Seismic structures beneath Popocatepetl (Mexico) and Gorely (Kamchatka) volcanoes derived from passive tomography studies

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A number of active volcanoes are observed in different parts of the world, and they attract great interest of scientists. Comparing their characteristics helps in understanding the origin and mechanisms of their activity. One of the most effective methods for studying the deep structure beneath volcanoes is passive source seismic tomography. In this study we present results of tomographic inversions for two active volcanoes located in different parts of the world: Popocatepetl (Mexico) and Gorely (Kamchatka, Russia). In the past century both volcanoes were actively erupted that explains great interest to their detailed investigations.

In both cases we made the full data analysis starting from picking the arrival times from local events. In the case of the Popocatepetl study, a temporary seismological network was deployed by GFZ for the period from December 1999 to July 2000. Note that during this period there were a very few events recorded inside the volcano. Most of recorded earthquakes occurred in surrounding areas and they probably have the tectonic nature. We performed a special analysis to ground the efficiency of using these data for studying seismic structure beneath the network installed on the volcano. The tomographic inversion was performed using the LOTOS code by Koulakov (2009). Beneath the Popocatepetl volcano we have found a zone of strong anti-correlation between P- and S-velocities that leaded to high values of Vp/Vs ratio. Similar features were found for some other volcanoes in previous studies. We interpret these anomalies as zones of high content of fluids and melts that are related to active magma sources.

For the case of Gorely volcano we used the data of a temporary network just deployed in summer 2013 by our team from IPGG, Novosibirsk. Luckily, during the field works, the volcano started to manifest strong seismic activity. In this period, 100 - 200 volcanic events occurred daily. We collected the continuous seismic records from 20 stations for 5-7 days that gives us the possibility to locate several hundreds of events and to build a preliminary seismic model beneath the Gorely volcano. We found a zone of low S-velocity located beneath the SE flank of the volcano, just between the Gorely and Mutnovsky volcanoes. This may serve as an argument for feeding these volcanoes from a single source.

Although Popocatepetl and Gorely volcanoes are considerably different in their size and eruption characteristics, we found some similar features in the seismic structures, such as anti-correlation of P- and S- anomalies and high Vp/Vs ratio patterns below summits. This provides common patterns that give us the keys for understanding the general mechanism of working the volcanic systems.