High pressure constraints core formation from x-ray nanoscale tomography

YINGXIA SHI[1]*, WENDY L MAO[1, 2], LI ZHANG[3], WENGE YANG[4], YIJIN LIU[2], JUNYUE WANG[4]

[1]Stanford University, Stanford, USA, yingxias@stanford.edu*
[2]SLAC National Accelerator Laboratory, Menlo Park, USA
[3]Carnegie Institution of Washington, Washington, D. C., USA
[4]Argonne National Laboratory, Argonne, USA

Core-formation represents the most significant differentiation event in Earth's history. Percolation of liquid iron-rich alloy through a crystalline silicate matrix has been suggested as a possible core formation mechanism, especially for the differentiation of planetesimals during the early history of our solar system, since radioactive decay of short-lived isotopes in the small accreting bodies cannot provide enough heat to form extensive melting (i.e. magma ocean) [1-2]. Previous experimental results looking at dihedral angles in silicate metal samples synthetized at elevated pressures and temperatures suggest that percolation is unlikely to be an efficient mechanism in our planet [3-4]. However, experimental conditions in previous work have been limited in upper mantle conditions (<30GPa). Moreover the measurement of dihedral angles using transmission electron microscopy or backscattered electron microscopy may not generate satisfactory statistics. Nanoscale x-ray computed tomography (nanoXCT) has exciting potential as an accurate probe to study the 3D connectivity and permeability of core forming melts in crystalline silicates. Using a laser-heated diamond anvil cell, experimental conditions over the entire pressure-temperature range in the lower mantle can be accessed. In this study, we compressed and heated the mixture of iron-rich alloy + orthopyroxene, and then used a focused ion beam (FIB) to mill the quenched samples to extract a portion for nano-XCT. Pilot studies from our group using 3D nano XCT have demonstrated the ability to image the detailed morphology of the iron-alloy and silicates, along with details of Fe-FeS eutectic intergrowth patterns, which help to distinguish the relative Fe content in Fe and FeS. Data resulting from the combination of these techniques could improve our understanding of planetary core-forming processes.

[1] Keil *et al* (1997) *Meteoritics and Planetary Science* **32**, 349-363.

[2] Rubie, *et al* (2007) *Evolution of the Earth* **9**, 51-90.

[3] Shannon & Agee (1996) *Geophysical Research Letters* **23,** 2717-2720.

[4] Terasaki *et al* (2008) *Earth and Planetary Science Letters* **273**, 132-137.

Lead Adsorption on Iron-amended Composts

ZHENQING SHI,*[1] YEEWEI CHAN[1], AND JAMES HARSH[1]

[1]Washington State University, Pullman WA, USA, zhenqing.shi@wsu.edu (* presenting author)

Biosolids high in Fe have been shown to reduce the bioavailability of soil Pb both to plants and, when ingested or inhaled, to humans. We characterizing an Fe-rich compost that was developed to serve the same role as Fe-rich biosolids. The objectives of this work are (1) to determine the effectiveness of this material in lowering the bioavailability of Pb in soils (2) to characterize the nature of the reactive sites and their mechanism of metal sequestration. In this study, we (1) determine the capacity for Pb as a function of Fe concentration and Fe source, (2) assess the ability of Fe-compost to transform Pb in contaminated soils to highly recalcitrant states, and (3) model the distribution of Fe between organic- and Fe-sites.

Batch experiments were conducted to study the capacity of the iron-amended compost to adsorb Pb, including adsorption isotherms at various pH and adsorption edges at various initial Pb concentrations. For some selected experiments, the compost samples with varying iron contents were used to evaluate the effect of iron-amendment. Generally, the iron-amended composts showed high Pb adsorption capacity (> 3% Pb in composts), suggesting high concentrations of reactive organic matter and iron oxides in these compost samples. Lead adsorption increased with Fe concentration, suggesting that Fe sites played a role in increased adsorption.

The ability of iron-amended composts to sequester Pb in contaminated soils was investigated by incubating two contaminated soils with the compost samples at the field moisture content. We are evaluating the extractability of Pb in these treated soils with sequential extraction methods.

The preliminary modeling results with WHAM VI described the Pb adsorption results well using humic material and iron oxides as adsorbents. The modeling results also suggested that organic matter dominated adsorption at high Pb concentrations and adsorption to iron oxides was greatest at lower Pb concentrations. We are currently calibrating the model parameters with more data and comparing the performance of different speciation models, such as SHM and CD-MUSIC. We hope to acquire a quantitative understanding of the roles of both organic matter and iron minerals on Pb sequestration by the composts.