Geophysical Research Abstracts
Vol. 14, EGU2012-1827, 2012
EGU General Assembly 2012
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Monitoring the resonant properties of the magmatic structures of Elbrus volcano based on observation of lithospheric deformations by the Baksan laser interferometer - strainmeter

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The Elbrus volcanic center is located on the northern slope of the main ridge of the Greater Caucasus. It includes Mount Elbrus, a double-top stratovolcano, and a number of small volcanic centers concentrated on its western flank. According to present understandings, the Elbrus volcano falls into the category of the so-called dormant volcanoes that become reactivated. It is a typical volcano of a continental type.

During a number of years to study magmatic structures of the Elbrus volcano, their resonant properties and dynamics the new resonant method has been used. The idea of method is simple enough. Magmatic structures, being a resonator, upon incidence of a broadband powerful seismic signal generate the secondary seismic waves, having a set of resonant modes and containing information about physical and mechanical properties of structure inhomogeneities. These resonant modes are determined by geometrical parameters and elastic properties of the magma chamber as well as by magma properties.

Estimation of the resonant parameters is based on the analysis of lithosphere deformations recorded by the wide-band Baksan laser interferometer-strainmeter with a 75-m armlength which is installed in the underground tunnel of the Baksan Neutrino Observatory, 20 km apart from Mt. Elbrus. Here we report the analysis of the teleseismic signals excited by seven mean-power earthquakes (the magnitude, as a rule, didn't exceed 6), that occurred within 2005-2010 in so-called "a near zone» of the volcano Elbrus (<1500 km). The relative proximity of the earthquake focuses to the volcanic edifice creates the possibility to excite the eigen oscillations of the Elbrus resonant structures (magma chambers), at the same time, the energies of these moderate-power earthquakes are not enough to excite the free oscillations of the Earth.

Spectral analysis revealed quite confidently 10 groups of resonance modes in the range of periods of 30 -150 s. In this group of the resonant modes, three modes are stand out with the periods of 62.1 s, 64.3 s, and 67.9 s, which are excited in 100% of seismic events. The intensities of these modes in the spectra are maximal, or close to the maximum. Estimates of Q-factor of the selected regional resonant modes lie in the range 250-300, that assumes that the revealed modes are generated by the structures containing magmatic fluids with a large gas component. The resonant parameters (frequencies and Q-factors of the resonant modes) we have found were interpreted in the framework of contemporary models of magma resonators. We estimated the depth and dimensions of the shallow magma chamber, as well as the properties of the magma fluid which are corroborated by available geological and geophysical evidence. Our interpretation of observational materials suggests that the intrachamber pressure seems to be rising owing to the advent of new portions of hot lava from a deep magma source.

The stated approach provides a window to volcano dynamics and lays a foundation of the new "resonant" method for monitoring the state of volcano.

This work is supported by the Russian Foundation for Basic Research.