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Geochemical and Hyperspectral Data Integration for Assessing Distribution and Enrichment Processes in Clay-Hosted Rare Earth Element Deposits in Southwestern Western Australia

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In Australia, REE exploration increasingly targets clay-hosted weathered granites, known for their potential as substantial REE sources, essential in high-tech industries. These deposits form in terrains characterised by extensively weathered regolith shaped by diverse climatic events. A comprehensive understanding of mechanical and hydromorphic dispersion of ore is essential for effective geochemical exploration. Integrating landscape evolution with variations in mineralogy and geochemistry across regolith and bedrock offers a foundational insight into the different weathering processes. Weathering profiles in the Splinter Rock area (SW of Western Australia) were studied from drill holes allowing the differentiation of three main units: 1) saprock; 2) saprolite and 3) transported cover representing low-lying basinal areas associated with paleochannels. Determining the extent of regolith transport can be challenging because in-situ and transported materials, such as clays and iron oxides, often share similar mineral compositions. Furthermore, the degree and characteristics of transport have been found to influence the quality of other regolith-hosted mineral deposits. Abrupt changes in the concentrations of certain elements, such as K and S, aided in this differentiation as mineral stability and weathering rates vary, affecting element release in the regolith. A sharp potassium increase near the profile's base, associated with less weathered saprolite or saprock, marks the geochemical boundary between in-situ and transported material. Elevated sulphur (S) and total organic carbon (TOC) up to 23%, associated with dark grey and black clay horizons, in mid-profile clays, indicate that the overlying lithologies are transported. In most drill holes, the highest Total Rare Earth Oxides and Yttrium (TREOY) concentrations (up to 6600 ppm) are located at or above the elevated K values and in the in-situ regolith. TREOY is also associated with higher Al values, corresponding to kaolinite, which significantly increases beneath the sulphur-rich horizon, marking a boundary with in-situ saprolite below. This distinction is reinforced as kaolinite abundance gradually diminishes and exhibits reduced crystallinity towards the profile base, indicating a shift to saprock.