Origin and Metamorphic Evolution of Blueschists and Very Low-Grade Rocks of the Meliata Unit, Western Carpathians

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Numerous petrological data on the blueschist facies rocks of the Meliata Unit have been obtained during the last decade (e.g. Faryad, 1995, Ivan and Kronome, 1996). Recently we have examined the very low-grade rocks (Arkai et al., 2003), which occur in the vicinity of this unit and obtained new structural data (Faryad et al., 2003) that help to determine more precisely the exhumation history of the high-pressure rocks. The Meliata accretionary wedge is situated along the southern margin of the West Carpathians in Slovakia and northern Hungary. Geochemical and petrological character of the Meliata metabasites indicates a continental rift volcanism to have taken part during rifting followed by spreading and formation of oceanic crust of the Triassic Meliata basin. Part of the oceanic crust and adjacent continental margin, underwent blueschist facies metamorphism during the Middle Jurassic subduction. These low-grade metamorphic rocks were exhumed and now occur in the mélange complex of the Meliata Unit in southern part of the Gemericum. The crustal rocks are represented by shallow water sediments and basement rocks with relics of amphibolite facies metamorphism. The accretionary wedge is a complex pile of crustal and oceanic units, which are built from bottom to top by three thrust sheets consisting of subblueschist, blueschist and very low-grade metamorphic rocks from bottom to respectively (Faryad et al., 2003). Maximum PT conditions, reached during the Middle Jurassic (155–160 Ma) blueschist facies metamorphism, were10-13 kbar and 400–450 °C. Sedimentary series and related basalts forming the mélange matrix suffered high-T anchizonal prograde regional metamorphism, the temperature and pressure of which might have varied between ca 280 and 340 °C and ca 1.5 and 3 kbar. The mylonitic retrogression of blueschist facies phyllites is characterized by 340 °C and 4 kbar. The mélange rocks are composed of Permian evaporates and Jurassic shells, marls and sandstones, which contain blocks (olistoliths) of Triassic radiolarites, cherts, limestones, serpentinites, gabbros and blueschists. Structural and metamorphic evolution of the Meliata accretionary wedge is characterized by fabrics and mineral assemblages testifying HP stage, retrogression during exhumation and emplacement of thrust sheets and late shortening of the whole wedge due to buttressing. The age of prograde anchizonal and retrograde blueschists ranges between ca 150 and 120 Ma, culminating at around 140–145 Ma. Thus, the very low-grade metamorphism of the Meliata sedimentary pile was younger than the subduction-related blueschist facies metamorphism.

References

ÁRKAI P., FARYAD S.W., O VIDAL and BALOGH K., 2003. *Int. Review of Earth Sciences*, 92: 68-85.

FARYAD S.W., 1995. *J. metamorphic Geol*, 13: .432-448.

FARYAD S.W., SCHULMANN K. and LEXA O., 2003. Geophysical Research Abstract, 5, 05617

IVAN P. and KRONOME K., 1996. *Mineralia Slovaca*, 28: 26-37.

MAZZOLLI G. and VOZÁROVÁ A., 1998. In: M. Rakús (Editors), Dionýz Štúr Publication, 89-106.

Application of Multicomponent Diffusion Modeling to Garnets in Polymetamorphic Rocks From the Eastern Alps

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Diffusion that occurs during geological processes in many minerals, e.g. garnet result from simultaneous flow of more than two components. In a multi-component system, the diffusion flux of any component does not depend only on its own chemical potential gradient, but also on those of all other diffusing components. Such systems can be modeled using the D-matrix formulation by Onsager (1945). Diffusion along a non-isothermal path can be modeled either numerically or by using the concept of a characteristic diffusion coefficient.

The multicomponent diffusion profiles measured in the microprobe in natural garnets were modeled using the approach, proposed by Chakraborty and Ganguly (1991). This method is applied to garnet in polymetamorphic rocks from the Austroalpine units of the Eastern Alps. The basement pelitic rocks contain porphyroblastic garnet (up to 2 cm in size) that shows two growth zones: a Pre-Alpine core ($Alm_{71–83}$, $Grs_{3–16}$, $Sps_{0–15}$, $Prp_{5–9}$) and an Eo-Alpine rim ($Alm_{71–82}$, $Grs_{4–24}$, $Sps_{0–2}$, $Prp_{10–21}$). Both core and rim are visible in hand specimen, because they contain different amounts of inclusions or opaque minerals (ilmenite and graphite) along their boundaries. These two garnets with distinct Ca, Fe and Mg contents have mostly sharp contact with very narrow diffusion zone. The old garnet reveals progressive zoning with bell shaped Mn profile which suggest either relatively low-temperature or short time span for the Pre-Alpine and Alpine metamorphic processes. PT conditions of 560–580 °C and 10 kbar for Alpine metamorphism were calculated using exchange thermobarometry garnet-biotite and GASP barometry in metapelite and garnet-plagioclase-amphibole thermobarmtry in amphibolite. According to isopleths of garnet obtained using construction of pseudosection in thermocalc, the garnet started to crystallize at 530 °C at ca 7 kbar kbar having reached a maximum of 580 °C and 10 kbar kbar. The simulation was done for a time interval estimated according to the P-T path. Diffusion coefficient was calculated for Mn, Mg and Fe, where Ca was treated as dependent component. The advantage of such simultaneous calculation is that it allows subtle details of variations in compositional profiles to be interpreted and also considerably reduces the uncertainty in retrieved time scales that may arise from using only one profile. The retrieved time scales for Alpine metamorphism in this area imply ~2 Ma for the selected P-T path excceding 530 °C.

References

CHAKRABORTY S. and GANGULY J., 1991. Compositional zoning and cation diffusion in aluminosilicate garnets. In: J. GANGULY (Editor), Diffusion, Atomic ordering and Mass Transport – selected problems in Geochemistry, Advances in Physical Geochemistry, 8, Springer-Verlag, New York, 120-170.

ONSAGER L., 1945. Theories and problems of liquid diffusion. *Ann. Y.N. Acad. Sci.*, 46: 241-265.

Deformation and Exhumation of Magmatic and Metamorphic Rocks of the Pohorje-Kozjak Mts. (Slovenia): Constraints from Structural Geology, Geochronology

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The Pohorje-Kozjak Mts., NE Slovenia are built of several Cretaceous nappes, consisting from bottom to top of medium-grade metamorphic rocks, slightly metamorphosed early Paleozoic rocks (Magdalensberg series), and Permo-Mesozoic sediments. These rocks are covered by late Early Miocene (18–16 Ma) clastic sediments deposited in the rifting western Pannonian Basin. Pre-Tertiary rocks were intruded by granodiorite (tonalite), related pegmatite, aplite and lamprophyre dykes and subvolcanic dacite bodies and dykes (Márton et al. 2002).

Eoalpine subduction and nappe stacking resulted in very high (to ultra-high) pressure metamorphism of kyanite-bearing eclogites (Janák et al. 2003). The juxtaposition of mafic eclogites and continent-derived metasediments (micaschists, gneiss, marble) represents the first exhumation process but its kinematics is still poorly understood.

Most of the metamorphic rocks record prominent mylonitic microfabrics associated with penetrative foliation and stretching lineation. Well-developed kinematic indicators show top-to-the-(E)NE or -SW extensional shearing. Deformation progressively increasing upward toward a “phyllite” zone, situated at the top of the Alpine medium-grade metamorphic rocks. This zone also represents a break in degree of metamorphism while low-grade rocks or truncated Permo-Mesozoic sediments are in direct contact with medium-grade rocks. Thus the “phyllite” zone is regarded as a low-angle ductile mylonitic shear zone accommodating horizontal extension and vertical shortening (thinning).

Some magmatic rocks record oriented texture (foliation and locally mineral lineation), part of which is related to syn-magmatic, other part to post-crystallisation solid-state deformation. Dynamically recrystallised quartz, boudinaged biotite and non-deformed feldspars broadly place the deformation into the higher greenschist facies. This deformation induced the formation of strong magnetic fabric with maximal anisotropy axis trending mainly ~E-W.

Ductile deformation was associated with and followed by brittle normal faults and intervening tilted blocks of different size. Faulting could reactivate but often cut earlier ductile low-angle zones. The direction of tension varied from ESE-WNW to NE-SW, roughly parallel to ductile stretching lineation. Post-extensional compressional deformation could be related to Plio-Quaternary transpression.

All rocks suffered a regional, Pliocene to Quaternary ~30° counterclockwise rotation. The amount of CCW rotation almost compensated an earlier clockwise rotation in lamprophyre dykes but was much less then a much larger CW rotation in granodiorite. The preservation of more complex rotational history in granodiorite suggests relative chronology as younging from granodiorite to dacite.