Microstructures and Rheological Behaviour of Marbles in Natural Strain Gradient

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Inversion metamorphic zonation is developed in the Eastern margin of the Bohemian Massif where two crustal nappes overlie a paraautochthonous unit of similar protolith origin. Maximum temperature during a prograde Barrovian metamorphism has been estimated at 350°C for the paraautochthone (PA), 450°C for the lower nappe (F_1), 520°C for the upper nappe and 620°C for the base of the orogenic root domain (MO) (Schulmann et al. 1991). Several types of calcite-bearing tectonites has been sampled from each tectonic unit. Mean grain size and crystallographic preferred orientation measurement and complete fabric analysis have been carried out.

Thin sections of marbles have been digitised and used for grain size and quantitative textural analysis. Grain size of coarse grained marbles has been calculated by the intercept area method. In case of grains smaller than 100 microns, long and short axes of each grain have been measured to minimise an error. Digitised images have been used also for estimation of grain shape preferred orientation, grain elongation and analysis of orientation of grain boundaries. This analysis shows at least two groups of different microstructures.

The first type of microstructure belongs to a grain growth process related to a temperature increase during the progressive underthrusting. Equant grains, large single peak grain size distribution and grain boundary migration as a main grain recrystallization mechanism are typical properties of this type of deformation. Strong c-axis fabric with two symmetric maxima is characteristic of these types of textures.

The second type of microstructure is more complex. It was developed during localised deformation and is associated with later nappe stacking. In the paraautochthonous unit, dynamic recrystallization diminished grain size from 200 to 20 μm and crystallographic preferred orientations show weak single peak maxima. Marbles in F_1 have been totally recrystallised reaching similar grain size 300 μm in all samples. The texture is marked by a grain aspect ratio > 3 and cuspate lobbate boundaries indicating that grains grew during dynamic recrystallization via grain boundary migration process. A similar texture has been already explained as a diffusion accommodated dislocation creep (Walker et al. 1990). Crystallographic preferred orientation show transition from two maxima towards a single maximum of c-axes. In the uppermost nappe, F_2, marbles were not activated in a large extent and deformation is localised in narrow zones where coarse grained marble recrystallises showing similar fabric characteristics as marbles in F_1.

The hypothesis of transition from dislocation to diffusion creep (Schmidt 1982) was not confirmed in our case. Our data shows that the ability of calcite to accommodate high strain depends more on dislocation creep than on diffusion creep. In case of PA and F_1, where the temperature did not overcome 500°C during nappe stacking, marbles accommodated the maximum of strain. However, late exhumation deformations are not localised in coarse grained marbles of F_2 that behaved as resistant bodies embedded in weaker rocks. Such a contrasting behaviour is explained in terms of contrasting pre/exhumational grain size of marbles in individual nappes affected by a similar thermomechanical event during the nappe stacking.

Interplay of Intrusion and Transtensional Tectonics: Čistá Granodiorite Stock in the Bohemian Massif

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The Čistá granodiorite intruded the Upper Proterozoic strata in the north-western flank of the Teplá - Barrandian zone in the Bohemian Massif. The central part of the Teplá - Barrandian is composed of two stratigraphic sections which differ from each other in structural style. Unmetamorphosed Lower Palaeozoic sediments (Ordovician to Middle Devonian) are deformed by folds with NE-SW trending hinges and by several NW or SE dipping thrusts, and lie unconformably on the metamorphosed Upper Proterozoic plus Cambrian volcano-sedimentary rocks. The Čistá granodiorite stock is a minor component of the Čistá-Jesenice massif whilst the majority of the pluton is formed by biotitic granite of the Tis type. The granodiorite intruded directly into the Proterozoic rocks apart from the eastern margin which pierced directly the Tis biotitic granite. The contact between these two granitoids coincides partly with a major brittle-ductile shear zone striking NE-SW and the biotite granite rim extends as a narrow tail to the SW.

The Barrandian rocks are characterised by low-grade metamorphism and superposition of several structures. Bedding in the metapelitic and metapsamitic rocks is overprinted by an axial cleavage produced by folding related to the Barrandian - Saxothuringian convergence which occurred at the Middle to Upper Devonian times and was oriented NW-SE in this region. A subsequent deformation phase generated sets kink bands at a scale from centimetres to several metres and dipping at low- to medium-angle to the (W) NW and (E) SE which indicate a lateral extension and vertical shortening.

Macroscopic structures in the igneous rocks are mostly