Background

The raw material sector demands for fast and non-invasive exploration technologies to reduce economic and ecologic costs as well as to increase public acceptance. The focus lies on critical raw materials such as rare earth elements (REE) for securing the supply to high-tech industries.

Laser-induced fluorescence (LIF) spectroscopy uses the light spectrum measured after illumination of a target as fingerprint of a sample’s composition. The method is especially suited for REE identification, but its application in raw material exploration and natural samples relies on accessible, transparent, well-characterised reference material. This motivated us to present a LiF spectral library.

Spectral LiF library

The high spectral resolution (0.13 nm) allows for deciphering wavelength dependencies in broad-band emission (350 - 800 nm).

Comparison to the USGS spectral library (Kikaly et al., 2017) confirms matching absorption.

LiF data processing

LiF data acquisition

LiF - 325 nm excitation

REE phosphates with representative LiF spectra showing diagnostic emission lines.

Characterisation of LiF emission lines

The high spectral resolution (0.13 nm) allows for deciphering multiple emission lines associated to individual energy transitions.

Sample homogeneity

Hyper-spectral reflectance images: FX10 camera, 0.17 mm pixel

Data analysis:

- R package HyperSpec (Beleites and Sergo, 2018)
- USGS library (Kikaly et al., 2017)

Application examples

Example 1: Analysis of REE emission line shifts dependent on host mineral

Suitable excitation wavelength - 442 nm and 532 nm

Using longer wavelength laser proved successful for selective REE excitation.

Example 2: REE identification in natural mineral, Xenotime Novo Horizonte

Summary & Outlook

Spectral library for REE phosphates provides transparent, well-characterised reference data for LiF based material analysis.

Suitable wavelengths are summarised according to efficient REE excitation and fit of detection range with position of diagnostic emission lines.

LiF library supports the development of LiF applications for raw material exploration.

We encourage others to contribute LiF REE spectra of phosphates and other minerals to strengthen LiF analysis and its applications.