OCGC SEMINAR

Probing the links between water availability, mineral reactivity, and CO2 storage

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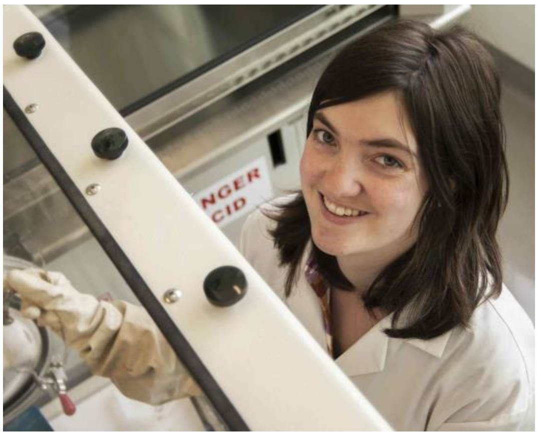
Abstract: Earth's shallow subsurface, or "critical zone," is of fundamental importance for supporting terrestrial life and maintaining water quality. This zone will be affected by climate change, which is expected to substantially alter rainfall patterns and evapotranspiration rates across the globe. Gas-driven mineral weathering reactions that occur in the water unsaturated region of the critical zone are an important source of nutrients for plant and microbial life. Such reactions also influence the bioavailability of water, influence water quality, and have a profound impact on the global carbon cycle, which regulates atmospheric CO_2 concentrations and climate over geologic time. Moreover, these natural reactions can be exploited and engineered to sequester anthropogenic CO_2. Mineral weathering rates are typically determined in the laboratory using homogeneous stirred reactors with excess water, but it has long been recognized that orders of magnitude discrepancies exist between these laboratory-measured rates and those measured in the field. Numerous explanations have been posited to explain this discrepancy including the lack of wetted surfaces available for reaction in unsaturated media. This talk will examine the physical and chemical impact of water availability on the mineral weathering reactions that capture and store CO_2. Our experimental results indicate there is a threshold in water content beyond which reactions occur unencumbered, but below which the rate and extent of mineral weathering is extremely limited. Reactive transport modelling of column experiments that investigated the replacement of brucite [$Mg(OH)_2$] by Mg-carbonate minerals in water-limited conditions revealed that a lack of available water limited both the bulk reaction rate and the maximum extent of reaction that can be achieved. These results build towards a better understanding of mineral reactivity in unsaturated materials, which will aid in the prediction of the response of mineral weathering reactions to climate change, and help the design of engineered of CO_2 sequestration strategies.



Dr. Anna Harrison *is an Assistant Professor at Queen's University since July 2018, and is joint-appointed between the Department of Geological Sciences and Geological Engineering and School of Environmental Studies. She received my BSc from the University of Alberta and her PhD from the University of British Columbia. After completing her PhD, she went to Stanford as postdoctoral fellow where she worked on the geochemical implications of hydraulic fracturing. She then took up an NSERC fellowship at Geoscience Environment Toulouse (a part of the CNRS in Toulouse, France). After one year at GET, she moved to University College London in London, UK to take up a Marie Sklodowska-Curie Individual Fellowship. In both Toulouse and London, she investigated mineral weathering in the unsaturated zone and isotopic tracers of mineral dissolution and precipitation. Her research focuses on mechanisms of fluid-mineral-gas interactions and the implications for environmental issues such as CO2 capture and storage.*

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