American Mineralogist, Volume 101, pages 2264–2278, 2016

Visible and short-wave infrared reflectance spectroscopy of REE phosphate minerals

David J. Turner[1,*], Benoit Rivard[2], and Lee A. Groat[1]

[1]Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada
[2]Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada

Abstract

Reflectance spectroscopy in the visible to short-wave infrared regions (500 to 2500 nm) was carried out using natural samples of the rare earth element (REE) phosphate minerals monazite, xenotime, and britholite. Samples were characterized by scanning electron microscopy and electron microprobe analysis. Absorption band positions were recorded with their probable origins, and spectral variability among the samples is discussed. Spectral features of these minerals are driven primarily by 4*f*-4*f* intraconfigurational electronic transitions of trivalent lanthanides. The distinct REE distributions of monazite, xenotime, and britholite drive their bulk spectral patterns, which in turn are sufficiently distinct to enable spectral classification. Spectral variability of some specific REE-related absorptions are interpreted to be driven by differences of the coordination polyhedra for the lanthanide cations between the crystal structures. Spectra of these minerals were also compared against carbonatite-hosted REE bearing fluorapatite. The work presented here strengthens the growing foundation for the interpretation of reflectance spectra of these REE phosphate minerals and enables exploitation of the observed features by the remote sensing community for detection, identification, and quantification of REE phosphate minerals. This is especially relevant for hyperspectral imaging spectroscopy with high spatial resolution, where the spectral response of a pixel becomes increasingly dominated by mineralogy.

Keywords: Hyperspectral, reflectance, spectroscopy, rare earth elements, REE, xenotime, monazite, britholite