

*Małgorzata ZIÓLKOWSKA-KOZDRÓJ,¹ Irena WOJCIECHOWSKA¹,
Piotr GUNIA¹, Wiesław KOZDRÓJ²*

GEOCHEMISTRY OF METAVOLCANIC ROCKS FROM KOWADŁO HILL
NEAR BIELICE (STARE MESTO CRYSTALLINE UNIT)
– PRELIMINARY DATA

Abstract: Two, geochemically different types of primary metavolcanics within the Cambro-Ordovician “leptyno-amphibolite” suite of the Stare Mesto metamorphic belt have been recognized due to interpretation of preliminary geochemistry data. The obtained results indicate, that intermediate metavolcanics (or their pyroclastics) might be derived from poorly fractionated andesites / andesitic basalts, whilst acidic metavolcanics had probably represented primary rhyolite / dacite-related protholith. Such geochemical diversity of Bielice metavolcanites might be caused by various rate of partial melting of the pristine melts at the different levels of the continental upper crust.

Keywords: Stare Mesto Crystalline Unit, leucocratic metavolcanic rocks, leptyno – amphibolites, geochemistry, metamorphism,

INTRODUCTION

Stare Mesto Crystalline Unit (SMCU) represents the easternmost part of the West Sudetes region (Lugicum). It is located at the base of the Orlica – Śnieżnik Dome and form a narrow, metamorphic belt contacting with the Velke Vrbno Group which belongs to the Moravo - Silesian zone (Skacel 1979, Schulmann, Gayer 2000). On the territory of Poland, only small parts of the SMCU can be observed on the Kowadło hill situated nearby Bielice village in the southern part of the Bialskie Mts.

The main lithological units of SMCU are: 1) Neoproterozoic (?), variegated, partly anatectic metasediments (biotite-bearing mica schists with intercalations of two-mica paragneisses, crystalline marbles, erlans, quartzites, graphite schists), 2) basic and acid metavolcanites (metakeratophyres) as well as metagabbros and serpentinitised ultrabasic rocks (Pouba 1966, Poubova, Sokol 1992). These metamagmatics are commonly regarded to the “leptyno-amphibolite” suite with 501-509 Ma age (Kröner et al. 2000). Syn- or postdeformational veins (sills) of Variscan granodiorites - tonalites (339 +/- 1,1 Ma; Parry et al. 1997) transect the folded sequences of host metamorphic rocks. The degree of metamorphic changes, evidenced by mineral assemblages is indicative for low-grade amphibolite facies

¹ *Institute of Geological Sciences, University of Wrocław, pl.M.Borna 9,
50-204 Wrocław, Poland*

² *Państwowy Instytut Geologiczny, Oddział Dolnośląski, al.Jaworowa 19,
53-122 Wrocław.*

conditions of Variscan regional metamorphism. Locally, the phenomena of Cambro-Ordovician low-pressure granulite facies conditions are also preserved (Perry et al. 1997; Štípská et al. 2001). Lithological boundaries within SMCU are generally NE-SW oriented, similarly as the orientation of penetrative foliation dipping on NW at the angle of 35-50° under the Orlica-Śnieżnik Dome orthogneisses. The contact between Orlica-Śnieżnik gneisses and the Stare Mesto “variegated suite” is sharp, tectonic and often marked by occurrence of cataclastic zones. An unconformity of structural elements at this zone is also often observed.

The studied laminated, banded metavolcanites are exposed in the small crags localized on the summit of the Kowadło hill (989 m.u.s.l). They form grey-yellowish intercalations, several metres thick, embedded within darker micaceous schists. Differently oriented tectonic mesostructures, represented by: 1) intersection lineations, 2) mineral lineations and 3) intrafolial mesofolds associated with quartz secretions allow to recognize a set of D₁-D₄ deformation events (Wojciechowska 1993). The younger granitoids, (locally with ore mineralisation) transect inconsistently older rocks of the metamorphic cover.

PETROGRAPHY

Four samples of metavolcanic rocks (leptites) from the Kowadło hill were selected for detailed petrologic studies. They show different fabrics depending on the intensity of deformation. Within less deformed parts, the larger porphyroclasts of alkali feldspars (some of them are table-shaped) are closely interfingered with irregular quartz grains. In the background strongly affected by deformation the grano- and granolepidoblastic structures are common. In this case, the metamorphic lamination is well defined by alternating coarse-grained or fine-grained assemblages composed of quartz-feldspar aggregates and biotite-rich layers containing parallelly oriented, elongated sets of biotite platelets. In the coarser parts of leptites one can observe, that larger grains of alkali-feldspars are strongly elongated consistently with direction of the foliation plane. In the “pressure shadows” the mosaic composed of completely recrystallised quartz—feldspar grains occur as well as single table-shaped K-feldspars and twinned plagioclases. The K-rich feldspars enclosed in the fine-grained layers underwent advanced alterations and often they are rich of tiny mica inclusions. Among accessories only single xenomorphic brownish zircon grains was determined during microscopic studies. However, at one specimen the presence of thin band containing chloritised green common hornblende and small amounts of green chlorite with sphene (leucoxene) was also ascertained.

GEOCHEMISTRY

The studied metavolcanics represent two geochemical groups. One, intermediate in composition, that might be derived from primary andesites or andesitic basalts (SiO₂ = 53-57% wt.%, # Mg = 49-50) and the second group, acidic, which can be comparable with rhyolites or rhyodacites (SiO₂ = 69-74% wt.%, # Mg = 41-53). This geochemical bimodality is also well visible on the

TiO₂/Zr-Nb/Y discriminative diagram (Winchester & Floyd, 1977). At this diagram, the projection points was concentrated within two isolated fields: 1) basalts / andesites and 2) dacites / rhyodacites. Geochemical data plotted on Zr – Zr/Y plot have given points in the area where MORB and WPB fields overlap.

On the MORB-normalized multielement pattern all studied samples show strong enrichment of mobile elements such as K, Rb, Ba, Th. The strong positive Ce and slight negative Ti anomalies are also recorded. This characteristic “humped” shape of profile line may indicate contamination of primary eruptive protholith by crust-related sedimentary material. Such enrichment, especially of Rb, Th and Nb can also be related to the influence of primary mantle – dominating component of primary melt. However, on the basis of the obtained results, it can be underlined, that all the relationships showing mobility of HFSE elements during shearing of metapyroclastic rocks are still unrecognized in details.

Two kinds of profiles are also well visible on chondrite-normalized REE spider-diagrams. First of them, typical for meta-andesites is characterized by flat distribution line of REE abundances on the level 30-70 time chondrite value. Such position of profile may suggest fast removing of basic melts during partial melting of the source material (Pearce 1983).

The ryodacites or/and dacites shows relative enrichments of LHREE (50-100 time chondrite) and display strong negative Eu anomalies. The observed sloping of this profile may be indicative for fractional crystallisation phenomena, when plagioclases (as a phase accumulating LREE) were removed from the primary felsic melt.

CONCLUDING REMARKS

Results of petrographic studies prove, that metavolcanics from Kowadło hill near Bielice underwent strong ductile shearing of primary intermediate/acidic volcanics (subvolcanics?) or their pyroclastic equivalents. The strong metamorphic changes of primary composition (due to mylonitisation and recrystallisation), cause that interpretation of the obtained geochemistry results must be carried with care. Irrespective of these disturbances, the preliminary results of trace and REE determinations, may suggests, that two primary volcanic-related suites can be recognized in the leptyno-amphibolite suite: one, more basic, connected probably with poorly fractionated andesites and the second, which represent well developed acidic component of primary cogenetic? intemediate/acidic volcanic association. The strong enrichment in mobile elements led to conclusion, that primary lavas? may have been formed during selective melting on the different levels of the upper-crust. Such phenomena can be indicative for the continental within-plate setting or (as it is evidenced by values of Zr/Y ratio) on the continental margin. The detailed explanation of this hypothesis requires further studies.

REFERENCES

- KRÖNER A., STIPSKA P., SCHULMANN K., JAECKEL P., 2000: Chronological constrains on the pre-Variscan evolution of the northeastern margin of the Bohemian Massif, Czech Republic. Geological Society of London. Special Publications., 179: 175-197.
- PEARCE J.A., 1983: Role of subcontinentst lithosphere in magma genesis at the active continental margins: In: HAWKESWORTH C.J., NORRY M.J., Continental basalts and mantle xenoliths. Shiva Publishing Ltd. Nantwich, 158-185.
- PARRY M., ŠTIPSKA P., SCHULMANN K., HROUDA F., JEŽEK J., KRÖNER A., 1997: Tonalite sill emplacement at an oblique plate boundary: northeastern margin of the Bohemian Massif. Tectonophysics, 280: 61-81.
- POUBA Z., 1966: The Silesicum. In: SVOBODA et al.: Regional geology of Czechoslovakia, Part 1, The Bohemian Massif, 213-246. Ustredni Ustav Geologicky, Praha.
- POUBOVA E., SOKOL A., 1992: The petrology and geochemistry of the metaophiolitic rocks of Stare Mesto crystalline unit. Krystalinikum 21: 67-88.
- SCHULMANN K., GAYER R., 2000: A model for continental accreconary wedge developed by oblique collision: the NE Bohemian Massif. Journal of the Geological Society, London, 157: 401-416.
- WINCHESTER J.A., FLOYD P., 1977: Geochemical discrimination of different magama suites and their differentiation products using immobile elements. Chemical Geology. 20: 325-343.
- WOJCIECHOWSKA I., 1993: The problem of the Orlica Discordance in the Eastern part of the Ziemia Kłodzka Region (The Sudetes, Poland) (in Polish with English summary). Acta Universitatis Wratislaviensis Prace Geologiczno-Mineralogiczne, 36: 9-26.