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Comparative petrological studies of some alkaline basalts, western Pannonian Basin, Austria

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Alkaline basaltic volcanism commenced in the Late Pliocene and continued until the early Pleistocene. Moreover, the alkaline basaltic magmas were developed in response to passive upwelling and decompressional melting of asthenospheric mantle material. The volcanism is characterized by mafic rock types ranging from highly undersaturated nephelinites (Stradnerkogel & Waltrafelsen) to basanites and alkali basalts (Burgenland).

The majority of the Burgenland lavas (Pauliberg and Oberpullendorf) are basalts and tephrite basanites. They have been affected by clinopyroxene fractionation. This fractional crystallization of clinopyroxene occurred at high pressure (>1.3 GPa) where dike walls were sufficiently warm to allow marginal crystallization of liquidus clinopyroxene. Olivine and augite phenocrysts, as well as groundmass olivine, augite and plagioclase, judging from the low AlVI/AlIV values that range from 0 to 0.48, grew within the magma at lower pressures.

The most primitive sample from Pauliberg (PLB-7) is not compromised by clinopyroxene fractionation and qualifies as olivine-fractionated derivatives of peridotite-source primary magmas that can be considered as primary magma.

The calculated mantle potential temperature from Pauliberg basalt yields 1386 oC and the melt fractions do not look very high ($\sim$ 0.02). Despite the uncertainties that arise due to Cpx fractionation, an adequate mantle potential temperature from Oberpullendorf basalt was obtained (Tp=1529 oC). These calculations indicate that they have been melted from ambient mantle i.e. no thermal anomaly indicated.

The compatible trace elements (Ni and Cr) support the observation made from major elements that these magmas represent primitive lavas and underwent only a little crystal fractionation.

On the other hand, the Stradnerkogel and Waltrafelsen nephelinites are the most undersaturated and evolved (mg-number = $\sim$54) lavas in the Styrian Basin. Major-elements can be adequately explained by melts mostly generated from carbonated mantle lherzolite ($\sim$ 5% CO2) at high pressure. They have the lowest Cr contents suggesting the lowest degree of partial melting form all studied lavas and they are strongly enriched in incompatible elements.

In the primitive mantle normalized diagram (McDonough & Sun, 1995) the Styrian magma does not show any negative Nb anomaly if compared to the neighbor elements, excluding any interaction with subduction related fluids/melts and/or crustal contamination. Additionally, the studied lavas except Pauliberg have (Tb/Yb)N ratio ranging from 2.2 to 2.3 and are comparable to those of the alkali basalts of Hawaii (1.89- 2.45). In contrast, Pauliberg alkali basalts have high (Tb/Yb)N ratios ranging from 2.73 to 2.9.

Pauliberg and Oberpullendorf alkali basalts are different in their Sr and Nd isotopic ratios, as the Oberpullendorf has high 87Sr/86Sr and low 143Nd/144Nd, whereas the Pauliberg has low 87Sr/86Sr and high 143Nd/144Nd. On the other hand, the nephelinites of Stradnerkogel and Waltrafelsen have the highest 143Nd/144Nd (0.512858) and lowest 87Sr/86Sr (0.703505) ratios. The Oberpullendorf alkali basalt has the lowest 143Nd/144Nd (0.512736) and highest 87Sr/86Sr (0.704279) ratios.

The isotopic compositions of the studied lavas indicate a depleted character and are similar to HIMU-OIB (relatively high 143Nd/144Nd and low 87Sr/86Sr isotopic ratios). Thus they are distinct from EMI-OIB and EMII-OIB (e.g. Weaver, 1991; Wilson, 1993).

References

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