Correlation of siliciclastic rock chemistry and palaeomagnetic results from the Barrandian Lower Palaeozoic (Teplá-Barrandian Unit, Bohemian Massif): Palaeotectonic evolution of depositional environments

F. PATOČKA* – P. PRUNER – P. ŠTORCH – O. MAN

Institute of Geology, Academy of Sciences of the Czech Republic, Prague, Czech Republic
* corresponding author, e-mail: pat@gli.cas.cz

The Barrandian area (the Teplá-Barrandian unit, Bohemian Massif) provided palaeomagnetic results on Early Palaeozoic rocks and chemical data on siliciclastic sediments of both Middle Cambrian and Early Ordovician to Middle Devonian sedimentary sequences; an outcoming interpretation helped to elucidate source areas of the sedimentary material and palaeotectonic settings of respective depositional environments.

Palaeomagnetic data on Early Palaeozoic rocks of the Teplá–Barrandian unit and recalculated data on contemporaneous units of the Variscan Europe are in good agreement with regard to the palaeolatitudinal drift values in the Middle Cambrian to Middle Devonian time span (e.g. Krs *et al.* 2001, Pruner *et al.* 2002).

Palaeolatitudes for both Middle Cambrian sediments and Late Cambrian volcanics of the Barrandian (58°S) correspond to those identified for the Armorican microplates and Gondwana (cf., Van der Voo 1993).

The Middle Cambrian siliciclastic rocks were sedimented during the oldest Early Palaeozoic sedimentation cycle, principally in the Příbram-Jince Basin. The most probable Precambrian source area of the sediments was an early Cadomian volcanic island arc developed on Neoproterozoic oceanic lithosphere, and accreted to the Cadomian active margin (e.g., Zulauf *et al.* 1999); the volcanic-arc related subduction and accretion are dated by Dörr *et al.* (2002) at >550 Ma and 550–540 Ma, respectively.

Inversion of relief in the Barrandian area interrupted the sedimentation and uplifted the Cambrian basin; the successory extensional Prague Basin subsided there since Tremadocian. Shallow-marine siliciclastic sedimentation prevailed in the Ordovician. Deeper-water black-shale deposition followed in the Early Silurian, and in turn was replaced by sedimentation of carbonate rocks in the course of late Early Silurian (Chlupáč *et al.* 1998). Within-plate basic volcanic rocks of the Barrandian evolved in chemical composition from dominantly alkaline to mostly transitional and tholeiitic since the Ordovician to Silurian (Patočka *et al.* 1993), and together with the described Silurian sedimentary record indicate that the Prague Basin extension reached its maximum in the latter period, although it may have continued until the late early Devonian.

Middle to Late Ordovician rocks of the Barrandian provided low palaeolatitude values of 27–29 °S that may be correlated with the Late Ordovician palaleolatitudes of 23–25 °S for the Crozon Penninsula (Armorican Massif) (Pruner *et al.* 2002).

The Early Ordovician to Early Silurian sediments of the Prague Basin in majority represent an accumulation of the siliciclastic material eroded from an older crust of continental arc/active continental margin type dominated by intermediate to acid (meta)igneous rocks. The older crust may be identified with the Cadomian-age crust of peri-Gondwanan fragments, involving the Neoproterozoic basement of the Teplá-Barrandian unit (e.g., Nance – Murphy 1994, Edel – Weber 1995). The Cadomian crust had been progressively extended and attenuated both by extension and erosion since the times of NW Gondwana breakdown in the earliest Palaeozoic. The siliciclastic sediments of the Middle Ordovician age reflect an intense contribution of clasts derived from dacitic to rhyolitic volcanic rocks of the Barrandian Upper Cambrian (e.g., Vidal *et al.* 1975). Synsedimentary basic extrusives had been providing steady input into the siliciclastic rocks since the Late Ordovician onward, and also the supply of recycled intrabasinal sedimentary component had been increasing in the sediments since the same period.

Above the Late Silurian and Early Devonian limestone suite of the Prague Basin (deposited throughout a period of withdrawal of the Cadomian clastic material source), the flysch-like siliciclastics of the early Givetian age completed the Early Palaeozoic sedimentation of the Barrandian, and marked an onset of the Variscan orogeny (Kukal – Jäger 1988). It has to be pointed out that the Middle Devonian siliciclastics are in many chemical features identical to those of the latest Ordovician to Early Silurian age. Chemical similarity of the Middle Devonian siliciclastics to the latest Ordovician and Early Silurian siliciclastic rocks may be interpreted as a result of reappearance of already deeply dissected Cadomian crust of continental arc/active continental margin type in a proximity of the Prague Basin in the mid-Devonian times (e.g., Strnad – Hladil 2001).

The comparison of the palaeomagnetic and geochemical results obtained on the Early Palaeozoic rocks of the Barrandian suggests that since the Middle Cambrian to Early/Middle Devonian boundary interval the extensional palaeotectonic regime of the Teplá-Barrandian unit was related to the Early Palaeozoic pervasive extension and fragmentation of the NW margin of Gondwana supercontinent and origin of the Armorican microcontinent assemblage. As a component of the Armorican assemblage of microcontinents, the Teplá-Barrandian unit experienced a substantial palaeolatitudinal drift towards the periequatorial realms: the palaeolatitudes of 58 °S and 17 °S were obtained for the Middle Cambrian and Middle Devonian rocks of the Barrandian, respectively (Krs *et al.* 2001). According to the evident consistence of the Barranian values with the Early Cambrian (48 °S), Early Ordovician (37 °S) and the latest Ordovician (23–25 °S) palaeolatitudes inferred for the Armorican Massif (Pruner *et al*. 2002), rather coherrent palaeolatitudinal translations may be presumed for the Teplá-Barrandian unit and Armorican Massif in the Armorican assemblage of mocrocontinents.

The Middle Devonian (early Givetian) flysch-like siliciclastic sediments indicate the reappearance of the Cadomian clastic material source area in the vicinity of the Barrandian (see above). The emergence of the old landmasses may be related to early Variscan and Variscan convergences and collisions among the Armorican microplates, and resulting amalgamation of the Variscan terrane mosaic of the Bohemian Massif (cf., Pharaoh 1999, Winchester *et al.* 2002). These processes involved palaeomagnetically documented large-scale palaeotectonic rotations (e.g. Krs *et al.* 2001) interpreted as oblique convergence and final docking of the Teplá-Barrandian unit microplate and the Bruno-Silesia (Hladil *et al.* 1999).

These investigations were supported both by the Grant Agency of the Academy of Sciences of the Czech Republic (Grant No. A3013802) and the Grant Agency of the Czech Republic (Grant No. 205/99/054), and follow the Research Scheme CEZ: Z3-013-912 (AS CR).

References

Chlupáč, I. – Havlíček, V. – Kříž, J. – Kukal, Z. – Štorch, P. (1998): Palaeozoic of the Barrandian (Cambrian-Devonian). Geological Survey, Prague, 183 pp.

Dörr, W. – Zulauf, G. – Fiala, J. – Franke, W. – Vejnar, Z. (2002): Neoproterozoic to Early Cambrian history of an active plate margin in the Teplá-Barrandian unit – a correlation of U-Pb isotopic-dilution-TIMS ages (Bohemia, Czech Republic). – Tectonophysics. 352: 65–85.

Edel, J. B. – Weber, K. (1995): Cadomian terranes, wrench faulting and thrusting in the central Europe Variscides: geophysical and geological evidence. – Geol. Rundsch., 84: 412–432.

Hladil, J. – Melichar, R. – Otava, J. – Galle, A. – Krs, M. – Man, O. – Pruner, P. – Čejchan, P. – Orel, P. (1999): The Devonian in the easternmost Variscides, Moravia: a holistic analysis directed towards comprehension of the original context. – Abh. Geol. B.-A., Wien, 54: 27–47.

Krs, M. – Pruner, P. – Man, O. (2001): Tectonic and paleogeographic interpretation of the paleomagnetism of Variscan and pre-Variscan formations of the Bohemian Massif, with special reference to the Barrandian terrane. – Tectonophysics, 332: 93–114.

Nance, D. – Murphy, J. B. (1994): Contrasting basement isotopic signatures and the palinspastic restoration of peripheral orogens: Example from the Neoproterozoic Avalonian-Cadomian belt. – Geology, 22: 617–620.

Patočka, F. – Vlašímský, P. – Blechová, K. (1993): Geochemistry of Early Paleozoic volcanics of the Barrandian Basin (Bohemian Massif, Czech Republic): implications for paleotectonic reconstructions. – Jb. Geol. B.-A., Wien, 136: 871–894.

Pharaoh, T. C. (1999): Palaeozoic terranes and their lithospheric boundaries within the Trans-European Suture Zone (TESZ): a review. – Tectonophysics, 314: 17–41.

Pruner, P. – Aifa, T. – Lefort, J. F. – Štorch, P. (2002): A comparison of paleomagnetic data of the Ordovician rocks of Barrandian (Bohemian Massif), Crozon Area and Rennes Basin (Armorican Massif). – Abstract, 8th Castle Meeting, Paleo, Rock and Environmental Magnetism, Castle of Zahrádky, Czech Rep., Sept. 2–7, 2002.

Strnad, L. – Hladil, J. (2001): Geochemistry and composition of the Middle Devonian Srbsko Formation in Barrandian area, Bohemian Massif: A trench or fore-arc strike-slip basin fill with material from volcanic arc or continental margin? – Geolines, 13 (2001): 111–112.

Van der Voo, R. (1993): Paleomagnetism of the Atlantic, Tethys and Iapetus Oceans. – Cambridge Press, Cambridge, 273 pp.

Vidal, Ph. – Auvray, B. – Charlot, R. – Fediuk, F. – Hameurt, J. – Waldhausrová, J. 1975. Radiometric age of volcanics of the Cambrian „Křivok1át–Rokycany“ complex (Bohemian Massif). – Geol. Rundsch., 64: 563–570.

Winchester, J. A. – the PACE TMR Network Team (contract ERBFMRXCT97-0136) (2002): Palaeozoic amalgamation of the Central Europe: new results from recent geological and geophysical investigations. – Tectonophysics, 360: 5–21.