Data Integration of Hyperspectral and Whole-Rock Geochemistry: New Insights into Mt Weld Carbonatite-Hosted REE Deposit

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Rare earth elements (REE) are essential for producing current and developing future technologies. Understanding existing REE deposits and identifying new viable REE resources is critical due to fragile supply chains and increasing demand in coming decades. The Mt Weld carbonatite-hosted REE deposit is one of the richest REE deposits in the world, however, remains relatively poorly understood.

This study extrapolates previously characterized major mineralogy and REE mineral distribution of selected samples from the fresh carbonatite, to an entire drill core (MWEX10270), providing unbiased and contiguous distribution of major carbonates and REE-host minerals. This is achieved by translating hyperspectral signatures – collected with HyLogger3™ technology - into relative mineral abundance and chemical composition. Six distinct zones are recognized within the central carbonatite: (I) weathering profile, (II) magnesiocarbonatite, (III) phosphate-siderite-rich magnesio- and ferro-carbonatite (MF carbonatite), (IV) phosphate-rich MF carbonatite, (V) phosphate-poor MF carbonatite, and (VI) calcio-carbonatite. Whole-rock geochemical reassessment, based on the newly defined zones, reveals a gradual variation in λ values (a quantitative descriptor of REE patterns) of MF carbonatite REE geochemistry, reflecting the progressive magmatic fractionation from Mg-rich to Fe-rich carbonatite magma. Meanwhile, the total concentration of REE is initially elevated in Mg-rich carbonatite but subsequently decrease as phosphorus concentrates within Fe-rich carbonatite. REE precipitate as monazite during the hydrothermal evolution of each magmatic stage, transitioning to REE-fluorocarbonates in the late-stage magma when REE and phosphorus become depleted.

The application of Hylogger3™ for Mt Weld carbonatite analysis demonstrates that the HyLogger is an effective tool for rapidly identifying REE-hosting minerals and their distribution precisely in fresh carbonatite drill cores. This study also establishes new knowledge that is important to better understand global carbonatite-hosted REE deposits and future explorations.