Microseismic profile across Tolbachik Dol (Kamchatka)

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Deep section up to 20 km, which reflects the distribution of relative velocities of transversal seismic waves, was constructed for the profile across Tolbachik Dol using the method of low-frequency microseismic sounding (fig.1). Tolbachik Dol is the southern regional zone of cinder cones of Plosky Tolbachik volcano in the southwestern sector of the Kluchevskaya group of volcanoes (Kamchatka). Last eruption within Tolbachik Dol is the Great Tolbachik fissure eruption 1975-76, included Northern and Southern vents [4]. Microseismic profile with the length 14 km crossed Tolbachik Dol through cinder cones of Northern vent.

In order to reconstruct the deep structure, we have chosen the method of microseismic sounding [1, 2], in which surface Rayleigh waves of different frequencies play the role of sounding signals. The waves determine the main contribution to the vertical component of the Earth's microseismic field. The geological structures presenting the velocity inhomogeneities interact with the incident Rayleigh waves (refraction, exchange, scattering) and distort the amplitude spectrum of the microseismic field in their vicinity. Spectral amplitudes of specific frequency f decrease at the Earth's surface over high velocity anomalies and increase over low velocity anomalies. It was found experimentally and in the model calculations that frequency f is related to the depth of inhomogeneity H and velocity of the fundamental mode of the Rayleigh wave $V_R(f)$ according to expression $H = 0.4V_R(f)/f$. This method was successfully tested in volcanic area [3] and some other geological objects of various scales and genesis. Wide-band digital velocimeters Guralp CMG-6TD (frequency range 0.03–50 Hz) were used for recording. We note that the selection of this method was to a great extent determined by the fact of its realization in difficult landscape conditions of the studied territory taking into account the difficulties in access to it.

Detected heterogeneities of the deep structure were interpreted by using of the results of the Great Tolbachik fissure eruption study. Some new features of the deep structure of magma conduits were found.

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References

1. Gorbatikov A. V , M. Yu. Stepanova, and G. E. Korablev (2008) Microseismic Field Affected by Local Geological Heterogeneities and Microseismic Sounding of the Medium, *Izvestiya, Physics of the Solid Earth*, Vol. 44, No. 7, pp. 577–592.

2. Gorbatikov A. V., Tsukanov A. A. (2011) Simulation of the Rayleigh Waves in the Proximity of the Scattering Velocity Heterogeneities. Exploring the Capabilities of the Microseismic Sounding Method. *Izvestiya, Physics of the Solid Earth*, Vol. 47, No. 4, pp. 354–368.

3. Gorbatikov, A.V., Kalinina, A.V., Volkov, V.A., Arnoso J., Vieira R., Velez E. (2004) Results of Analysis of Data of Microseismic Survey at Lanzarote Island, Canary, Spain // *Pure appl. Geophys*. V. 161. P. 1561–1578.

4. The 1976-1976 Large Tolbachik Fissure Eruption in Kamchatka. Moscow: Nauka, 1984. 638 p.

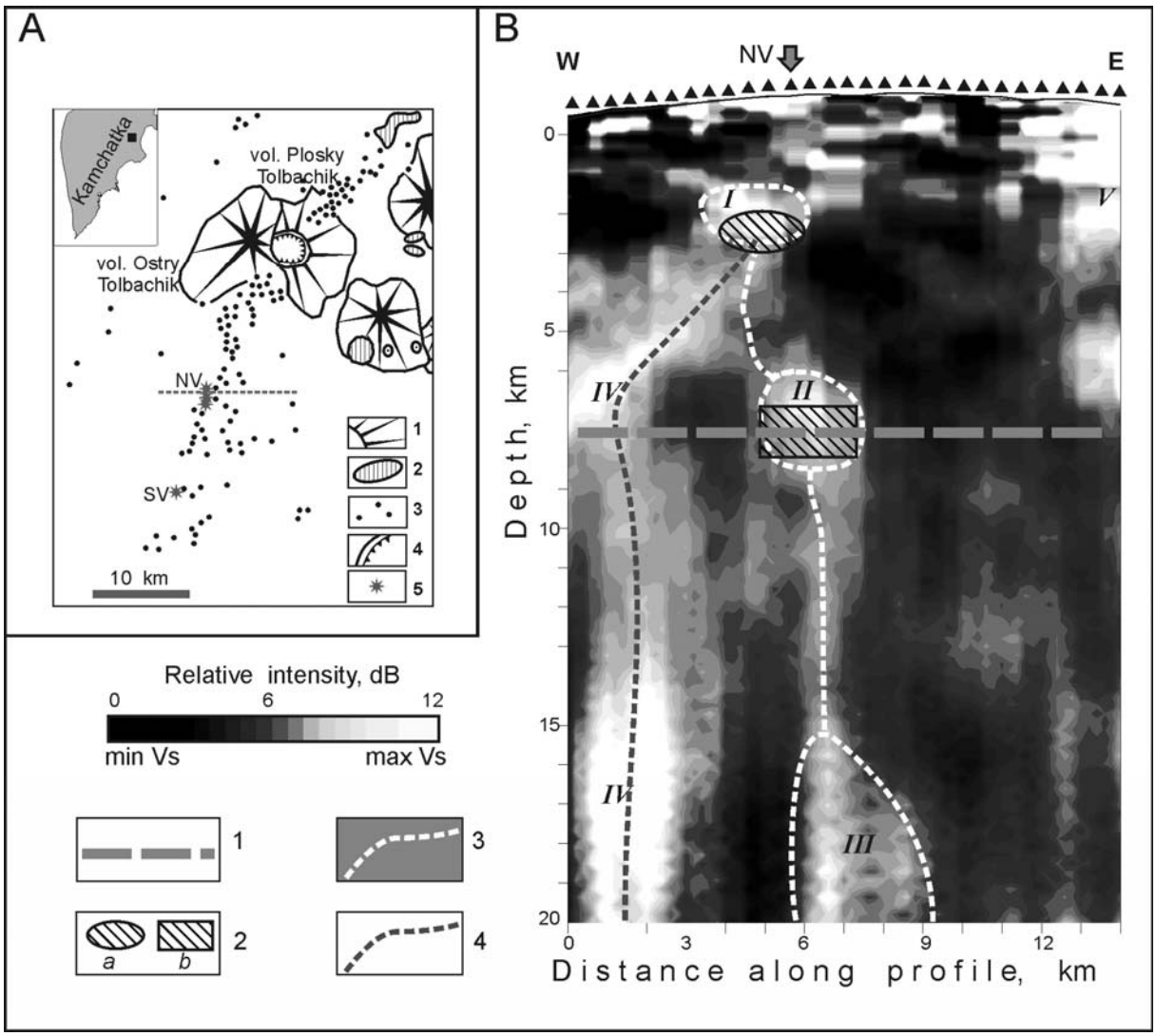

Fig.1. Investigated area and results of microseismic sounding.
A - Southwestern sector of the Kluchevskaya group of volcanoes. The dashed line - microseismic profile. 1 – cones of stratovolcanoes; 2 – exstrusions; 3 – Holocene cinder cones; 4 – calderas; 5 – New Tolbachik volcanoes of 1975-76 Great Tolbachik fissure eruption (NV - Northern vent, SV - Southern vent).
B - Deep section along microseismic profile, presented in the parameters of relative velocities of transversal seismic waves. ***I – V*** – low-velocity areas, detected by the method of microseismic sounding. 1 – the boundary of the crystal basement ; 2 – magma chambers under Northern vent on the depth 2-3 km (a) and 7-8 km (b) according to [4]; 3 – the main magma conduit of Northern vent with the proposed magma chambers ***I***, ***II*** and ***III***; 4 – possible alternative way for magma motion to the chamber ***I*** through low-velocity area ***IV***.