New Site

Tolbachik eruption in 2012-2013 in Kamchatka, Russia

Sergei Grishin
Institute of Biology and Soil Science
Far East Branch of Russian Academy of Sciences
(Russia)

Fig. 1. Tolbachik volcano. Blocky lava flows introducing in the forest belt in winter.

Fig. 2. Lava flows moving into the forest igniting standing trees only in the front of the flow. (Photo: D.Melnikov)

Tolbachik (N55° 49'51", E160° 19'33") is a volcanic complex on the Kamchatka Peninsula in the far east of Russia. It consists of two volcanoes, Plosky (flat) Tolbachik (3,085 m ASL) and Ostry (sharp) Tolbachik (3,682 m ASL). In the late November 2012, a major volcanic eruption started in the northern part of Tolbachinsky Dol (the central part of the Kamchatka Peninsula) (Fig. 1). Tolbachinsky Dol is in Holocene lava plateau, having an area of approximately 900 km^2 (Fedotov S.A. 1984). As the result of eruption, the vast area of Tolbachinsky Dol has been covered by extensive lava flows over tens of square kilometers. The unpredictable event gives us important information for the study of succession and dynamics of plant cover and wildlife following the eruption. To examine the successional process, a group of seven researchers with different specialties was formed within Institute of Biology and Soil Science (IBSS FEB RAS, Vladivostok, Russia). We aim to conduct an integrated research to understand more detailed process in terrestrial ecosystems following volcanic events. We have started the research: 1) to detect the extent of ecosystem change from ground-based observations and satellite data, including identification of the areas of different vegetation types (forests, elfin, grasslands, mountain tundra, and others) buried by lava flows and of distribution of deposits of volcanic ash, 2) to identify the impact of the eruption on the terrestrial ecosystem including the soil, the higher and lower plants, fungi, and animals, as well as the transformation of biogeochemical cycles of elements within the ecosystem, and 3) to bookmark the sites recorded by GPS for a long-term monitoring of ecosystems following the eruption. To achieve the objectives, the volcanic impacts have been examined at five thematic clusters, as follows: 1) vegetation, 2) soil-pyroclastic cover, 3) biogeochemical aspects in the formation of the territory, 4) living components of soil (especially in algae, fungi, and nematodes), and 5) wildlife (especially in small mammals). Before the eruptive event of 2012-2013, eruptions occurred in 1941 and in 1975-1976 in the twentieth century. Since 1976, researchers of IBSS FEB RAS have studied the vegetation and soil cover area, and the impact on them of the eruption (Grishin 1992 and 1994, Grishin & Shlyakhov 2009, Grishin *et al.* 2013). Because flora, vegetation, and soils have already examined before the eruption in 2012-2013, we have some information in the previous conditions in forest ecosystems.

The latest eruption began suddenly on November 27

New Site

Fig. 3. The side of cooled lava flow, covered with detritus. Trees without contact with lava were not injured. (August, 2014)

in 2012, without almost seismic activity. Moderate ash fall was observed only at the beginning of the eruption. According to satellite imagery, fine ash was deposited toward a northwesterly direction with a distance of about 85 km and a width of 10-12 km. The thickness of ash deposits did not exceed a few millimeters. Based on the weak toning of snow covered by dark tephra, during the winter and spring in 2012-2013, the ash fall was rare and small and an impact was detected on only the sparse vegetation in the mountainous area.

Lava flow from the two centers of eruption located at approximately 1,800 and 1,500 m ASL, rushed to the south and then turned to west in the early days. The lava flow from the northern center moved on only the first day (on December 1) of the eruption, reaching an altitude of about 700 m ASL and passing about 10 km. The lava flow from the southern center effused particularly and intensively during the first 2-3 weeks. They passed more than 15 km through the alpine zone of volcanic desert, semi-desert, and subalpine zone. Furthermore, the lava flow intruded deeply in the forest area, passing in it 8 km and reaching an altitude of about 300 m. Due to frosty winter and snow cover, forest fires did not arise, but trees caught on fire when they contacted to red-hot lava (Figs 2, 3). The width of lava flow was 1,500 m in average. In the mountainous part of the Dole (1,100-1,600 m ASL), an extensive lava field was formed over 5 km in length and 2.5-3 km in width. The field was completely filled by new lava, and a few old cinder cones remained standing. During the eruption new lava layer overlapped, consequently the thickness of lava layer reached several tens of meters.

Following the cessation of the first stage of eruption (the end of 2012), the activity was still observed only in the north-eastern sector of the Dole. At the second stage of the eruption (first half of 2013), a vast lava flow was formed, reaching up to 4 km in length and up to 3 km in width. In August 2013, the lava flowed to channels and tunnels, located under the cover of hardened lava, and passed several kilometers down from the crater in the active zone. The lava squeezed on the surface looks like red plastic "pillows". Its temperature measured with a pyrometer at a peripheral point of the lava was 650-700 ° C (Fig. 4). Squeezed out lava flowed slowly (approximately 1 m / h) with burning and burying the vegetation (Fig. 5). Based on satellite images, the area overlapped by the lava flows reached approximately 35 km^2 in June 2013. The study sites where vegetation succession was examined in 1995 and 2006 (Grishin *et al.* 2013) were covered by lava.

By surveying of the area in eruption and its impact with satellite images, we identified land area covered by lava flow of 2012-2013 into six major categories in lands: 1) volcanic badlands in the alpine and subalpine zones (800-1,800 m ASL) covered with very sparse grasses and vegetation with moss and lichen, 2) old-lava flow land with approximately 1,000 years old, with a partially formed grass-shrub vegetation at altitudes of less than 1,400 m; they have areas with relatively narrow (300-500 m in width), but long (up to 12-15 km) bands, 3) cinder deserts near the eruption area, consisted of two major fields with outcrop of lava and petrophytic plants, 4) areas of

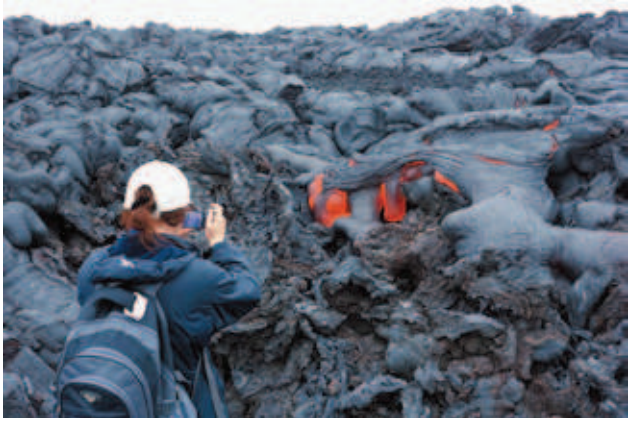

Fig. 4. Temperature at a point in red hot lava measured with an emission pyrometer was 650-700 °C.

New Site

Fig. 5. Squeezed lava slowly (about 1 m / h) advancing to the adjacent territory while burning and burying the vegetation.

subalpine elfin wood trees and meadows, growing alder (*Alnus fruticosa*) and Japanese stone pine (*Pinus pumila*), interspersed with grassy meadows and scoria wastelands; the vegetation of the areas was impacted by heavy ash fall of 1975, 5) forest fragments of birch *Betula ermanii* (in the range of 600-900 m ASL); the upper parts of the forests are limited by sparse forest stands, and 6) larch forests growing *Larix cajanderi* (less than 600 m ASL) and sparse larch forests (in the range of 600-900 m ASL). Almost all area covered by new lava flows had volcanic landscape with poor vegetation (No. 1-3 in the above land category). Their total area exceeds 20 km^2. Forest vegetation, the most productive component of vegetation of Tolbachinsky Dol, was destroyed in the ares about 8 km^2. Importantly, that duration of succession on lava of the Dol is very long: the mature forests growing on old lava in this area have developed during the periods about 2,000 years (Grishin 1992 and 1994). The area covered by lava flows of 2012-2013 is close to the area covered by lava of southern vent of Great Tolbachik fissure eruption of 1975-1976 (36 km^2) (Fedotov & Markhinin 1984). These areas are major centers of the largest lava effusion in the recent history (from the end of the XVII century) of the Russian Far East. Lava flows of other major eruptions were significantly smaller in size.

Relief at the northern part of the Dol dramatically changed; the vegetation was destroyed by lava flow over a large area. Surprisingly, despite the very large lava flows, the effect of this eruption on the environment was very small outside the lava cover. In trees growing at a meter from the side of the lava flow, we could not find any oppression caused by the lava flow. Furthermore, we did not see there not only damaged vegetation, but also mass death of animals. According to our short-term observations, small animals, such as red and reddish-gray vole, stoat and hare, have developed new habitats on the sides of cooled new lava flow (where it is still hot and saturated by gases in the depths) and the safety surrounding areas. Moderate ash falls gave vegetation some impact locally in the mountain (above 1,600 m ASL), mainly to the east of the active crater. There was redeposition of fresh tephra caused by blowing out and flushing. As a result the tephra was accumulated in some depressions over the area. Vegetation was buried in such sites, their size generally less than 100-200 m in diameter. However, in vegetation in the adjacent areas, only minor damage was found. Certain change in forest ecosystems may occur at several years after the eruption, according to observation after 1975-1976 eruption.

We sampled in the eruption's area more than 100 kg of volcanic deposits, soil and plants, to analyze the elements et al. at the laboratories of IBSS FEB

Fig. 6. A heavy scoria field formed locally near the active crater.

Fig. 7. Dr. Takashi Nakano on cooled surface of lava. (August, 2014)

New Site

Fig. 8. A field base camp on the edge of the scoria desert near the cooled side of lava flow.

RAS and the other institutes (Fig. 6). To examine the change of vegetation and ecosystem following volcanic activity, beside the field work on Tolbachik, our expeditionary team continues yearly field research at Kamchatka's active volcanoes, Sheveluch and Kluchevskoy. In 2014 we went there again. That was a small team, but a Japanese co-researcher, Dr. Takashi Nakano, also joined us (Fig. 7). He has studied vegetation change at Mt. Fuji, a famous volcano in Japan (see his report in DIWPA Newsletter No.24 in 2011).

We have studied change of vegetation on lava flow. However, there is few study in Tolbachinsky Dol area. The eruption destroyed not only vegetation, but also infrastructure. The lava covered two of three base camps that are capable to use for a year. Furthermore, the road between the eruption area and Kozyrevsk village was also destroyed. Only source for drinking water was also filled with lava. However, since the beginning of the eruption at Tolbachik, many visitors including tourists, photographers and researchers, have visited to look at the erupting volcano. They come not only from Kamchatka, but also from many other regions of Russia and other countries. Because this is a rare chance for observation of recent impacts of active volcano, the number of visitors will increase yearly. The vast landscape caused by the following eruption and lava flow and the subsequent change of vegetation and ecosystems are very interesting aspects for scientific research, as well as for many people with great interest for eco-tourism (Figs 8, 9).

Fig. 9. Evening bonfire at a field camp with the eruption in the background.

References

Fedotov S.A., Markhinin Ye. K. (Eds.) (1984) The Great Tolbachik Fissure Eruption; geological and geophysical data 1975-1976, Cambridge Univ. Press, Cambridge, United Kingdom, 353 p.

Grishin S.Yu. (1992) Successions of subalpine vegetation on lava flows of Talbachinsky Dol (Kamchatka). Botanicheskiy Zhurnal, No. 1. : 92-100 (in Russian).

Grishin S.Yu. (1994) Role of *Pinus pumila* in primary succession on the lava flows of volcanoes of Kamchatka. Proceedings-international Workshop on Subalpine Stone Pines and Their Environment. Forest Service, U.S. Dept. of Agriculture. p. 240-244.

Grishin S.Yu., Shlyakhov S.A. (2009). Vegetation and soils of the Tolbachik area (Kamchatka). Vestnik KRAUNC, Earth Science Series, 2 (14): 130-142 (in Russian). http://www.kscnet.ru/kraesc/2009/2009_14/art13.pdf

Grishin S.Yu., Krestov P.V., Verkholat V.P. et al. (2013). Dynamics of vegetation of Tolbachinsky Dol (Kamchatka) in the last decades. Komarov Memorial Lectures, LXI. Vladivostok. p. 119-158 (in Russian).

DIWPA OFFICE

For a free subscription to this newsletter, or address change, please e-mail to the DIWPA OFFICE

diwpa@ecology.kyoto-u.ac.jp

We are ready to deliver an electronic copy to you. Thank you for your cooperation in promoting paperless.

Also, we always welcome your articles, news or any information related to biodiversity for DIWPA News Letter. Please send them to us.

Center for Ecological Research
Kyoto University

509-3, 2-chome, Hirano,
Otsu 520-2113, JAPAN
Tel & Fax: +81-77-549-8238
E-mail: diwpa@ecology.kyoto-u.ac.jp
http://diwpa.ecology.kyoto-u.ac.jp/