End of Summer FURSCA Report
Sedimentology of Nearshore and Terrestrial Environments of the Late Cretaceous of the Morondava Basin, Western Madagascar

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Introduction

The goal of my summer 2021 FURSCA project was to analyze thin sections of rock samples from the Late Cretaceous of the Morondava Basin, Western Madagascar. Through detailed sedimentological description and analysis of these thin sections, I was able to interpret the depositional environments that hosted key fossils (dinosaurs, sharks, turtles, invertebrates). Prior to starting my project, I hypothesized that the environments would represent an overall rise in sea level along the Morondava coast through the Late Cretaceous, transitioning from rivers and floodplains to shallow marine settings (Marshall et al., 2015).

Results

Over the course of the summer, I was able to point count 13 thin sections, each at 1,000 points. Point counting is a quantitative method used to describe the composition of a rock (Horowitz and Potter, 1971). When viewing the thin section under a microscope, a grid of points is overlain on the slide and the grain at each point is identified and recorded into a spreadsheet. Point counting is used to get a less-biased data set. I point counted in stratigraphic order and as I finished each section, I began to reconstruct the depositional environments each were formed in and the stratigraphic context of the succession.

Overall, my original hypothesis was correct. The samples at the bottom of the sequence are terrestrial deposits, rich in detrital minerals such as quartz and feldspars. As you move up, the dinosaur-bearing deposits represent a rise in sea level. The environment transitions to a open-marine setting with abundant authigenic minerals, specifically glauconite, and open-marine

microfossils, like *Globotruncana* forams and calcispheres. (Figure 1 shows images of some of the fossils found in thin sections). The uppermost unit in the succession that I analyzed this summer was deposited in a shallow marine setting, likely a tidal flat. Through thin section analysis, I was able to reconstruct the changes in the paleoenvironment that hosted key fossils. I was also able to tie each sample to a step in sequence stratigraphy. Sequence stratigraphy helps you explain how sediment fills in a basin. The different parts within sequence stratigraphy are related to changes in sediment supply and accommodation space. Through sequence stratigraphy, we are able to track the sedimentary evolution of the basin our samples are from.

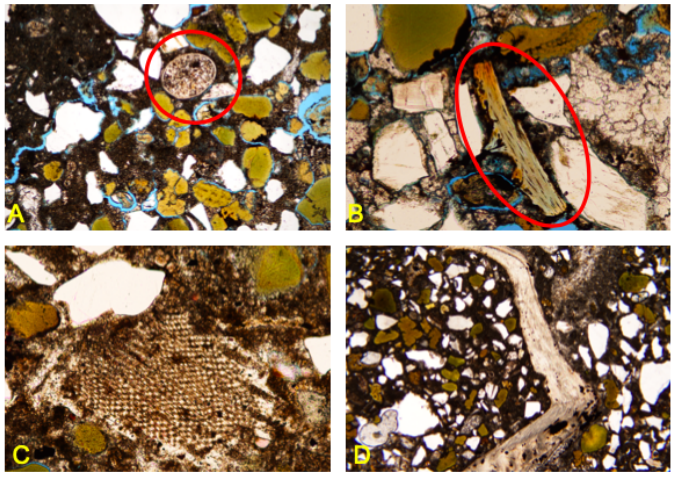

Figure 1: Images of fossils found in thin sections. (A) An algal cyst or calcisphere (circled in red). The calcisphere is ~.25 mm in diameter. (B) A portion of a fish jaw (circled in red). This fragment of the fish jaw is ~0.6 mm in length. (C) An echinoid plate. It is ~0.5 mm in length. (D) A portion of a brachiopod. The brachiopod is ~9 mm in length.

In addition to analyzing thin sections, I created maps of both the Ampolipoly area (the area where my samples were from) and the Morondava Basin as a whole. Maps of Madagascar are difficult to come by and those that do exist are outdated, difficult to read, and in some cases, incorrect. Using ArcGIS, I combined maps created by french geologist, Henry Besarie, and Malagasy government agencies, to create a map that was accurate and usable for my research.The map includes the geology of the Morondava Basin from the Quaternary through the Middle Jurassic, the past and present geography of the area, rivers and lakes, major roads, relevant faults, and the localities of samples collected by Dr. Madeline Marshall in 2012 and 2015. I plan to include my map in my senior thesis and in future publications. In addition, I

created a web map application that allows you to explore the geology of the basin by zooming in and out, searching for specific localities and cities, and turning layers on and off.

Link to the web map:

https://ac-gis.maps.arcgis.com/apps/webappviewer/index.html?id=880ca10f6fc64483928483f4dfe9c509

For the last three weeks of FURSCA, my research advisor, Dr. Madeline Marshall, brought Moses Jatta and myself into the field with her to assist on her main project in the Permian Phosphoria Rock Complex (PRC) of south eastern Idaho. We were accompanied by Drs. Kimberely Lau and Chelsie Bowman from Pennsylvania State University. Drs. Lau and Bowman are interested in completing a geochemical analysis of the sediments located within the PRC. Over the course of three weeks, we visited three spots within Idaho to collect samples and describe the rock sections (the Cassia Mountains, Caribou National Forest, and Swan Valley, Idaho). Previous to the trip, I combined maps made by geologists that previously studied the area to make a more usable map of field localities in the Cassia Mountains.

Link to the web map:

https://ac-gis.maps.arcgis.com/apps/webappviewer/index.html?id=e6f1b5783a68412389dd8678d2b5706d

While in the field, I got practice using a Brunton Compass to measure the strike and dip of rocks, using a Jacob's staff to measure a stratigraphic section, trenching the sides of mountains

to expose rock, taking field notes and making sketches, collecting and taking inventory of over 400 rock samples, among many other skills. In addition to learning important skills necessary for a career in geology, I also had the opportunity to apply what I have learned in the classroom, to rocks in the field, and how to make interpretations about the paleoenvironments. Though they were different in many ways, it was interesting to make comparisons between my samples from Madagascar and those from Idaho. We even found samples in Idaho that had abundant amounts of glauconite, which is the mineral I am most interested in within my Madagascar samples. In the future, I plan to continue working on the samples we collected this field season in Idaho.

Conclusion

Over the course of FURSCA this summer, I have had the opportunity to learn invaluable lab and field skills necessary for a career in geology. Additionally, this summer has helped me realize that I truly love geology and I want to spend the rest of my life studying it. With that being said, in the fall, I plan to apply to graduate schools for geology. In the future, I want to work in a natural history museum as a curator or research geologist.

This fall, I am going to use my research to write a departmental honors thesis. I also plan to publish my research on Madagascar with my advisor Dr. Madeline Marshall. In October, I will be presenting my research at the Geologic Society of America's annual conference in Portland, OR. I will be doing an oral presentation along with a poster presentation with my fellow lab mate, Moses Jatta. Finally, I will be presenting my research at Elkin Isaac in the spring of 2022.

I would like to thank the Bruce A., '53 and Peggy Kresge, '53 Endowed Science Fellows for giving me the opportunity to grow as a scholar. I would also like to thank Dr. Madeline

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