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Mineralogical and geochemical control on rare earth elements enrichment in rocks and lateritic soils: a case study of the Eboundja nepheline syenite and related weathering materials.

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The Rare Earth Element (REE) ore deposits are commonly found in specific igneous rocks (e.g., carbonatite, nepheline syenite and peralkaline granite) and in regolith deriving from the weathering of primary REEs-bearing rocks. The aim of this study is to evaluate the main factors controlling REEs enrichment in weathering profiles derived from lateritization processes in the Eboundja area. Eboundja has an alkaline intrusion outcrop known as the Eboundja nepheline syenite. This rock is enriched in rare earth elements (37 - 996 ppm) and Y (6 - 72.2 ppm) [1]. Two weathering profiles developed on this massif were selected for this work. The two profiles have similar morphological and mineralogical characteristics, with a succession of five horizons. From base to top: source rock, saprolite, marble zone, ferruginous zone, loose clay zone and organo-mineral horizon. Although both source rocks are metaluminous nepheline syenites, they differ in mineralogy and rare earth content. One of the source rocks (EB6), characterized by a very low rare-earth concentration (4.73 ppm), contains nepheline, cancrinite and sodalite in its mineralogy. Related weathering materials have a maximum REEs content of 43.18 ppm in the loose clay zone. The other source rock (EB2), with a high REEs concentration (583.05 ppm), contains Fe-actinolite, but no cancrinite or sodalite. The derived weathering materials are characterized by an accumulation of REEs in the saprolite, with a maximum REEs content of 1173.4 ppm. Fractionation of titanite and zircon during magmatic differentiation appears to have influenced rare earth fractionation and hence rare earth enrichment in the Eboundja nepheline syenite [1]. However, large amounts of REEs can be leached and transported due to hydrothermal alteration by carbonate-rich, high-salinity aqueous fluids. Moderate lateritization combined with strong kaolinization processes resulted in REEs supergene enrichment in both regolith compared to the parent rock initial REEs content. The proportion and distribution of primary and secondary minerals (including: kaolinite, muscovite, halloysite, gibbsite, goethite, quartz and hematite and K-feldspar), combined with pH, strongly influenced REEs enrichment in weathering profiles. This work revealed that Eboundja area is favorable for further REEs exploration.

[1] Nsifa, Tchameni, Siqueira, Pouclet & Bascou (2013). JAES 87, 44–58.

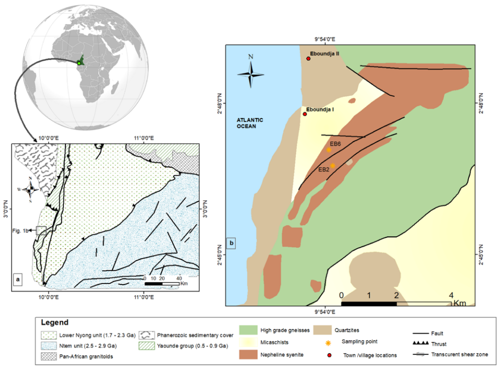

Figure 1: (a) Geological sketch map of SW Cameroon with location of the studied nepheline syenite; (b) Map of the Eboundja nepheline syenite with location of the sampling points (EB6, EB2).

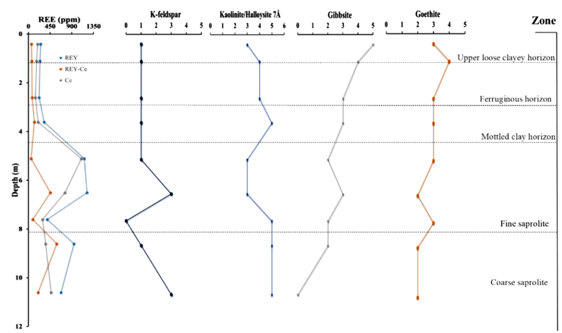

Figure 2: Variations of REE concentration and minerals content (expressed in semi-quantitative value) with depth in EB2 profile.