Geophysical Research Abstracts
Vol. 16, EGU2014-4548-1, 2014
EGU General Assembly 2014

Pre-eruption deformation and seismic anomalies in 2012 in Tolbachik volcanic zone, Kamchatka

Yulia Kugaenko, Vadim Saltykov, and Nikolay Titkov

Geophysical Survey of Russian Academy of Sciences, Kamchatka Branch, Petropavlovsk-Kamchatsky, Russian Federation (ku@emsd.ru)

Tolbachik volcanic zone (active volcano Plosky Tolbachik, dormant volcano Ostry Tolbachik and Tolbachik zone of cinder cones) is situated in the south part of Klyuchevskaya group of volcanoes in Kamchatka. All historical fissure eruptions of Tolbachik volcanic zone (1740, 1941, 1975-76 and 2012-13) were connected with one or another activity of Plosky Tolbachik volcano. In 1941 the fissure vent was occurred during the completion of 1939-41 terminal eruption of Plosky Tolbachik. In 1975 the Large Tolbachik Fissure Eruption (LTFE) was forestalled by Plosky Tolbachik terminal activity of the Hawaiian type and then was accompanied by the catastrophic collapse in the crater of Plosky Tolbachik.

What events took place in the vicinity of Plosky Tolbachik in 2012 before the 2012-13 fissure eruption?

In contrast of the 1975-76 LTFE the eruption 2012-13 was not preceded by intensive seismic preparation. Nowadays Klyuchevskaya group of volcanoes is under monitoring by 12 seismic stations, so we can investigate seismicity in details on the lower energy level then forty years ago.

We analyzed seismicity of Plosky Tolbachik using regional catalogue 1999-2012. Anomalies of low-energy ($M \geq 1.5$) seismicity parameters (increase of seismicity rate and seismic energy) were discovered. This is evidence of seismic activization covered the whole Plosky Tolbachik volcano. The significance of this anomaly was estimated by distribution function of emitted seismic energy. Statistically significant transition of seismicity from background level to high and extremely high levels was revealed. It corresponds to multiple growth of earthquake number and seismic energy in 2012, July-November (five months before the eruption). The seismicity transition from background level to high level was happen in August 2012. During last three weeks before fissure eruption seismicity of analyzed seismoactive volume was on extremely high level. Earthquakes from fissure site directly appeared only on November 27 during first hours of eruption.

For investigation of pre-eruption crust deformations we used data of 8 permanent GPS stations located within Klyuchevskaya group of volcanoes. GPS points were at the distances from 20 to 60 km from eruption site and Plosky Tolbachik. The permanent GPS network registered horizontal compression of adjacent area had begun half a year before the fissure eruption. The compressive strain reached about 10^-7 immediately prior to one. The principal axis of the compressive strain was approximately directed to Tolbachik volcanic zone. It is a good indicator of the slow inflation of the magma reservoir in the area of Plosky Tolbachik. Then during first months of eruptive activity a lowering and a tension of surrounding areas were observed and the stretching strain reached 1.5×10^{-6}. The principal axis of the stretching strain after the eruption start was oriented exactly to the eruption site as the evidence of magma chamber deflation.

So unrest of Tolbachik volcanic zone and the 2012-13 Tolbachik fissure eruption were preceded by simultaneous anomalies in seismic and GPS data with the duration about 5-6 months. GPS measurements, as well as seismic survey, confirmed the hidden magma inflowing into the reservoir under Plosky Tolbachik volcano in July-November 2012 without any magmatic activity in the crater.

As a result of that, the preparation of the 2012-13 Tolbachik fissure eruption and process of magma intrusion were relatively long, the magma source was located under Plosky Tolbachik volcano and then it migrated laterally very quickly (during several hours) to the south slop of the Plosky Tolbachik volcano, where lava started to flow from the emerged surface fissure.