

Deployment of Down-Hole Microcosms at the Hanford Site IFRC

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Multiple microcosm experiments were devised and deployed together, in October 2009, to investigate transformations across lithologic and hypothesized geochemical boundaries in the IFRC subsurface. Wells 3-24 and 3-27 included screened intervals that crossed the Hanford-Ringold stratigraphic contact, including both the 'oxidized' and 'reduced' interval boundary within the Ringold FM. The sampler assembly consisted of a PVC support rod with passive sampling cells, consisting of polyethylene cylinders capped with 41 μm nylon filters. Sample zones were separated by flexible baffles. The experimental matrix included substrates within multilevel sample cells: groundwater; oxidized Ringold sediment, reduced Ringold sediment, and Hanford sediment; mixed Fe, Ti oxides (particles and thin films); and polished basalt thin sections, along with experimental substrates fixed to the sample support rod on its exterior: dissolved gas samplers; multi-well iChip samplers; and Bio-Sep beads. The samples deployed in Well 399-3-24 will be removed and examined after six weeks of exposure; the samples from Well 399-3-27 will be removed at a time based on observations from Well 399-3-24. Sample types and the target data are described below; complimentary results are intended to provide information on biogeochemical processes at depth and across environmental boundaries at the Hanford Site.

399-3-24



Geochemistry

Groundwater analyses for ionic species, pH, and dissolved gases will provide a context for biological experiments and determine whether an anaerobic environment is imposed by reduced sediments in the Ringold Fm. Polished basalt surfaces will be examined for differential weathering. Dissolved gas samplers shown.



BioSep Beads

Beads were deployed in mesh pouches attached to the outside of the support rods. The purpose of experiments is to characterize activity and composition of microbial populations colonizing different surrogate solid phases (natural sands vs Bio-Sep beads baited with various electron donors and acceptors). Specific physiological groups trapped in beads could serve as inocula for isolation.



iChips

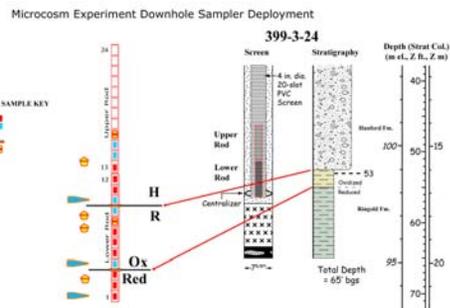
iChips were attached by placement in perforated polyethylene centrifuge tubes on the outside of the support rods. The source of microorganisms in all 6 i-chips is groundwater collected from the same well (399-3-27) one week prior to installation. Before installation, i-chips were incubated in 50 ml Falcon tubes filled with anoxic filtered groundwater. A1 and A2 were placed for cultivation/enrichment of Fe(II)-reducing microorganisms. B1 - B4 were placed in the oxidized Ringold for in situ cultivation/enrichment of Fe(II)-oxidizing microorganisms. Microorganisms were concentrated 10X by filtering groundwater through a 0.2 μm filter and then washing the filter in 1/10 of the initial volume of groundwater, or diluted 1/10 in filtered groundwater.

Polished Basalt

A standard thin section of reference Umtarum basalt was fragmented and distributed in groundwater sampling cells. Surfaces will be examined for weathering effects.

Sediment & Defined Fe Incubation

Natural oxidized and reduced Ringold sediments (~18 g per cell) and ferrihydrite-coated Accusand (~20 g per cell) were prepared aseptically and anaerobically into MLS. After a period of incubation, these materials will be analyzed on-site and in-lab. On-site: redox, DO, H₂ potential using microelectrodes (WSU); Sediments-associated Fe(III) and S(-II); acid-extraction, AVS; Fe(II) phase: Mossbauer, XRD or μ-XRD, XANES/ EXAFS; Synchrotron-based X-ray microscopy; Microbial community analyses; To(VII) reactivity.



399-3-27



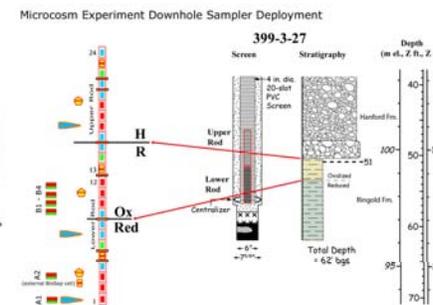
Mixed Fe, Ti Oxide Thin Films and Particles

Sampling cells containing the following substrates were deployed in each of the three zones (Hanford, Ringold oxidized and Ringold reduced):

- Thin films (5nm) of Fe₂O₃ (100) and Fe₂TiO₄ (100) on MgAl₂O₄ (100) and Fe₂O₃ (0001) on Al₂O₃ (0001) by pulsed laser deposition

- 41μm nylon filters containing synthetic Fe₃Ti₂O₄ (x = 0.15, 0.6 and 0.9) and a sample of the magnetic fraction of silty, fine sands from the trench 94 Subpit (218-E-128 Burial Ground).

Thin films will be analyzed by XPS to assess changes in the chemistry and by AFM to image potential microbial activity on the surface. The nylon filters containing mixed Fe, Ti oxide particles will be incubated in 100X concentrated IFRC groundwater to stimulate growth of any microbes associated with the substrate. Changes in the chemistry of the particles will also be assessed.



Collaborative Effort

The geochemical results for groundwater, dissolved gases, and surface weathering of basalts will be shared as received, and are intended to provide an environmental context for microbial processes occurring across chemical boundaries. All results will be shared between collaborators for maximal benefit to individual researchers.