Geochemistry of Metabasites in the Stronie Group and Nové Město Group, the Orlica-Śnieżnik Dome, West Sudetes

Izabella NOWAK and Andrzej ŻELAŹNIEWICZ

Institute of Geological Sciences, PAS, Podwale 75, 50-449 Wrocław, Poland

The Stronie Group (SG) supracrustal rocks, together with a variety of gneisses enclosing small bodies of granulites and eclogites, form the middle and eastern parts of the Orlica-Śnieżnik dome (OSD). The westernmost flank of the OSD is formed by the Nové Město Group (NMG). Metabasites within the Stronie Group appear as small lensoid or irregular bodies, rarely exceeding 0.5 km^2, associated with mid-grade metamorphosed metapelitic schists, subordinate marbles, quarzites and acid metavolcanic rocks. They form two groups: alkali basalts of WPB type and subalkali tholeiites similar to MORB, with typical ratios of characteristic elements. No low-Ti metabasites has been identified. Alkali basalts are characterized by Nb/Y > 1.5, Ti/V > 50, Zr/Y > 4, Zr/Nb < 5. In metatholeiites the ratios are: Nb/Y < 0.7, Ti/V < 50, Zr/Y < 4, Zr/Nb > 20. Metabasites of WPB type occur as laminated biotite amphibolites which pass laterally to mica schists or to calcareous schists next to marble bodies. At least part of these amphibolites likely originate from tuffitic protolith merged with clastic rocks and represent pyroclastic products of early stage of a continental rift volcanism. MORB-like metatholeiites are more frequent, though their occurences are widely separated and differ in size. They have fine-grained gabbroic or diabasic protoliths interpreted as hypabysal lava bodies or dykes feeding individual volcanoes during more advanced rifting. Marbles contain problematic fossils of early Cambrian age (e. g. Gunia 1984), which suggests similar age for the interlayered metatuffs. U-Pb SHRIMP analyses of zircons from acid metavolcanics throughout the SG yielded similar ages of ~500 Ma (Murtezi and Fanning 2005). Accordingly the same age is assumed for the SG metabasites.

In the NMG, Domečka and Opletal (1980) and Opletal et al. (1990) identified subalkalic tholeiites interpreted as ocean floor basalts and co-magmatic calc-alkaline felsic volcanites, apparently different from (meta)basites of the Stronie Group at the OSD core. Our studies show that the NMG metabasites, generally similar to the main series tholeiites of Floyd et al. (1996, 2000), can be subdivided into 3 different types: within-plate tholeiites (WPT) which dominate in the region, less common MORB-like tholeiites, and scarce Ti-tholeiites, based on Zr/Y, Ti/Y, Ti/V, Zr/Nb, $(La/Yb)_N$ and $(La/Sm)_N$ ratios and abundances of HFSE and REE. In the field, the WP-tholeiites (Zr/Y ca. 3.57 to 5.70; Ti/Y ca. 290–450) and MORB-like tholeiites (Zr/Y < 3.5; Ti/Y < 320) form roughly parallel belts concordant with the regional meridional strike of the main lithological boundaries and that type of their distribution continues E-ward to the Stronie Group. It is observed in the field that the WP tholeiites and Ti-tholeiites are accompanied by felsic volcanites which injected the former and the MORB-like tholeiites intruded other mafites. Both field evidence and geochemistry confirm earlier conclusion of Opletal et al. (1990) who concluded that the bimodal magmatic rocks were derived from the same magma source. U-Pb SHRIMP datings of acid metavolcanics in the NMG reveal an age of ~500 Ma, identical with that determined for the SG rocks.

In the NMG, the WPT and MORB-like metabasites have rather uniform isotopic signature εNd(500) ~5–7 suggestive of similar mantle source and possibly weak contamination with crustal material. A MORB source transitional between N-MORB and E-MORB and an enriched mantle source are suggested. A N-MORB-like source might possibly be mixed with an enriched OIB-like source (plume). For the WPT, both the isotopic and characteristic elemental ratios may also point to mild contamination due to some crustal admixtures. The SG MORB-like metabasites have similar isotopic signature to the NMG metatholeiites εNd(500) ~5–6. They come from a common depleted mantle source. Isotopic signature εNd(500) ~2–4 of the SG alkali basalts suggest derivation of the alkali magmas from a different more enriched mantle source than the source of the metatholeiites.

The mafic magmatism recorded in the NMG and SG likely developed in a relatively short period of Mid-Late Cambrian magmatic episode in a continental rift-related (probably back-arc) setting which reached the stage of new oceanic crust production represented by MORB-like metabasites. The scarce alkali basalts from the eastern part of the SG area are assigned to earlier stages of the rifting. Palaeogeographic assignment of the rift basin needs dating of its sedimentary-volcanogenic infilling. Further U-Pb datings are under way.

References

FLOYD P.A., WINCHESTER J., CIESIELCZUK J., LEWANDOWSKA A., SZCZEPAŃSKI J. and TURNIAK K., 1996. Geochemistry of early Palaeozoic amphibolites from the Orlica-Śnieżnik dome, Bohemian massif: petrogenesis and palaeotectonic aspects. *Geol. Rundschau*, 85: 225–238.

FLOYD P.A., WINCHESTER J., SESTON R., KRYZA R. and CROWLEY Q.G., 2000. Review of geochemical variation in Lower Palaeozoic metabasites from the NE Bohemian Massif: intracratonic rifting and plume–ridge interaction. *Geol. Soc. Lond., Spec. Publ.,* 179: 155–174.

GUNIA T., 1984. Microflora of Pre-cambrian limestones of the Duszniki Zdrój region (Central Sudetes). *Roczn. PTG,* 14: 65–92.

MURTEZI M. and FANNING M., 2005. Petrogenesis, age and tectono-metamorphic evolution of the acid metavol-

canites of the Stronie formation (Orlica-Śnieżnik Dome, Sudetes, SW Poland), *Geolines*, 19: 85.
OPLETAL M., DOMEČKA K. and ČECH S. et al., 1980. Geology of the Orlické hory Mountains. Academia, Praha, pp. 202.
OPLETAL M., JELÍNEK E., PECINA V., POŠMOURNY K. and POUBOVA E., 1990. Metavolcanites of the SE part of the Lugicum, their geochemistry and geotectonic interpretation. *Sbor. geol. věd. Geologie*, 45: 37–64.

Granitoids from the Ditrău Alkaline Massif, Transylvania, Romania

Elemér PÁL-MOLNÁR

Department of Mineralogy, Geochemistry and Petrology, University of Szeged, 6722 Szeged, Egyetem u. 2-6., Hungary

Re-examination of a part of the Ditrău Alkaline Massif [DAM], identified earlier as granite, has revealed that it has a complex petrography, containing monzonites, syenites and granites. These rocks are peraluminous and peralkaline, moderately to highly fractionated. The most fractionated are the oversaturated rocks (granites) representing the subalkaline branch of the magmatic evolutionary trend, while alkaline branch contains quartz-monzonites, quartz-syenites, syenites and probably nepheline syenites.

According to the discrimination diagrams, Ditrău granites are A1-type and within-plate granites. K/Ar ages obtained from amphibole and biotite vary between 217.6 ± 8.3 and 196.3 ± 7.4 Ma, which fall close to the age of nepheline syenites (216.0±8.1 Ma) and hornblendites (226.0 ± 9.6 Ma) from the rocks of the massif which also support the coeval relations between them.

Occurrence of characteristic accessory minerals, zircon morphology and data from geochemistry and microthermometry suggest a mantle derived parental magma from which the series of derivates were formed by fractionation, differentiation and contamination processes in the upper crust in an extensional, within-plate tectonic setting.

Introduction

The mineral composition, structure and magmatic evolution of the DAM (Transylvania, Romania) have been discussed for more than 150 years. During this time numerous researchers attempted to explain the genesis of the massif. Summarising extensive previous research, two possible hypotheses have emerged concerning the origin of the granite: (1) it is either a differentiation product of mantle-derived ultramafic melts or (2) it was formed by crustal contamination process. The purpose of this paper is to augment understanding of the formation of the granitoid rocks in the DAM by using zircon morphology, geochemistry, fluid inclusion analysis and geochronology.

Ditrău Alkaline Massif has a complex petrography: a wide variety of igneous rocks have been described from the DAM. Within a short distance from a peridotite to granite, nepheline syenite type rocks crop out. The granitoid rocks occur in many places in the DAM, the largest body occurring in the north-eastern part of the massif.

Petrography of the granitoid rocks

The examined rocks are dominantly leucocratic, pale-grey, pale-pink or reddish in colour. Modal analyses, mineral composition and textural studies enabled a clear differentiation of the following rock types: syeno- and monzogranites; syenites, quartz-syenites, alkali-syenites; monzonites, quartz-monzonites.

On the basis of the mafic minerals, two well-separated groups can be distinguished within the studied rocks. The first contains biotite±hornblende, whereas in the second displays alkali pyroxene (aegirine) and alkali amphibole (arfvedsonite) are the main mafic components. These two groups mean different chemical character (Shand 1947, Clarke 1992), the first one is metaluminious and the second one is peralkaline. The most frequent accessory minerals are apatite, zircon, sphene, allanite and opaque minerals.

The zircon crystals of the studied populations are dominantly transparent, colourless, pale-yellow and pale-brown or rarely reddish-brown in colour and all grains are euhedral. Their zonality shows more than one crystallisation phases. The most frequent subtypes (Pupin 1980) are: P_4, P_5, P_3, S_{19}, S_{20}, S_{24} és D in the examined rocks, plotting at the boundary of the subalkaline and alkaline fields which suggest that the zircon crystals were formed in a hyperalkaline or hypoaluminous geochemical environment.

Geochemistry

The examined rocks are moderately to highly fractionated. The SiO_2 contents ranges between 63.5–77.1 wt%. The calcium and magnesium contents are low: 0.1–0.9 and 0.1–0.6 wt% but sample AGK-6831 is less fractionated and contains 2.1 wt% CaO and 1.0 wt% MgO. The FeO*/MgO is relatively high: 4.6 to 10.7 wt%. The alkali contents are also high; K_2O varies between 4.7–6.5 and Na_2O ranges between 4.4 to 6.1 wt%. According to the Q-P diagram (Debon Le Fort 1983) the examined rocks are classified as granites, monzonites, quartz-syenites and syenites which separate two distinct groups regarding SiO_2 vs. (Na_2O+K_2O) diagram where plotted on the fields of alkaline and subalkaline series. Their chemical character is peraluminous and peralkaline but metaluminous also occurs in the A/CNK vs. A/NK diagram after Maniar and Piccoli (1989). Two separated groups of samples can be seen in the Harker variation diagrams which are correspond to the alkaline and subalkaline series.

The REE patterns of the examined granites can be characterised by a moderately falling LREE part with marked negative Eu anomaly and a slightly lifting HREE part. The ratio of Eu/Eu* ranging from 0.02 to 0.48. On the multi-element variation diagram where element contents are normalized to chondrite shows negative Ba, Sr, Eu anomalies.