

EGU2020-4015

<https://doi.org/10.5194/egusphere-egu2020-4015>

EGU General Assembly 2020

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Mantle feeding sources of the Northern group of volcanoes in Kamchatka inferred from the tomographic inversion of travel time data of the KISS network

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The major part of the Northern group of volcanoes (NGV) in Kamchatka is occupied by the Klyuchevskoy group, which is a unique cluster of more than thirteen volcanoes having exceptionally diverse eruption styles and compositions. The NGV also includes Shiveluch volcano to the north and Kizimen volcano to the south, both andesitic strongly explosive volcanoes. The crustal structure beneath the Klyuchevskoy group was previously explored using data of the permanent stations and several temporary networks; however, for studying the mantle structures, no high-quality data was available. To close this gap, a temporary seismic KISS network was installed throughout the NGV by an international consortium from August 2015 to July 2016. Together with 22 permanent stations, it included more than 100 simultaneously operating seismic stations. Based on the KISS data, we manually picked more than 43,000 arrival times of the P and S waves from 665 events (65 picks per event on average). Furthermore, this dataset was supplemented with the arrival times from the slab-related seismicity recorded by permanent stations during long-term observations. Several resolution tests have demonstrated that this dataset allows very high quality recoveries of the anomaly both laterally and in the vertical direction. The distributions of seismic anomalies in the uppermost mantle (50 km depth) show clear connection with the composition of the volcanoes. All the andesitic volcanoes (Kizimen, Udina, Zimina, Bezmyanny, Zarechny, Kharchenko and Shiveluch) are located above prominent low-velocity anomalies, whereas the basaltic volcanoes (Nikolka, Tolbachinsky Dol, Ostry and Plosky Tolbachik, Ushkovsky and numerous monogenic cones) are mostly associated with higher velocities in the mantle. This correlation might be explained by the effect of the mantle temperature to the rheological properties of the crust. Over the hot mantle, the crust becomes ductile, and it favors for forming intermediate crustal reservoirs, where magma is accumulated and separated for long time making it more felsic. Above the colder mantle, the crust is brittle and may be fractured by ascending

mafic intrusions. In this case, mantle material quickly penetrates through the crust and reaches the surface producing fissure basaltic eruptions and shield volcanoes. Another important conclusion follows from the interpretation of the vertical section throughout the NGV from Kizimen to Shiveluch. Along this section, the only one deep low-velocity anomaly reaching depths of more than 100 km is located beneath Shiveluch, which perfectly coincides with the gap in the Pacific slab imaged by other studies. Further to the south, the low-velocity anomaly is observable in the uppermost mantle down to 60-70 km. This result shows that all the volcanoes of the NGV are fed from a single source associated with the ascent of the hot asthenosphere through the slab window beneath Shiveluch. Then the hot asthenospheric material spreads southward along the crust bottom. This flow heats the mantle wedge, which is highly contaminated with volatiles coming from the slab, and leads to active melting and forming magma sources. This may explain exceptional activity and diversity of the volcanoes in this zone.