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Effects of surface charge and hydrophobicity of synthetic metal oxides on attached growth of environmental bacterial isolates

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In order to evaluate effects of the surface hydrophobicity and charge of hematite, goethite and aluminium hydroxide on the cell attachment of bacterial strains isolated from a contaminated site, a series of experiments were performed to:

- 1) Synthesize and characterize these minerals,
- 2) Develop a coating method,
- 3) Evaluate attached growth and biofilm formation on the synthetic mineral surfaces.

The synthesized minerals were thoroughly characterized. The potentiometric titration results showed that; point of zero charge, PZC, of all of the synthetic metal oxides, is above the pH of experiment (6.5). Contact angle shape analysis proved that all mineral surfaces are hydrophilic. Mineral plates (coated 12 well-plates of polystyrene) were thoroughly characterized, and the results proved that coated surfaces are identical to the original synthetic minerals.

The experimental results showed that, hydrophobic bacterial strains, attach poorly to the hydrophilic mineral surfaces. Nevertheless, hydrophilic strains produced extensive, proliferated biofilms.

The attachment results on hematite, goethite, and aluminium hydroxides, were compared to the attached growth on a quartz surface, which is hydrophilic and negatively charged, under similar experimental conditions. Results showed that although hydrophobic strains exhibit similar attachment pattern on all of these mineral surfaces, the hydrophilic strains show considerably more tendency for biofilm formation on the positively charged metal oxides than negatively charged quartz. This implies that electrostatic interactions play an important role in cell attachment to metal oxide surfaces.

Rare earth elements fractionation modelling between manganese oxide and humic acid

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Several studies demonstrated that rare earth elements (REE) speciation is controlled by organic matter in natural waters. More recently, Davranche *et al.* [1] provided evidence that manganese oxide (MnO₂) could compete with humic acid (HA) for REE binding, according to pH and time reaction. Competitive binding of REE to HA and MnO₂ was modelled using two sub-models. Interactions with HA were described using Model VI (Tipping [2]) and adsorption onto MnO₂ was described using a surface complexation model (SCM). Model VI parameters for the whole REE series described by Pourret *et al.* [3] were further refined. SCM parameters necessary to describe MnO₂ surface reactions were derived from published laboratory data using a linear free energy relationship. Introducing Model VI and SCM into PHREEQC allowed considering cerium redox behaviour. Models coupling was validated by testing laboratory datasets on MnO₂ and HA competition for REE binding [1]. Modelling revealed that REE-HA complex was the dominant species whatever the HA/MnO₂ ratio. The development of a Ce anomaly appears strongly limited. However, modelling did not reflect the proportion of REE-HA complexes adsorbed onto MnO₂. Next step will thus be to introduce ternary surface complexes. This work shed more light on the reliability of speciation modelling to predict REE distribution between HA and MnO₂, and will thus become an interesting tool in investigating processes that govern REE speciation in natural waters.

[1] Davranche, Pourret, Gruau, Dia, Jin & Gaertner (2008) *Chem. Geol.* **247** 154-170. [2] Tipping (1998) *Aquat. Geochem.* **4** 3-48. [3] Pourret, Davranche, Gruau & Dia (2007) *Chem. Geol.* **243** 128-141.