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Alkaline syenite and carbonatite magmatism in Quaternary eruptive centers of the Eifel: case studies from the Rockeskyller Kopf Volcanic Complex and the Laacher See Volcano

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The Quaternary Rockeskyller Kopf Volcanic Complex (RKVC) of the western Eifel contains a series of plutonic to sub-volcanic xenoliths that correspond to a full sequence of rocks, which are characteristic of alkaline-ultramafic magmatic complexes with carbonatites worldwide. Calcite-bearing foiditic lapilli are abundant in pumice layers of the RKVC. Calcite also forms spherical globules in unhydrated foiditic glass shards and inclusions entrapped in olivine and clinopyroxene phenocrysts of palagonite tuffs from RKVC.

Carbonate-bearing nosean syenites are observed in plutonic to sub-volcanic xenoliths from Laacher See volcano (LSV) as well. They have variable calcite proportion and locally have carbonatitic composition. In both occurrences, the main rock-forming carbonate is represented by calcite. It is associated with apatite, magnetite, phlogopite, and pyrochlore, comprising a typical carbonatite paragenesis worldwide.

The description of major textural characteristics of carbonate-bearing alkaline syenite rocks of RKVC and LSV, their geochemistry, Sr/Nd and C/O isotopic signatures of carbonate fractions and calcite mineral chemistry are presented.

The chondrite-normalized REE patterns for carbonate-bearing nosean syenite, mafic xenoliths, and carbonate-bearing lapilli of RKVC show similarities to each other and to other carbonatites and alkaline syenites worldwide. All samples have smooth chondrite-normalized REE patterns with strong LREE enrichment. The REE patterns of the carbonate-bearing nosean syenites of LSV, on the other hand, show different patterns with a depletion of the heavy REEs and a negative Eu anomaly, which is unusual for such rocks.

Based on petrographic, geochemical and mineral chemical evidence of these rocks, we assume magmatic carbonate formation in a highly fractionated undersaturated silicate magma. The petrographic spectrum of the studied xenoliths allows a comparison with older alkaline rock occurrences in which a vertical zoning from ultramafic units at greater depth and increasingly alkaline syenite composition at higher levels is observed. The proportion of carbonatitic rocks also increases at higher levels that is accompanied by an increased proportion of volatiles.

The RKVC and LSV can be considered as volcanic segments of alkaline magmatic systems extending over great depths. The high proportion of ashes and pumice layers, as well as volatile-containing phases of subvolcanic formations, indicate the high proportion of volatiles in this system.