Research Interests and Future Work Draft

Over the past 50 years, oceans have lost approximately 2% of their dissolved oxygen (O_2) concentrations—resulting in O_2-deficient waters and significant loss of marine biodiversity. With O_2 levels expected to decrease in the future, creating a more hostile anoxic (no O_2) environment for living animals, there is a critical need to understand what factors control these changes. One way is by examining perturbations of biogeochemical cycles during ocean anoxic events (OAE) as preserved in the rock record. Significant research is currently centered on understanding global, abrupt climatic events. My research aims to address the knowledge gap around local episodes, those controlled by volcanic events. More specifically, I aim at understanding the link between volcanic imprint on sedimentological and biogeochemical cycles of the ocean-atmosphere system during a well-known tumultuous climatic event, called the Toarcian Anoxic Event (T-OAE).

Current Work

At present my research goal is to understand the effect of the North Sea Dome (NSD)—a volcanic structure—on basin restriction and ocean-atmospheric changes during the T-OAE by assessing the spatial and temporal distribution of redox sensitive trace elements (RSE) and quantitative values of Fe (iron) species. In our modern oxygenated oceans, RSE/OC (organic carbon) is commonly used to track seawater concentration—as a first order approximation of RSE. Therefore, low ratios are often associated with basin restriction; higher values are associated with open oxygenated waters. For this work, I am currently conducting a systematic study of the Lower Jurassic Drake Formation, within the Norwegian North Sea, to provide critical insight on the sedimentological and geochemical impact of the NSD on basin restriction and spatial extent of oxic and anoxic (Fe rich-versus sulfur-rich) waters and serve as an analog to assess local volcanic imprint on regional environmental changes.

This year, I was awarded the Woodrow Wilson National Fellowship, funding that will go towards conducting: a) iron-speciation to fingerprint oxic, sulfidic or ferruginous conditions and b) pyrite sulfur isotopes to assess the extent of euxinia. These analyses will be carried out at the High Magnetic Field Laboratory, Florida State University during Spring 2021. I will test the hypothesis using iron (Fe) speciation coupled with methods found in Algeo and Rowe, (2012). Iron proxies will be most effective for distinguishing oxic, anoxic and Fe (II) rich, and euxinic conditions in the target study area during Drake Formation deposition. Pyrite sulfur isotope analyses will help constrain seawater sulfate availability and identify the local extent of euxinic conditions. These combined measurements are essential for reconstructing and estimating the spatial extent of redox conditions.

Near Future Work (Short Version)

As part of my PhD research, I will also work on identifying key geochemical differences within a restricted versus an open-marine setting using Drake and Draupne Formation intervals, respectively. Given the environmental conditions, we expect significantly higher values of redox sensitive trace elements (RSE) within the Drake Formation than in the Draupne Formation. The goal of this work to understand the temporal evolution of anoxia within black shale intervals during the Jurassic. Samples were collected January of this year in Stavanger, Norway, and I have received funding for this work through Equinor. I expect to start working on this research by the end of this year.