Deep Structure of the Region of the Uzon-Geyser Volcanic-tectonic Depression (Kamchatka) by Low-Frequency Microseismic Sounding

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The the Uzon-Geyser Volcanic-tectonic Depression (Kamchatka) is volcanic structure of oval shape elongated in the latitudinal direction with a size of 9×18 km. It is related to the Eastern Kamchatka volcanic belt and includes two world-renown unique natural sites: the Valley of the Geysers and Uzon Caldera [4]. The depression is related to the cross-section node of large regional fractures: magmatic and fluid conducting volcanic gaping fault of the northeastern extension and sublatitudinal Uzon-Valaginskii strike strip fault.

On base of new passive seismic technique the deep structure of the Uzon-Geyser Volcanic-tectonic Depression was investigated. In September 2009, special geophysical observations were performed for the first time to reconstruct the deep structure and the medium in the depression region.

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 Rayleigh 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 microseismic signals decrease at the Earth's surface over high-velocity anomalies and increase over low-velocity anomalies.

Thus, deep sections up to 30 km, which reflects the distribution of relative velocities of transversal seismic waves, were constructed for the first time in the hardly accessible conditions of Uzon-Geyser Depression zone using the method of low-frequency microseismic sounding (fig.1). Their integral interpretation using the previously known results of the geological, morphological, and petrological investigations was performed. Crystallized acid magma chamber under the caldera complex at depths of 6–10 km was identified and localized. The regions of concentration of basalt melts were distinguished and localized. We emphasize high consistency between the upper parts of the sections with the geological concepts about the peculiarities of the structure in the study region. The geometry of the revealed deep structures is in agreement with the model of the supposed magma intrusion into the upper layers of the crust based on the data of the satellite interferometry [5]. For more details see [3].

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References

1. Gorbatikov, A. V , Stepanova, M. Yu., Korablev, G. E. (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. 354–369.
3. Kugaenko, Yu. A., Saltykov, V. A., Gorbatikov, A. V., Stepanova, M. Yu. (2010) Deep Structure of the Region of the Uzon-Geyser Volcanic-Tectonic Depression Based on the Data of Microseismic Sounding // *Doklady Earth Sciences*, Vol. 435, Part 1, pp. 1465–1470.

4. Leonov, V.L., Grib, E.K., Karpov, G.A., Sugrobov, V.M ., Sugrobova, N.G., and Zubin, M.I. (1991) Uzon Caldera and Valley of Geysers, in *Active Volcanoes of Kamchatka*, edited by S.A. Fedotov and Y.P.Masurenkov. Vol.2. pp.92-141. Moscow: Nauka.

5. Lundgren P., Lu Zh. (2006) Inflation model of Uzon caldera, Kamchatka, constrained by satellite radar interferometry observations. *Geophysical Research Letters*. VOL. 33, L06301, doi:10.1029/2005GL025181

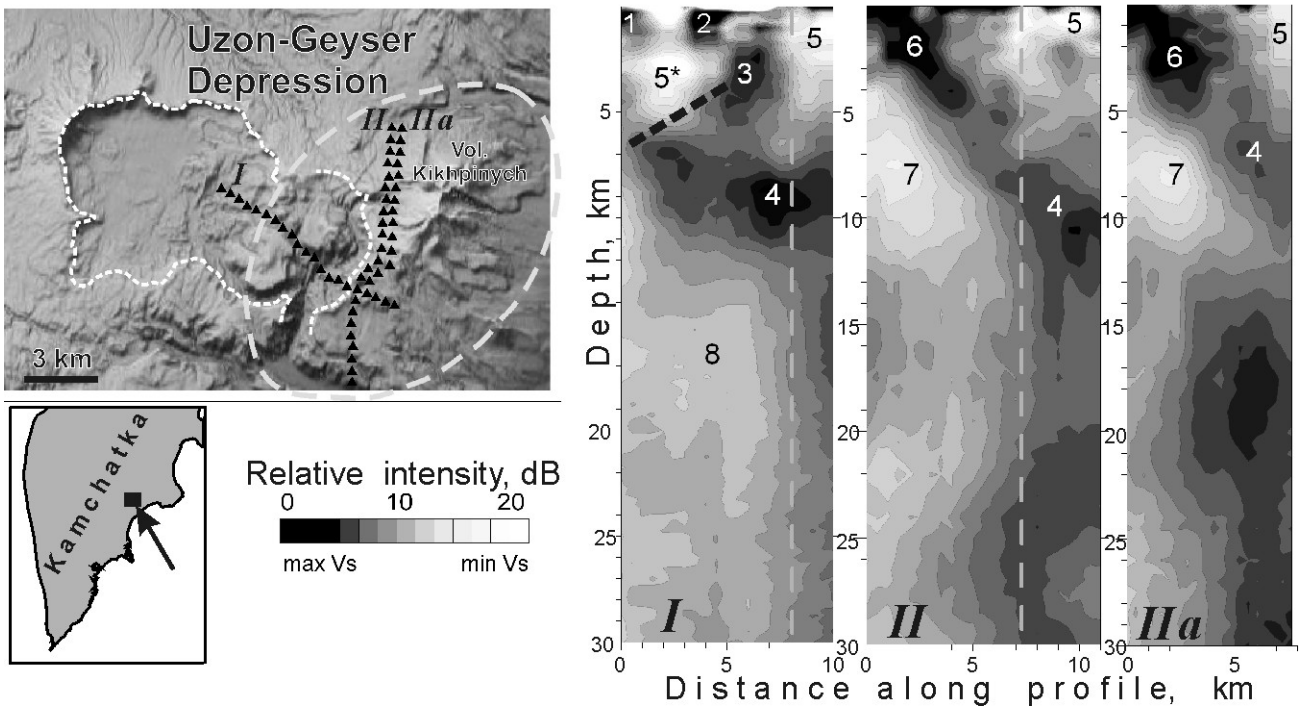

Fig.1. Normally oriented profiles of measurements and deep sections along profiles presented in the parameters of relative velocities of transversal seismic waves. The dashed line shows the cross section of sections ***I*** and ***II***. Elements of the deep structure (1-8):
1 - a hardened lava massif of dacite and rhyodacite (Belyaya Mountain) composition covered by lacustrine deposits;
2 - region of extrusive domes of Late Pleistocene age in central part of depression;
3, 4 - parts of the crystallized acid magma chamber; the depth of the location of the main part of the chamber (region 4) corresponds to the boundary of the crystal basement;
5 - zone of not-segmented deposits of the precaldera complex;
6 - the pathways of magma propagation along the system of sublatitudinal distortions controlled by the regional Uzon-Valaginsky Fracture in the Quaternary time, which manifested itself as a tension structure;
7 - region of increased concentration of basalt magma, which is a peripheral source that fed the Holocene basalt eruptions of the Kikhpinych volcanic center;
8 – possible basalt magma chamber under intrusive 4. Its formation is related with partial blocking of the free basalt spreading to the surface due to the screening effect of the crystallized acid magma chamber 4.