

IODP Proposal Cover Sheet

1008 - Pre

Belize Barrier Reef Postglacial Sea-level

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|------------|---|------|-------------------|
| Title | Postglacial Atlantic sea-level reconstruction through drilling the Belize Barrier Reef (BBRdrill) | | |
| Proponents | Eberhard Gischler, Stefano Fabbri, Flavio Anselmetti, Daniela Basso, Mara Diaz, Gerald Dickens, Andre Droxler, Gregor Eberli, Thomas Felis, Jörn Peckmann, Nathan Rabideaux, Jody Webster, Christian Zeeden | | |
| Keywords | Belize, barrier-reef, postglacial, sea-level | Area | western Caribbean |

Proponent Information

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|-------------|--------------------------------------|
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Abstract

In contrast to the Indo-Pacific, where postglacial sedimentary successions of coral reefs including relative sea-level data were obtained from outcrops and coring, e.g., in Vanuatu as well as in Tahiti and the Great Barrier Reef (IODP drilling), there is only one such record in the Atlantic (Barbados, eastern Caribbean). The Barbados core data are extremely valuable, however, there are also limitations and challenges. The cores were not rigorously investigated with regard to sedimentology, paleoecology, and taphonomy, and there are apparent differences to more recent, IODP-based data, e.g., the evidence of meltwater pulse (MWP) 1B, the timing and height of sea level during the last glacial maximum (LGM), the apparent lack of microbialites, as well as mismatches with Holocene sea-level curves. Therefore, it is planned to obtain glacial-postglacial reef sections by coring in the western Caribbean, which would provide valuable comparisons with the existing eastern Caribbean (Barbados) and the Indo-Pacific records. The barrier and atoll reef system offshore Belize is the largest modern tropical reef complex in the Atlantic Ocean, and well-suited for this purpose. It also represents a mixed carbonate-siliciclastic sedimentary system. Late Quaternary reefs were deposited largely during sea-level highstands, like those of the Holocene and marine isotope stage 5, which are well-studied, unlike the reef deposits from lower highstands and lowstands of sea level. The latter deposits, including those from the last postglacial, can be recovered by drilling in fore-reef areas of the 250 km-long barrier reef of Belize. Based on a recent site survey, which obtained highly resolved bathymetric and shallow seismic data from the area, and based on discussions during an international workshop, three drill areas have been identified. These include two transects of four drillholes each, oriented perpendicular to the modern reef crest. Drillholes will be situated on linear ridges running along the fore-reef slope. One of these transects will be located off Carrie Bow Cay where shallow coring in the fore-reef area has been performed by previous studies. A third transect of four drillholes will be located on a southward shoaling ridge, running more or less parallel to the modern reef crest south of the mouth of English Cay Channel. In addition to these 12 drillholes, one site is planned in deep water east of the barrier reef and one on the delta of the English Cay Channel in order to obtain off-reef reference records with both limited and strong siliciclastic input, respectively.

Scientific Objectives

We propose four scientific objectives (O1-O4), which are focused on investigating the evolution of a mixed-carbonate-siliciclastic reef margin during the late Quaternary as expression of environmental change. The objectives relate to the challenges 1-7 summarized in two themes of the IODP Science Plan 2013-2023 (1 climate and ocean change; 3 biosphere frontiers). Moreover, this proposal will address five of the seven strategic objectives and two of the five flagship initiatives of the 2050 Ocean Drilling Science Framework.

(O1) Reconstruction of last glacial maximum (LGM) and postglacial sea-level rise in the western Atlantic relates to Challenge 2, how ice sheets and sea level will respond to a warming climate.

(O2) Reconstruction of environmental parameters using corals, coralline algae, and cryptic microbialites in late Quaternary reef successions of Belize addresses the Challenges 1, 3, and 7 of the IODP Science Plan including the response of the climate system to elevated levels of carbon dioxide, the control of precipitation associated with El Niño, and the sensitivity of ecosystems and biodiversity to environmental change.

(O3) Elucidation of reef paleoecology in relation to postglacial sea-level rise and associated environmental changes addresses Challenge 1 and 2 as well as Challenge 7, i.e., the sensitivity of ecosystems to sustained higher levels of carbon dioxide.

(O4) Assessment of microbial life in a barrier-reef system addresses Challenges 5, 6, and 7, namely the origin, composition, and significance of seafloor communities, the limits of seafloor realm, and the sensitivity of ecosystems and biodiversity to environmental change.

Non-standard measurements technology needed to achieve the proposed scientific objectives

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

no

Science Communications Plain Language Summary

Using simple terms, describe in 500 words or less your proposed research and its broader impacts in a way that can be understood by a general audience.

Tropical coral reefs are important archives of environmental change, including sea-level and temperature rise. Since the last ice age, sea level has risen by some 125 m and ocean temperatures by several degrees. This has been shown impressively by IODP drilling in Tahiti and the Great Barrier Reef, in the Pacific. There is only one comparable record in the Atlantic, off the coast of Barbados in the eastern Caribbean. However, there are data limitations and challenges regarding the Barbados data. Therefore, it is planned to collect drill cores from the Belize Barrier Reef, located in the western Caribbean, the largest reef system in the Atlantic. The shallow Belize offshore region (shelf) is a so-called mixed-carbonate-siliciclastic system, where calcium carbonate (limestone) is produced on the outer shelf by reef-building organisms and silicates like quartz and clay minerals on the inner shelf derived from the hinterland. The balance of these two sediment sources provides crucial clues regarding the environmental changes in time. During the Quaternary period, the past ca. 2.5 million years, climate fluctuated between warm and cold episodes lasting tens of thousands of years. Due to the waxing and waning of polar ice shields, sea level fluctuated up and down accordingly. In Belize, the coral reefs studied so far were largely deposited during warm episodes and high sea levels. This research plans to investigate coral reefs that were deposited during lower and minimum sea levels during glacial and post-glacial times, with a focus on the past ca. 20,000 years, i.e., the time interval since the maximum of the last ice age. These deposits can be recovered from fore-reef areas along the Belize Barrier Reef, in water depth to some 150 m. It is planned to use the infrastructure of the IODP to drill and systematically investigate twelve cores from three locations of the deep fore-reef of Belize. For reference, two additional cores will be drilled in greater water depth to recover age-equivalent deep-sea deposits. The planned research builds on previous research as well as on a recent site survey during which the bathymetry and shallow subsurface of the study area were investigated, and on an international workshop of geoscientists. This research has not only pure scientific significance, but is of socio-economic relevance as the data will help to better understand current and future global climate change, which will be characterized by rising temperature and sea level.

Proposed Sites (Total proposed sites: 14; pri: 14; alt: 0; N/S: 0)

| Site Name | Position (Lat, Lon) | Water Depth (m) | Penetration (m) | | | Brief Site-specific Objectives |
|-----------------------|-------------------------|-----------------------|-----------------|-----|-------|---|
| | | | Sed | Bsm | Total | |
| BBRN-01A (Primary) | 17.305153 -88.028445 | 77 | 73 | 0 | 73 | A documentation of glacial and postglacial reef growth and drowning under the influence of siliciclastic input from English Cay Channel mouth. |
| BBRN-02A (Primary) | 17.300435 -88.030151 | 64 | 86 | 0 | 86 | A documentation of glacial and postglacial reef growth and drowning under the influence of siliciclastic input from English Cay Channel mouth. |
| BBRN-03A (Primary) | 17.296514 -88.035326 | 65 | 85 | 0 | 85 | A documentation of glacial and postglacial reef growth and drowning under the influence of siliciclastic input from English Cay Channel mouth. |
| BBRN-04A (Primary) | 17.289380 -88.037387 | 39 | 111 | 0 | 111 | A documentation of glacial and postglacial reef growth under the influence of siliciclastic input from English Cay Channel mouth (likely vertically stacked postglacial reefs). |
| BBRN-05A (Primary) | 17.306063 -88.023613 | 140 | 50 | 0 | 50 | Reference section to recover deep-water archive with siliciclastic influence, for comparison to shallow-water, reefal sections. |
| BBRC-01A (Primary) | 17.227982 -88.041285 | 25 | 125 | 0 | 125 | A documentation of glacial and postglacial reef growth (likely vertically stacked postglacial reefs) in an area of reticulate reef distribution. |
| BBRC-02A (Primary) | 17.228039 -88.041735 | 50 | 50 | 0 | 50 | A documentation of glacial and postglacial reef growth in an inter-reef geomorphological depression; in an area of reticulate reef distribution. |
| BBRC-03A (Primary) | 17.228263 -88.042151 | 40 | 50 | 0 | 50 | A documentation of glacial and postglacial reef growth on an inner reef ridge in an area of reticulate reef distribution. |
| BBRC-04A (Primary) | 17.228427 -88.042819 | 28 | 50 | 0 | 50 | A documentation of glacial and postglacial reef growth on an inner reef ridge in an area of reticulate reef distribution. |
| BBRS-01A (Primary) | 16.805617 -88.076939 | 17 | 133 | 0 | 133 | A documentation of glacial and postglacial reef growth (likely vertically stacked postglacial reefs). |
| BBRS-02A (Primary) | 16.805562 -88.077181 | 31 | 50 | 0 | 50 | A documentation of glacial and postglacial reef growth in an inter-reef geomorphological depression. |
| BBRS-03A (Primary) | 16.805507 -88.077373 | 26 | 50 | 0 | 50 | A documentation of glacial and postglacial reef growth on an inner linear reef ridge. |
| BBRS-04A (Primary) | 16.805554 -88.077615 | 32 | 50 | 0 | 50 | A documentation of glacial and postglacial reef growth in an inter-reefal geomorphological depression. |
| BBRS-05A (Primary) | 16.805696 -88.075667 | 159 | 50 | 0 | 50 | Reference section to recover deep-water archive without siliciclastic influence, for comparison to shallow-water, reefal sections. |