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

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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 4*f*-4*f* intra-configurational electronic transitions of trivalent lanthanides, as well as 5*f*-5*f* electronic transitions of uranium and vibrational overtones and combinations of H_2O and OH^-. Spectra of eudialyte are also impacted by relative amounts of $^{IV}Fe^{2+}$ and $^{V}Fe^{2+}$. 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