allel to bedding planes; D2 – folding with fold axes trending ENE–WSW, associated with veining (veins subparallel to axial planes); D3 – the second phase of thrusting towards NE, combined with drag folding trending NNW–SSE (thrust over Culm rocks in the eastern quarry); D4 – several phases of younger (Alpine?) fracturing.

A combination of precise stratigraphic and structural data allowed to interpret the 3D tectonics of the area as thrust-separated tectonic slices several hundreds of metres thick (first hundreds). During thrusting, limestones in the nearest vicinity of these thrusts were folded by dragging. The 3D structure is comparable to that described from the Němčice–Vratíkov Belt (NE margin of the Brno massif) by Melichar and Kalvoda (1997) and from Adamov (tectonic slices of Devonian rocks within granodiorites of the Brno massif) by Rez and Melichar (2002)

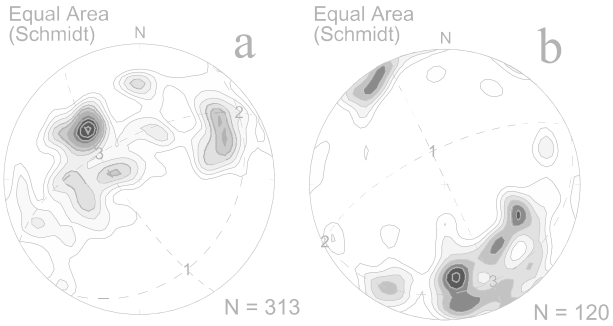

Fig.1. Equal-area projections of directional structural elements from the area under study: a) poles to bedding planes – at least two systems of folds could be recognized: the younger one forming a great arc (defined by points 2 and 3) and the older one forming two kidney-shaped maxima in the upper half of the plot; b) fold axes.

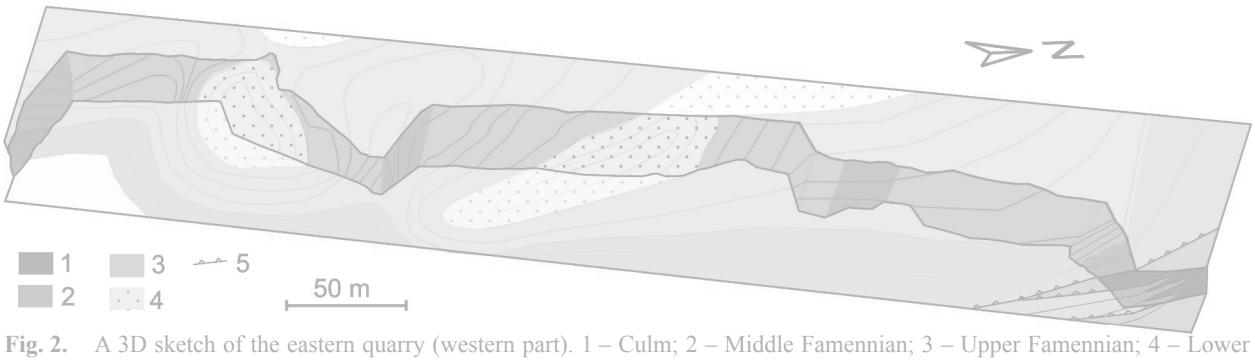

Fig. 2. A 3D sketch of the eastern quarry (western part). 1 – Culm; 2 – Middle Famennian; 3 – Upper Famennian; 4 – Lower Tournaisian; 5 – thrusts.

References

MELICHAR R. and KALVODA J., 1997. Strukturně-geologická charakteristika němčicko-vratíkovského pruhu. Sborník II. semináře České tektonické skupiny, pp. 51-52. Ostrava.

REZ J. and MELICHAR R., 2002. Tektonika výskytu devonu u Adamova. *Geol. Výzk. Mor. Slez. v R. 2001*: 57-61.

Preliminary Data on Mafic Rocks from the Kotusz-1 Borehole (Western Part of the Polish Rotliegend Basin)

Krzysztof SADOWSKI[1] and Stanisław MADEJ[2]

[1] *Institute of Geology, Adam Mickiewicz University, ul Maków Polnych 16, 61-606 Poznań, Poland*
[2] *Institute of Geological Sciences, University of Wrocław, pl. M. Borna 9, 50-204 Wrocław, Poland*

Intensive Permian volcanic activity in NE Germany (*Southern Permian Basin*) described by Benek et. al. (1996) has continued in the area of W Poland (*Polish Rotliegend Basin*). Lava flows described from the area of the Fore-Sudetic Monocline are composed of rhyolite, rhyodacite, dacite, trachyte, lathite, andesite and basalt (Siemaszko, 1981; Kłapciński et al., 1988). Volcanic rocks may be accompanied by hypabyssal rocks, which are represented by microdiorite and microgabbro, and scarcely by plutonic rocks – granites (Jackowicz 1994).

In the northern part of the Fore-Sudetic Monocline, within the Wielkopolska Basin, hypabyssal and abyssal mafic rocks were found in the Kotusz-1 borehole. They are represented by strongly altered gabbroides spot-drilled at an interval between 2301.3–2357.0 m. The drilling of the borehole was stopped at a depth of 2357.0 m without reaching the bottom-side of the gabbroids. The mafic complex (2301.0–2301.3 m) is overlain by Zechstein transgressive breccia. The upper part of the magmatic complex is constituted by grey-black, fine-grained gabbro. Medium-grained gabbro, which we focus on, is located near the bottom of the borehole. Gabbroids, present in the Kotusz-1 borehole, show signs of alteration of various intensity.

Hand specimens of these rocks are grey-green in colour, massive and medium-grained. Gabbro is microscopically fine-grained. Chlorite and actinolite prevail in the rock. Rocks

contain minor calcite, quartz, titanite and opaque minerals (sulphides). Chlorite is characterized by a stable chemical composition. The value of Fe/Fe+Mg oscillates between 0.23-0.27. It contains 23.4–26.6 % chamosite (Fe), 73.9–76.0 % clinochlore (Mg) and less than 0.5 % of pennantite (Mn). Amphiboles from the studied samples are classified as actinolite. The performed analyses of opaque minerals show the presence of pyrite and secondary minerals replaced by titanite. Actinolite together with carbonates, quartz and chlorite take part in the formation of post-pyroxene pseudomorphs that are being described and often have a subautomorphic shape of the primary pyroxene crystals that did not survive rock alteration. Participation of secondary processes (albitization, carbonatization, silicification, chloritization and uralitization), that completely erased the primary mineral composition of the rock is evident from thin sections.

The rocks plot in the subalkaline basalt field on the diagram of Winchester and Floyd (1977). They are characterized by Nb/Y ratio of ~0.4, low content of TiO_2 (1.1–1.5 wt.%) and La/Nb ratio of ~1. According to the Th-Zr-Nb discrimination of Wood (1980) and Th/Yb vs. Nb/Yb of Pearce and Peate (1995), the rocks lie in the E-MORB field. In the Zr-Nb-Y diagram (Meschede 1986), the analysed samples fall in the WPT (within-plate tholeiite) field at the boundary with E-MORB. The gabbroids show a very flat REE pattern as compared to the E-MORB composition. The concentration of REE is very similar to the standard (sample/E-MORB ~1).

Spot-drilled gabbroids in the Kotusz-1 borehole, together with hypabyssal and abyssal rocks known from the boreholes of Banie-1 and Chrzypsko-2 (Jackowicz, 1994) indicate the presence of magma matter of various sizes rooted in the Carboniferous deposits which are connected with Autunian volcanc rocks lying higher up in the section. Gabbroids from the Kotusz-1 borehole may form a roof or an apophysis of a larger magma body, which may be indicated by the occurrence of (medium-grained) texture with the grain-size decreasing towards the roof of the cross-section. The thickness of the described magma body is unknown, since its roof has been eroded; moreover, drilling did not reach its footwall. Source magmas for the gabdroids are presumably connected with the initial rifting stage, which was triggered by heating of the upper mantle by hot plumes. An increase in temperature in the upper mantle led to the generation of magmas with E-MORB characteristics. The La/Nb ratio of ~1 implies that the magmas were contaminated by crustal material during their ascent. The secondary changes in the Permian volcanic rocks of the Fore-Sudetic Monocline were described by Dubińska et al. (1998) as a result of a very low-grade metamorphism (*VLGM*). A similar alteration of volcanic rocks from the Rotliegendes (Northern part of the Fore-Sudetic Monocline) was reported by Jackowicz (1994) and interpreted as mainly post-magmatic metasomatic alteration. Microscopic observations of mafic rocks from the Kotusz-1 borehole indicate that the pristine rock consisted of plagioclase, pyroxene and olivine. All these components were replaced by newly formed minerals (mainly chlorite and actinolite). The described mineral changes seem to be a result of hydrothermal metamorphism. The intensity of the secondary changes decreases towards the roof. The presence of hydrothermal solutions can be connected with the existence of thermal flux of an increased intensity in the area of the Polish Basin of the Rotligendes in the Permian–Triassic period, as described by Karnkowski (1999).

References

BENEK R., KRAMER W., McCANN T., SCHECK T., NEGENDANK J.F.W., KORICH D., HUEBSCHER H.D. and BAYER U., 1996. Permo–Carboniferous magmatism of the Northeast German Basin. *Tectonophysics*, 266: 379-404.

DUBIŃSKA E., BAGIŃSKI B., KAPROŃ G. and BYLINA P., 1998. Pumpellyite in altered volcanic basic rocks from the region of Gorzów Wielkopolski (north-west part of Fore Sudetic Monocline): evidences of very low grade metamorphism (VLGM). *Przegl. Geol*., 46, 1: 71-79.

JACKOWICZ E., 1994. Permian volcanic rocks from the northern part of the Fore–Sudetic Monocline. *Prace PIG*, 145: 1-45.

KARNKOWSKI P., 1999. Origin and evolution of the Polish Rotliegend Basin. *Polish Geological Institute Special Papers*, 3: 1-93.

KŁAPCIŃSKI J., JUROSZEK C. and SACHANBIŃSKI M., 1988. Wulkanity dolnego permu północnej części monokliny przedsudeckiej. *Acta Univ.Wratisl.(875). Pr. Geol. Miner*., 11: 3-31.

MESCHEDE M., 1986. A method of discriminating between different types of mid-ocean ridge basalts and continental tholeiites with the Nb–Zr–Y diagram. *Chem. Geology*, 56: 207-218.

PEARCE D.C. and PEATE D.W., 1995. Tectonic implications of the composition of volcanic arc magmas. *Annual Reviews in Earth and Planetary Science*, 23: 251-285.

SIEMIASZKO E., 1981. Autunian intrusives in the Fore–Sudetic Monocline. In: Symp. Centr. European Permian. Jabłonna 27–29.IV.1978, pp. 201-210.

WINCHESTER J.A. and FLOYD P.A., 1977. Geochemical discrimination of different magma series and their differentiation products using immobile elements. *Chem. Geology*, 20: 325-343.

WOOD D.A., 1980. The application of the Th–Hf–Ta diagram to problems of tectonomagmatic classification and to establishing the nature of crustal contamination of basaltic lavas of the British Tertiary volcanic province. *Earth and Planetary Science Letters*, 50: 11-30.