LAM-ICP-MS and whole-rock investigations on mantle xenoliths from Chukotka, NE-Siberia

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The late Cenozoic intra-plate Bering Sea Basalt Province comprise 17 volcanic fields that occur on islands in the Bering Sea, on the west coast of Alaska and on the northeast cost of Russia. The lavas are mainly tholeiitic and alkalic olivine basalts with subordinate basanites and nephelinites. The Enmelen volcanic field in east Chukotka differs from the other volcanic fields in that the majority of the lavas are undersaturated (olivine melanephelinites and few tephrites) and carry abundant mantle xenoliths.

Xenoliths hosted by the lavas are spinel lherzolites. Augite, diopside, orthopyroxene, olivine, ilmenite and phlogopite megacrysts up to 13 cm in diameter are also very common.

On the basis of trace element analyses of whole-rock and of their clinopyroxenes, three groups of spinel lherzolites can be distinguished. Group A shows chondrite-normalized whole-rock REE patterns with typical depletion of LREE relative to intermediate and HREE (La_N = 0.5 x C1 and Yb_N = 1.4 x C1). The clinopyroxene chondrite-normalized REE patterns have La_N ranging between 0.8 - 1.2 x C1 and Yb_N ~ 10 x C1 and plot almost parallel to the whole-rock REE patterns. As there is no evidence for metasomatic events, model calculations show that group A represents the residue left after 3-4% fractional melting of a primitive mantle. Group B is represented by spinel lherzolites that have whole-rock chondrite-normalized REE patterns with strongly enriched LREE relative to intermediate and HREE (La_N = 9 x C1 and Yb_N = 1 x C1). Their clinopyroxenes are also enriched in LREE and plot sub-parallel to the whole-rock REE patterns (La_N ~ 70 x C1 and Yb_N ~ 10 x C1). The lack of hydrous phases suggests that group B has experienced cryptic metasomatism in previous stage(s) of their evolution before re-equilibration. Group C is characterized by the presence of amphibole. Whole-rock chondrite normalized REE are enriched in LREE relative to intermediate and HREE (La_N = 5 x C1 and Yb_N = 1 x C1). Chondrite-normalized REE from the core of clinopyroxenes have patterns with depleted LREE similar to those of group A. However, their rims show, relative to the core, an increase of the LREE (La_N/Sm_N = 0.21 and 2.44 for core and rim respectively). The introduction of fluids, rich in OH, LREE, Sr and Ti and the formation of amphibole must have taken place shortly prior to the incorporation of the rocks into the host lavas and before re-equilibration could be achieved.

CO_2 Fluxes from the Mantle Plume in the Eifel

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Introduction

Geodynamic phenomena in the western part of the Rhenish Massif are triggered by a mantle plume centred slightly south of the West Eifel. The mantle plume has been identified by Ritter et al (2001) as a columnar low P-velocity anomaly in the upper mantle with a lateral contrast of up to 2 %. The plume structure is about 100 km wide, it extends into the upper mantle to at least 400 km depths and corresponds to about 150-200 K excess temperature (Ritter et al 2001). Surface expressions of the mantle plume in the Eifel are not only very young volcanism and an enhanced geodynamic activity but also the presence of numerous mineral springs and gas emanations extremely enriched in carbon dioxide.

Results and Discussion

At present the Eifel districts are among the major CO_2-gas producing regions in Europe. There is an overabundance of CO_2-gas rich springs, with the overall distribution of CO_2-gas being much more extensive than the distribution of Tertiary and Quaternary volcanics at the surface. This is predominantly the case for the West Eifel, where to the SW and NW (the Ardennes) of the volcanic West Eifel several clusters of CO_2 gas discharges and CO_2-gas rich springs occur. Rare gas isotopes in these waters and gases show a significant enrichment of mantle-derived volatiles (Griesshaber and Niedermann 2002), although, south of the volcanic West Eifel and in the Ardennes there is neither volcanism at the surface nor an incorporation of melts within the crust.

The central aim of this study is to present the overall distribution pattern and thus anomalies of carbon dioxide in waters and gases at the Eifel districts. From the different partial flows the surface flux of carbon dioxide has been determined for the East and West Eifel districts, the Hocheifel and the Ardennes. Herewith the amount of magmatic carbon dioxide is assessed that is added in the region of the Eifel mantle plume to the continental crust.

References

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