

## **Evidence of heterovalent europium in zoned Llallagua apatite using wavelength dispersive XANES**

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### **ABSTRACT**

Eu L<sub>3</sub>X-ray absorption near edge structure (XANES) spectroscopy was conducted with a wavelength dispersive (WDS) spectrometer to determine the valence state of europium in a natural, Mn- and REE-rich apatite from Llallagua, Bolivia. Europium exists in both the divalent and trivalent states in the Llallagua apatite with a Eu<sup>2+</sup>/Eu<sup>3+</sup> ratio between 0.12 and 0.22. With the enhanced energy resolution of WDS the EuL<sub>3</sub> fluorescence line can be resolved from the MnK $\alpha$  line, allowing for significant reduction of background in the EuL<sub>3</sub> absorption edge region and resolution of the Eu XAS, which is difficult by conventional methods because of fluorescence peak interference. The anomalous partitioning behavior of Eu in these samples (Rakovan and Reeder 1996) can be explained by the observed presence of Eu<sup>2+</sup> and Eu<sup>3+</sup> and is consistent with the suggested size effect on intrasectoral zoning of REEs in apatite.