A finite element method is applied to model the thermal structure of the subducted Pacific plate and overlying mantle wedge beneath the southern part of the Kamchatka peninsula. A numerical scheme solves a system of 2D Navier-Stokes equations and a 2D steady state heat transfer equation.

A model with the izoviscous mantle exposed very low temperatures (~800 ºC) in the mantle wedge, which cannot account for the magma generation below the volcanic belt. Instead, a model with the strong temperature dependent viscosity shows an essential rise of the temperature in the wedge. At the temperature of more than 1300 ºC beneath the active volcanic chain, the melting of the wedge peridotite becomes possible. Albeit the subducting slab below the Kamchatka peninsula is rather old (~70 Myr), some frictional heating along the interplate between the subducting oceanic slab and the overlying Kamchatka peninsula lithosphere would be enough to result in the melting of the subducted sediments and basaltic oceanic crust. Dehydration (> 5% wt. H₂O release) occurs in the subducting slab as a consequence of metamorphic changes. As a consequence, the hydration of the mantle wedge peridotite might produce its melting, which may rise to the base of the continental crust as diapir like blobs.

Considering that the melting processes in the subducting plate generate the most of the volcanic material, we developed a dynamic model which simulates the migration of the partially melted buoyant material in a form of blobs in the viscous mantle wedge flow. The blobs with the diameter of 0.4 - 10.0 km rise up to the base of the continental lithosphere within 0.002 - 10 million years depending on the blob diameter and surrounding viscosity.

The thermal structure obtained in the model with temperature dependent viscosity is used to estimate the seismic P-wave velocity anomalies (referenced to PREM) associated with the subduction beneath Kamchatka. A low velocity zone (~ -7% velocity anomaly) is obtained beneath the volcanic belt and a high velocity anomaly (~4%) for the cold subducted lithosphere. These results agree with the seismic tomography invention inferred from P-wave arrivals.

Keywords: Kamchatka subduction zone, thermal models, mantle wedge flow, blobs, tomographic imaging.