Interplay between Detailed P/T Estimates and Natural Deformation Microstructures as a Base for Thermal and Rheological Modelling

Stanislav ULRICH, Karel SCHULMANN and Josef JEŽEK

Faculty of Science, Charles University, Albertov 6, Praha 2, Czech Republic

The studied area (the Svratka Dome of the Moravian Zone) is located at the eastern margin of the Bohemian Massif. It is represented by imbricated continental Cadomian crust with well-developed inverted Barrovian metamorphic zoning (Štípská and Schulmann 1995). The Moravian nappe pile consists from the bottom to top of: 1) the Para-autochthon (PA) - basement rocks with Devonian metasedimentary cover of the Deblín and Květnice series (phyllites, marbles and quartz-rich metapebbles), 2) the Lower nappe (LN) called the Bílý potok series (biotite and garnetiferous mica schists, quartzites and marbles at the top), 3) the Upper nappe (UN) (the Bíteš orthogneiss and garnetiferous mica schists at the top with boudins of marbles and intercalations of quartzites of the Olešnice series), 4) the Svratka Crystalline Unit belonging to the upper plate (UP) in our model.

Detailed thermobarometrical investigations were performed in the PA, LN and UN units to complete the hitherto published data (Čížek 1985, Pertoldová 1986, Pitra et al. 1994, Štoudová 1988, Tichý 1992, Weber 1996) and to carefully relate pressure and temperature conditions with major tectonic events. In the tectonic model of Schulmann et al. (1991), it was suggested that Barrovian metamorphism (M1) results from D1 underthrusting and that M2 retrogression originated during the subsequent progressive D2 nappe stacking.

Carbon isotope exchange between graphite and calcite was used as a thermometer in the PA as well as in the UN where older data of Čížek (1985) were recalculated. Fluid inclusions from the quartz veins in the PA and LN were studied to complete P/T estimates related to later D2 episode. Oxygen isotope exchange between micas and quartz was used as a thermometer in mylonitized quartzites in all units. In the UN, the garnet-biotite and amphibole-plagioclase thermometers were applied in the mica schist and metagabbro, respectively. Finally, the phengite content of muscovite was investigated in order to estimate pressures of metamorphism in the Biteš orthogneiss.

The microstructural study of marbles and P/T estimates of M1 metamorphism in individual units have shown dominant grain boundary migration recrystallization mechanisms associated with grain growth as a result of increased temperature of ductile flow. Thermal modelling coupled with microstructural observations of marbles suggests an increase in T during the exhumation path of UN and UP in conjunction with the maintenance of grain size. In contrast, the exhumation of LN and PA is associated with a decrease in temperature, decrease in recrystallized grain size and change in deformation mechanism defined as the high stress grain size sensitive regime (Walker et al. 1990). The decrease in recrystallized grain size coupled with the decrease in temperature in lower grade units are responsible for rheological weakening and localization of deformation in marbles during nappe stacking.

Initial grain size (differential stress) inherited from the prograde P/T path, the temperature achieved at the end of M1 metamorphic event, and the calculated shape of the retrograde P/T path provide a sufficient database for comparison with experimentally defined deformation mechanism maps. In the case of marbles from the Svratka Dome, such a comparison shows that for natural strain rate ($10^{-14}s^{-1}$) there exists a critical differential stress threshold (ca. 10 Mpa) below which marbles are not capable of reducing the grain size during exhumation and syntectonical localizing of the deformation.

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