Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28086

Revisiting the type locality of foyaite – Serra de Monchique, Portugal

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Peralkaline F-rich igneous rocks incorporate economically viable amounts of REEs and HFSEs. An exemplary plutonic body is the alkaline to peralkaline Cretaceous (68.8 ± 1 Ma; [1]) Serra de Monchique complex in southern Portugal. Based on mineral compositions and field relations, the differentiation history of the complex will be elucidated with special focus on partitioning of halogens, REEs and HFSEs.

The complex consists of two main units: an inner homogeneous nepheline to sodalite syenite and an outer unit of heterogeneous nepheline and sodalite to quartz-(monzo)syenites and breccias. Intercalated between the two main units are small outcrops of melasyenites. The complex is crosscut by lamprophyric and phonolitic dyke rocks.

Alkali feldspar, nepheline and sodalites are present as the dominant felsic minerals in all units. Plagioclase is very sparse in the inner syenites, but more abundant in the outer unit. Clinopyroxene following the diopside-aegirine trend ($Di_{80}Hd_{12}Ae_{05}$ – $Di_{02}Hd_{09}Ae_{89}$) forms the dominant mafic mineral together with biotite and locally occurring primary amphibole. Besides trace amounts of fluorite, Zr- and Nb-rich titanite, brookite and zircon occur throughout the complex as magmatic phases. Accessory fluoroapatite ($Fap_{49}Hap_{47}Clap_{04}$ – $Fap_{81}Hap_{07}Clap_{12}$ – $Fap_{100}Hap_{0}Clap_{0}$) in the outer unit may show REE-enriched rims (up to 0.664 $LREE^{3+}$ apfu), while trace amounts of pyrochlore are restricted to the outer unit. Late magmatic phases include partly F-rich HFSE-bearing silicates of the wöhlerite-, rinkite- and catapleiite-groups, documenting a transition from miaskitic to agpaitic phase assemblages during their evolution. In contrast, the melasyenites contain abundant amphibole, clinopyroxene, apatite and late magmatic biotite, while HFSE-bearing silicates are lacking in these rocks.

Alteration by hydrothermal fluids affected the whole complex. Aqueous fluids resulted in significant growth of zeolites and amphibole, carbonate-bearing fluids formed calcite and cancrinite, mostly at the expense of sodalite and nepheline. Breakdown of HFSE- and F-bearing silicates by carbonate-bearing fluids led to the growth of secondary fluorite, calcite and zircon, whereas breakdown of titanite caused formation of calcite and anatase. Locally restricted replacement of clinopyroxene to secondary amphibole and fluorite furthermore suggests the presence of fluorine in the alteration fluids.

1] Grange, Scharer, Merle, Girardeau & Cornen (2010), Journal of Petrology 51, 1143-1170