MOZAMBIQUE SHELF CORES – RESEARCH INITIATIVE

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GOALS OF PROJECT

- To decipher the initiation, growth and drowning of the fringing reef during the last glacial maximum.
- To assess the composition of the reef and the contribution of microbial crusts in stabilizing the reef.
- To thoroughly analyze the diagenetic alteration in this reef that was never exposed to fresh water.
- To produce a comprehensive petrophysical data set of the core material that includes porosity, acoustic velocity, and resistivity.

INTRODUCTION AND RATIONALE

The slopes above the newly discovered giant gas fields offshore Mozambique (Fonnesu et al., 2020) revealed a long, approximately 40 m thick fringing reef that crested at -95 m water depth. The reef started to grow during the Last Glacial Maximum (LGM) at approximately 20 kyrs and drowned during the subsequent deglaciation. Such lowstand reefs have been cored in a few places around the world, including offshore the modern Barrier Reef and Tahiti (Camoin et al., 2006; Heindel et al., 2012). However, these earlier borings have not achieved the level of core recovery as those of Mozambique. The shareholders have released these cores to the CSL – Center for Carbonate Research- for scientific study.

We are expecting the official release from the government of Mozambique. A 2 m section was made available to us a couple of years ago. It showed a diverse coral community with several species but also thick crusts of greyish microbialites and microbial pellets inside the coral framework (Tomchovska et al., 2022).

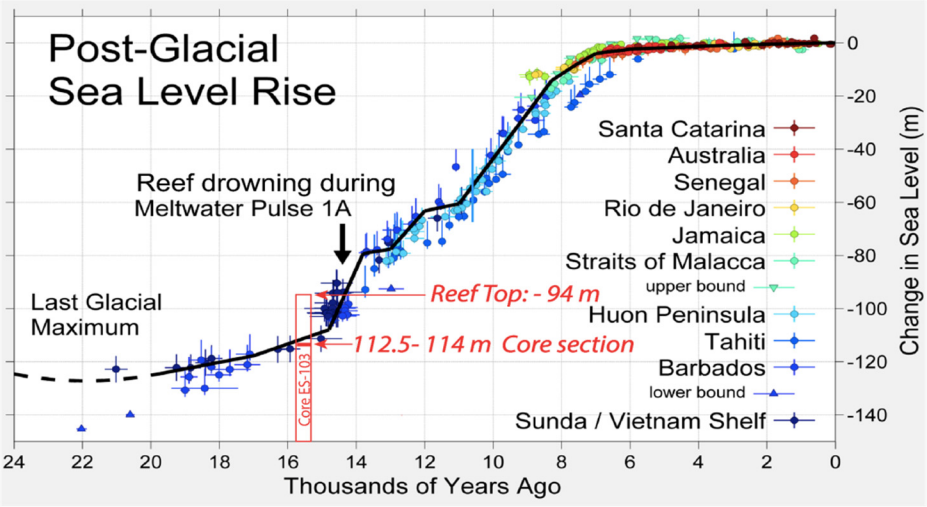

Figure 1: Core position within the post glacial sea-level rise. This lowstand reef that crested at -94 m has a diverse coral community and encrustations of microbialite (M) as well as calcareous red algae (CR).

Two samples collected for C-14 dating from this section yielded ages of 13400 and

13600 kyrs, documenting reef growth shortly after the LGM during the deglaciation and the accelerated sea-level rise event called Meltwater Pulse 1A (Figure 1).

The Mozambique cores (Figure 2) will provide a unique opportunity to study lowstand reef complexes that have never been exposed to freshwater diagenesis. Given the high level of preservation, these cores are of intrinsic value as they represent an unaltered geological record.

Analyses of these cores will address several fundamental topics.

These include 1) the evaluation of seawater composition and temperature during the LGM, 2) the timing and rate of sea-level rise during the early deglaciation, 3) early marine diagenetic processes, 4) the identification of the coral species and their changes from the LGM through the early stages of the deglaciation, 5) the role of microbial crusts that have been documented as important components of reef environments during the LGM, and 6) relate the pore structures to the petrophysical properties of these carbonate rocks cemented solely in the marine realm.

PLANNED TASKS

4) Curation of core: The cores will be cut longitudinally into two halves. One half will be the archive core, which will be photographed and preserved, while the other will be used as a "working" half for a myriad of analyses, including petrographic, geochemical and petrophysical analyses.
5) Detailed core description on the archive half of the core will use Dunham's classification.
6) Coral ecology: Identification of the coral species will be undertaken using morphological attributes. In addition, changes in coral community structure will be assessed as sea-water composition changes during the onset of the deglaciation.

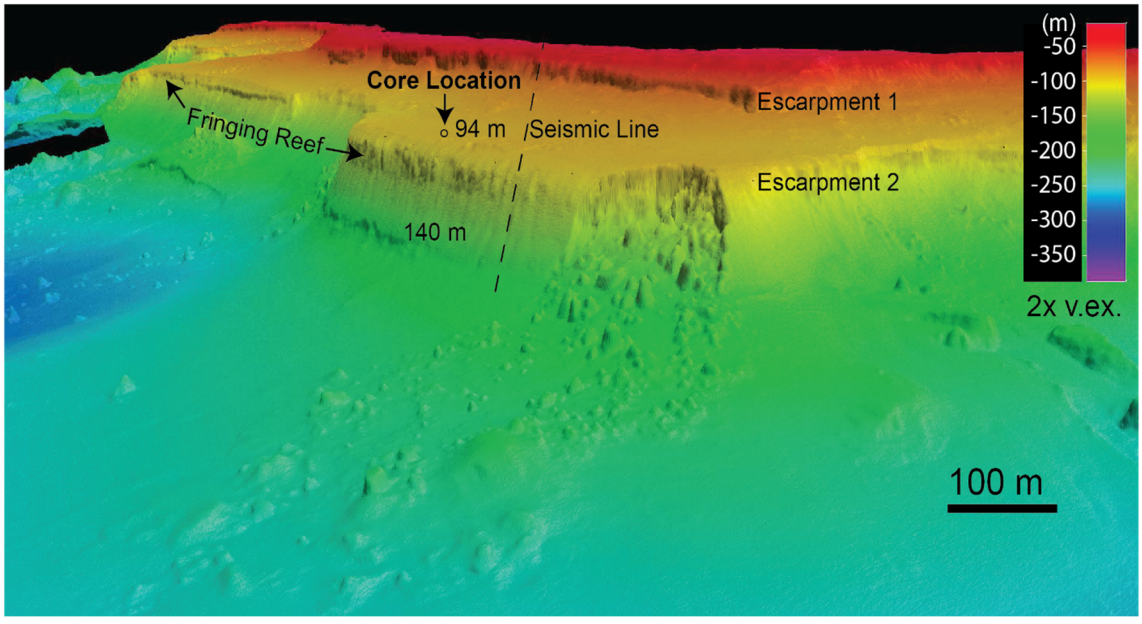

Figure 2: Core location on the fringing reef.

7) Quantitative analysis of core components will be undertaken by identifying textures (i.e. microbial crusts, corals, sediment grains) (Fig. 3) in core and on stitched images. The quantification will be done on adjusted images using Image J's "analyze particles" function.
8) Thin section analysis of petrographic fabrics, diagenetic alterations and grains will be conducted.
9) SEM (scanning electron microscopy) analysis of the microbial crusts and marine diagenetic cements will be undertaken.
10) Age determination using the C-14 method on reef material and crusts will be employed to determine if they grew coevally.
11) Petrophysical studies will be done on 1 inch core plugs that are drilled vertically and horizontally into the working half of the core. Porosity will be measured with a Micromeritics AccuPyc 1330 Helium pycnometer utilizing Boyle's law. Laboratory measurements of acoustic velocity and electrical resistivity measurements will be performed on brine-saturated core plugs under variable pressures using a New England Research Autolab1000 system.
12) Geochemical analyses will consist of 1) stable isotope analysis on regularly spaced samples in each core, 2) XRD of the same samples to determine mineralogy and 3) clumped isotopes to determine the water temperature during reef growth.
13) Results from this research will be compared to previous studies conducted in Tahiti and offshore the Great Barrier Reef. The comparison will include reef composition, coral species ecology, and geochemical signature.

Component	Percentage of Surface Area
Coral	53.6%
Microbialite crust	14.1%
Calcareous coralline algae (CCA)	3.8%
Skeletal rudstone to grainstone	28.5%

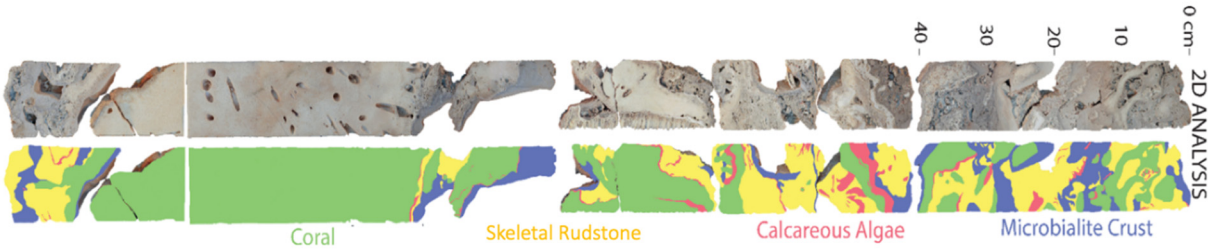

Figure 3: Quantitative analysis of the 2 m core section, displaying the four elements present and their respective abundance.

WORKPLAN

The study of this extensive core material and the large scope of the project will require three to four years to complete. The proposed tasks are arranged in the workplan below; roughly in chronologic order, but once sampling is completed, several investigations will be done simultaneously by different scientists.

Work Plan

Activities	Year 1	Year 2	Year 3	Year 4
	Transportation of cores to Miami			
	Curation core, cutting, sampling			
	Description of Core	Description of Core		
	Thin section analysis	Thin section analysis	Thin section analysis	
		Quantitative component analysis	Quantitative component analysis	
		Age determination	Age determination	
		Coral ecology	Coral ecology	
		Geochemical analysis	Geochemical analysis	Geochemical analysis
		Petrophysical studies	Petrophysical studies	Petrophysical studies
			SEM analysis	SEM analysis
				Comparison to other studies
				Final Report/Papers

SIGNIFICANCE

The cores from offshore Mozambique will add a much-anticipated data set for establishing the environmental conditions during the Last Glacial Maximum and the early sea-level rise. In addition, these microbially encrusted coral reefs seem to preferentially grow during deglacial periods. They typically contain large intraframe porosity yet display an extraordinary strength, thus maintaining this porosity to large burial depth. If such microbialite/coral reefs form in a lowstand setting, they could be identified as lowstand reefs on seismic data and are potentially excellent reservoirs.

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