ABSTRACT

In this thesis we present the results of the numerical models of lithospheric subduction focused on the influence of rheological properties of the crust. We use a two-dimensional Cartesian model with non-linear rheology, including the major phase transitions at the depths of 410 km and 660 km. The separation of the subducting and overriding plates is facilitated by a low-viscosity crust, prescribed on the top of the subducting plate. Previous studies have shown that the mechanical properties of this crust significantly influence the deformation of the subducted plate in the transition zone. Here we focus 1) on a detailed analysis of the combined effects of the crustal thickness and viscosity on the slab deformation and its ability to penetrate to the lower mantle and 2) the implementation of the non-linear crustal rheology and testing the influence of its parameters. In the case of models with constant viscosity we show that the increase of the crustal thickness and/or the decrease of its viscosity makes it easier for the subducting plate to move and therefore leads to increasing the subduction velocity and rollback. If the ratio between the crustal viscosity and its thickness $\psi \leq 3.3 \times 10^{16}$ Pa s m^{-1} the slab stagnates above the boundary at the depth of 660 km. For higher ratio ψ the slab penetrates to the lower mantle. Non-linear crustal rheology has a major influence on the slab deformation in the transition zone. Trade-off between the subduction velocity and crustal viscosity results in switching between stagnant and penetrative modes of subduction. Sensitivity of the models to the parameters of pseudoplastic deformation at shallow crustal depths is probably more significant than sensitivity to the parameters of dislocation creep that dominates the crustal deformation at higher depths.