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ISOTOPIC CHARACTERISTICS OF VOLCANIC ROCKS FROM SOUTHWESTERN POLAND AND NEIGHBOURING AREAS IN CZECH REPUBLIC AND GERMANY

Abstract: The volcanic rocks (basanites, nephelinites, trachyandesites and trachytes) from southwestern Poland and neighbouring areas in Germany and Czech Republic were investigated (LT). They form the easternmost part of the Central European Volcanic Province (CEVP). Analyses of Pb, Sr, Nd and Hf isotopic ratios were carried out using MC-ICP-MS and TIMS. Our data indicate strong influence of HIMU-type mantle component comparing to volcanic rocks from western Bohemia and Moravia.

Keywords: CEVP, basalts, Pb, Sr, Nd, Hf isotopes, magma evolution, mantle sources.

INTRODUCTION

The Lower Silesia volcanic rocks occuring in the southwestern Poland belong to the Central European Volcanic Province (CEVP) extending from the Eifel through the Czech Republic and ending in the Lower Silesia (Fig. 1). This volcanic chain is composed of large separated fields and smaller intrusions (pipes, necks, flows, veins) of basalts and their differentiates. They form isolated bodies in local concentrations (Lubań-Bogatynia, Jawor-Jelenia, Niemcza-Lądek Zdrój, The Opole Silesia). Radiometric ages of basaltoids range from 4 to 40 Ma (Alibert et al. 1987, Birkenmajer et al. 2002). Volcanic rocks are situated along zones of deep fractures active since Paleozoic (Dziedzic 1989). They are emplaced in various geological units and rocks of different ages and lithologies. There are several types of basaltoids distinguished in the Lower Silesia (Kozłowska-Koch 1987): olivine melilite (Męcinka), nephelinite (Kozów, Góra Św. Anny), basanite (Gracze, Wilcza Góra, Lutynia). Many of them contain ultramafic xenoliths (lherzolite, harzburgite, rarely dunite and wehrlite). Investigated rocks are located along the eastern border of the Zittau-Bogatynia tectonic structure and their emplacement was controlled by the Opolno-Zdrój fault, which crosscut the Hercynian granitic basement (Alibert et al. 1987).

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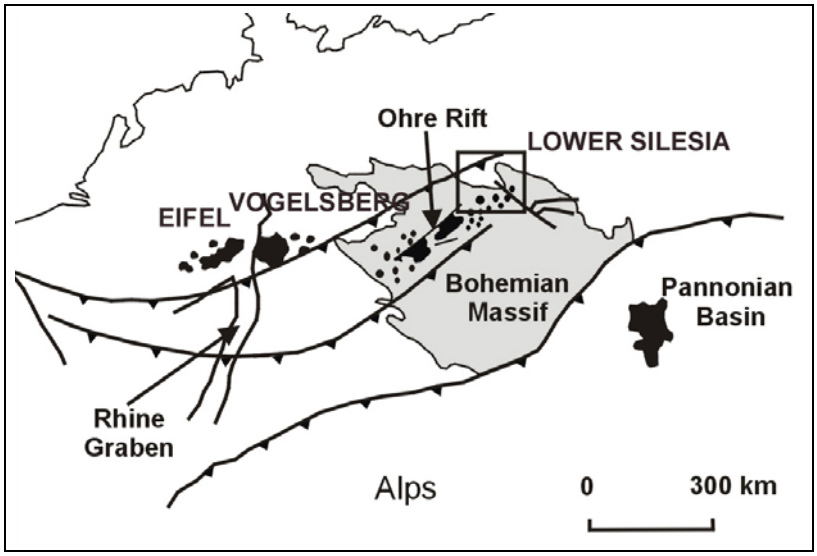

Fig.1. Map of the central Europe, showing the location of investigated area (after Wilson, Downes 1991).

SAMPLES AND ANALYTICAL TECHNIQUES

We collected 24 samples (16 samples from SW Poland, 5 samples from northern Czech Republic, 3 samples from Zittau area in Germany). The group of specimens are in close relationship with the Ohre rift in Czech Republic. Additionally, for comparison we collected 7 samples from Western Bohemia in Czech Republic (WB) and 2 samples from Moravia (M) in eastern Czech Republic.

Pb, Sr, Nd and Hf were chemically purified in the clean laboratory at the Danish Lithosphere Centre in Copenhagen (Ulfbeck et al. 2003, Peate, Baker 2003). Pb, Nd and Hf isotopic composition was analysed by double focussing, magnetic sector VG AXIOM multiple collector inductively coupled plasma mass spectrometry (MC-ICP-MS). Sr isotopes were measured by conventional thermal ionisation mass spectrometry (TIMS) in the Geological Institute at the University of Copenhagen.

RESULTS

Studied volcanic rocks represent alkali magmas, moderately deficient in silica (SiO_2=40-47,85 wt%). According TAS diagram they locate mostly in the basanite and nephelinite fields. Basaltic trachyandesite are not very common (SiO_2=51,25-53,18 wt%). Trachytes are scarce (SiO_2=62,07 wt%). Apart from more differentiated rocks they show quite high MgO content (8,07-15,16 wt%). They contain more Na_2O (2,1-7,77 wt%) than K_2O (0,41-4,97 wt%).

Our samples show HIMU-like characteristics (Fig.2), with radiogenic lead isotopic ratios ($^{206}Pb/^{204}Pb$=19.4-20.8). These ratios are much higher than $^{206}Pb/^{204}Pb$ in lavas from the Eifel and Vogelsberg regions (Germany), from

Western Bohemia (Czech Rebublic) and Moravia (Czech Republic). Most of the basaltoids have isotopic composition close to LVC (Hoernle et al. 1995). There is strong positive correlation between Nd and Hf isotopic ratios, and they plot below the main mantle array. The further from Ohre rift (Bogatynia group: ε_{Hf} 4,68-5,85) the higher Hf ratios we obtain (Zittau-Lubań group: ε_{Hf} 6,22-7,93). The $^{87}Sr/^{86}Sr$ are quite low (0,70326-0,7044), and they confirm general trend of decreasing of Sr isotopic ratios across CEVP (from W to E) postulated by Blusztajn and Hart (1989).

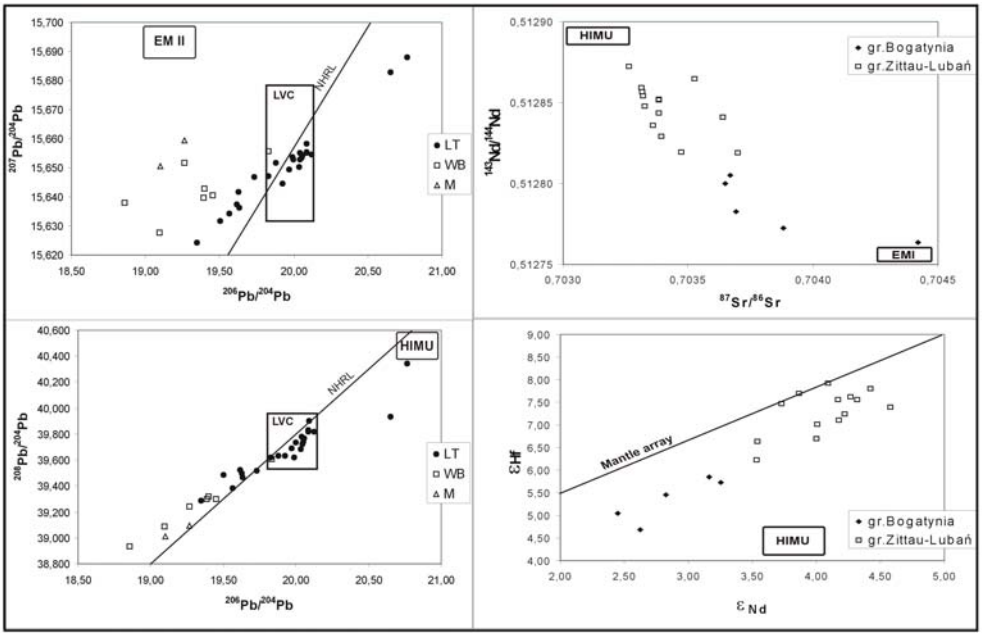

Fig.2. Pb, Sr, Nd and Hf covariations. HIMU – high μ mantle source, EMI and EMII – enriched mantle, LVC – low velocity component.

DISCUSSION AND CONCLUSIONS

The geochemical and isotopic variations observed in mafic lavas are used to clarify the role of petrogenetic processes (melting, differentiation) and heterogeneities in the mantle source (Alibert et al. 1987):

1. Basanites and nephelinites represent primitive alkaline magmas, which could be the effect of partial melting in the depleted mantle source. The occurrence of silica-saturated trachytes is related to assimilation of upper-crustal melts.
2. There is visible positive correlation between Nd and Hf isotopic ratios, which could be explained by mixing between depleted mantle and old subducted sediments in OIB mantle reservoir.
3. The HIMU-like Pb-Nd-Hf isotopic characteristics is typical for many West African (eg. Cameroon line) and West European plumes (eg. West Bohemia). As there is only small amount of movement between these plates for the last 60

Ma, there might be some connection between these volcanic provinces, for example via common lower mantle source. HIMU-type can be connected also with crustal contamination of melts derived from the asthenosphere.

4. Most of LT samples plot in LVC field, so presence of weak asthenospheric plumes is also regarded (Hoernle et al. 1995, Faure 2001). They could influence at the base of the lithospheric mantle or after intruding along deep fractures.

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