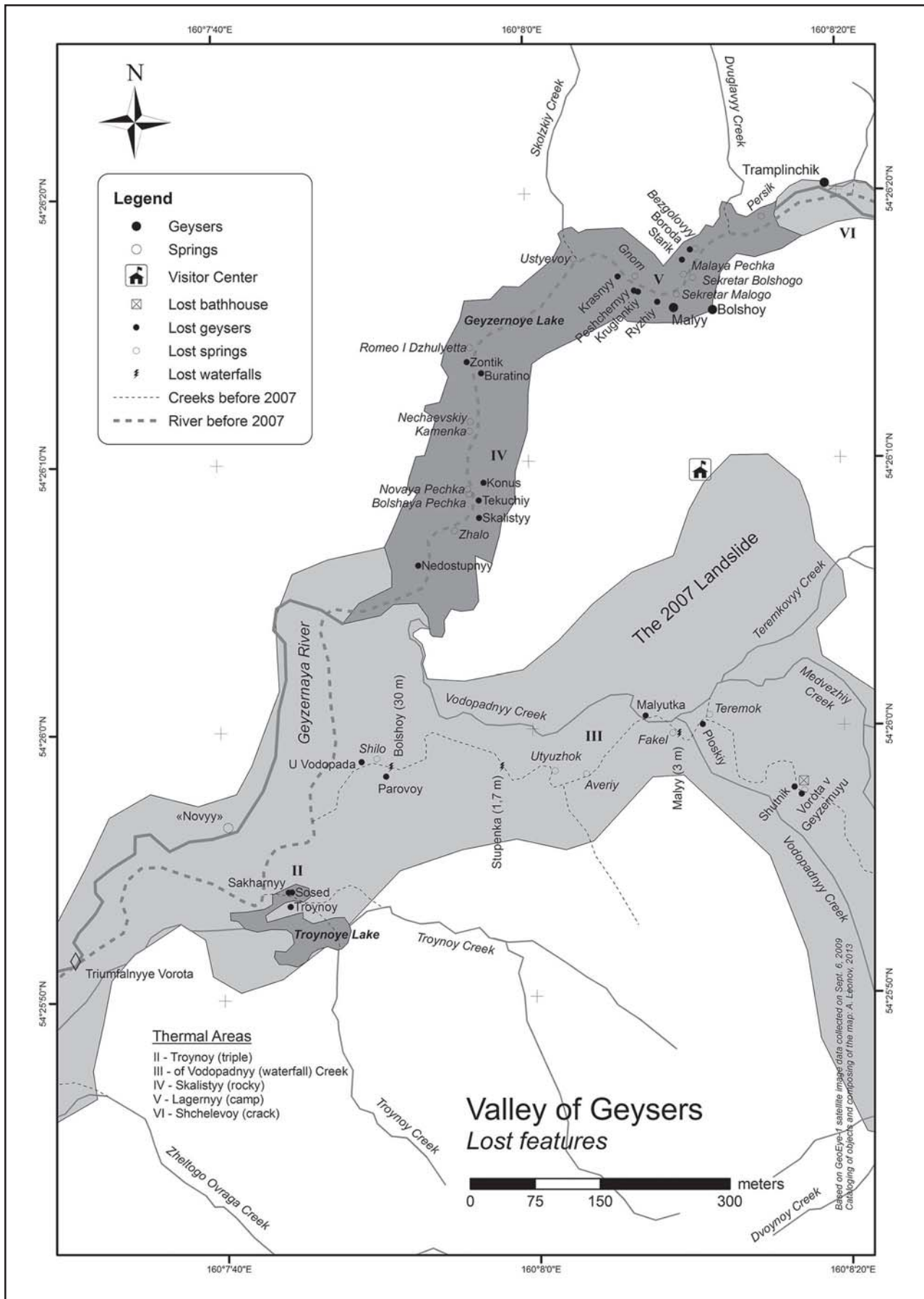


by Andrey Leonov



Two Views of Triumphalyye Vorota after the Landslide, 2008 (above) and 2011





LOST GEYSERS

No.	<u>Name on the map</u> <i>Other known names</i>	<u>The Geysers of 'The Valley of Geysers,' GOSA Transactions</u> <u>report entry</u>
II thermal area		
1	Troynoy (triple)	2-1. Troynoy
2	Sakharnyy (sugary)	2-3. Sakharnyi
3	Sosed (neighbor)	2-2. Sosed
III thermal area		
4	Parovoy (steamer)	3a-1. Parovoy
5	U Vodopada (near the waterfall) <i>Skrytnyy (hidden)</i>	3a-2. Skritnyi
6	Malyutka (baby)	—
7	Ploskiy (flat)	—
8	Shutnik (joker) <i>Bannyy (bathhouse), Kovarnyy (treacherous), Teremok</i>	3b-7. Shutnik (joker)
9	Vorota v Geyzernuyu (gate to the Geyzernaya)	3b-8. Vorota and 3b-9. Geyzernuyu
IV thermal area		
10	Nedostupnyy (unaccessible)	—
11	Skalistyy (rocky)	4-2. Skalistyi
12	Tekuchiy (fluid) <i>Lafet (gun carriage)</i>	4-3. Lafet
13	Konus (cone) <i>Konus Khrustalnyy (crystal cone)</i>	4-4. Conus Khrustalnyi
14	Buratino <i>Malenkiy Prints (little prince), Prints Buratino (prince Buratino)</i>	4-8. Malenkii Prints
15	Zontik (parasol)	4-9. Unnamed ("Zontik")
V thermal area		
16	Krasnyy (red)	probably, 5-3. Unnamed
17	Peshchernyy (cave) <i>Raskrityy Kamen (split rock)</i>	5-4. Raskrityi Kamen
18	Kruglenkiy (round) <i>Smuglyy (swarthy)</i>	5-5. Smuglyi
19	Ryzhiy (red haired)	5-6. Ritii
20	Starik (old man)	probably, 5-11. Norka
21	Boroda (beard) <i>Borodach (the bearded man)</i>	5-13. Boroda

LOST SPRINGS

<u>No.</u>	<u>Name on the map</u> <i>Other known names</i>	<u>GOSA report entry</u>
III thermal area		
22	Shilo (awl)	3a-3. Shilo
23	Utyuzhok (iron)	3b-1. Utyuzhok
24	Averiy <i>Drevniy (ancient)</i>	3b-2. Drevniy
25	Fakel (torch) <i>Vechnyy Fontan (eternal fountain)</i>	3b-3. Fakel
26	Teremok <i>Teremkovyy</i>	3b-4. Teremok
27	Vorota v Geyzernuyu (gate to the Geyzernaya)	3b-8. Vorota and 3b-9. Geyzernuyu
IV thermal area		
28	Zhalo (bee stinger)	4-1. Zhalo
29	Bolshaya Pechka (large oven)	4-5. Bolshaya Pechka
30	Novaya Pechka (new oven)	4-6. Novaya Pechka
31	Kamenka (stone oven)	4-7. Kamenka
32	Nechaevskiy	—
33	Romeo I Dzhulyetta (Romeo and Juliet)	—
V thermal area		
34	Sekretar Bolshogo (Bolshoy's secretary)	5-10. Sekretar Bolshovo
35	Sekretar Malogo (Malyy's secretary)	5-8. Sekretar
36	Ustyevoy (outfall)	4-10. Ustevoy
37	Gnom (dwarf)	—
38	Malaya Pechka (small oven)	5-12. Malaya Pechka
39	Bezgolovyy (headless) <i>Zhulyen (julienne)</i>	5-14. Bezgolovyyi
40	Persik (peach)	probably, 5-15. Seryi Tyulpan

LOST WATERFALLS

<u>No.</u>	<u>Name</u>	<u>Height</u>
41	Bolshoy (large) waterfall	30 m
42	Malyy (small) waterfall	3 m
43	Stupenka (step) waterfall	1.7 m

Thermal features from the GOSA report (II, III, IV, V thermal areas) that are not included in the tables above:

2-4, 2-5, 2-6, 3b-6, 5-1, 5-2 are small springs that have never been named (or even mentioned) by Russian authors.

“3b-5. Teremkovyyi” is a mistake. The word “Teremkovyy” in Russian map is not a name of a feature, but a part of a composite name “Teremkovyy slope of dwarf geysers.”

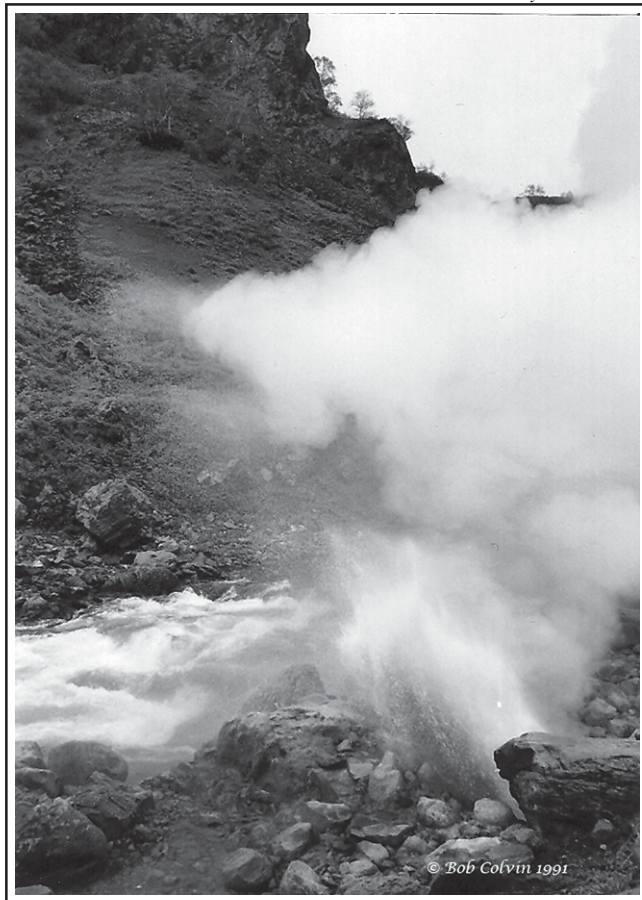
by T. Scott Bryan



by Bill Warnock



by Bob Colvin



Pervenets Geyser, Thermal Area 1, as seen by the GOSA Expedition in 1991

by Vladimir Leonov



by Andrey Leonov



Pervenets Geyser. Two photos on the lower left, show a distant and close-up view of the steaming crater formed after Pervenets was buried (2008). Photo above shows Pervenets after the river washed away the side of the steaming crater and Pervenets began to show geyser activity (2011).

however the geyser continued to function for several days, until the Geysernaya River overtopped its dam. After that, the river started to make a new course over the top of the landslide, carrying rocks and pebbles. This completely covered Pervenets, eventually piling up to a depth of 6 meters. Geothermal activity continued and soon a steaming crater formed over the vent site. In 2009 the crater was half-washed away with the river. In 2011, the geyser activity restored with the period 13 minutes, but only to a height of 1 meter.

[Editors' Note: The GOSA Report, *The Geyser of 'The Valley of Geysers,'* included the following information about Pervenets. All quotes from the GOSA Report will be in italics.]

Thermal Area I

"Group 1 is a small cluster of springs which includes just one geyser (Pervenets; First), a handful of small perpetual spouters, and some thermal seeps. It is the downstream most of all the thermal groups, at an elevation of only about 280 meters. Our only brief visit to this group was on July 02.

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 T. I. 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 1/2 minutes and 2 minutes 37 seconds) that the force declines into a concluding minor bursting and weak steam phase. The two observed intervals were about 42 minutes and 43m 50s. A third interval based on a distant steam cloud was less than 45 minutes long."

The GOSA Expedition took a number of photos of the geysers and

by T. Scott Bryan



Vitaly Nikolayenko with Martha Fenimore climbing toward Troynoy

by Bill Warnock



The Shield of Troynoy

by Bill Warnock



Vitaly Nikolayenko with Bill Warnock in front of Troynoy

springs in Thermal Areas II, including Troynoy, Sakharnyy, and Sosed.

Thermal Area 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 Valley of Geysers.

Troynoy (Triple or Trio) has been famous because of the large size of its main jet and the beauty of its three cone-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 degrees from the vertical. The most massive jet is from the northern vent; it spews huge

by T. Scott Bryan



by T. Scott Bryan



by Bill Warnock



Three Views of an Eruption of
Troynoy Geyser

by T. Scott Bryan

volumes of water outwards as far as 30 meters toward the river, but at the very low angle of 75 degrees from the vertical so that its actual height is only 2 to 4 meters. The third, southern vent is the smallest and most vertical of the three, reaching 6 to 7 meters at 20 degrees 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 Geyser. 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. Vitaly stated that it was just about 2 1/2 hours during 1990. The overflow of 1hr13m we observed probably indicates little change.

Sosed (Neighbor) erupts from a small vent partially covered by an overhanging cliff of geyserite, which is actually part of Sakharnyy Geyser's 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



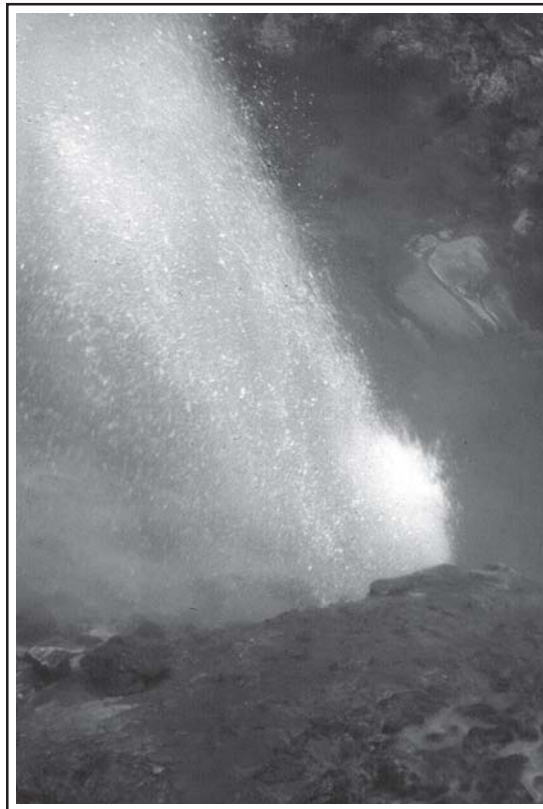
Sosed erupting with the cone of Troynoy in background

by T. Scott Bryan



Sosed erupting behind the cone of Sakharnyy

by Bill Warnock



Sosed in Full Eruption

during the last 29 minutes of Troynoy's cycle.

Sosed, when at full force, erupts at an angle of about 30 degrees 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.

Sakharnyy (Sugary) 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. Sakharnyy is an extremely vigorous geyser.

Despite its proximity to Sosed, Sakharnyy evidently is not affected by the Troynoy-Sosed cycles; per our records, it appeared to be identically active before, during, and after Troynoy. . . It indicates significant bimodality to the intervals; e.g., either 11 to 37 seconds or 2m54s and greater. There does not appear to be any correspondence between the interval and its succeeding duration 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

by Bill Warnock



Sakharnyy (and Sosed on the right behind it)

by T. Scott Bryan

Sakharnyy in eruption



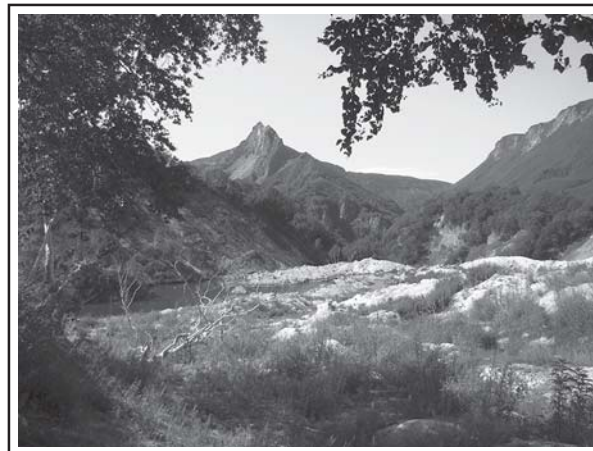
by Andrey Leonov



Views of the Troynoy area after the landslide; left and bottom left, taken in 2010; below right, taken in 2011. (The lake is formed right above the ex-Troynoy; see map on page 8.)

by Andrey Leonov

by Andrey Leonov



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 Geyser, except that it rises from a confining cone rather than an open pool."

Thermal Area III was also buried by the landslide.

"Group III extends along most of the length of Ruchy Vodopadnyy (Waterfall Creek), so named because of three waterfalls along its course. The falls are Bolshoy Vodopod (25 meters), Stupenka (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 Bolshoy Vodopod (Big Waterfall), I have arbitrarily divided the group into two parts.

Group IIIa consists of the few springs just below the Bolshoy 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 Bolshoy Vodopod, and includes the bathhouse for the Valley community.

Utyuzhok (Little Iron). Virtually a perpetual spouter, in eruption every time it was seen, Utyuzhok 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 fracture. The name is descriptive of the geyserite deposits.

Fakel (Torch). Located just downstream from Malyy Vodopod (Little Waterfall), this feature showed all the signs of being a perpetual spouter but is listed as a geyser on Vitaly's thermal map. As is common to so many of these

by T. Scott Bryan



Utyuzhok

by T. Scott Bryan

Fakel on a Foggy Day



by T. Scott Bryan



Averiy observed by Bill Warnock (left) and Jack Hobart (right)

springs, the eruption jets from the cliff and over the stream at an angle of 30 degrees from the vertical. The height is perhaps 2 meters.

Drevniy (Ancient); also known as **Averiy**). Another near perpetual spouter, I will state that Drevniy is a true geyser, albeit small and perhaps infrequent. Vitaly 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 Drevniy 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, reach-

by T. Scott Bryan



Shutnik, 1991

ing 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 (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 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 Vodopadnyy.

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 (REI Adventures' tour leader) moments after she dipped a pailful of water from the crater, an eruption began with little (no observed) warning."

Thermal Area IV

Let's return to June 3, 2007. The dam on the Geyzernaya River caused a lake to rapidly rise behind it. This lake

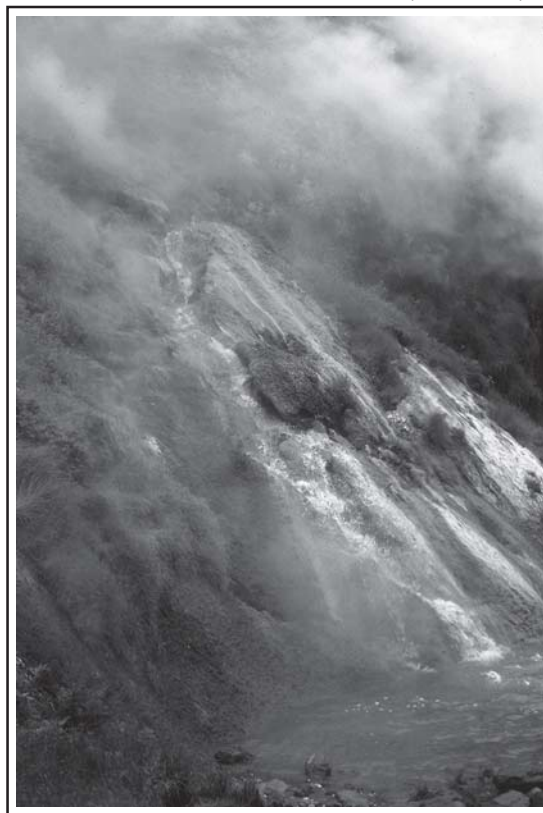
flooded all geysers within Thermal Areas IV and V, including Malyy and Bolshoy. On June 7, the water level in the lake reached its maximum elevation and the lake flooded the Shchel Geyser plus the lower portion of the Vitrazh. Fortunately the river found a way through the dam, and the water level started to decline. During the first four hours the water level decreased by 9 meters, freeing the Vitrazh and Shchel, although Bolshoy stayed 2 meters below the water level.

By September 2007 water level in the lake had decreased enough for Bolshoy's vent to reappear. Its first eruption was witnessed on September 12, 2007. Thus Bolshoy restored its activity 3 months after the landslide with the same height and period as before (see photo on page 22).

[Editors' Note: The GOSA report describes Group IV as follows:

"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,

by T. Scott Bryan



*Skalistyy,
1991*

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 Bolshoy and Malyy Geysers in addition to the hill-sides. Accordingly, we visited the area only once, and then rather briefly.

The Lost Geysers include Skalistyy, Konus, and Buratino.

“Skalistyy (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 eruption reaching heights as great as 15 meters.”

The following information is courtesy of Kronotsky Reserve:

“A powerful cyclone hit Kamchatka on September 17-19, 2013. Because of the strong rains, a mudflow was formed in the upper course of the Geyzernaya River. It went down the river and deepened the riverbed over the dam (which was formed after the 2007 landslide). As a result, the water level in the Geyzernaya Lake decreased by 5 meters.

After the water level decreased, a dozen hot springs of various sizes cropped out on the lake’s banks. One of the new geysers was photographed right across the river from the Bolshoy Geyser.” [Skalistyy remains more than 20 meters below the water level.]

***Konus Khrustalnyi (Crystal Cone).** Simply named Konus by T. I. Ustinova, the name has been appended in order to distinguish it*

by Anna Zavadskaya, Kronotsky Reserve



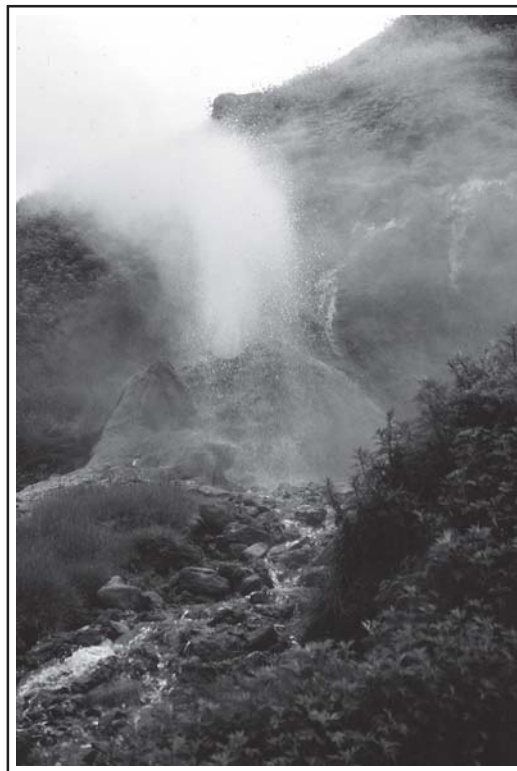
A new geyser was photographed across the lake from the Bolshoy Geyser after the water level decreased in September 2013.

Bill Warnock



Konus geyser overflow, 1991

by T. Scott Bryan



Konus geyser, in eruption, 1991

by T. Scott Bryan

from *Konus Rozovvyy*, 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.

Konus 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 2m23s and 2m19s. The eruption concludes with a short steam phase.

Buratino or *Malenkii Prints* (*Prince Buratino* or *Little Prince*). Under the name "*Prince Buratino*," this geyser was subject to the technique of "hydro-sounding" 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 9m20s with durations of 1m45s. 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 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 awhile. 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



Malenkii Prints, also known as *Buratino* geyser, 1991

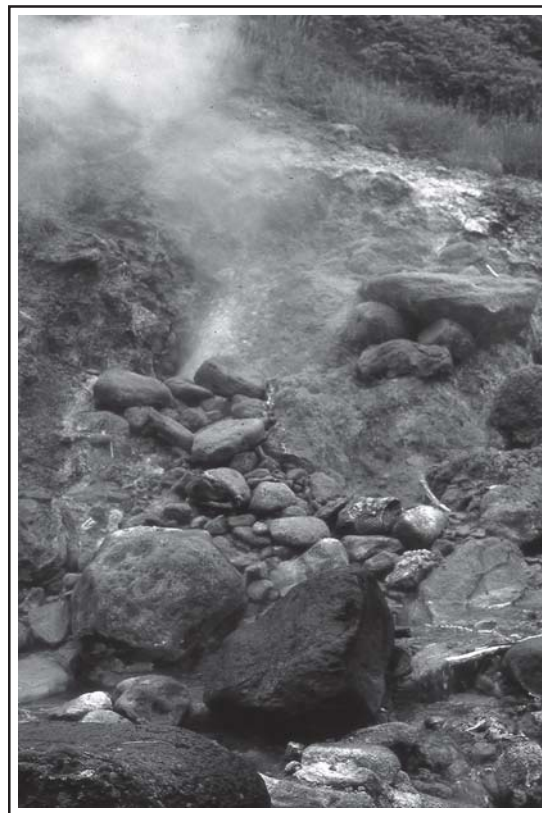
(45°) water jet. The duration was 1m5s. A second eruption began after an interval of just 7m28s (duration 1m12s), and a third was seen after another 5m52s (duration 1m6s).

Lost springs in Group IV include *Zhalo*, *Bolshaya Pechka*, and *Kamenka*.

"The name **Zhalo** was given to this impressive geyser/spouter by Vitaly 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.

by Bill Warnock



Buratino, close up view, 1991

by Bill Warnock

Bolshaya Pechka (large oven) 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.

Kamenka (stone oven) 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.

Thermal Area V

Lost Geysers and springs in Group V include geysers Peshchernyy and Kruglenkiy, and springs Sekretar Malogo and Sekretar Bolshogo, Ustyevoy, and Persik.

"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 Malyy and Bolshoy 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 litera-



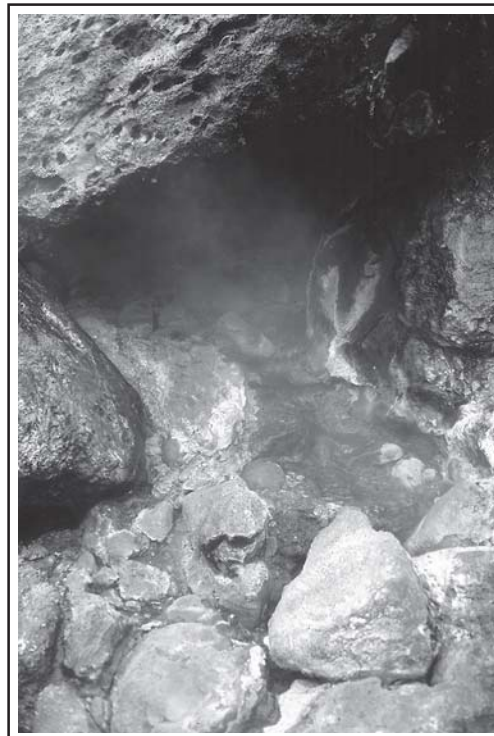
Scott Bryan near Bolshaya Pechka, (not in the frame), looking up river, 1991

by T. Scott Bryan



Kamenka spring, a video capture, 1991

by T. Scott Bryan



Raskrytyy Kamen, also known as Peshchernyy geyser, 1991

by T. Scott Bryan



Kruglenkiy, also known as Smuglyy geyser, 1991

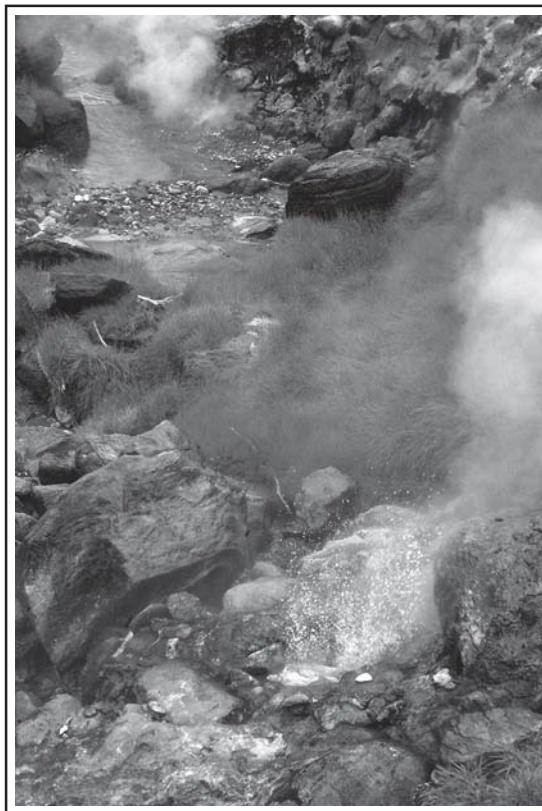
ture as the total existing within the entire Valley of Geysers!

Raskrityy Kamen, also known as **Peshchernyy** geyser 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.

Sekretar Malogo (Malyy's Secretary). Located near the northern base of Malyy's 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 Vitaly stated that quiet intervals occur on irregular intervals.

Sekretar Bolshogo (Bolshoy's Secretary). Very similar in appearance and setting to (Malyy'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

by T. Scott Bryan



Sekretar Malago, in foreground and Sekretar Bolshogo, in background; View up the river, 1991

by T. Scott Bryan



Seryi Tyulpan, also known as Persik, 1991

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.

Seryi Tyulpan (Gray Tulip), now called **Persik** (Peach). Somewhat upstream from the rest of the Group V features, Seryi Tyulpan is a near 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.

The most significant thermal features in this group are Bolshoy and Malyy. Not only were they affected by the landslide as noted by Leonov [on page 17], but more changes have continued until now.

The GOSA report describes them each as follows:

“Bolshoy was named for the contrast between the size of its crater versus that of Malyy-Bolshoy’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 Malyy is among the larger of the cone-type geysers in the Valley, Bolshoy is one of the largest of the fountain-type geysers. Bolshoy’s eruptions bear a strong resemblance to Yellowstone’s Echinus Geyser.

Bolshoy’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.



Bolshoy, erupting at the water level, and Malyy boiling underwater, 2011
by Aleksandra Filatkina, Kronotsky Reserve



Bolshoy geyser right after the cyclone on September 17-19, 2013; it is now above the water level

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. [Not reproduced] The average overflow was only 14 1/2 minutes. The average of eleven intervals was only 1h16m, with a tiny standard deviation of just 3.38 minutes. Most of Bolshoy’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 Malyy, Bolshoy is a showcase: nowhere else are there large geysers of the two classic eruption styles that are so frequent and so close together.

The years 2013 and 2014 brought more changes to this area. Following the cyclone on September 17-19, 2013, the water level in the lake decreased by 5 meters. But it was only a prelude.

A large landslide happened in the upper course of the Geyzernaya River in the beginning of 2014. An earthquake of $M = 4.2$ was registered on January 2, 2014 near east coast of Kamchatka. Probably it was a trigger of the event.

The landslide dammed the Geyzernaya River in the upper course, and formed a mudflow (mixed clay, water and snow) which went down the Geyzernaya River.

Many springs all along the river obviously suffered from the mudflow. The estimation of their actual state needs a thorough field survey by scientists, which is not done yet. We will try to do a survey of the 2014 changes in the next article.

The mudflow deepened a riverbed over the 2007 dam, and the water level in Geyzernaya Lake decreased approximately 1 meter. Moreover, it filled the lake with a large portion of alluvium. For the moment, at the area of the Malyy geyser, the lake is gone and a gravel plate is formed instead. Several craters with boiling water formed on the surface of this plate, the largest one is formed above the Malyy geyser. The eruption of Malyy geyser was photographed in January 2014 (see photo by Vladimir Yakovshuk on page 24), but during the April expedition, no eruptions were witnessed from the crater. The current status of the geyser is unknown, obviously, it is still changing.

“Malyy is among the most significant of the Valley’s geysers. Its eruption is large, frequent, and pretty. The name, by T. I. Ustinova, is in reference to the size of the crater, which is less than half as big as that of nearby Bolshoy, not

by Vladimir Leonov

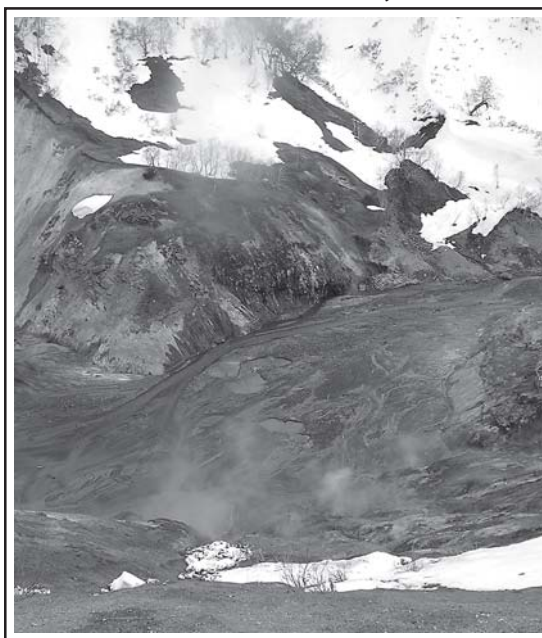


Bolshoy geyser, seen erupting after the January 2014 landslide and lake drop

by Vladimir Leonov



by Vladimir Leonov



Above and left, the area near the Malyy geyser of April 28, 2014

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 Malyy than we did, but this probably does not matter much. Malyy 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 31m30s; in 1945, 32m20s; 1951, 31m06s; 1954, 31m26s; 1960, 32m14s; 1978, ~32m; 1984, 32m34s; and 1990, ~35m (verbal, per Vitaly).

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 38m37s, standard deviation 3m06s. . . . There were, in addition, dozens of open, multiple intervals noted; although not recorded here, their analysis would produce insignificant statistical changes.

Malyy 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 roiling 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

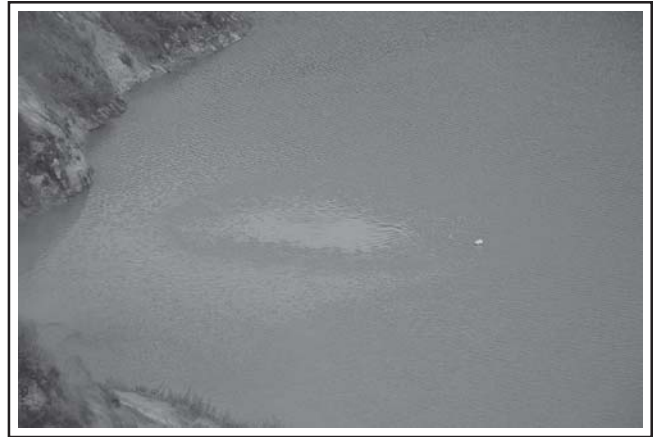
by Bob Colvin



Malyy geyser, 1991

by Aleksey Rogozin

*Malyy geyser,
erupting
underwater,
2009*



by Vladimir Yakovchuk, Kronotsky Reserve



*Malyy geyser erupts
again after 6.5 years
under the water, 2014*

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 Malyy'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. Malyy 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 Malyy 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.

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

Returning to the results of the 2007 landslide, one of the landslide's tongues came close to Visitor Center and other buildings in the Valley of Geysers. The main houses were not affected (Visitor Center, Scientific Station and Ranger Station), however some household buildings and other structures were destroyed including bath, helipad and some boardwalks. The landslide stopped only 1 meter from the wall of the Visitor Center, and several meters from a helicopter on the helipad! Pilots had to trim trees brought in by the landslide in order to free the helicopter blade!

Thankfully, it was a wonder that nobody was killed or even injured during the landslide.

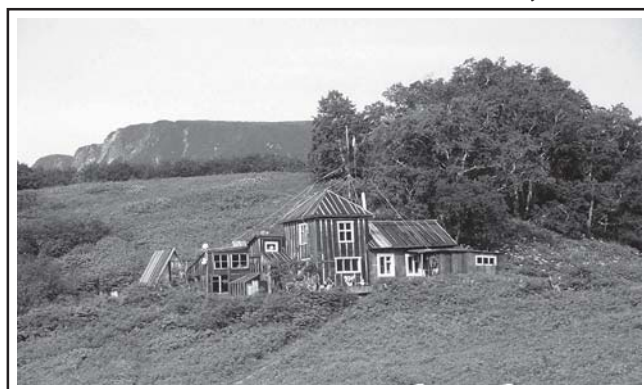
Krepost Spring, across the river from Shchel Geyser, switched to a geyser after formation of the lake and the gravel spit at its inflow. Although its eruptions had been witnessed before, e.g. during the 1991 GOSA visit, it was generally considered a spring. After the landslide, it started to erupt periodically and thus was included in the catalog as a geyser.

by Bob Colvin



Left and below,
Valley of Geysers
Lodge, 1991

by Bob Colvin

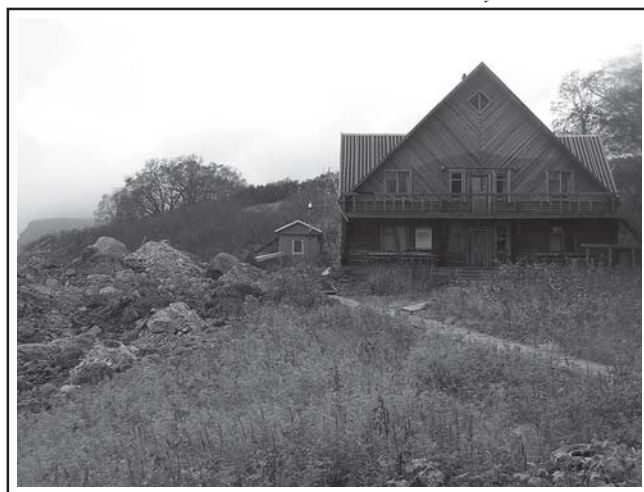


by Vladimir Leonov



Left and below,
current Visitors'
Center after the 2007
Landslide, showing
the closeness of the
landslide, 2008

by Vladimir Leonov



Geyzernaya River, Vodopadnyy Creek and others changed their courses as a result of the landslide. Several little lakes emerged in depressions on the landslide's surface, fed by creeks that were dammed by the landslide. One of the largest lakes emerged right above the buried Troynoy Geyser. The moist climate enabled rapid return of vegetation to the landslide surface.

Many new boiling springs appeared near the landslide borders and on the river banks. Unfortunately, no noticeable new geysers were still observed on the landslide. At the same time, several geysers and springs were reported on the banks of the lake, especially after the level drop after the 2013 cyclone and 2014 landslide.

The beautiful Geyzernaya Lake is gradually shrinking because of gravel spit growth. From 2007-2013, the gravel spit has reached 300 meters in

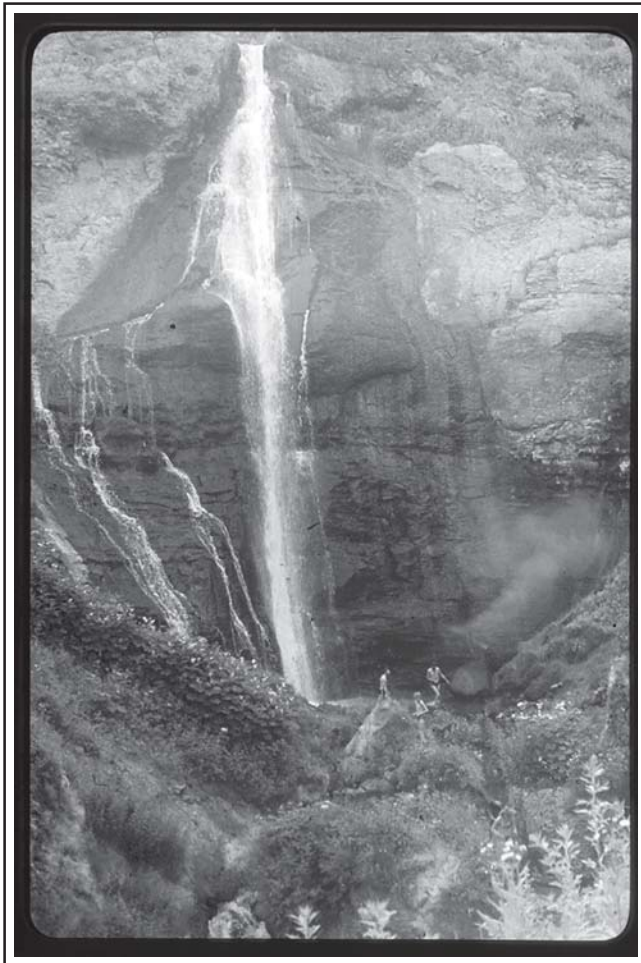
length, about 25% of the initial lake extent. After the 2013 cyclone and 2014 landslide, the lake has shrunk in length at 300 meters more. Although hard to forecast, we can estimate that the lake will probably disappear in 5 years.

The changes in the Valley are very rapid. It is a pity to see such dramatic transition in a familiar environment, but on the other hand, it is good luck for us to observe such geological changes during a human life.

Final Comment from Andrey Leonov:

"I visited the Valley first time in 1990, when father took me in geological expedition. I was 12 years old. One of the most colorful memories is bathing under 30-meter waterfall. I was sure that the stream should knock me down, but -- to my surprise -- I

by Vladimir Leonov



30 meter waterfall on Vodopadnyy creek was buried with landslide in 2007. Thickness of landslide deposits achieves maximal height here: more than 60 meters, 1990

managed to stand under it! One of the figures on the photo is me. This place is gone."

Comment from Ekaterina Nikolaenko (daughter of Vitaly). She prepared these comments especially for this article.

"They said in TV news that a landslide happened in the Valley and it's gone. First reaction is a shock, and then a deep feeling of grievous loss, like a loved one passed away and life will never be the same.

To a great regret, the mudflow destroyed one of the most picturesque parts of the Valley: Pervenets Geyser, Bolshoy waterfall and the whole Vodopadnyy creek. It was not a tourist part, and most of travelers did not visit it. But for those who lived and worked in the Valley, it was probably the most loved part.

I am especially sad about the Bathhouse that was sometime built by our father. Hot water was supplied to this Bathhouse through tubes from the nearby springs, and the cold water – from Vodopadnyy creek. The bath-tub was embedded right into the earth and in summer you could take a bath and admire the landscape simultaneously. This will never be possible again.

In my childhood, I often went to bathe in Vodopadnyy creek alone. Its riverbed abounded with beautiful natural bathtubs and stone slides that were carved by streaming water during centuries. Bathing over there was one of my favorite amusements in the Valley. And a travel to Pervenets, Sakharnyy and Troynoy together with father was every time the adventure! It always revealed for me something new in the Nature that was so loved by father.

The Valley for me is connected with childhood and father. Despite many years elapsed from 2007, this loss is still felt as acute as if the landslide happened yesterday. But it is normal for the Nature and it is the only consolation for me. I am very happy that I was so lucky to spend my childhood in this unique country. Honestly, for me it is the most beautiful and loved place on the Earth!"

(Ekaterina Nikolaenko, 2013)