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Geochemical signatures of rift-related igneous rocks in the Cenozoic Central European Volcanic Province

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Petrological and geochemical investigation of igneous, mafic and differentiated rocks from the Rhoen Mountains and the Grabfeld (Heldburg Dike Swarm) - integral areas of the Central European Volcanic Province (CEVP) - have revealed signatures indicative of rift-related magmatic processes.

The age spectrum of these rocks according to new, precise ^{40}Ar/^{39}Ar data (Abratis et al., in press) is clearly divided into two distinct subsets, with volcanic rocks of the Rhoen dating between 20 – 18 Ma and those of the Grabfeld area situated in the SE dating between 16 – 14 Ma. This clearly indicates a regionally and temporally distinct evolution of the Miocene volcanism. The composition of the volcanic rocks in the two volcanic fields is remarkably diverse, with the Rhoen Mts. mafic magmas being dominated by alkali basalts over tholeiites and minor basanites, whereas the magmas in the Grabfeld are mostly basanitic with subordinate alkali basalts and nephelinites. Comparable igneous suites have been reported from the Vogelsberg and the northern Hessian Depression.

The geochemical and isotopic characteristics of the different magma types strongly correlate for every rock type in both areas (e.g. ^{87}Sr/^{86}Sr$_i$ = 0.7034 to 0.7040; ε_{Nd} = 3.9 to 4.7; and ^{206}Pb/^{207}Pb$_i$ = 19.0 to 19.3). REE patterns can be interpreted as reflecting melts derived from a garnet-bearing mantle. As the lithospheric mantle exhibits a pressure-dependent mineralogical stratification of spinel to garnet peridotite, the REE patterns illustrate variable degrees of partial melting within the transitional zone between a garnet-peridotite and spinel-peridotite mantle facies, close to the base of the lithosphere. Similar radiogenic isotope ignatures (Sr, Nd, Pb) for the same magma

types in both sub-areas of the CEVP point to a chemically uniform source which is identical to the source of most of the other, western to Mid-European magma fields. Minor differences in the magma composition are either due to decreasing degrees of melting of the subcontinental mantle, or to increasing depths of melting. A major question for the understanding of rift-related magmatism is why the volcanic activity ceased (18 Ma) in the Rhoen area whereas it continued in the Vogelsberg and the northern Hessian Depression in the W-NW, and started in the Grabfeld (16 Ma) farther SE.

Partial melting of the mantle was in both areas induced by adiabatic decompression of the asthenosphere. A lack of magmatic activity between 18 and 16 Ma in combination with the transition and onset of magmatism from the Rhoen Mts. into the Grabfeld during this volcanic period indicates a geochemically similar, fertile mantle package at subcontinental levels below both areas. In the Rhoen, this fertile mantle domain acted as a magma source over ca. 2 Myrs (20-18 Ma), prior to tapping a virtually identical reservoir in the Grabfeld area with a comparable lifetime between 16 and 14 Ma.

References:

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