Primary charge of ferrihydrite nanoparticles: experiment and theory

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For particles in the nanometer range, the electric field in the diffuse double layer (DDL) surrounding them diminishes not only because of neutralization of charge but also because of flaring out of the radiating field. For nanoparticles at an ionic strength lower than ~0.01 M, theory predicts enhancement of the primary charge (expressed per unit surface area) compared to large particles.

Ferrihydrite (Fh) is an environmental nanomaterial par excellence. To observe the effect of the spherical electric field on surface charge, we prepared Fh suspensions of very low ionic strength. A 2-line Fh material was synthesized following [1]. After 4 hours aging, the material was washed and centrifuged until the electrolyte concentration was about 5 x10^{-5} M. CO_2 was excluded at all times. Despite the very low salt level, shaking and stirring of this suspended material was not sufficient to disperse the particles significantly. However, prolonged ultrasonication (30 min) lead to a transparent and very stable colloidal suspension. Samples from the sonicated as well as the nonsonicated deionised Fh suspension were titrated by successive additions of $NaNO_3$ solution while the pH was kept constant. The charging curves derived from these salt titrations did not show enhancement of surface charge at low ionic strength as expected from application of spherical DDL theory (Basic Stern approach). Rather they correspond to the model calculations for a flat double layer development. This inconsistency poses a number of fundamental questions. How well can Fh nanoparticles be dispersed? Is it sufficient to use the flat Gouy-Chapman DDL to describe the electrical field around nanosize particles?

[1] Schwertmann U., Cornell RM (1991) *Iron oxides in the laboratory*. VCH 137 p.

Molecular mechanisms of As-binding to biogenic iron(III) (hydr)oxides precipitated by the nitrate-reducing iron(II)-oxidizer *Acidovorax* sp. strain BoFeN1

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Arsenic in the environment is oftentimes of geogenic origin and mainly bound to iron (III) minerals. Iron (III)-reducing bacteria can dissolve Fe (III)-containing minerals and thus promote a release of the arsenic into the environment. In turn, aerobic and anaerobic neutrophilic iron (II)-oxidizing bacteria form Fe (III) minerals that have the potential to co-precipitate or sorb arsenic during iron (II) oxidation and iron (III) mineral precipitation [1].

We therefore quantified arsenic immobilization by the nitrate-reducing Fe (II)-oxidizing bacterium *Acidovorax* sp. strain BoFeN1, closely related to an *Acidovorax* strain recently found in As-contaminated Bangladesh aquifers, in batch and soil microcosm experiments. We quantified dissolved and solid-phase arsenic and iron content and speciation by LC-ICP-MS and synchrotron-based methods (EXAFS, XANES, STXM) upon the biotic co-precipitation process. The modes of association of arsenic with the resulting mineral phases is documented at the molecular level. These information are discussed in terms of relative arsenic solubility and durability of the mineral trapping process

[1] Hohmann *et al.* (2010). *Environ Sci Technol* **44**(1): 94-101.