SWIR-VNIR spectroscopy as a rare earth exploration tool: A TerraSpec study of the Nechalacho Rare Metal Deposit (Thor Lake, Canada)

V Möller[1], AE Williams-Jones[1]

[1]Earth & Planetary Sciences, McGill University, Montreal, Quebec

Field-based short wave infrared (SWIR) and visible near infrared (NIR) spectroscopy is routinely deployed to characterize the alteration mineralogy in porphyry Cu-Au-Mo and epithermal Au deposits as a vector to mineralization. Considerably less attention has been devoted to rare earth element (REE) deposits, which pose particular challenges in exploration and mining owing to their exotic ore and alteration mineralogy. For REE deposits, handheld XRF has been the method of choice. We present a combined laboratory, geochemical and field study that evaluates the exploration and grade control potential of the TerraSpec 4 SWIR-VNIR spectrometer (ASD Inc.) applied to one of the world's largest high-grade REE resources, the Nechalacho Rare Metal Deposit. SWIR-VNIR spectroscopy takes advantage of the characteristic spectral absorptions of mineral bonds (e.g., Al-OH, Fe-OH, C-O), but can also detect the elemental absorptions of the REE. As a fast field method (measurement times < 1 s), it facilitates the systematic and detailed collection of downhole profiles or outcrop traverses. By studying mineralogically characterized (SEM, electron microprobe) and assayed reference samples from the Nechalacho deposit, we established a framework for the alteration (ankerite, chlorite, biotite, illite) and ore mineralogy (bastnäsite, synchysite, parisite). Analysis of pure REE-oxide powders confirmed that the element neodymium can be reliably identified by its 741, 798 and 864 nm absorptions, independent of the host REE-mineral. Nd is strongly correlated with both the heavy REE (Eu to Lu) and light REE (La to Sm) mineralization in the Nechalacho deposit (the Basal and Upper Zones, respectively). By systematically comparing drill hole assay data to software-processed and quantified spectral Nd absorptions, we identified a strong correlation between assay and spectral data. The Nd absorptions can thus be used as a direct proxy for REE-mineralization in drill core and outcrop. The spectral data also allows the spatial contouring of cryptic hydrothermal alteration (e.g., chlorite-carbonate and biotite alteration) which overprinted the magmatic mineralogy in the deposit and locally caused remobilization of the REE. Field-based SWIR-NIR spectroscopy, owing to its fast measurement and processing capabilities and the direct detection of REE, represents a powerful novel tool for regional and deposit-scale REE exploration, REE deposit characterization and mine production grade control.