

Modeling the relationship between sorption and residence times

M.A. MAYES*, S. JAGADAMMA, W.M. POST,
J. FRERICHS AND G. WANG

P.O. Box 2008, Oak Ridge, TN 37831

(*correspondence: mayesma@ornl.gov)

We seek to improve representations of stabilization and degradation of organic carbon in soils in terrestrial C cycling models. Major processes considered in the model include sorption of dissolved compounds onto mineral and particulate soil fractions, incorporation into microbial biomass, enzyme-facilitated degradation, and mineralization of dissolved and native carbon. Soils from temperate, tropical, and arctic climates will be used. The sorptive capacity of three orders of magnitudes of dissolved compounds common to soil solutions (sugars, starch, lipids, etc.) will be measured using ^{14}C labelling. Subsequently, the soils containing adsorbed compounds will be subjected to short-term incubation experiments to determine rates of mineralization from each soil fraction. Chloroform fumigation will be used to measure ^{14}C allocated to microbial biomass. Enzyme assays will be used to determine the potential for enzyme activities in response to various treatments. This presentation will consist of initial experimental findings and presentation of the model framework. The initial findings will be evaluated in terms of project goals produce a testbed for modelling microbially-facilitated sorptive and degradative processes at the soil mineral interface.

The effect of *M. thermoflexus* on the Fe-bearing mineral assemblage associated with low temperature basalt-water reactions

L. MAYHEW¹*, G. LAU¹, T. MCCOLLOM²
AND A. TEMPLETON¹

¹Dept. Geological Sciences, University of Colorado–Boulder
(*correspondence: mayhewl@colorado.edu)

²Laboratory for Atmospheric and Space Physics, University of Colorado–Boulder

Water-rock reactions, such as serpentinization of ultramafic rocks in the ocean crust, alter Fe(II)-bearing silicate minerals producing secondary minerals and H_2 gas and are therefore thought to support chemolithotrophic life in extreme environments (e.g. the deep subsurface). However, the alteration of Fe-bearing silicate minerals present in these rocks has not been extensively studied under low temperature, anoxic conditions. We inoculated a low temperature (55°C), anoxic water-Fe⁰-basalt system with a methanogenic Archaeon, to determine if 1) microbial growth could be supported by *in situ* production of H_2 gas and 2) the presence of the microorganisms influenced the production of H_2 gas and the Fe-bearing secondary mineral assemblage.

Growth of *M. thermoflexus* is evidenced by time series measurements of H_2 and CH_4 showing the continuous production of H_2 in the abiotic control while in cultures microbial methanogenesis draws down H_2 and produces CH_4 . Upon saturation, purging the headspace gases destabilizes Fe-bearing minerals and releases Fe and Si to solution. $[\text{Si}_{(\text{aq})}]$, while buffered to relatively constant values, was lower in the abiotic control than cultures. $[\text{H}_2]$ appears to affect the speciation of Fe in the solid phase products. Collection of synchrotron-based μXRF maps at multiple energies within the Fe K-edge and μXANES analyses integrated with principal components analyses and XANES fitting enables visualization and quantification of the distribution of the Fe-species. After ~ 1 year of reaction, Fe-bearing secondary mineral assemblages associated with high $[\text{H}_2]$ (abiotic control) are different than those associated with low $[\text{H}_2]$ (culture experiments). For example, minnesotaite, an Fe-phylosilicate, is ubiquitous in the abiotic control but much less abundant in the culture experiments. We will discuss how the geochemical reaction paths and Fe-speciation differ between the abiotic control and the culture experiments. This work suggests that at low temperatures microorganisms may have a profound effect on what has long been thought to be solely an abiotic reaction and may produce diagnostic mineral assemblages that may be preserved in the geological record.