of it. As Jeff Cross reminded us, because the eruptions of the larger geysers are spectacular, they are worth the wait. This fascination for geysers by tourists is evidenced by the hundreds of accounts we have of their activity. And as many have mentioned, no other place else on earth has that (at least in this magnitude), and so that fact alone makes the geyser history worth recording.

Finally, Tara Cross has put the frosting on the cake by reminding us about what makes tour guides tick, and we should remember that tour guides are an essential part of that tourism now being so studied by historians. I love her comment: "[Geysers] give me great joy. I would like others to experience that too." That is the essence of a tour guide—someone who loves showing things to people.

And I would argue that it is the essence of tourism itself.

Geyser gazers have many motivation for their hobby, but Lee points out the most important thing: we are, in fact, all tourists, temporary visitors to a unique wonderland. Why should we limit ourselves to studying geysers for some deeper analytical purpose when experiencing the geyser is the greatest reward we could ever have? As Michael Goldberg concludes, "The event we've traveled to Yellowstone to see is too small to register in any big picture view of the Park's ecosystem, hydrology, and volcanic history. Even so, it is still larger than life."

VIRTUAL VALLEY OF GEYSERS

Andrey Leonov

The Valley of Geysers is one of the largest geyser fields in the world and the only one in Eurasia. It is located on Kamchatka peninsula in the Russian Far East, in the Kronotskiy Reserve, that is a part of the UNESCO World Heritage Site "Volcanoes of Kamchatka." During the Russian national contest in 2008, it was voted as one of the seven Wonders of Russia.

The Valley of Geysers is a renowned tourist destination. But its average attendance is only about 3000 people a year because of its remote location and reserve status. This is only a tiny percentage of those who would like to visit, so virtual tourism is the only way to enable anyone to see the Valley.

The project "Virtual Valley of Geysers" (www.valleyofgeysers.com) was started in 2009, but the idea was born two years earlier. On June 3, 2007 a huge landslide dramatically changed the Valley. Half of all geysers were destroyed. Together with my father, one of specialists who know the Valley very well, we posted a bilingual article about this event in my blog (http://spanishflyer.livejournal.com/7519.html) that became very popular as did a subsequent article in 2008. Such great demand for any information about the Valley led me to an idea of creating a free, publicly-available virtual model of this unique place. This would allow everybody to virtually visit the Valley, explore the landscape and geyser locations, plus watch photos and videos.

Virtual Valley of Geysers (the full version). Hi res 3D model of the territory (DEM based on CartoSat 2.5 m + texture image GeoEye-1 0.5 m). Interactive models of steaming geysers.

Virtual Valley of Geysers (the full version). 3D model of the territory (DEM based on CartoSat 2.5 m + texture image GeoEye-1 0.5 m). Interactive models of steaming geysers. The bear is a snapshot of an animation showing him walking by.

I made my first model of the Valley in the beginning of 2009 using Google Earth. It was just a KML file showing locations and names of the main geysers and other objects. Various organizations supported the further development of my idea, including the management of the Kronotskiy Reserve, where the Valley of Geysers is located, and the Institute of Volcanology and Seismology FEB RAS, which performs the most of geological studies in the

Valley. Several my friends and colleagues joined me in creating the model. Later in 2009 we announced the "Virtual Valley of Geysers" project and launched our website.

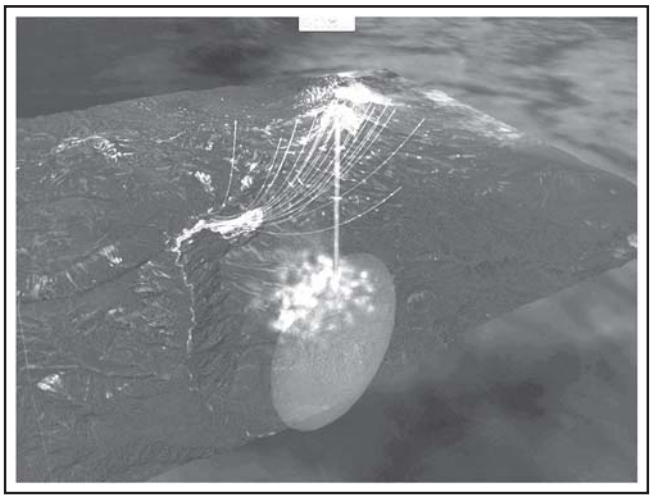
High resolution satellite imagery is a necessary component for creating a virtual model of the region. It provides a detailed and photorealistic view of the landscape, and also allows precise georeferencing of the objects. One of our sponsors R&D Center ScanEx helped us buy GeoEye-1 imagery for the Valley of Geysers region in 2009 (later, the GeoEye Foundation provided us a larger image), and also provided a high resolution DEM (digital elevation model), resulting in a precise 3D-model of the territory.

We decided to create two versions of the model: an Internet version based on Google Earth and a full version for stereoscopic "virtual reality" systems based on the precise landscape model.

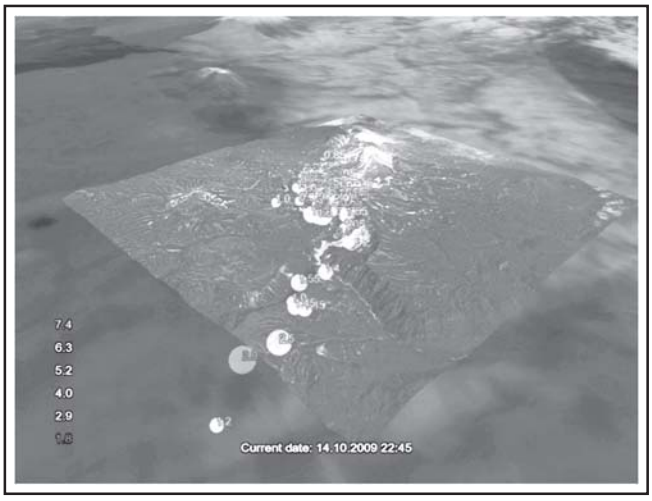
The Internet version is based on Google Earth and freely available on the project's web site. It is just a KML file that is shown on the base of Google Earth virtual globe. The full version is being demonstrated in the public museum of the Kronotskiy Reserve (in Kamchatka), and in the permanent exhibition of the Russian Academy of Sciences (in Moscow).

The 3D model of the landscape is linked with a web database containing texts, photos and videos. It is so-called "3D-document." Getting the content for the model was not the simple task. During 2009-2011, we made three expeditions to the Valley and gathered a lot of information about geysers and other objects. Also we made stereo videos of all main geysers – the first 3D video of Russian geysers.

All essential content is available in the Internet version. Its only obvious drawback is the low resolution of DEM (90 m in the Google Earth vs. 2.5 m in our precise model), however if you have never visited the Valley, you will probably not notice the difference. Also the Internet version does not include animated elements like walking bears or steaming geysers, and cannot be seen in stereo mode.



Virtual Valley of Geysers (the full version). Principal scheme of the geothermal system (data courtesy of IVaS FEB RAS, scientific consulting by Valeriy Droznin).



Virtual Valley of Geysers (the full version). Micro seismic activity in 2009 year (data courtesy of KEMSD RAS, scientific consulting by Yuliya Kugaenko).

To explore the 3D-model, visit page: http://valleyofgeysers.com/model. The menu on the left allows toggling visibility of objects and layers. Click on any object to view its short overview. Most of them include hyperlinks to full descriptions in the catalogue. To view the model in the fullscreen mode, press the "Fullscreen" button. In this mode, the menu is hidden on the left: just place the mouse pointer to the narrow gray strip on the left to open it.

To watch stereo video, visit page: http://valleyofgeysers.com/videos. 3D videos are marked with "3D." To switch on stereo, click on 3D button in the player and choose a 3D mode. Default 3D mode is anaglyph. You can watch anaglyph stereo video on any display using anaglyph (red-cyan) glasses. Some degradation of color occurs in anaglyph mode. If you have a special 3D display with shutter-glasses (NVidia 3D vision), choose HTML5 mode. To switch on 2D, click again on the same 3D button. It is a standard functionality of the YouTube player, we just use it on our web site.

Among the other achievements of the project, there is a new "Catalogue of the main objects of the Valley of Geysers." It is the most comprehensive overview of the Valley's thermal features and other tourist attractions, including 56 geysers. We will present this catalogue in detail in our next article. This catalogue is already partially available on our web site: http://valleyofgeysers.com/geysers.

The model is intended not only for virtual tourism, but also for scientific tasks. We see that the Valley of Geysers changes irreversibly due to natural processes. It is set aside as a Natural Heritage Site, and no human intervention is allowed to prevent natural disasters like landslides, or to mitigate their consequences. Now, we will be able to preserve this natural wonder and its ever-changing status for future

generations “digitally” as an evolving 3D document. For example, we are going to buy GeoEye-1 Geo Stereo image in 2012 to improve our model and explore the changes that have occurred to the landscape since 2009.

The landscape model is used also for scientific visualization tasks (in the full version). For example, microseismic activity is shown under the ground surface, allowing geophysicists to study the 3D structure of seismic events “cloud” in stereo mode. The geothermal system model is intended for basic geological education and helps to answer the question “How does a geyser or the overall geothermal system of the Valley work?”

The project is fueled by noncommercial interests. It is being developed by collaborative efforts of enthusiasts who love Kamchatka and the Valley of Geysers, plus generous contributions from the Russian Foundation for Basic Research and other organizations.

The first four photos show the 3D modeling of the Valley, plus its subsurface features and seismic activity. The remainders are photos of geyser activity and the status of the river blockage.

Many thanks to Jack Hobart who kindly edited this article.

by Andrey Leonov

Bolshoy Geyser erupting just above the current surface of the landslide-produced lake, 2011.

by Andrey Leonov

Bolshoy Geyser closeup, 2010

by Andrey Leonov

Gorizontalnyy Geyser – initial burst, 2011.

by Andrey Leonov

Gorizontalnyy Geyser erupting horizontally across the Geysernaya River, 2011.

by Andrey Leonov

Vitrazh (Stained Glass Wall) and Fontan Geyser, 2011

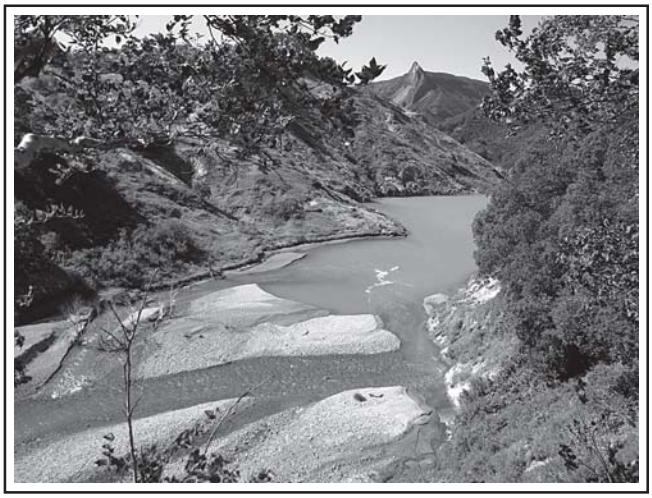
by Andrey Leonov

Vitrazh (Stained Glass Wall) and Fontan Geyser, 2011.

by Andrey Leonov

Valley of Geysers.
General view on the central part from the top of Vitrazh.
Fontan Geyser is erupting, 2011

by Andrey Leonov



Valley of Geysers.
The gravel spit is growing fast, while the landslide-dammed lake is lowering and shrinking in extent, 2011