Rare Earth Mineral Concentrations Within Fluorite in the Illinois-Kentucky Fluorite District and Igneous Intrusives at Hicks Dome Cryptoexplosive Complex, Southeastern Illinois and Northwestern Kentucky (USA)

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The rare earth elements (REE) are composed of the lanthanide series of 15 elements with atomic numbers (57) through (71), scandium (21), and yttrium (39). Due to their geochemical behavior, REE rarely form their own minerals and more often are found incorporated within the structure of other minerals. There is a growing concern over the economical availability of REE because of their diverse and expanding array of technological applications and limited supply. This paper presents the results of a mineralogic and geochemical study of fluorite ore, ultramafic rock, and igneous breccia from the Illinois-Kentucky Fluorite District (USA).

Igneous rocks and fluorite ore were analyzed through whole rock, trace element geochemistry, and electron microscopy to determine the relative abundance of REE. Geochemical analysis (ICP-AES and ICP-MS) of outcrop (whole rock) samples from the Sparks Hill Diatreme (Hardin County, Illinois) detected elevated concentrations of cerium group or light rare earth elements: La (293 ppm), Ce (467 ppm), Pr (45.5 ppm), and Nd (143 ppm). Results of electron microprobe analyses indicate that the source of REE anomalies in the Sparks Hill Diatreme is an REE fluorcarbonate mineral. Electron microscopy detected several tabular fluorcarbonate grains that are less than 20 µm in size and associated with an unidentified Al-Sr phosphate. The fluorcarbonate was identified as synchysite [Ca(Ce, La, Nd, Y)(CO3)2F] and was found in both the well-rounded clasts and the matrix within the diatreme/breccia. Synchysite is similar to other rare earth fluorcarbonates such as parisite [Ca(Ce, La, Nd)(CO3)2F], bastnasite [(Ce, La, Y)CO3F], and rontgenite [Ca(Ce, La)(CO3)2F]. These fluorcarbonate minerals can occur together as intergrowths and thus are difficult to classify. The identification of a rare earth fluorcarbonate mineral within the igneous diatreme/breccia at Sparks Hill can have significant economic implications relating to the concentration of REE within the Illinois-Kentucky Fluorite District. Future studies will focus on the fluorite, igneous breccia, and the rare earth fluorcarbonate through additional geochemical and electron microprobe analyses.