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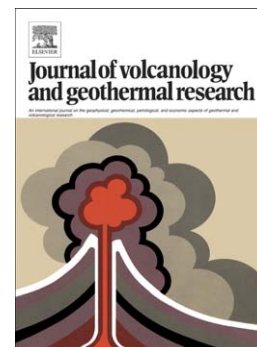
Seismic monitoring of the Plosky Tolbachik eruption in 2012–2013 (Kamchatka Peninsula Russia)

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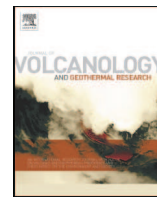
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ABSTRACT

The active basaltic volcano Plosky Tolbachik (Pl. Tolbachik) is located in the southern part of the Klyuchevskoy volcano group on the Kamchatka Peninsula. The previous 1975–1976 Great Tolbachik Fissure Eruption (1975–1976 GTFE) occurred in the southern sector of Pl. Tolbachik. It was preceded by powerful earthquakes with local magnitudes between 2.5 and 4.9 and it was successfully predicted with a short-term forecast. The Kamchatka Branch of Geophysical Survey (KBGS) of the Russian Academy of Science (RAS) began to publish the results of daily seismic monitoring of active Kamchatka volcanoes on the Internet in 2000. Unlike the 1975–1976 GTFE precursor, (1) seismicity before the 2012–2013 Tolbachik Fissure Eruption (2012–2013 TFE) was relatively weak and earthquake magnitudes did not exceed 2.5. (2) Precursory earthquake hypocenters at 0–5 km depth were concentrated mainly under the southeastern part of the volcano. (3) The frequency of events gradually increased in September 2012, and rose sharply on the eve of the eruption. (4) According to seismic data, the explosive–effusive 2012–2013 TFE began at ~05 h 15 min UTC on November 27, 2012; the outbreak occurred between the summit of the Pl. Tolbachik and the Northern Breakthrough of the 1975–1976 GTFE. (5) Because of bad weather, early interpretations of the onset time and the character of the eruption were made using seismological data only and were confirmed later by other monitoring methods. The eruption finished in early September 2013. This article presents the data obtained through real-time seismic monitoring and the results of retrospective analysis, with additional comments on the future monitoring of volcanic activity.

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1. Introduction

The Klyuchevskoy volcano group (KVG) is located near the junction of the Kuril-Kamchatka and Aleutian arcs and is characterized by the highest rate of erupted material among volcanic centers in this subduction zone (Piip, 1956) (Fig. 1). The KVG includes 14 active and extinct volcanoes; Klyuchevskoy, Bezymianny and Pl. Tolbachik have been the most active in recent years (Figs. 1, 2). The large basaltic stratovolcano Pl. Tolbachik (55°49.5' N, 160°23.5' E, summit elevation 3080 m) forms a single mountain range with the neighboring extinct Ostry Tolbachik (Os. Tolbachik, 55°50.0' N, 160°19.5' E, summit 3682 m) and is situated in the southern part of the KVG (Dvigalo et al., 1991; Fedotov et al., 2011; Ermakov et al., 2014). Pl. Tolbachik has several features that distinguish it from other volcanoes in the Kuril-Kamchatka arc: a flat summit formed by a Hawaiian-type caldera 3 km in diameter, a smaller inner crater 1.7 km in diameter and 600 m deep located in the southern part of the volcano, two radial linear zones of cinder cones with a total length of 70 km (similar to Hawaiian volcanic rifts)

(Fig. 1), Pahoehoe lavas of the Hawaiian type, and the formation of lava tubes in the Tolbachik zone of cinder cones.

Fedotov et al. (2011) calculated the location and the size of the magma chamber using data on the evolution of the volcanic cone and its history of eruptions, magma discharge, deformation and earthquakes. The top of this chamber lies 2 km deep under the Pl. Tolbachik summit caldera, and its horizontal dimension is less than 6 km. The last three major Tolbachik eruptions occurred in 1941, 1975–1976, and 2012–2013, and occurred along the SSW “rift” zone. The total volume of ejected lava and tephra during these three eruptions was approximately 2.0 km³ dense rock equivalent (DRE), a volume recalculated to a density of 2.8 g/cm³ for non-vesiculated magma taken from the average densities of slightly vesicular lavas of 2.5 g/cm³ and pyroclast densities of 1.1 g/cm³, which corresponds to an average rate of lava production of 0.86 m³/s for the last 72 years (Polyak and Melekestsev, 1981; Zelenski et al., 2014). According to this production, Pl. Tolbachik is one of the most powerful and productive volcanoes in the Kuril-Kamchatka arc.

Based on seismicity, the explosive–effusive 2012–2013 Tolbachik Fissure Eruption began at ~05 h 15 min UTC on November 27, 2012, between the top of Pl. Tolbachik and the Northern Breakthrough of the 1975–1976 Great Tolbachik Fissure Eruption (Senyukov et al., 2013b). The eruption produced three large lava fields extending up to 17.8 km

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