Previous Research Experience

Working with Dr. [redacted], my first project focused on discovering whether the collapse of the North American Laurentide ice sheet during the deglaciation released a deluge of freshwater into the Gulf of Mexico. As much of the water circulating through the Gulf of Mexico flows into the North Atlantic gyre by way of the Florida straits, a core was selected west of Key West. In this core, we could analyze microscopic carbonate shells for clues dating back to the ice sheet collapse. I expected that the melt-water mass would be cold and fresh. As even very cold fresh water is significantly more buoyant than salty ocean water, the species *Globerinoides ruber*, an organism which calcifies at the top of the water column, was selected for analysis; this species should have calcified in the midst of a melt-water pulse and recorded the ambient conditions within its shell.

These shells were analyzed on a light isotope mass spectrometer. The isotopic ratio of the oxygen gives us information regarding the temperature and salinity of the water mass. Water molecules composed of the lighter isotope of oxygen have less mass; these molecules evaporate preferentially - water from the Laurentide ice sheet had a lighter isotopic composition than ambient ocean water; as temperature of a water mass increases, lighter oxygen isotopes are preferentially built into the shell. The two factors have counteracting influences on the isotopic composition of *Globerinoides ruber*. Mg/Ca trace metal analysis provides temperature proxy, allowing correction of oxygen isotopes for salinity. The *rubers* were carefully cleaned and run on an optical emission inductively coupled argon plasma mass spectrometer (OES).

Results did not show melt-water pulses. Either the fresh flow mixed, perhaps via a hyperpycnal event, or the melt water pulses originated from Antarctica or via the St. Lawrence Seaway. I presented the results to the faculty of the School of Earth and Atmospheric Sciences as *The Florida Straits through the Last Glacial Maximum*. Mg/Ca data indicated temperatures increased locally during Heinrich events, suggesting the temperature gradient from south to north may have increased during these massive ice-rafting events. An increased temperature gradient implies a reduction in the transport of warm, northward-moving ocean water as the production of North Atlantic Deep Water (NADW) slows. Some results of this study were presented at the annual AGU Fall Meeting by Dr. [redacted] entitled *Florida Current Salinity and Transport across the Last Glacial Termination*.

A few months later, while studying ecology in the rainforests of Australia, Dr. [redacted] suggested I apply for an NSF funded Research Experience for Undergraduates (REU) in paleoclimatology at the University of [redacted]. At [redacted], the REU focused on the high stands of the Pleistocene, Pliocene and Miocene. To explore conditions surrounding high stand events, we turned to aminostratigraphic relative age dating. While aminostratigraphy has been employed for years with bivalve mollusks, such as *chione*, higher concentrations of amino acids have recently been found in *Balanus spp.*, the common barnacle; much higher concentrations of amino acids in *Balanus spp.* allows for much higher resolution. Measuring the racemic ratios of aspartine, glutamine, valine, phenylalanine and L-isoleucine, allows us to determine relative ages of geologic formations. Shell material was collected from a number of these formations by us and past REU fellows. While collecting samples I wondered to myself about how many other people had the chance to snorkel around the Florida coast, while getting paid for it; the second day of sampling had me wondering how long my sunburn would last.

A significant issue with racemic dating is the osmotic contamination of the shell's surface amino acids with those found within the formation. Over time, amino acids from the surface and in the crevices of the shell's crystal structure exchange with those found in the environment. By

clearing the inter-crystalline amino acids through exposure to a strong oxidizing agent, the amino acids locked in the interior crystal structure of the shell can be analyzed. Working closely with [redacted], then an undergraduate of [redacted] and now a graduate student of biochemistry at [redacted], I pioneered methods producing high resolution relative age dates with *Balanus spp.* by varying grain size and duration of exposure to oxidation. We collected material from formations around Florida, and analyzed the crystal structure with a SEM; the scans were used to determine structural variability among and within formations. Running a matrix of tests from 0 to 36 hours of oxidation on grain sizes varying from 125*um* to 500*um* revealed intra-crystalline amino acids uncompromised; the first 12 hours of hydrolysis amino acid concentrations quickly fell, while the subsequent twenty-four hours saw amino acid concentration remain relatively constant.

Results were recovered via liquid chromatography; the samples of shell reacted with hydochloric acid and baked for twenty-two hours; then the liquid samples were evaporated and reconstituted with a solution containing an internal standard. Fluorescence detection determined the concentration of various amino acids; the identities of the amino acids were confirmed by the time taken for the molecules to traverse the column and appear on the detector. When the concentrations which were graphed as a scatter plot, the spread of the oxidized samples were much tighter than the unoxidized control, suggesting the successful elimination of amino acids not associated with the original shell. These findings proved the efficacy of this technique, and were presented at Geological Society of America's South-Eastern conference and published as *Improving Aminostratigraphic Resolution using Balanus spp. in Lower Miocene to Upper Pleistocene Fossiliferous Sediments in Florida.*

My senior research project focused on assessing flow through the Florida Straits 15-45kyr ago, a time of dramatic climate oscillations. The project built upon a paper in which my adviser showed a drop in flow through the Florida Straits through the LGM; this paper in *Nature* described how density gradients alter with shifts in velocity in a geostrophically balanced current. Incorporation of oxygen isotopes within carbonate varies with both temperature and salinity; thermal expansion gives water of a lower temperature a heavier isotopic value; an increase in salinity, as mentioned earlier, gives a heavier isotopic value. Therefore isotopic ratios of oxygen are proportional to density. Using benthic species, *P. arimininsis* and *C. Pachyderma,* we interpolate equipycnals across two cores situated on opposite sides of the Florida Straits, interpreting the slope of those lines of equal density as proportional to current speed.

Developing the Florida margin should shed light for the first time on whether DO events, clearly resolved in GISP, had a strong effect upon NADW. Preliminary results suggest H Events have had an effect on NADW, but DO events remain elusive; I presented preliminary results at Georgia Tech's Undergraduate Research Symposium as *Circulation Alterations before the Last Glacial Maximum*. Detailed results from this research on DO Events are still forth-coming, and will be presented at the annual fall AGU meeting of the as *Searching for Circulation Shifts in Marine Isotope Stage Three.* Given the vital role of NADW production to the climate system, especially given its sequestration significance to the carbon cycle, the results of this current study should be well received.

Given the opportunity, I should love nothing better than to continue this vein of research at [redacted] University as a graduate student of Dr. [redacted] within the [redacted]; to pursue this course, I require this NSF graduate research fellowship. Mounting evidence confirms the fundamental importance of understanding of our earth's climate systems; I am prepared to work closely with other scientists undertaking this endeavor.