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Relamination of continental crust – a comparison between numerical model and Variscan Bohemian Massif

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During continental collision a part of the lower-plate material can be subducted, emplaced at the base of the upper plate and eventually incorporated into its crust. This process is called relamination and has been proposed to explain characteristics of several orogens, both modern and ancient. In the Bohemian Massif, European Variscides, it led to formation of a mixed orogenic root containing felsic rocks that originated from both upper and lower plate. We present a comparison between a thermo-mechanical numerical model of relamination and data acquired in the Bohemian Massif. It shows important similarities, namely in locations of high-pressure rocks within the orogen, typical rock associations, shape of the pressure–temperature paths and peak conditions; however, some features are still to be explained.

In the Bohemian Massif, the highly metamorphosed felsic rocks originating from the lower plate crop out in three distinct regions: near the plate interface, near the magmatic arc and in the back-arc in a current distance of up to several hundreds of kilometers from the plate interface. In the models, the locations where the relaminant exhumes are the same. However, in the model, the distance that the relaminant can travel from the subducting plate towards the back arc is relatively small ($\sim$200 km). This distance and the time that the relaminant resides under the lithosphere can vary significantly between the models depending on the velocity of the plates and strength of the upper plate.

In the back-arc (Moldanubian) domain of the Bohemian Massif, the high pressure felsic rocks are surrounded by middle crust and in some parts by thin rims of mafic rocks. Such rims are observed also in the models, where they form during exhumation of the relaminant through the lithosphere and lower crust.

The pressure–temperature paths obtained in the model and inferred from the data have similar shapes showing: initial UHP stage, subsequent HP conditions during the flow beneath the lithosphere, quick isothermal exhumation to mid-crustal depth and slow cooling in the middle crust. In the model, peak temperatures in the relaminant can exceed 800 °C, and pressures can reach $\sim$3.5 GPa during subduction stage and $\sim$2.5 GPa during the flow beneath the lithosphere. The modelled peak temperatures are still low compared to the data – some estimates of peak temperatures in the felsic granulites exceed 1000 °C. There is also a significant variation in peak conditions between models showing exhumation in different locations in the orogen.