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Ultrahigh Temperature Event in the Moldanubian Zone; its Significance for the Origin of Durbachites

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A rock sequence of durbachite–gabbro to monzogabbro–kinzigite–gneiss–durbachite was mapped in the E–W-trending, 2 km long profile in the N part of the Jihlava pluton; however, direct contacts between the individual rock types were not observed due to Quaternary cover. The mineral assemblage of gabbro and monzogabbro, mainly clinopyroxene + biotite + plagioclase + K-feldspar, resembles mafic charnockites. Common amphibole is secondary; coarse-grained apatite (up to 3 vol.%) represents an important primary phase. The mafic minerals from gabbro exhibit systematically higher X_{Mg} relative to monzogabbro (Cpx – 0.75 vs. 0.57, Bt – 0.6 vs. 0.4), which values indicate important role of fractionation. Temperatures of their formation recalculated from the composition of mesoperthitic K-feldspar (Nekvasil 1992) of monzogabbros of about 1000–1100 °C are suggested.

Kinzigites are coarse- to medium-grained, grayish-red to grayish-brown rocks, composed of prismatic sillimanite (up to 2 cm long), garnet (core $X_{Mg} = 0.30$, rim $X_{Mg} = 0.16$) cordierite ($X_{Mg} = 0.69$), possibly two generations of biotite ($X_{Mg} = 0.46$–47, high TiO_2 3.59–5.28 wt.%), fibrolitic sillimanite II and K-feldspar. Plagioclase (An_{36-39}), quartz, hercynite ($X_{Mg} = 0.33$–0.26), relics of orthopyroxene(?), ilmenite and rutile are minor to accessory phases. K-feldspar rimmed, flowed around and cemented other rock-forming minerals.

The mineral assemblage, textural relations and zoning in garnet indicate a rather complicated evolution. Stage A is represented by abundant inclusions of hercynite, ilmenite and quartz enclosed typically in prismatic sillimanite I and garnet. The reaction cannot be constrained due to the absence of early-formed minerals. Stage B is characterized by volumetrically important mineral assemblage of sillimanite I + garnet (cores). Numerous inclusions of hercynite and quartz exclusively in sillimanite I and garnet suggest the reaction: Hc + Qtz = Alm + Sil. During stage C, cordierite rims around garnet indicate possible reactions: Grt + Sil + L = Crd + K-f or Grt + Sil + Qtz = Crd. Abundant assemblage fibrolitic sillimanite II + biotite marked stage D and may have originated by the reaction: Grt + Crd + L = Sil + Bt. The above model fits pretty well with the textural relations and chemical composition of the individual minerals. However, further detailed field, textural and microprobe studies are required to verify the presented data.

The estimated PT path in the early stages A, B and C exhibits nearly isobaric thermal cooling. High temperature (up to 900 to 950 °C) estimated for stage A may be attributed to the intrusion of hot mafic magma (charnockite gabbro?) within the crust. The mineral assemblages of stages A and B indicate that kinzigite is a restite formed at temperatures of about 900 to 1000 °C from a metapelitic or metapsammitic protolith (see Patino Douce and Johnston 1991; Spear et al. 1999).

Koller and Klötzli (1998) suggested formation of the Weinsberg granite suite (porphyritic rocks – granites to quartz monzodiorites), by the reaction of the Cadomian mafic charnockites with granite melt. Our data indicate that similar reaction of charnockitic gabbro with granite melt may have been responsible for the origin of the durbachite suite. The studied kinzigite represents a restite from which granitic melt may have been generated (Patino Douce and Johnston 1991; Spear et al. 1999).

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Problems Related to the Role of Shear-bands as Kinematic Indicators

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Small-scale shear zones inclined at intermediate angles to an earlier anisotropy are often observed in deformed rocks. They are traditionally described as shear bands, C-bands, extensional crenulation cleavage, asymmetric boudinage, asymmetric folds or normal kink bands formed as a result of extension along an older anisotropy (or shortening perpendicular to the anisotropy). Their sense of shear (or internal rotation) and geometry are widely used to describe the large-scale kinematics of deformation and/or the deformational history of a given area. These various structures result from different processes and unless this is fully understood, there is a great danger of drawing wrong conclusions if they are used as kinematic indicators. It can be shown that when these three-dimensional structures are looked at in two-dimensional outcrops or in thin sections, they may seem geometrically identical.

We have developed simple computer techniques allowing geometrical evaluation of all possible sections across folds of arbitrary geometry (degree of asymmetry, shape and interlimb angle). In order to determine shear-band geometry, we used criteria defined by Platt and Vissers (1980) such as the angle of limbs and enveloping surface and the interlimb angle. Planar sections, in which a fold exhibits geometry of a shear band, are quantified using the above criteria and displayed in stereographic projection as shaded areas. In addition, the quality of shear-band shape is visualized by different intensity of shading.

We demonstrate that for any fold geometry, there are two distinct groups of sections close to the axial plane showing shear band-like geometry and opposite sense of shear criteria. The size of areas in a stereogram representing these sections is increasing with the increasing fold interlimb angle. Symmetrical folds exhibit symmetrically distributed areas of the same size in the stereogram whilst asymmetrical folds show areas of different sizes and positions in stereographic projection. Since geologists are traditionally using sections parallel to lineation and perpendicular to foliation to determine kinematics of deformation (and lineations are often parallel to fold axes), there is a high probability of misinterpretation when secondary folds are present. We shall provide two field examples, from the Jeseníky Mountains and from the Vepor basement of Western Carpathians, where reconstructions of structural evolution related to extensional collapse are often based on apparent extensional shear bands, which are in fact oblique sections of compressional folds.

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Cretaceous Collision in the Western Carpathians: Role of Complex Basement Shape on Crustal-Scale Polyphase Deformation Partitioning

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The present structure of the SE Western Carpathians consists of three main tectonometamorphic units. From the north to the south and from the bottom to the top they are: 1) Variscan crystalline basement with Late Paleozoic and Mesozoic cover (Vepor Unit). 2) Early Paleozoic basinal, mostly turbiditic metasedimentary unit (Gemer Unit) overlying pre-Cambrian? crystalline basement (sub-Gemer Unit). The Vepor crystalline complex irregularly surrounds the Gemer embayment from west and east. 3) Mesozoic accretionary wedge (melange) containing blueschist-facies relics (Meliata Unit) is overlain by flat unmetamorphosed Silica nappe.

The pre-Alpine crystalline Vepor Unit and the Gemer Unit in the S show NW-dipping Variscan fabric and inverted metamorphic zoning resulting from south-verging Variscan thrusting. The latter is manifested by overthrusting of high-grade gneisses over Barrovian micaschists in the Vepor unit, and by