[Back] [Session SM5.6]

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Seismotomographic structure of the central zone of Kamchatka suprasubduction complex according to the dense seismological networks data

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The strongest earthquakes and the largest explosive eruptions are confined to plate convergent boundaries. Many geodynamics aspects attract the scientific community's attention since answers to the most important questions cannot be obtained without reliable information about the deep structure. Geophysical studies of the crust and mantle provide essential information for lithospheric blocks interactions, mantle convection and fluid migration. This data is necessary to identify reliable criteria for assessing volcanic and seismic risk.

The studied area is central Kamchatka, where the cities of Petropavlovsk-Kamchatsky, Elizovo, and Vilyuchinks are located. It includes territory from the Gorely and Mutnovsky volcanoes in the south to the Bakening volcano and the Verkhneavachinskaya caldera in the north. It extends from the eastern to the western peninsula coasts. The study area includes the Avachinskaya group of volcanoes, the Vilyuchinsky and Zhupanovsky volcanoes, Karymshina caldera and a number of monogenic cinder cones. This region is assumed to be located at a transition between two principle different subduction regimes in the north and south of Kamchatka. Previous studies are sparse and have poor resolution due to the low density and uneven distribution of seismic stations.

In this study, we used a large dataset recorded by a new dense temporary network deployed in 2019-2020, which was specially designed for performing high-quality seismic tomographic studies of the suprasubduction complex structure (crust and upper mantle) beneath central Kamchatka. This dataset was supplemented by data recorded by (1) the temporary network operated on the Avachinskaya group of volcanoes in 2018-2019 and (2) the permanent stations Kamchatka branch of the Federal Research Center of the GS RAS. The seismic model is based on the data from 2687 local earthquakes that occurred during the operation of the mentioned temporary networks and were recorded by 134 regional stationary and temporary stations. In the tomographic inversion we used 59088 travel times of P-waves and 34697 of S-waves.

The new model makes it possible to trace zones of fluid and melt release from the slab, their migration in the mantle wedge and crust, and allows assessing their role in feeding the magmatic systems. Volcanoes of the Avachinskaya group have a common magma plumbing system at a depth more than 50 km, which could be traced from the slab. The Vilyuchinsky volcano feds through an intermediate large magma chamber located at a depth of 30-55 km, which is also related to the feeding of the Bolshebannaya hydrothermal system situated to the west. This large chamber fed from a conduit originated on the slab at more than 70 km depth. The feeding system of the Gorely and Mutnovsky volcanoes is traced to the slab at depths of more than 100 km.

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