Exploration Model for REE Deposits Associated with Nepheline Syenite Occurrences in Tropical Areas: Case Study of the Eboundja Nepheline Syenite (Cameroon)

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Our ambitious goals for a green future could be challenged by the global supply of critical metals. In order to meet the growing demand for critical metals, more exploration projects are needed. In this context, nepheline syenite is an interesting exploration target. These are undersaturated alkaline rocks generally enriched in HFSEs, rare earths, and other relatively rare elements (such as Li, Zn), and have the potential to form significant economic deposits of these elements. Previous work shows that the mineralising processes behind rare earth deposits associated with nepheline syenite are of three types: magmatic differentiation, post-magmatic hydrothermal events, and meteoric weathering. The Eboundja nepheline syenite is an intrusion dated at about 590 Ma. It belongs to a group of syenitic plutons found along the southern Atlantic coast of Cameroon, at the margin of the Congo craton. It was evaluated for possible rare earth mineralization in 1985. Petrographic observations show that the Eboundja syenite consists of albite, nepheline, microcline, cancrinite, sodalite, amphibole, biotite, sulphur, and monazite. Monazite appears to be the main rare earth ore. But the REE concentration in the rock is low, as is the monazite content. The agpaitic index indicates a metaluminous to peralkaline character. The favourable climatic factors observed in this region (average annual rainfall of 1,700 mm) allow sufficient weathering of this rock. The present work reveals total rare earth contents on the order of 1,000 ppm in the weathering materials (higher than the generally accepted limit of exploitability for rare earth deposits in regolith). Furthermore, all rare earths are enriched in the weathering materials relative to their content in the source rock. These results allow us to consider weathering as the main REE enrichment process in this case. In addition, we used all the exploration data to build a 3-D model.