Colloidal Mobilization and Transformation of Nano-sized Goethite and Magnetite with Presence of Arsenate under Alkaline Condition

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Environmental fluctuation not only changes the behavior of contaminants in soils but also transits sorption characteristics of metal (hydr)oxides through transformation. In the previous study, it was found that a transition from rod-shaped goethite (10 x 50 nm, FeOOH) to spherical bernalite (27.3 nm, Fe(OH)3) through reconstructive transformation under pH 10 condition with presence of arsenate and phosphate while no transformation was observed at pH 4 and 7 or without arsenate and phosphate. Furthermore, the As/Fe ratio in the bernalite showed 1.5 times higher than that of goethite, and the bernalite nanoparticle showed no aggregation through the transmission electron microscope (TEM) observation while the goethite was aggregated. For that reason, it is important to measure the minimum pH range where the transformation starts. A batch experiment was conducted, the goethite and magnetite (109.4 nm, Fe3O4) were employed. All experiments were conducted triplicates. The samples were mixed with 0.25 g of iron (hydr)oxides and 50 mL of 10 mM arsenate with 0.1 M NaCl or soil extractant as a background, and the pH was adjusted to 7, 8, 9 and 10 with HCl and NaOH. The samples were agitated for 30 days; then the adsorption capacity was measured using ICP-OES after filtration with 200 nm syringe filter, and the samples were air-dried on a carbon-coated Cu grid for further identification of transformation using TEM. As a result, the bernalite transformation from the goethite is observed at pH 10, but there was no transformation in the magnetite. The result is now analyzing for further interpretation. If the bernalite transformation occurs at the mildly alkaline condition with soil extractant, the bernalite would be the reason for colloidal mobilization from the soil environment, and it would facilitate the transport of oxyanions to the water system. Limiting nutrients and toxic metalloids such as phosphate, nitrate, arsenate and selenate would be co-transported to the water system, and it would yield severe environmental problems, such as eutrophication and metal poisoning.