

Mineralogy and Geochemistry of Typical Profiles of Regolith-Hosted REE Deposits in the Shaoguan Area, Guangdong Province, China

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Rare earth elements are indispensable in high-tech industries, military applications, and renewable energy technologies. Regolith-hosted (ion-adsorption) REE deposits commonly found in South China, have garnered significant attention due to their substantial reserves and relatively easy extraction processes, making it crucial to investigate the mechanisms behind REE migration, fractionation, and enrichment [1,2].

This study focuses on three representative weathering profiles from the newly discovered REE deposits in Shaoguan, northern Guangdong Province, South China. The samples were analyzed using petrological, mineralogical, geochronological, and geochemical methods. The results show that the ore bodies, 5-10m in thickness, mainly occurred in the semi-weathered layer of the profiles. The REE content in this layer can reach up to 2363×10^{-6} , with the overall leaching rate up to 82%. The (La/Yb)_n ratios for all three profiles exceed 10. The bedrocks are predominantly biotite monzogranite and biotite syenite, with zircon U-Pb ages around 160 Ma. Key rare-earth minerals in the bedrocks include apatite, zircon, sphene, monazite and allanite.

Sequential extraction techniques were employed to quantify different REE species. The results indicate that REEs in the bedrock are primarily in insoluble forms (up to 80%). In the weathered ore bodies, however, the ion-exchangeable REE species constitute up to 62%, followed by carbonate-bound REEs, REEs associated with Fe-Mn (hydr)oxides are negligible. Observations of bedrock thin sections revealed compositional zoning in allanite and apatite, with secondary REE fluorocarbonate minerals and monazite filling their cavities, suggesting the influence of hydrothermal processes. Consequently, REEs in the minerals are released, migrated, and fractionated during both hydrothermal and weathering processes. They are subsequently adsorbed by clay minerals altered from silicate minerals, leading to their eventual enrichment in the ore bodies.

[1] Li, Zhou and Williams-Jones (2019) *Economic Geology*, 3:541-568

[2] Huang, Tan, Liang et al., (2021) *Ore Geology Reviews* 134, 104172