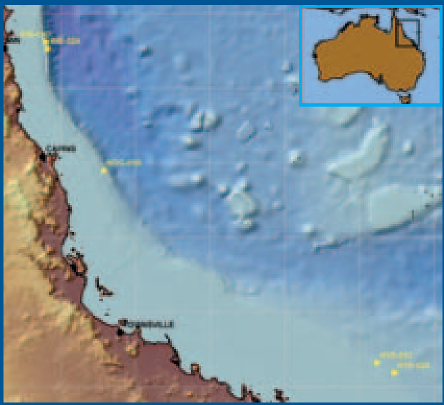
Great Barrier Reef Environmental Changes Expedition



In February 2010, scientists from Expedition 325 Great Barrier Reef Environmental Changes (GBREC) left Townsville, Australia, onboard the *Greatship Maya* to spend 8 weeks collecting cores from the fossil coral reefs at three locations on the seaward side of the present day Great Barrier Reef. The expedition was led by Co-chief Scientists Dr Jody Webster of the University of Sydney, Australia and Dr Yusuke Yokoyama of the Ocean Research Institute at the University of Tokyo, Japan. The *Greatship Maya* is a dynamically positioned geotechnical drillship and is managed by GC Rieber. Drilling services were contracted out to Bluestone Offshore PTE, Singapore.

Scientific goals

The scientific objectives of the Great Barrier Reef Environmental Changes Expedition were:

1. to establish the course of sea-level rise during the last deglaciation (~20-10 ka),
2. to define sea-surface temperature variations,
3. to analyse the impact of these environmental changes - abrupt sea-level and climate changes - on reef growth and geometry for the region over the period of 20-10 ka.

To meet these objectives a succession of fossil reef structures preserved on the shelf edge seaward of the modern barrier reef were cored in depths ranging from 42.27 to 167.14 meters below sea level.

Coral reefs and climate change

The deglaciation that followed the last major ice age started some 20,000 years ago. Knowing the timing and nature of the subsequent sea-level rise is one of the essential components that will help us to understand the dynamics of large ice sheets and how the Earth has adjusted since the ice melted. The disappearance of glacial ice sheets was also responsible for dramatic changes in the input of freshwater into the oceans, which disturbed the oceans' thermohaline circulation that in turn impacted on global climate.

Dates: February 11 - April 6, 2010
Platform: *Greatship Maya*
Deepest hole: 46.4 m
Number of boreholes: 34
Number of cores: 420
Core recovery: 225 m (30 %)
www.eso.ecord.org/expeditions/325/325.php

Greatship Maya on site.

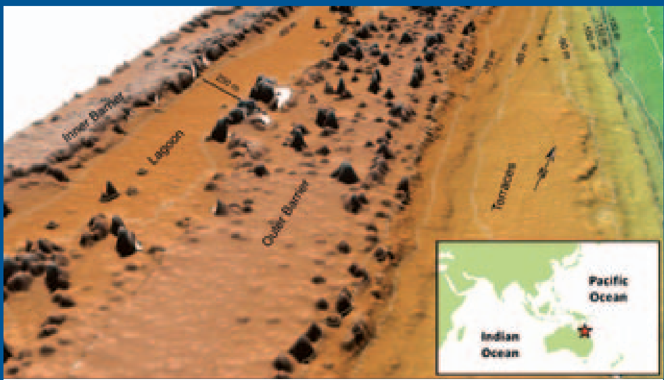
Scleractinian coral colonies can monitor seasonal sea-surface temperatures (SSTs) and record past SSTs. So far, the only published sea-level and climate record that encompasses the whole deglaciation is based on offshore drilling of Barbados fossil coral reefs which overlie an active subduction zone, implying that the apparent sea-level record may be biased by tectonic movements. Key locations to address these problems are in tectonically inactive areas far away from glaciated regions, including sites visited by Expedition 325 Great Barrier Reef Environmental Changes and the previous Expedition 310 Tahiti Sea Level.

IODP
INTERNATIONAL OCEAN DISCOVERY PROGRAM

ECORD
EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

Scientific results

Four transects located within three geographical areas were drilled during the Expedition: Hydrographer's Passage (2 transects; north and south), Noggin Pass (1 transect), and Ribbon Reef (1 transect). Cores were recovered from 34 holes across 17 sites. Borehole geophysical wireline logging was conducted at four holes.



Submerged reef structures on the shelf edge near Noggin Pass, Great Barrier Reef. Features include parallel barrier reefs composed of a raised ridge and pinnacles, a lagoon containing patch reefs and seaward terraces (from Abbey and Webster, 2011).

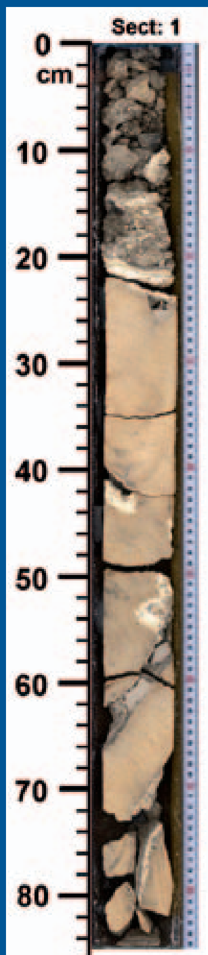
Shelf edge features (pinnacles, terraces, ridges and "reefs", etc.) were proven to be clearly constructional coral reef features that will provide new insights into the evolution of the Great Barrier Reef (GBR). Cores were recovered from successions of these fossil reef features from 42 to 127 mbsl. Therefore, most if not all of the postglacial sequence from the Last Glacial Maximum (LGM) to the present day was recovered. The upper coral-algal-microbialite reef units are well developed and thick (up to 20-30 m). *Acropora*-dominated assemblages imply very shallow reef settings, while basal sections characterised by abundant microbialites. Samples from these lithologies should provide a truly excellent sea-level and reef-response record.

The post-glacial reef grows on older, more complicated Pleistocene limestone units, which have different composition spatially and temporally (*i.e.* cross-shelf variation), and analysis of these cores may deliver reef response records from glacial and inter-glacial periods before the LGM.

Preliminary U/Th- and AMS C14-derived chronology confirms that the recovered cores span the period of interest since the LGM, including comprehensive new coverage of crucial periods in Earth's sea-level and climate history *e.g.*, MIS3, MIS2 (LGM),

The Expedition Team at the Onshore Science Party in Bremen.

19 ka - Meltwater Pulse, and Meltwater Pulses 1A, 1B, as well as existing time intervals before the LGM. During the Onshore Science Party at the IODP Bremen Core Repository, high-quality coral samples, consistent with shallow, high-energy settings, were taken for subsequent dating and sea-level change investigations.



Photograph of a coral core showing massive coral colonies.

Massive coral colonies suitable for paleoclimate studies and spanning the LGM and post-glacial sequence were recovered in the cores. During the Onshore Science Party, more than 200 massive coral colonies were slab-sampled for paleoclimate studies, which are also underway.

During the offshore phase, cores were recovered from holes in various water depths and situated on four transects in three different geographic areas along the GBR, each with different shelf morphologies. Therefore, results of analyses of samples taken during the Onshore Science Party can be interpreted in a broad temporal and spatial context, which will allow better understanding of the development of the GBR in response to environmental changes.

For further reading

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- Abbey, E.A and Webster, J.M., 2011. "Submerged Reefs." In Encyclopaedia of Modern Coral Reefs, edited by D. Hopley. New York: Springer-Verlag
- Webster, J.M.et al., 2008. From corals to canyons: the Great Barrier Reef margin. Eos, Trans. Am. Geophys. Union, 89(24):217–218. doi:10.1029/2008EO240002
- Yokoyama, Y.et al., 2006. Sea-level during the early deglaciation period in the Great Barrier Reef, Australia. Global Planet. Change, 53(1–2):147–153. doi:10.1016/j.gloplacha.2006.01.014