SEG 2024 Conference: Sustainable Mineral Exploration and Development

From Eboundja Nepheline Syenite (Southern Cameroon) to Ion Adsorption REEs Deposit: Implications for REE Deposits Genesis

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REEs are essential metals for green technologies and high-tech industries. REE deposits are found in specific rocks (e.g., nepheline syenite) and regolith (ion adsorption deposits). Among these deposits, ion-adsorption REE deposits present the advantage of a low-cost extraction process. However, most of these deposits are found in southern China, and few have been discovered in other parts of the world. This work focuses on a newly discovered ion adsorption REE deposit in southern Cameroon. In this study, we compare the geochemical, mineralogical, and geological characteristics of two regolith profiles developed over the Neoproterozoic nepheline syenite of Eboundja (southern Cameroon) to assess the key factors controlling the formation of weathering-related REE deposits. The study area is characterized by a tropical rainforest climate with four seasons; and annual rainfall of about 2,800 mm. The two profiles, here referred to as EB2 and EB6, are located on two slopes and have similar morphological features (from base to top: source rock, saprolite, mottled zone, ferruginous zone, loose clay zone, and organo-mineral horizon). Both source rocks are metaluminous nepheline syenites with different mineralogical content. The two regolith profiles have similar secondary mineralogical assemblages including kaolinite, muscovite, halloysite, gibbsite, goethite, quartz, and hematite. The main findings of this work highlight that: (1) within Eboundja nepheline syenite, allanite, zircon, and pyrochlore fractionation during magmatic differentiation have particularly influenced the REE-ratio in the primary rock; (2) hydrothermal alteration in the presence of high salinity fluorine and carbonate-rich aqueous fluid may have favored re-mobilization of REEs and thus overprinted the REEs initial enrichment; (3) weak to strong lateritization, and strong kaolinization processes are highly effective for REE concentration at the Eboundja weathering profiles; and (4) the proportion and distribution of relict primary and secondary minerals, combined with pH, strongly influenced REE enrichment and distribution in weathering profiles.