Gallium Sorption and Inclusion in Al and Fe Oxides

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Gallium (Ga) biogeochemistry in soils has not been well-characterized and its movement in contemporary soils offer insights on the formation of Ga-rich bauxites. We characterized the partitioning of Ga using a sequential extraction and laboratory mineral synthesis experiment. We utilized soils from four Critical Zone Observatories: Southern Sierra in California, Calhoun in South Carolina, Luquillo in Puerto Rico and Boulder Creek in Colorado. Lithology were granitoids at each CZO. For the sequential extraction, we determined three Ga fractions (1) organic matter phase using acetic acid + H2O2, (2) Al and Fe phase via citrate-bicarbonate-dithionite, and (3) residual phase using HF+HNO3 digestion. The majority of Ga was accumulated in the Al and Fe and residual mineral phase and Ga/Al ratios varied among fractions. We synthesized Al and Fe oxides using the hydrolysis method of 0.3 M Al and Fe nitrates in 5 M KOH in the presence of 0.1, 10, 1000 µM Ga at pH 7 and 10 at 50 ° C for 225 days. We found that synthetic goethite-ferrihydrite minerals included Ga rates 1.5 to 7 times greater than synthetic bayerite-nordstrandite Al oxides. At the highest Ga concentration of 1000 µM, Fe oxides were 23 to 31 % Ga g/g while Al oxides were 12 to 15 % Ga g/g. XRD analyses suggest that lattice structure for Al and Fe oxides were not affected by increasing Ga inclusion. Our results indicate that Ga included in both Al and Fe phases, with a preference for Fe oxides.