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Influence of pH on mobilization and formation of iron-dominated colloids in podzol

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Increasing evidence is found that naturally occurring nanoparticles (<20 nm), such as natural organic matter (NOM) and Fe-dominated colloids may play a key role in transport and retention of trace metals. These two colloid types have different affinities for trace elements.
Extraction of colloids from soils indicates that both colloid types can contain iron, and that the extraction protocol itself may influence colloidal Fe-speciation. These interdependencies are therefore of particular interest for correctly understanding the fate of trace metals in the environment.

In order to assess the influence of pH on mobilization and/or formation of iron-dominated colloids, we extracted the A-, E- and B-horizon of a podzol at 3 different pH levels (pH 4, pH 7 and pH 9, respectively). Flow Field-Flow Fractionation, coupled to ICP-MS, was used as a high-resolution size separation technique which allows the detection and quantification of colloids and associated metals.

Iron-dominated colloids were only found in extracts from the E- and B-horizon with pH 7 and pH 9; in the other extracts all Fe was associated to NOM.
The samples in which iron-dominated colloids were found exhibited a higher iron to DOC ratio than the samples without such colloids from the same soil horizon.
The concentration and composition of the extracted NOM was pH dependent; at pH 4 it was dominated by fulvic acids and small organic ligands. The latter has a relatively low affinity for complexing iron, potentially contributing to the lower iron to DOC ratio.
Iron-dominated colloids were present in pH 9-extracts that had equilibrated only one hour with soil from the B horizon; the resulting suspension was stable over several days. Upon lowering the pH to 4, dissolution kinetics of the iron dominated phase was slow. On the contrary, upon increasing the pH of the pH 4-extract of the same soil to pH 9, iron-dominated colloids readily formed.

The results show that the extent to which iron is mobilized from soil as either iron-NOM-complexes or iron-dominated colloids depends on the pH of the pore water or extract pH. In natural environments, iron speciation may change along a pH gradient, e.g. in rivers, from predominantly iron-NOM complexes to iron-dominated colloids.