Possible applications for visible/infrared reflectance spectroscopy (VIRS) in exploration for rare-earth elements

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Visible-Infrared Reflectance Spectroscopy (VIRS) uses absorption responses to electromagnetic radiation of 350–2500 nm wavelengths to characterize natural materials and identify minerals that have distinct absorption spectra. Its principal application in exploration geoscience is in the study of hydrothermal alteration assemblages, but the current interest in exploration for rare-earth element (REE) deposits awakened our interest in possible applications to this type of mineralization. Some interesting possibilities emerged from pilot studies.

Individual REE oxides have unusual absorption responses in the visible region (390 nm–750 nm) and notably in the near infrared (NIR; 750 nm to 1300 nm), which is normally a relatively "quiet" region for natural minerals. REE-bearing minerals (e.g., monazite, bastnaesite, betafite and xenotime) also produce these unusual NIR absorption features. This behaviour is related to the unique electron shell configurations of the lanthanide elements, and the absorption patterns are highly specific. However, there are presently few spectra from REE-bearing minerals in the available reference databases, and such minerals typically show wide variations in composition, including REE distributions. Notwithstanding these complications, VIRS data acquired from mineralized samples in several areas of Labrador reveal distinctive spectral responses indicative of REE, even though their exact mineralogical sources are not yet readily identifiable. This implies that VIRS analysis could be used to test for potential REE mineralization in samples identified on the basis of other criteria such as anomalous radioactivity. However, the threshold for such detection is as yet unknown. The diverse styles of REE mineralization now identified in Labrador afford us an opportunity to gather and distribute VIRS absorption spectra for unusual minerals, which may be useful to explorationists elsewhere. As an example, the first reference spectra for the Na-Ca-Fe-Zr-REE silicate eudialyte (from the Red Wine Mountains area) are presented and discussed.

The VIRS method may also be of use as a first-order tool for recognizing favourable host rocks to REE mineralization. This type of mineralization is commonly associated with peralkaline igneous suites. Peralkalinity is a geochemical characteristic that can be discerned through whole-rock analyses,

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but it is also manifested by primary Na-Fe-rich chain silicates such as aegirine (a pyroxene) and arfvedsonite or reibeckite (amphiboles). These minerals are similar to common igneous pyroxenes and amphiboles, but can be identified through their short-wave infrared (SWIR; 1300 nm to 2500 nm) absorption responses. Thus, VIRS methods may be able to confirm compositionally suitable host rocks from hand samples, without making thin sections or obtaining analyses.