Department of Chemical and Environmental Engineering

2013—2014 Seminar Series

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9:30—10:30 AM

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Daniel Giammar

Harold D. Jolley Career Development Associate Professor

Department of Energy, Environmental and Chemical Engineering

Washington University in St. Louis

Chemical Reaction and Transport Controls of Carbonate Mineral Formation in Geologic Carbon Sequestration

Geologic carbon sequestration is a potential strategy for mitigating the impacts of anthropogenic CO_2 emissions on climate change. The rates and products of geochemical reactions can influence the fate and transport of CO_2 injected into geologic systems as part of a sequestration strategy. Laboratory experiments were performed to examine potential sequestration reactions involving the magnesium-rich mineral forsterite. The dissolution rate of forsterite (Mg_2SiO_4) was quantified as a function of CO_2 pressure, temperature, and salinity over a range that is relevant to sequestration in ultramafic rocks. Rates increased with increasing temperature and increasing salinity, and the effects of CO_2 pressure were only through their influence on solution pH. Magnesite ($MgCO_3$) is a desirable product of CO_2-water-forsterite reactions, and its solubility and required saturation index for nucleation were examined at elevated pressure and temperature. The presentation will conclude with an evaluation of the coupled dissolution-precipitation processes in diffusion-limited systems. An approach that integrated bench-scale experiments, *in situ* nuclear magnetic resonance spectroscopy, and reactive transport modeling investigated the development of chemical gradients that could control the overall extent of mineral trapping of carbon. All three approaches found that the onset of magnesium carbonate precipitation was spatially localized about 1 cm below the interface of a forsterite bed with the well-mixed solution. Although magnesite precipitation decreased the porosity of the packed bed, mineral carbonation continued at depths below the zone of maximum precipitation.

Short Biography: Daniel Giammar is an Associate Professor in the Department of Energy, Environmental and Chemical Engineering at Washington University in St. Louis. His research focuses on chemical reactions that affect the fate and transport of heavy metals and radionuclides in natural and engineered aquatic systems as well as the geochemistry of carbon sequestration. His research has been supported by the Water Research Foundation, National Science Foundation, U.S. Environmental Protection Agency, and the U.S. Department of Energy. Dr. Giammar received his B.S. in Civil Engineering from Carnegie Mellon University in 1996, and he earned his M.S. and Ph.D. in Environmental Engineering Science at Caltech in 1998 and 2001. He is a member of ACS, ASCE, AWWA, and WEF, and he is a registered professional engineer in Missouri. In the 2012-2013 academic year Dr. Giammar was a visiting professor in the Department of Civil and Environmental Engineering and the Andlinger Center for Energy and the Environment at Princeton University. He was recently appointed an Associate Editor of *Environmental Science & Technology*.