Metabasites from the Polish Part of the Andělská Hora Formation (Moravo-Silesian Zone): Geochemistry, Metamorphic History and Geotectonic Meaning

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A belt of metabasites (greenschists) 2.5 km long occurs in the vicinity of the Pokrzywna village (Opava Mts., Moravo-Silesian Zone). These volcanics appear as interlayers within the upper part of the Andělská Hora Formation (AH Fm.) composed of dark phyllites, metagreywackes and subordinate metaconglomerates (Sawicki, 1959). Přichystal (1981) considered them a possible northern prolongation of the Šternberk–Horní Benešov volcanic belt.

The AH Fm. is the oldest sequence of the Variscan flysch (Culm facies) in the Moravo-Silesian Zone but its precise age has not been established yet. It has been attributed Upper Frasnian – Tournaisian age (Dvořák, 1995), Middle Viséan age (Kumpera, 1983) or the uppermost Lower Viséan to lowermost Middle Viséan age (Otava et al., 1994; Hartley and Otava, 2001).

Metabasites of the AH Fm. lie conformably in metasediments, hence being mostly of synsedimentary – pyroclastic – origin. They are derived from layered, fine-grained tuffites, coherent, crystal tuffs and partly from lava flows. Subvolcanic rock (a sill?) several metres thick with preserved euhedral structure was found at only one locality.

During the Variscan convergence, basic extrusive rocks and the surrounding sediments were incorporated into an accretionary wedge and metamorphosed under greenschist-facies conditions (up to epidote blastesis in chlorite zone). A strong post-tectonic recrystallization of calcite is observed in all metabasites. The subvolcanic sill rock is impregnated by numerous hydrothermal ankerite blasts. Metamorphism was associated with folding and localized shearing along axial cleavage planes.

Despite the different types of primary rocks, all metabasites show similar geochemical signatures of the subalkaline, low-Ti tholeiitic basalts. Most of the investigated samples represent volcanic products derived from a transitional zone between within-plate (ocean island basalts) and N-MORB sources, comparable with enriched E-MORBs. Only one sample of lava flow clearly shows N-MORB affinities. The above observations point to the conclusion that the geotectonic conditions during sedimentation of the AH Fm. were still extensional, and oceanic plateau basalts were generated. This is consistent with the opinion of Přichystal (1993) who noticed that the character of volcanic activity in the Šternberk–Horní Benešov Belt in the Devonian to Lower Carboniferous was transitional, i.e., deviated from continental, alkaline, rift-related volcanism towards more mature, tholeiitic volcanism of the marine basin.

As a final remark, it can be concluded that E-MORB type volcanics of the AH Fm., although enclosed in "flysch-like series" – which should suggest rather orogenic tectonic setting – were actually influenced by no subduction processes.

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Alpine Tectonic Inversion – Principal Mechanism of the Variscan Basement Uplift and Exhumation in the Sudety Mts.

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The most important tectonic feature of the Sudety Mts. and the neighbouring areas (Fore-Sudetic Block, North Bohemian Basin) is their present tectonic style of horst and graben structures. The uplifted elements are very often built of crystalline rocks of the Variscan basement, while neighbouring depressions are composed of younger, epi-Variscan molasse or platform sediments. The youngest strata of the cover involved in the faulting processes are of Santonian age, thus pointing to the Sub-Hercynian – Laramide phases as the dominant orogenic movements. The final relief of Sudety Mts.

was shaped by the Upper Miocene/Pliocene tectonic activity (Dyjor, 1995), related to folding and thrusting in the Carpathian Foredeep leading to the reactivation of old structures in the foreland.

The epi-Variscan cover in the northern peripheries of the Bohemian Massif may be generally divided into three sequences: Upper Carboniferous – Triassic, Middle–Upper Jurassic (now present as scarce relics) and Upper Cretaceous (Cenomanian – Santonian). The stratigraphic gaps, mainly in Lower Jurassic, Lower Cretaceous and in post-Santonian times, indicating sea regressions and breaks in sedimentation, are well correlated with corresponding orogenic events recorded in the Carpathians by Plašienka (1997), especially the closure of the Meliata–Halstatt ocean in the Late Jurassic and the closure of the Penninic–Vahic ocean in the latest Cretaceous to Early Tertiary. During these two periods of compression, the Bohemian Massif played a role of a flexured, foreland area affected by long-distance horizontal stresses (Ziegler et al., 1995) which were also transmitted to the north as far as the Polish Trough (Krzywiec, 2000). Thus, the Bohemian Massif may be considered as a rigid, forebulge segment in front of the northward propagating Alpine orogeny.

The above mentioned horizontal stresses in the Late Palaeozoic – Mesozoic cover produced several folds trending NW–SE to WNW–ESE, well visible in the North Sudetic Basin and the Intra-Sudetic Basin. Intensive fracturing led to the formation of prominent fault lines (many of them inherited after late- and post-Variscan extension) along which some basement blocks were squeezed, uplifted and then affected by erosion. The most spectacular proof of the shortening are inverse faults and even gently dipping thrusts (such as the Lusatian Thrust, Hronov–Poříčí T., border faults of the Nysa Garben (i.e., Zieleniec T., Młoty T., Krosnowice T.), Struga T., Wierzchosławice T., Jerzmanowice T., faults at the SW margin of the Sowie Mts. block, faults bounding the Czerwieńczyce Graben and others). Some of the horsts originated this way may be described as a “pop-up structures”. Displacements of the hangingwalls on the thrust planes have not been sufficiently estimated yet. Geophysical investigations suggest that dip-slip displacement magnitudes may have reached a few hundred meters but the total displacement magnitude may be greater as observed on sub-horizontal slickensides suggesting a strong strike-slip component during tectonic transport. Linking the origin of the compressional and strike-slip related structures with synchronously developed, NE–SW-trending extensional rift zones associated with Neogene volcanics (like the Ohře Rift), Cymerman (1999) postulated left-lateral Alpine transpression for the Sudety Mts.

While the Lower Cretaceous stage of regional uplift is difficult to assess due to nearly complete removal of the Jurassic strata, the total post-Santonian vertical movements may be well defined by taking the transgressive Cenomanian sediments as a reference horizon (Don, 1996). By comparing its deepest position in the North Bohemian Basin (c. 600 m b.s.l, Malkovský, 1987) and in the North Sudetic Basin (c. 800 m b.s.l., Wykroty N 14 borehole, Bossowski, 1991) with the highly positioned outcrops in the Orlickie and Bystrzyckie Mts. (c. 800 m a.s.l.), a given total vertical difference is greater than 1600 m.

There is a close relationship between Alpine, deep-seated faults and thrusts and the distribution of mineral and thermal waters in the Sudetes. A further detailed recognition of the present crustal activity within the fault network is also important for the identification of geohazards (seismicity) and location of hydrographic constructions.

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Magmatic Fabric Pattern of the Land’s End Granite (SW England): Comparative Study of AMS and Feldspar Phenocrysts Tensors

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Land’s End granite (274.5 Ma), the westernmost pluton of the Cornubian batholith (SW England), intrudes intensively deformed Upper Devonian metasedimentary and metavolcanic rocks of The Mylor Slates Formation. Diverse structures docu-