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Tomographic images of Avacha and Koryaksky volcanoes in Kamchatka

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In this study, we have mapped for the first time robustly the 3D structure of two upper-crustal magmatic reservoirs beneath the active volcanoes Avacha and Koryaksky, which are called “home volcanoes” for Petropavlovsk-Kamchatsky, the main city of Kamchatka (~200,000 inhabitants). These volcanoes represent a serious potential hazard for the city, because they are located at a distance of 25–30 km from the populated areas. A new tomographic model (V_p , V_s , V_p/V_s ratio) was built, for which we used the arrival times of seismic P- and S-waves from almost 5,000 local events, recorded by a permanent network of seismic stations during 2009–2018. The resolution of the derived models was carefully tested by a series of synthetic simulations. Prominent anomalies with extremely high V_p/V_s ratios (up to 2.4) were retrieved directly beneath both volcanoes and interpreted as magma reservoirs containing high degrees of partial melt and/or fluids. Beneath Avacha, the upper limit of the anomaly is located at the depth of ~2 km below the surface. The reservoir appears to be connected to the surface by a neck-shaped anomaly of high V_p/V_s ratio associated with active seismicity, which is interpreted as a magma and fluid conduit. Beneath Koryaksky, the magma related anomaly is deeper: its upper limit is located at a depth of ~7 km below the surface. This anomaly is connected with the volcanic cone by a vertical seismicity cluster, which possibly marks the pathway of fluid ascent and degassing. Between the volcanoes, a 2–3 km thick layer of very low V_p and V_s is interpreted as deposits of volcanoclastic sediments. Generally low V_p/V_s ratios in the area between the volcanoes show that the magma reservoirs in the upper crust are not interconnected.

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