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Pb-Sr-Nd isotopic compositions and trace element geochemistry of hornblende phenocrysts in Tertiary lavas from the Rhön (CEVP)

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Primitive alkaline lavas with high TiO_2 concentrations (3-4 wt.%) from the Rhön area (Central European Volcanic Province; CEVP) contain 0.5-2.0 cm large hornblende phenocrysts with high MgO ($\sim$14 wt.%) and high TiO_2 (4.5-5.6 wt.%) concentrations. These hornblende phenocrysts can be classified as ferri-kaersutite (Zaitsev et al., 2011). Based on high TiO_2 abundances and distinct MgO-Al_2O_3 relationships relative to other CEVP lavas, the hornblende-bearing lavas may have been generated by partial melting of pyroxene-rich veins with abundant hydrous (amphibole) mineral phases. Evidence for residual amphibole in the mantle source of the parental magmas is provided by negative K anomalies in mantle-normalized trace element patterns and the lack of K-Ba fractionation.

Xenolith studies (Witt-Eickschen et al. 1993; 1998; 2003) in the Eifel area have provided petrological evidence for hornblende-bearing upper mantle rocks. Hornblende from these xenoliths has markedly lower TiO_2 concentrations (0.4 wt.%) than the ferri-kaersutite crystals. Amphibole from magmatic veins in spinel peridotite xenoliths, however, has up to 3.7 wt.% TiO_2. These veins have been interpreted to be derived from partial melting of metasomatized zones of the upper mantle.

Rare Earth Element pattern of the ferri-kaersutites show LREE enrichment relative to HREE abundances with maximum concentrations for Nd and a general convex downward REE pattern. Modelled trace element concentrations of the amphibole – using simple mineral-melt equations – are similar to measured incompatible trace-element concentrations of ferri-kaersutite. Thus, high-TiO_2 amphibole crystallized from a high-TiO_2 alkaline magma and crystals represent true phenocrysts rather than upper mantle xenocrysts. The Sr isotope composition of ferri-kaersutite samples is similar to the Sr isotope composition of the corresponding lavas (initial $^{87}Sr/^{86}Sr$: 0.7035-0.7037). Amphibole samples show Nd and Pb isotope ratios that are similar relative to their corresponding whole rocks (εNd: +4; $^{206}Pb/^{204}Pb$: 19.3 – 19.4;$^{207}Pb/^{204}Pb$: 15.63 – 15.67; $^{208}Pb/^{204}Pb$: 39.1 – 39.3), except for two mineral separates that exhibit crust-like unradiogenic Nd (εNd: -3 and -4) and unradiogenic Pb ($^{206}Pb/^{204}Pb$: 18.2 and 17.1;$^{207}Pb/^{204}Pb$: 15.62 and 15.55; $^{208}Pb/^{204}Pb$: 38.2 and 37.6) isotope compositions. Phlogopite mineral separates from the Tertiary Urach volcanic field show a broadly similar variation in Sr, Nd, and Pb isotope composition (Hegner et al., 1995), interpreted as an ancient crustal signature. Osmium isotope data revealed substantial crustal contamination in most alkaline lavas from the Urach volcanic field (Blusztajn and Hegner, 2002), which supports the presence of a crustal component in the Urach phlogopite crystals. For the hornblende-bearing Rhön lavas, unpublished Os isotope data also indicate some crustal contamination that however, is not obvious from the Nd and Sr isotope data. In contrast to the Urach samples, even the most primitive hornblende-bearing lavas from the Rhön have very radiogenic Os isotope composition (init. $^{187}Os/^{188}Os > 0.250$), which may be inherited from their amphibole-bearing pyroxenite source. In contrast, apparently uncontaminated lavas from the Rhön and the nearby Vogelsberg area have, relative to the hornblende-bearing lavas, unradiogenic init. $^{187}Os/^{188}Os$ of ca. 0.13-0.14 reflecting the Os isotope composition of the peridotitic upper mantle. Thus, the "crust-like" Nd and Pb isotope signatures in igneous amphibole megacrysts does not necessarily reflect crustal contamination, but may reflect inheritance from ancient mantle components in the source of the hornblende-bearing alkaline lavas from the Rhön.

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