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Spatially resolved trace element and isotope data on volcanic rocks in the southern Central European Volcanic Province as a tool for deciphering mantle metasomatism

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The southern Central European Volcanic Province in SW Germany and E France comprises two distinct groups of primitive SiO_2-undersaturated alkaline rocks. (I) Upper Cretaceous to Eocene (73–47 Ma) olivine nephelinites, basanitic nephelinites, and nepheline basanites are characterized by olivine (Fo_{73-88}) and clinopyroxene macrocrysts (diopside-rich phenocrysts and partly resorbed green-core pyroxenes), embedded in a groundmass of nepheline, clinopyroxene, titanomagnetite, ± haüyne, ± phlogopite, ± plagioclase, and accessory hydroxy- and fluorapatite. (II) Oligocene to Miocene (27–9 Ma) melilite-bearing olivine nephelinites and olivine melilitites consist of olivine macrocrysts (Fo_{83-93}) and melilite and clinopyroxene phenocrysts in a groundmass of clinopyroxene, titanomagnetite, ± nepheline, ± perovskite, ± haüyne, ± F-rich phlogopite/kinoshitalite, and accessory fluorapatite. Whole-rock and mineral compositions demonstrate that the magmas of the melilite-free rocks originated at the base of the lithosphere from an amphibole-bearing garnet (spinel) lherzolite that previously underwent hydrous metasomatism (< 6% partial melting). In contrast, the younger, melilite- and perovskite-bearing rocks derived from a carbonated amphibole-±phlogopite-bearing garnet wehrlite in the uppermost asthenosphere (< 3% partial melting), affected by subduction-related metasomatism with a high $CO_2/(CO_2+H_2O)$ ratio.

However, the role and type of metasomatism in the two subcontinental mantle sources prior to partial melting and the behaviour of volatiles during melt formation and evolution in the study area are not yet well understood. Thus, spatially resolved trace element and isotope LA-ICP-MS analyses (Sr, Nd, Li, B) on individual clinopyroxene, olivine, melilite, perovskite, and apatite crystals were conducted to further constrain mantle source characteristics, the nature of mantle metasomatism, the relevance of magma mixing events, and the composition of possible lower crustal contaminants. Preliminary results for clinopyroxene macrocrysts show clear differences (e.g. in REE patterns, Sc, Zn, and Ga concentrations, Zr/Hf and Nb/Ta ratios) between the two age groups, between the different macrocrysts (green-core pyroxenes, chrome diopside xenocrysts, phenocrysts), and between cores and rims of crystals. The combined trace element and isotopic data of the phenocrysts will allow to distinguish the sources involved and to test the hypothesis of two different mantle sources, one of which underwent carbonate metasomatism and the other hydrous metasomatism prior to melt formation.