Formation of Nanominerals and Their Growth Units

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The transformation of dissolved species into solids is perhaps the least understood process in the formation of minerals and other condensed phases. This is particularly true of nanominerals; a class of natural and synthetic materials that consist of particles with dimensions that are less than several tens of nanometers. Well-known examples include ferrihydrite and schwertmannite, as well as many aluminum and manganese-(oxyhydr)oxides and clays. Nanominerals are precipitating continuously by a number of different (bio)geochemical processes occurring in Earth's near-surface aqueous environments. They also play important roles in the cycling of nutrients and contaminants, including radionuclides, in the environment due to their high surface area, high reactivity, and susceptibility to transformation/dissolution (metastability). We have been using schwertmannite, a ferric hydroxysulfate, as a model system for understanding the formation steps of a nanomineral. This talk will include our recent experimental results on schwertmannite formation from the application of synchrotron total scattering and various laboratory methods. These results suggest a new pathway for schwertmannite formation that involves assembly during aggregation of ferric (oxyhydroxy-)sulphate growth units that are approximately 1.5 nanometers in size. This pathway may have important implications for understanding the occurrence and reactivity of natural schwertmannite, as well as the formation of other nanominerals in environmental systems.