Identification of REE minerals using fluorescence spectroscopy

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Rare earth element (REE) bearing minerals show characteristic emission lines related to f-f energy cascades in lanthanide (III) ions. However the details of REE emissions in minerals, which have multiple REE substitution and many other defect types, are the result of complex interactions between the lattice and local defects (including chemical substitution), affecting which REE are detected and their quantum efficiency.

The present study reports the fluorescence of several REE ore minerals including eudialyte, catapleiite, bastnaesite, parisite, ancylite and wöhlerite. We observe common features, including discrete REE emission, REE energy transfer, thermoluminescence (TL) and thermal hysteresis of luminescence properties. Many minerals display TL; e.g. some fluorites show strong TL at 320 nm and 275-300°C, interpreted as a point defect coupling with substituted Ce(III).

Ancylite(Ce), catapleiite and eudialyte have emission lines from one REE at 25°C which then changes reversibly to another REE on heating above 150-200°C. In contrast, irreversible fluorescence hysteresis is observed after heating e.g. catapleiite to 400°C.

We attribute high energy excitation emissions to coupling of the conduction band with REE, possibly involving energy cascades via multiple REEs. TL indicates the presence of traps that we infer are point defects physically coupled in the vicinity of the lanthanide ion. These properties are provenance dependent; strong in minerals from one locality and absent in the same mineral from elsewhere. Many REE bearing minerals show no luminescence.

In principal fluorescence can be a useful exploration tool, and may form the basis of automated smart sorting, if the fluorescence of the minerals in that locality is characterised.

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