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Petrology and volatile content of mantle xenoliths from Eifel Rift

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Eifel Volcanic Field (Germany) is a key locality for the investigation of the European Sub-Continental Lithospheric Mantle (SCLM), since huge amounts of ultramafic xenoliths are brought to the surface by the Neogenic to Quaternary volcanic products both on the western and eastern side of the rift system.

This work focuses on the geochemical characterization of a large collection of mantle xenoliths sampled within lava, sills and/or necks (eastern part of the rift system), as well as within scoria cone and/or pyroclastic deposits (western part of the rift system). A detailed textural and petrological study of the bulk xenoliths and the primary mineral phases was complemented by the determination of the concentration of volatiles (He, Ne, Ar, CO₂) in mineral-hosted Fluid Inclusions (FI) after single-step crushing.

The xenoliths are generally lherzolitic, harzburgitic and wehrlitic in composition, with the occasional modal presence of both amphibole and phlogopite documented only in samples from the western localities. Few ol-clinopyroxenites and one ol-websterite are also present. Texture varies from protogranular, porphyroclastic and equigranular in most of the xenoliths, to cumulitic in some samples.

Olivine is typified by Mg# [$\text{MgO}/(\text{MgO}+\text{FeO}_{\text{tot}})$ mol%] varying from 83 to 92; similarly, orthopyroxene has Mg# of 84-92, whereas clinopyroxene has Mg# between 84 and 94. Al₂O₃ content of orthopyroxene and clinopyroxene ranges from 0.5 to 6.5 wt% and from 0.7 to 8.2 wt%, respectively. Spinel is characterized by Cr# [$\text{Cr}_2\text{O}_3/(\text{Cr}_2\text{O}_3+\text{Al}_2\text{O}_3)$ mol%] ranging between 10 and 82, and by Mg# varying from 40 to 78.

A remarkable difference exists between the xenoliths sampled in the eastern and western localities. The formers are in fact characterized by the highest Mg# for clinopyroxene and Cr# for spinel, together with the lowest Al₂O₃ contents for both pyroxenes.

Volatiles analyses suggest that clinopyroxenes and most of the orthopyroxenes have the highest CO₂ and noble gas concentration, while olivines are gas-poor. This variability in FI concentration seems not related to the variations observed in the He, Ne, and Ar isotopic compositions.

³He/⁴He values range between 5.5 and 6.9 Ra, where Ra is the ³He/⁴He ratio of air (1.39×10^{-6}), lying within the range proposed for the European SCLM (6.3 ± 0.4 Ra), and slightly below that of MORB (Mid-Ocean Ridge Basalts; 8 ± 1 Ra), being also comparable to previous measurements performed in western Eifel.

The Ne and Ar isotope ratios fall along a binary mixing trend between air and MORB-like mantle. He/Ar* ratios in FI and Mg# vs. Al₂O₃ trends of the main mineral phases indicate that variable extents of partial melting, followed by metasomatic processes, affected the local mantle domains.

The ongoing carbon isotopic measurements in the most CO₂-rich xenoliths, complemented by the noble gases measurements in FI and by mineral chemical analyses will provide new insights on: i) the

volatile content and recycling processes occurring within the European SCLM; ii) the composition of fluids rising through the crust, intimately related to the monitored emissions in volcanic/seismic active contexts.

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