

Visible and short-wave infrared reflectance spectroscopy of selected REE-bearing silicate minerals

DAVID J. TURNER^{1,*}, BENOIT RIVARD², AND LEE A. GROAT¹

¹Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada

²Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada

ABSTRACT

Natural samples of the rare earth element (REE)-bearing silicate minerals cerite, mosandrite, kainosite, zircon, and eudialyte were studied using reflectance spectroscopy in the visible to short-wave infrared regions (500 to 2500 nm) and further characterized by scanning electron microscopy and electron microprobe analysis. Spectral features of these minerals are driven primarily by $4f-4f$ intra-configurational electronic transitions of trivalent lanthanides, as well as $5f-5f$ electronic transitions of uranium and vibrational overtones and combinations of H_2O and OH^- . Spectra of eudialyte are also impacted by relative amounts of $^{46}\text{Fe}^{2+}$ and $^{56}\text{Fe}^{2+}$. Respective spectra of these REE-bearing silicate minerals are sufficiently distinct to enable spectral classification. Spectral variability (e.g., band depths and locations) of some specific REE-related absorptions, such as an Er^{3+} - and Yb^{3+} -related absorption near 978 nm and Nd^{3+} -related absorptions near 746, 803, and 875 nm, are interpreted to be driven by cation site differences in the crystal structures. This work adds to the growing understanding of REE-bearing mineral reflectance spectroscopy, which facilitates detection, identification, and quantification of REE-bearing silicate minerals in remote sensing applications. This is especially relevant for hyperspectral imaging spectroscopy with high spatial resolutions where the spectral response of a pixel becomes increasingly dominated by mineralogy rather than lithology.

Keywords: Hyperspectral, reflectance, spectroscopy, rare earth elements, cerite, eudialyte, zircon, mosandrite