Pre-Carboniferous metamorphic history recorded by metabasites of the Mariánské Lázně Complex, Western Bohemia

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Geological evolution of allochthonous units along the western boundary of the Teplá-Barrandian Unit (TBU) and their parent terrane has been a matter of discussions for decades. One of the minor units of geological importance within the region is the Mariánské Lázně Complex (MLC). The MLC comprises high-grade metamorphosed rocks of variable provenance and is exotic in comparison to the neighbouring meta-sedimentary blocks of TBU, Moldanubian Unit and the Saxothuringian Unit. Several projects by the Czech Geological Survey and a doctoral thesis have investigated the geological evolution and sources of the unit using field structural investigation, petrological and geochemical tools. New geochronological U-Pb, zircon, monazite and titanite data from eclogites, granulites, amphibolite, and orthogneisses of the MLC (Timmermann et al., in print) suggest Cambrian events recorded in HP/MT-HT rocks. A previously proposed hypothesis on Variscan subduction (e.g. Beard et al. 1995) is not suported by these new U-Pb data and field observation.

The present triangular Mariánské Lázně Complex is a complicated tectonic imbrication of serpentinized ultrabasic rocks, amphibolites, amphibole gneisses, mylonitized paragneisses and orthogneisses, and coronitic metagabbros. The presence of minor boudins of eclogites and mafic granulites enclosed in reworked amphibolite-facies rocks is a diagnostic feature of the unit. Southeastwards, rocks of the MLC are tectonically imbricated with rocks of the Teplá Crystalline Unit (TCU). The TCU consists mostly of poly-metamorphosed pelitic metasediments with varied intercalations and shows at least two obliquely overlapping systems of regional metamorphic zonation, both reaching kyanite and sillimanite zones. Along the NW-SE trending boundary zone between the MLC and TCU, bodies of metagabbro in an intimate and unclear spatial association with orthogneisses are common, hosted by refoliated paragneisses. Rocks of the bimodal magmatic series intruded along the contact between the MLC and the Teplá Crystalline Unit (TCU) within the short time span between 496±1 Ma (Bowes and Aftalion 1991) and 518 Ma (Dörr et al. 1998). Variscan granitoids and younger volcanic and sedimentary rocks complete the lithological characteristics of the area.

Several types of gabbroic rocks, varying in mineral and geochemical composition, were recognized in this area, in addition to varied types of HP/HT MLC rocks (Stedra et al. 2002). Aerial distribution of gabbro types is not affected by the presence of tectonic boundary between the Mariánské Lázně Complex and the Teplá Crystalline Unit. Trace- and REE-contents, in addition to the isotopic ratios, show better than MORB the within-plate sub-continental source of these metagabbros.

A substantial part of field work was focused at the structural characteristics of the unit and mutual relationships between rocks. Geophysical anomalies and gradients were taken into account to decipher subsurface extent of contrasting lithological bodies, and the marked deep-rooted anomalous shear zone was identified thanks to magnetic and Bouguer anomalies along kyanite izograd rocks of the TCU.

Qualitative cathodoluminiscence method was used for distinguishing and location of individual rock-forming minerals, Al-rich accessories and REE-bearing accessory minerals like apatite, titanite, zircon, and xenotime.

The combined application of traditional geothermobarometers for the amphibole-bearing rocks opens the way for detailed discussion of individual calibrations, their accuracy and validity for P-T estimations and phase equilibria recorded in amphibole-bearing rocks. This also allowed for P-T-t paths of the MLC eclogites, granulites, amphibolites and metagabbros to be reconstructed. Domainal equilibria controlled by local fluid pressure and diffusion in retrogressed HP/HT rocks appeared to be more powerful mechanism than the reactions described from similar progressively metamorphosed rocks. It is proposed that pre-Cambrian eclogites and granulites record differing P-T-t paths predating the Late-Cambrian/Early-Ordovician bimodal magmatism, and common path of these high grade basic rocks through a weak pressure increase (stacking), subsequent isobaric cooling (relaxation during underplating), and decompression associated with melting (final exhumation) followed.

The summary of the new data indicate that the Mariánské Lázně Complex preserves at least two groups of high-grade rocks displaying contrasting pre-Variscan metamorphic history. The MLC metamorphic rocks of igneous pre-Silurian origin formed in contrasting settings, and their protoliths, even of the basic rocks, are of multiple sources.

The hypothesis that basic and felsic granitoids were emplaced into the already established late Proterozoic or early Cambrian lower/mid-crustal rock assemblage is supported by the petrological features, field structural relationships and geochemical data of the metagabbros and

other basic rocks. It is proposed that the oldest basement rocks of the western part of the TBU represent a relict of the tectonically active middle crust.

There are several possible original settings, the two examples being, e.g. a deep reworked part of an old mixed accretionary wedge, or the subducted segment of the continental margin with incorporated back-arc members and metasedimentary and magmatic oceanic rocks. The model of subduction and exhumation of the part of back-arc basin presented by Chemenda *et al.* (2001) is one of possible scenarios for burial and exhumation of the pre-Ordovician rock sequence, forming part the MLC/TCU area at present. The episode of Early Ordovician mafic magmatism postdated the first stages of the tectonic evolution outlined. After the emplacement of felsic and mafic granitoids, the rock sequence, possibly as a single unit, experienced compressional phase that resulted in growth of garnet in orthogneisses and coronitic gabbros. Timing of this event is ambiguous, but may correspond to early Variscan stacking of upper crustal segments. Variscan stacking and exhumation widely affected Sm-Nd and U-Pb systems, but does not have to necessarily be identical with metamorphic peaks recorded in the rocks.

Pargasite from undeformed pegmatite from Tisová (MLC) was recently dated by Ar-Ar method at ca 379±4 Ma (Bowes et al. 2002). This age is presented to date cooling below 500–550 °C shortly after intrusion of pegmatite melt and after still Devonian metamorphic peak. This would characterise the last stage of partial melting, corresponding with Devonian MP/HT event reported also from western ZEV (O´Brien et al. 1997). The date shifts thus backwards the older tectonic phases that resulted in penetrative metamorphic recrystallisation and ductile deformation of the unit. During the very late and post-Variscan green-schist facies to brittle thrusting and faulting, the high-grade part of MLC and TCU was juxtaposed against the upper crustal low-grade metasediments of the major part of the Teplá-Barrandian Unit. Further detailed study of metasedimentary and felsic rocks from the MLC and TCU, in addition to thourough distinctions between rock types described, are still necessary to fill unexplained gaps in evolution of the area.

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