MOZAMBIQUE SHELF CORES – RESEARCH INITIATIVE

Gregor P. Eberli, Ricardo Argiolis[1], Ralf J. Weger, James Klaus, Peter K. Swart, Amanda Oehlert, and others.

1) EniProgetti SpA

PREFACE

In 2023 the CSL made a proposal to the Instituto Nacional De Petroleo (INP) of Mozambique in which we "kindly asked to have access to the shelf cores drilled in offshore Mozambique, which we intend to investigate in an integrated study that includes sedimentology, diagenesis, reef ecology, geochemistry and petrophysics".

On July 17, 2025, the Instituto Nacional De Petroleo (INP) of Mozambique granted permission to the University of Miami to analyze the cores. They had been stored in London and arrived in December in Miami. To our surprise and delight, the core material is more extensive than anticipated. It consists of 10 cores drilled at 4 sites.

In our solicitation to INP we listed the rational, projects goal and proposed a 4-year work program, which is outlined below. It is followed with a description of phase one of the initiative.

RATIONALE FOR THE STUDY

The fringing reef offshore Mozambique 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. However, these borings have not achieved the level of core recovery as those of Mozambique.

The Mozambique cores 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 geologically record.

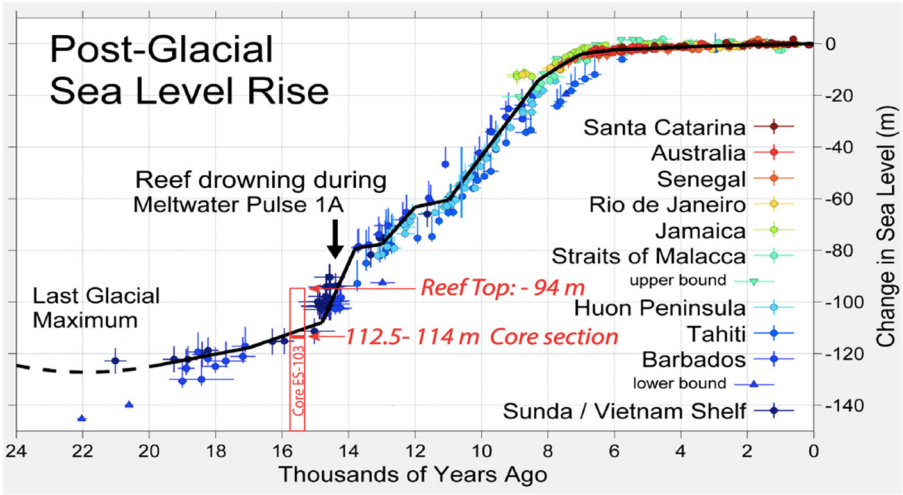

Figure 1: Position of one of the cores from Mozambique within the post glacial sea-level rise. This lowstand reef that crested at -94 m. A 2-m core section has previously been studied in Miami.

Analyses of these cores will be instrumental to address several fundamental objectives. These include: 1) the assessment 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 structurally volumetric components of reef environments during the LGM, and 5) relate the pore structures to the petrophysical properties of these carbonate rocks cemented solely in the marine realm.

GOALS OF PROJECT

- To decipher the timing of 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.

WORKPLAN AND TASKS

The study of this extensive core material and large scope of the project will require four years to complete. The proposed tasks are arranged in the workplan below; roughly in a 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

SUMMARY OF PROPOSED TASKS

1. 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.

2. Detailed core description on the archive half of the core will use Dunham classification.

3. 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 deglaciation.

4. Quantitative analysis of core components will be undertaken by identifying textures (i.e. microbial crusts, corals, sediment grains) in core and on stitched images. The quantification will be done on adjusted images using Image J's "analyze particles" function.

5. Thin section analysis of petrographic fabrics, diagenetic alterations and grains will be conducted.

6. SEM (scanning electron microscopy) analysis of the microbial crusts and marine diagenetic cements will be undertaken.

7. Age determination using C14method on reef material and crusts will be employed to determine if they grew coevally.

8. 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.

9. 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 isotope to determine the water temperature during reef growth.

10. 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.

SIGNIFICANCE

Constraining the relative sea-level (RSL) changes during the Last Glacial Maximum (LGM) is difficult because data points of sea level is limited to a few locations (Vacchi et al., 2025). Cores from offshore Mozambique will add a much-anticipated data point for establishing the timing, magnitude and rate of elative sea level changes from the onset of the LGM at ~29.5 ka BP to the beginning of the main phase of deglaciation at ~16.5 ka.

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 and are potentially excellent reservoirs. If such microbialite/coral reefs form in a lowstand setting, they could be identified as lowstand reefs on seismic data.