

PETROPHYSICAL PROPERTIES OF A FRINGING REEF MARGIN

Pierre Casco, Viviana Diaz, James S. Klaus, Donald F. McNeill, Albertus Ditya, Ralf Weger, and Gregor P. Eberli

PROJECT OBJECTIVES

- Determine the petrophysical properties (electrical resistivity, ultrasonic velocity, porosity, permeability, and density) within a seven borehole transect across the Pleistocene reefal carbonates of the southern Dominican Republic.
- Assess the relative influence of primary depositional facies and subsequent diagenetic alteration on the measured mechanical and petrophysical properties.
- Develop a gridded model from core measurement and stratigraphic data that can be used to assess optimal seismic acquisition parameters and limits of imaging resolution within the reefal margin.

PROJECT RATIONALE

Understanding controls on the petrophysical properties of carbonates is often key to proper interpretation of reservoir properties (porosity, permeability) from either seismic or well-log data. Petrophysical properties of carbonate sediments exhibit considerable spatial heterogeneity based on grain size, texture, and packing. Furthermore, diagenesis alters the original fabric and rock properties shortly after deposition due to changes in mineralogy and inversion of pore distribution.

The objective of this project is to complete a comprehensive characterization of the mechanical and petrophysical properties of the Pleistocene reefal carbonates of the southern Dominican Republic. Following the initial drilling phase of the Dominican Republic Drilling Project in 2010, a total of 170 plug samples were analyzed for mechanical and petrophysical properties (Ditya, 2012). These samples were collected at a maximum depth of ~60 m, and represented primarily by shallow water depositional facies heavily impacted by meteoric diagenesis. In 2012 a second phase of drilling added new deep wells in both younger and older strata, and extended existing wells to recover the deeper water forereef facies.

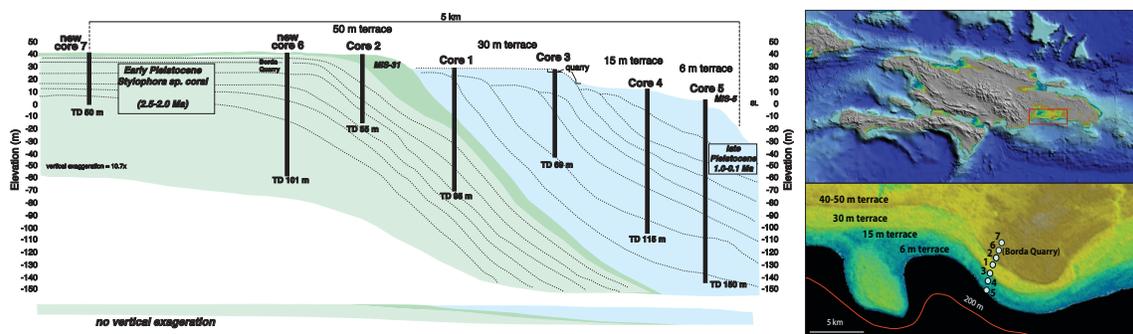


Figure 1. Cross-sectional model of Pliocene to Pleistocene reef sigmoids on the southern coast of the Dominican Republic based on seven drilled boreholes

SCOPE OF WORK

Since the initial drilling of the Dominican Republic cores we have been working to develop a temporally constrained sequence stratigraphic model for the seven core transect through the Pleistocene reef deposits. Age determinations were based on biostratigraphic markers, strontium isotopes, magnetostratigraphy, and radiometric dating. A revised depositional model constrains the prograding reef system of the southern Dominican Republic to between 1.6 and 0.125 Ma. Once dated, these cores were used to assess accretion and progradation rates, and reconstruct fringing reef zonation and facies geometries both vertically and perpendicular to the coast.

In addition to the previously sampled cores (Ditya, 2012), 87 additional one-inch diameter cylindrical plugs of variable length were drilled for petrophysical measurements. Plugs were sampled from the cores using a water-cooled diamond drill bit with vertical and horizontal orientation. The ends of the plugs were cut off and then polished to within 0.01 mm precision (measured with a micrometer gauge) to create a flat surface for optimizing contact area between sample and sonic or electric transducers. Samples were dried at 60°C for 48 hours and then stored in a desiccator for approximately 24 hours. The dry-mass of the samples were measured to the microgram using a Thomas Scientific T200S electronic scale. Chips from one end of each plug were sent to the University of Iowa's Geology Department for thin section preparation.

Petrophysical measurements will include electrical resistivity, ultrasonic velocity, porosity, permeability, and density. The petrophysical properties will be compared to assess their relationship to each other and for external comparison, for instance: porosity-permeability, porosity-acoustic velocity. The petrophysical properties will then be analyzed based on petrographic observations in order to assess a correlation between petrophysical properties and depositional / diagenetic environments.

EXPECTED RESULTS

The dataset of petrophysical properties will be coupled to geologic parameters:

- Age
- Platform morphology (isolated, shelf, and ramp)
- Climate zone (tropical, cool-water, temperate)
- Depositional environment (top, shoal, slope, basin)
- Type of information (outcrop, subsurface)
- Texture (Dunham)
- Dominant pore type and microporosity
- Sequence stratigraphic position
- Mineralogy

The resulting dataset will be compiled with other well-studied projects to provide an unprecedented catalogue of sample set information with interconnected relationships (See Schnyder et al. this volume).

REFERENCES

Ditya, A., 2012, Petrophysical characterization of Pliocene-Pleistocene reefal carbonates, southern Dominican Republic. MSc. Thesis, University of Miami, Coral Gables, Florida, 129 pp.