Rare earth element and Y substitution in ynthetic apatite

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Apatite is the most abundant phosphate mineral in the crust and is formed in igneous, sedimentary, and metamorphic settings. Although apatite forms generally as an accessory mineral, it controls the Rare Earth Element (REE) abundance in some rock types. The chemical sensitivity of apatite towards REE concentrations may give insight to the formation and history of the environment in which it formed. Previous work has been done using synthetic apatite to determine the diffusivity of REE. These rates have also been compared to natural apatite with high REE concentrations. No research has been completed to evaluate the maximum concentrations of REE that can be incorporated into an apatite crystal structure, and if substitution of Silicon (Si) and Sodium (Na) for Calcium (Ca) and Phosphorous (P) will allow for higher REE concentration. Synthetic fluorapatite was produced to determine the concentration of REE that can successfully be incorporated into the structure. Microcrystalline apatite was created by combining calcium Phosphate ($Ca_3(PO_4)$) with fluorite (CaF_2). The fluorapatite was then prepared by combining fluorite with the microcrystalline apatite. The process for the fluorapatite ($Ca_5(PO_4)_3F$) was repeated for each batch with the addition of REE and Si or Na. Dysprosium, erbium, lanthanum, neodymium, samarium, and yttrium were used as the REE in concentrations of 1× (~300 ppm), 10× (~3,000 ppm) and 100× (~30,000 ppm) natural abundance for both Si and Na apatite batches. The apatite samples were analyzed for REE, P, Ca, Na, and Si concentrations present in the apatite by electron microprobe analysis (at the University of Maryland), laser ablation – inductively coupled plasma mass spectrometry (at Memorial University) and powder X-ray diffraction. With the collected data, the relationship between REE substitution, charge balancing, and the equilibrium partitioning controlled by Si or Na will be investigated. Early analysis indicates silica is the preferential choice for charge balancing in the apatite crystals, at all dopant levels. The relationship between Si and Na is evident and the final REE concentrations observed in the synthetic apatite will be compared to natural apatite crystals with abundant REE.

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