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IODP EXPEDITION 307: SITE U1316 SUMMARY MODERN CARBONATE MOUNDS: PORCUPINE DRILLING

Hole U1316A	51°22.551'N	11°43.803'W	948.4 mbsl
Hole U1316B	51°22.562'N	11°43.810'W	948.1 mbsl
Hole U1316C	51°22.543'N	11°43.795'W	948.0 mbsl

Site U1316 (Proposal Site PORC-4A) is located in the downslope sediment deposits ~ 700 meters to the southwest of Challenger Mound. The principal objectives at Site U1316 were:

- To gain insight into history of drift deposits on the downslope flank of the Challenger Mound and the off-mound transport of mound-related skeletal and non-skeletal grains.
- To investigate the character and age of the sigmoid units observed in the upper seismic P1 that appears to form the basement of the Challenger Mound.
- To evaluate whether the sigmoid shaped units contain high concentrations of gas and thus represent a potential hazard for drilling in the Challenger Mound. Further drilling of Challenger Mound (Site U1317) was made contingent on investigation of the sediments along its flank at Site U1316.

Sediments recovered from Site U1316 located basinward of the Challenger Mound contain a sedimentary suite of post-, syn- and pre-mound growth phases that correspond to three identified lithological Units 1-3, respectively. The uppermost Unit 1 is 52-58 m thick, and mainly composed of grayish-brown silty clay. It is subdivided into two subunits. Subunit 1a is dominated by dark grayish-green silty clay, whereas Subunit 1b contains fining upward sand beds of about 0.7 to 1.0 m thickness. Dropstones are observed throughout the unit. Unit 2 is a coral bearing facies of 10-13 m in thickness and underlies Unit 1 with an erosional surface. Corals of the basal layer of this unit exhibit floatstone facies, and they could have been buried in their growth position. The age of this unit is mostly Pleistocene, which corresponds to the age of the thick coral mound at the Site 1317. This unit rests on the Unit 3 with a distinct unconformity surface. The Unit 3 consists of the 92-m thick (Hole U1316C) heterogeneous, dark green colored, glauconitic siltstone, and is calcareous in the lower part. Dolomite precipitation formed lithified layers around 72 mbsf.

Biostratigraphic data confirm the ages of Units 1 as early Pleistocene by continuous occurrence of *Emiliani huxleyi* (0.26 Ma-recent). The age of the Unit 2 is within the Pleistocene (0.46 – 1.95 Ma; from LAD of *Discoaster triadiatus* to LAD of *Pseudomilliana lacunose*). A significant hiatus was recognized above Unit 3, which includes Miocene microfossils. However, an inconsistency arises in age of top of this unit that is dated as early Miocene by nannofossils, but is dated as early Pliocene by planktonic foraminifers.

Archive halves were measured for their magnetization after 0, 15, and 20 mT demagnetization steps. Inclinations for lithostratigraphic Unit 1 average to 66°, in the neighborhood of the expected inclination (68°) at the site latitude (51.4° N), therefore Unit 1 is normal polarity and is assigned to the Brunhes Chron (0-0.78 Ma). The Brunhes/Matuyama boundary is not observed. Below the mound base in lithostratigraphic Unit 3, magnetic intensities are weaker, typical for carbonate-rich sediments, inclination data more scattered, and could not be interpreted in terms of magnetic polarity stratigraphy. XCB coring disturbance also degraded the paleomagnetic signal in these cores.

Distinct trends and patterns in the physical properties measurements were observed that could be related to lithology and to the seismic section. Lithological Unit 1 has high magnetic susceptibility and natural gamma typical of siliciclastic-rich sediment, and both of have lower values in Units 2 and 3, supportive of the observation of increased carbonate content relative to Unit 1. The downhole increase in density at the Unit 2/3 boundary is the cause of a strong reflection, recognized as a regional unconformity, in the seismic survey.

After an unsuccessful attempt to log Hole U1316A, Triple Combo and FMS-sonic downhole logs were acquired between 60 and 140 mbsf in Hole U1316C. The density, resistivity, and acoustic velocity logs show a steady downhole increase due to compaction, interrupted by 1-5-m-thick intervals of higher values, indicating the presence of more lithified layers. The PEF values for these layers indicate they are carbonate-rich. These lithified layers are the cause of several strong reflections in the sigmoidal package in the seismic section at this site.

The interplay of diffusion and burial and the microbial mediated reactions dictate the profiles of interstitial water chemical species and dissolved gas chemistry at Site U1316. Li and B are apparently being released at depth during silicate diagenesis, whereas Sr is most likely released during deeper carbonate diagenesis. Concave-up curvature in the profiles of minor elements – Li, Sr, and B – suggest that high rates of sediment burial in the uppermost 80 mbsf may be dominating diffusion. Interstitial water alkalinity, ammonia, and sulfate profiles indicated two zones of microbiological activity: an upper zone of activity between the surface and 10 mbsf, and a lower zone between 80 and 100 mbsf, probably driven by methane oxidation. Prokaryotes are present in all samples counted, but abundances appear to be low throughout much of Site U1316; a zone of nearly 30 m thickness between 56 mbsf and 85 mbsf appears to represent a 'dead zone' based on the absence of evidence for cell division. However, prokaryote abundances increase in the zone of apparent methane oxidation coupled to sulfate reduction. The enhanced ethane/methane ratios suggest preferential removal of methane over ethane through the methane-sulfate transition (82 to 130 mbsf). Generally, methane concentrations are low within the Unit 3A sediments and only increase to concentrations of 2 mM at 130 mbsf. We found no significant accumulations of gas within the sediments that coincided with the wave shaped reflectors in the seismic survey.