suggests a nearly synchronous melting of the variously enriched subcontinental mantle along the Variscan Belt.

References

CHERNIAK D.J., 2000. Pb diffsuion in rutile. *Contrib. Mineral. Petrol.,* 139: 198-207.

GERDES A., WÖRNER G. and FINGER F., 2000. Hybrids, magma mixing and enriched mantle melts in post-collisional Variscan granitoids: the Rastenberg Pluton, Austria. In: W. FRANKE, V. HAAK, O. ONCKEN and D. TANNER (Editors), Orogenic Processes: Quantification and Modelling in the Variscan Fold Belt. Geological Society London Special Publication 179, London, pp. 415-431.

HEGNER E., KÖLBL–EBERT M. and LOESCHKE J., 1998. Post-collisional Variscan lamprophyres (Black Forest, Germany): $^{40}Ar/^{39}Ar$ phlogopite dating, Nd, Pb, Sr isotope and trace element characteristics. *Lithos*, 45: 395-411.

HOLUB F.V., 1990. Petrogenetická interpretace chemismu kaliových lamproidů evropských Hercynid. PhD. thesis, Charles University, Prague.

HOLUB F.V., 1997. Ultrapotassic plutonic rocks of the durbachite series in the Bohemian Massif: Petrology, geochemistry and petrogenetic interpretation. *Sbor. geol. Věd, ložisk. Geol. Mineral.,* 31: 5-26.

HOLUB F.V. and JANOUŠEK V., 2003. Geochemical and Sr–Nd isotopic constraints on the genesis of ultrapotassic plutonic rocks from the moldanubian zone of the Bohemian Massif. *J. Czech Geol. Soc.,* in print.

JANOUŠEK V., ROGERS G. and BOWES D.R., 1995. Sr–Nd isotopic constraints on the petrogenesis of the Central Bohemian Pluton, Czech Republic. *Geol. Rdsch.,* 84: 520-534.

JANOUŠEK V., BOWES D.R., ROGERS G., FARROW C.M. and JELÍNEK E., 2000. Modelling diverse processes in the petrogenesis of a composite batholith: the Central Bohemian Pluton, Central European Hercynides. *J. Petrology,* 41: 511-543.

KOŠLER J., 1993. Age and geochemistry of the Staré Sedlo and Mirotice complexes, Bohemian Massif, Czech Republic. PhD. thesis, Glasgow University, Glasgow.

KRÖNER A., O'BRIEN P.J., NEMCHIN A.A. and PIDGEON R.T., 2000. Zircon ages for high pressure granulites from South Bohemia, Czech Republic, and their connection to Carboniferous high temperature processes. *Contrib. Mineral. Petrol.,* 138: 127-142.

SCHALTEGGER U., 1997. Magma pulses in the Central Variscan Belt: episodic melt generation and emplacement during lithospheric thinning. *Terra Nova*, 9: 242-245.

TURPIN L., VELDE D. and PINTE G., 1988. Geochemical comparison between minettes and kersantites from the Western European Hercynian orogen: trace element and Pb–Sr–-Nd isotope constraints on their origin. *Earth Planet. Sci. Lett.,* 87: 73-86.

VAN BREEMEN O., AFTALION M., BOWES D.R., DUDEK A., MÍSAŘ Z., POVONDRA P. and VRÁNA S., 1982. Geochronological studies of the Bohemian Massif, Czechoslovakia, and their significance in the evolution of Central Europe. *Trans. Roy. Soc. Edinb, Earth Sci.,* 73: 89-108.

WENZEL T., MERTZ D.F., OBERHÄNSLI R., BECKER T. and RENNE P.R., 1997. Age, geodynamic setting, and mantle enrichment processes of a K-rich intrusion from the Meissen massif (northern Bohemian Massif) and implications for related occurrences from the mid-European Hercynian. *Geol. Rundsch.,* 86: 556-570.

WENZEL T., OBERHÄNSLI R. and MEZGER K., 2000. K-rich plutonic rocks and lamprophyres from the Meissen Massif (northern Bohemian Massif): Geochemical evidence for variably enriched lithospheric mantle sources. *Neu. Jb. Mineral., Abh.,* 175: 249-293.

P-T-d Evolution of Marbles and Mica Schists in the Krowiarki Range, the Lądek-Śnieżnik Metamorphic Unit, West Sudetes

Mirosław JASTRZĘBSKI

Institute of Geological Sciences, Polish Academy of Sciences, Podwale 75, 50-449 Wrocław, Poland

The Krowiarki Range occurs in a convergence zone of the Lądek-Śnieżnik Metamorphic Unit (LŚMU) fan-like feature. It is composed of polyphase anticlinorial and synclinorial macrostructures – their converging axes plunge to the NW (Don, 1964). Along the NW-trending Krowiarki Range, from the vicinity of Stronie Śląskie in the SE to Żelazno in the NW, structural and petrological studies of interlayered marbles and mica schists were carried out in order to establish the P-T-d path of their tectono-metamorphic evolution and to provide data for a more detailed geodynamic reconstruction of the LŚMU.

The earliest deformation structures in marbles are scarce, small-scale, isoclinal, intrafolial F_1 folds, with the axial plane foliation S_1 mostly parallel to the folded bedding planes. The D_2 tight, asymmetric folds in the S_1 are more evident in marbles, especially in their impure variants, than in mica schists where the S_2 axial plane foliation is a predominant tectonic feature. The D_2 fold axes plunge at low angles to the NW. The S_2 metamorphic foliation generally dips towards NE, N or NW, usually at low and rarely at high angles. Penetrative L_{2i} intersection lineation parallel to F_2 axes and occasional L_{2s} stretching linea-

tion perpendicular to F_2 axes were formed. Successive rodding lineation L_3 and S_3 mylonitic fabric formed parallel to the zonally reactivated S_2 foliation. Lineation L_3 plunges toward the N or NW at low angles. The concentric D_4 folds range from tens of metres in scale to the centimetre scale of crenulation then forming crenulation lineation L_4. The D_4 axes with L_4 lineations exhibit two maxima – 330/10 and 40/40. Large, NW-plunging D_4 folds visible in outcrops determine the structural architecture of the Krowiarki Range. They are considered to be mesoscopic equivalents of the macroforms described by Don (1964).

On the microscopic scale, the S_1 foliation in mica schists is locally preserved as inclusion trails of the *chl-ctd-ma-q-ilm* assemblage within intertectonic garnet cores. *Ctd-chl-ma* inclusions disappear towards the rim growing simultaneously with the D_2 where the *q-ilm* inclusion trails take curved shape and continue into the external S_2 foliation, which additionally contains the *bi-st-ky* assemblage. The D_2 axial fabric is marked by parallel arrangement of *cc-dol-tr-phl-mu-q* in marbles from the Stronie Śląskie area and *cc-dol-chl-mu-q* in marbles occurring in the Żelazno area. On the thin-section scale, the D_4 structures appear as intensive crenulation, but with no associated new axial-planar foliation.

D_1 and D_2 events took place under progressive conditions of regional metamorphism; in mica schists, they are characterized by normal garnet zoning and prograde mineral assemblages. In the SE part of the Krowiarki Range, the peak mineral assemblage consists of *g(rim)-ky-st-bi-mu-ilm-q*, which forms the S_2 foliation. In mica schists, staurolite disappears to the NW and is missing west of the village of Romanowo. Pressure-temperature calculations carried out by THERMOCALC software (running on the average P-T mode), for the D_2 peak mineral assemblages differ slightly along the Krowiarki Range and show temperatures of 603 ± 21 °C and 548 ± 16 °C for its SE part (Stronie Śląskie) and NW part (Żelazno), respectively, attaining a pressure of about 8 kbar in both cases. The calcite-dolomite thermometry applied to the Stronie Śląskie marbles yielded maximum temperatures of 565 °C for the calcites arranged parallel to the S_2 axial plane foliation and 512 °C for the carbonates constituting the S_3 mylonitic foliation. The maximum temperatures calculated for marbles occurring to the northwest decrease to 430 °C near Żelazno.

Generally subvertical attitude of the S_2 foliation and a relatively high angle at which it intersects the enveloping surface to F_2 folds observed in some outcrops indicates that the ENE–WSW shortening was assisted with an important vertical stress component. On the other hand, the continuous transition between the internal foliation S_1 preserved in the garnet cores to the external S_2 foliation seen in thin sections points to nearly parallel S_1 and S_2 planes. The observed steep inclusion trails within the inter-tectonic garnet cores may be the result of the rotation of garnet porphyroclasts during D_2 movement. Some S_3 shear zones reactivating the S_2 were developed during the uplift and the drop of temperature, invariably indicating top-to-the-N/NW kinematics.

Tectonic features of earlier stages of structural evolution were together reoriented during the last compressional stages, i.e., NW–SE followed by NE–SW shortening. The observed orientation of S_2//S_3 foliation in the Krowiarki Range is mainly due to the rotation about NW-plunging macrofold axes. During progressive metamorphism (D_1–D_2), the NW part of the Krowiarki Range might occupy a higher structural level. This is shown by lower temperatures obtained for the S_2 fabrics in both schists and marbles and northward disappearance of tremolite from marbles and staurolite from mica schists. The light difference in the metamorphic grade, i.e., temperatures, along the Krowiarki Range may have resulted from folding of D_2-established isograds during the D_4 event around the NW-plunging axes of F_4 folds, which corresponds with the slope of macroform axes towards the NW proposed by Don (1964). Accordingly, the results of this study show that the fan-like pattern of the Lądek-Śnieżnik Metamorphic Unit developed by a tectonic event following the regional metamorphic peak.

References

DON J., 1964. The Złote and Krowiarki Mts., as structural elements of the Śnieżnik metamorphic massif. *Geol. Sudetica*, 1: 79-114. (in Polish with English summary).

The Rheological Parameters Controlling Asymmetrical Cretaceous Extensional Process in the Vepor unit, West Carpathians

Petr JEŘÁBEK[1], Karel SCHULMANN[1], Ondrej LEXA[1] and Jakub HALODA[2]

[1] *Institute of Petrology and Structural Geology, Charles University, 128 43 Prague, Czech Republic*
[2] *Institute of Geochemistry, Mineralogy and Mineral Resources, Charles University, 128 43 Prague, Czech Republic*

The Vepor unit composed of the pre-Alpine basement and Mesozoic cover sequences is one of the major crustal segments incorporated into the Alpine structure of the Central West Carpathians. The basement mostly consists of high-grade orthogneisses, migmatites and large Variscan calc-alkaline intrusive bodies overlying metasedimentary rocks, mainly micaschists, paragneisses and amphibolites. It is generally accepted that this superposition results from a southward Variscan nappe stacking. Two major Alpine deformational events have been recognized in the Vepor unit, the earlier E-W extension followed by dextral transpressional regime, which resulted from oblique convergence of the Vepor basement and presumed