

Banded Iron formations (BIFs): Key to the Rise of Atmospheric Oxygen

Bridget Lee - PhD. Student at the University of California, Riverside
Collaborator - Dr. Noah Planavsky, Yale University

Description of Research

Ongoing debates over the timing and mechanism of the dramatic rise of atmospheric oxygen known as the “Great Oxidation Event” (GOE; ca. 2.3-2.4 Ga) are at the center of studies on the co-evolution of life and its environments on early Earth. Critical to the discussion is the occurrence of banded iron-formations (BIFs) prior to 2.4 Ga and their relative disappearance soon after. In this project, I aim to characterize iron (Fe) and manganese (Mn) deposition in BIF sequences exposed in the Minas Supergroup in Brazil, which despite spanning the GOE, are far less studied than equivalent units elsewhere in the world. The overarching motivation of this study is the environmental changes that led to (and resulted from) the rise of oxygen and their relationships to life. I am performing a detailed profile construction of the redox and diagenetic processes that influenced Fe and Mn deposition of the BIFs to bring new insights into biospheric conditions just prior to and coincident with the GOE.

To my two weeks visit to Yale, I brought seventy total digested samples for Fe ($\delta^{56}\text{FeT}$) and Mo ($\delta^{98}\text{Mo}$) isotopic analysis. The iron (Fe) and Molybdenum (Mo) concentrations were measured ahead of time at the at University of California Riverside. At Yale, a portion of total digest acid solution were evaporated and dissolved with 7 mol/L HCl (Figure 1). A portion of this acid were loaded with Mo double spike and passed through chromatographic columns (Figure 2). Each sample was doped according to the Mo concentration to keep a constant sample/spike ratio. Mo separation was attained using a two-stage column procedure: a first stage of anion resin separating Mo and most Fe from the matrix, and a second stage of cation exchange separating Mo from remaining Fe. Two blanks, two duplicates and two standards were run in each set of columns.

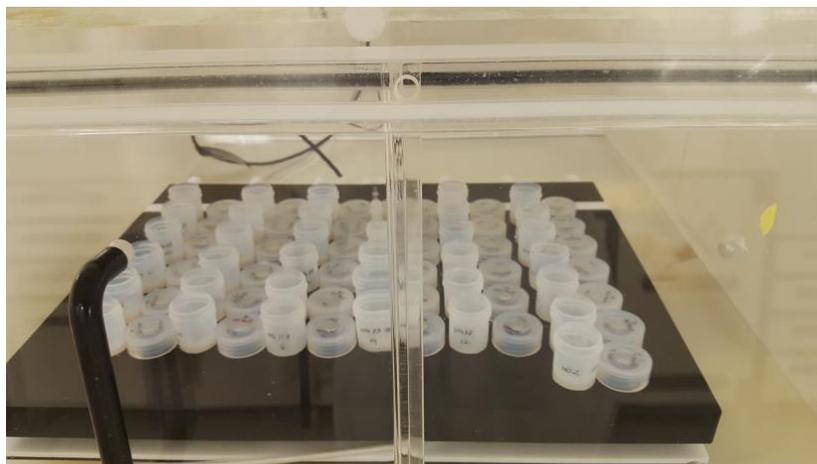


Figure 1: Evaporating acid from the solution.



Figure 2: Chromatographic column work.

Outcomes of Collaboration

This collaboration enabled me to get a new insight about Minas Supergroup. I encountered the need to examine weathering processes and surficial water chemistry using Mn, Fe and Mo to infer perturbations of an anoxic late Archean environment. For this reason, we only performed a small batch isotope measurement which rose more questions towards Mn, Fe and Mo that are commonly hosted in accessory minerals and solid solutions in silicates, carbonates, sulfides, and oxides. I aim to investigate in more depth about the dissolution of these host minerals during weathering that is controlled by several factors, including mineral abundance and reactivity, the redox state, the pH of the water and complexation with other species.

This collaboration opened the door to future work together and I intend to revisit Yale in coming months to finish the isotope analysis and discuss the results in more depth with collaborator Dr. Noah Planavsky. Our new results will help us construct a more comprehensive understanding of changes in the chemical profiles of these elements and their isotopic compositions can be used as indicators of both weathering and paleoredox processes. I am thankful for the NASA Astrobiology Early Career Collaboration Award for funding this project and the opportunity to work with researchers at Yale University.