Cultivation of deeply buried microbes shows influence of geochemistry

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The deeply buried biosphere is thought to contain a tenth of the Earth's total biomass. Although some studies have been perfomed on subseafloor sediment, the microbiology of this environment is relatively underexplored. Sediment from the Peru margin was specifically recovered for microbiological study during Ocean Drilling Program (ODP) leg 201 (ODP sites 1225-1231). This sediment was well characterized geochemically, and had microbial populations between 10^5-10^9 cells/cm^3 sediment (D'Hondt et al., 2003).

Site 1229 sediments from throughout the retrieved core were inoculated into the following media: marine salt with added carbon source, marine salt with no added carbon source, and low salt with added carbon source. Enrichments were incubated at 2°C to encourage the growth of psychrophilic microorganisms. After liquid enrichment, samples were shifted to agar media to allow colony formation. The colonies that formed represented common marine genera of bacteria. Surprisingly, no bacterial colonies were retrieved by cultivation from sediment at either of the two sulfate/methane transition zones (SMTZ) at Site 1229, both of which had elevated direct cell counts. Although standard lab cultivation is known to only allow small percentages of the population to be grown, it is unusual for environments with high direct cell counts to not yield cultivated colonies. These experiments suggest that bacterial cells are recoverable by standard techniques at depth in the sediment column, and that SMTZs may influence bacterial growth, or the elevated cell counts may not be composed of bacterial members. Further, the recovery of microbes between multiple SMTZs suggests active recolonization of deep sediment is on-going.

Reference

D'Hondt, S., Jørgensen, B.B., et al. et al. 2003. *Proc. ODP, Init. Repts. 201*. ODP, College Station, TX.

Poisoning of iron biomineralization by surface compositional changes

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Introduction

Iron oxides are common constituents of surface and subsurface environments that have a prominent role in contaminant retention. Transformation or dissolution of such phases resulting from dissimilatory iron reduction thus has a pronounced impact on the fate and transport of contaminants (and nutrients). Pristine ferrihydrite, for example, undergoes rapid conversion to secondary iron phases due to biotic and abiotic mediated transformations. Despite the reactivity noted for synthetic ferrihydrite, iron oxides within soils and sediments will likely have compromised (or enhanced) reactivity owing to changes in surface composition and supporting substrate. Accordingly, here we explore the impact of surface modifications (e.g. phosphate) and supporting substrate on ferrihydrite reduction by *Shewanella putrefaciens*.

Batch studies illustrate that the surface area of the host substrate influences the reactivity of ferrihydrite by dictating its conformation higher surface area substrates promote ferrihydrite biomineralization while low surface area materials or unsupported ferrihydrite retard biomineralization. Alterations in surface composition further change the extent and pathway of iron biomineralization. Ligand displacement with phosphate or arsenate induced non-linear effect on the extent of biomineralization as revealed by extended X-ray absorption fine structure (EXAFS) spectroscopy; at low surface coverage little impact is noted while at high coverage the extent of bioreduction and remineralization is greatly impeded, and green rust becomes a dominant product. In contrast to the dramatic impact of arsenate and phosphate, arsenite, and humic acid adsorption have much smaller influences on the extent of iron biomineralization but do alter the reaction products.

Our results reveal the importance of considering the molecular-scale heterogeneity of solids, and specifically iron (hydr)oxides, inclusive of adsorbates and substrates, when evaluating dissimilatory iron reduction and biomineralization within soils and sediments. Surface coatings of ferrihydrite, which are the prevalent state of such materials within natural environments, will react quite differently than a homogeneous precipitate, with the reactivity dependent on the electronic properties and surface area of the substrate. Furthermore, alterations in surface composition of ferrihydrite will diminish its reactivity toward reduction.