Facies and Diagenesis of Older Pleistocene Coral Reefs, Great Barrier Reef, Australia (IODP 325)*

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Abstract

IODP expedition 325 drilled 34 holes along four traverses across the Great Barrier Reef of Australia thereby penetrating some 750 m of reefal deposits of the late Quaternary in water depths ranging from 40-170 m. The expedition took place during 12 February - 1 April and was followed by the onshore science party in Bremen, Germany, during 1-16 July 2010 involving 28 scientists from 9 countries. IODP expedition 325 has three major objectives. They include (1) a reconstruction of deglacial sea level for the period 20-10 kyrs BP with a focus on MWP 1A and 1B events, (2) to use the variability of sea surface temperature and sea-level change on reef growth patterns including drowning, and (3) to quantify paleoclimatic change in high-resolution by sampling skeletons of massive corals during the same time window. According to preliminary age dating, the majority of cores cover the time period of about 25-10 kyrs BP. These late Pleistocene sections appear diagenetically unaltered and comprise coralgal boundstone, coralgal-microbial boundstone, skeletal grainstone and rudstone, and unconsolidated sand. In five cores taken in depths of 40-85 m water depths at three traverses, older Pleistocene (>25 Kyrs BP) reefal deposits were recovered in lower core sections. Lithologies include skeletal grainstone to rudstone, some packstone, coralgal boundstone, and few occurrences of coral-microbial boundstone. Usually, they exhibit clear evidence of diagenetic modification in the meteoric realm, such as caliche phenomena, neomorphism, dissolution vugs, and low magnesium calcite cement growth. Samples are currently being investigated under sedimentologic and diagenetic aspects, and detailed results will be presented at the meeting.
References


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Session on modern and Pleistocene carbonates: sedimentology, diagenesis, and processes; AAPG Houston, April 2011
Previous studies:

establishment of the Great Barrier Reef: during MIS 11

Ribbon Reef 5

International Consortium GBR Drilling (2001)
Webster & Davies (2003)
Braithwaite et al. (2004)
Objectives of IODP leg 325

1. establish the course of post-glacial sealevel rise at GBR (20-10 kyrs BP)
   - MWPds
   - max. SL-drop
   - saw-tooth pattern of SL-rise
   - test model predictions

2. define SST-variation in same time interval

3. analyze impact of sealevel change on reef growth and geometry
   - drowning events
   - foreslope processes
   - reef modelling
IODP Expedition 325 GBR coring transects

Core locations
- Ribbon Reef (2)
- Noggin Pass
- Hydrographer's Passage (2)
Greatship Maya (Bluestone Offshore, Singapore)

93 m long, 19 m wide, 32 m high
draft 6.3 m; 4,840 tons
66 berths
operational to 1,800 m depth
Noggin Pass
planned drill sites
Noggin Pass, seismics with planned drill sites
NOG-01B

Main lithologic units:
- Unit 1: mainly coral-algal-microbial laminae
- Unit 2: un lithified carbonate sediments (Halimeda and benthic forams common) (post glacial/ Older Pleistocene)
- Unit 3: grey packstones/grainstones etc (Halimeda, bryozoans, IR, molluscs; common; Older Pleistocene)
- Unit 4: un lithified carbonate sediments (mud & very fine sand; abundant planktonic forams)
- Unit 5: light coloured Halimeda-benthic foraminifera rudstone/grainstones; sometimes coals & rhodoliths (older Pleistocene?)
- Unit 6: mainly coral framestones with light coloured grainstones (Halimeda, LBF, coral, molluscs; older Pleistocene)

LGM sea level

Two-way traveltime (ms)

0.5 km

(SEismic line from Webster, Yokoyama & Cotterill, 2009)
IODP 325 Great Barrier Reef

- co-chiefs: Jody Webster (Australia), Yusuke Yokoyama (Japan)

- 28 scientists from 9 countries involved (USA, Japan, UK, Australia, Germany, France, Spain, China, India)

- 34 holes drilled at 14 sites

- 747 m drilled / penetrated (planned: 1.480 m)

- 225.3 m of core material recovered

- mean recovery 34.5%

IODP Expedition 325 Harvest!
late Pleistocene coralgal facies (25-10 kyrs)
microbialite facies (only late Pleistocene; 25-10 kyrs)
microbialite facies
(close-up)

only occurs in post-glacial deposits; presumably during rapid sea-level rise and porous reef frameworks
older Pleistocene coralgal facies (>25 kyrs)
older Pleistocene grainstone facies (>25 kyrs)

older Pleistocene subaerial exposure horizons
Thin-section micrographs 1; older Pleistocene facies

- a: marine and meteoric cements
- b: neomorphosed coral; peloidal and blocky cement
- c: dissolution, blocky and dogtooth cements
- d: marine and meteoric cements
Diagenetic features observed:

- Early marine cements (acicular, peloidal, microcrystalline)
- Meteoric-phreatic and meteoric vadose cements (blocky, meniscus, scalenohedral or dog-tooth)
- Dissolution
- Neomorphism

Thin-section micrographs 2; older Pleistocene facies

Widths of pictures 5 mm
Sedimentology and chronology 1

occurrence of older Pleistocene

explanation: 26.45 kyrs BP
Sedimentology and chronology 2

![Graph showing sedimentology and chronology with various depth and horizon markers, and color-coded layers representing different sediment types such as modern, coralag boundstone, coralag-microbialite boundstone, packstone, floatstone, lime sand, mud, and unconsolidated.]
Sedimentology and chronology 3

Explanation: 20.45 yrs BP

Hole M0057A
Hole M0056A
Hole M0055A
Holes M0052A, M0052B, and M0052C
Hole M0053A
Holes M0054A and M0054B

Occurrence of older Pleistocene
2E. Late Quaternary Upper Slope Deepening (Fining) Upward Sequences Offshore the Great Barrier Reef, IODP 325 Expedition
B.B. Harper; A.W. Droxler; E. Gischler; J.M. Webster; Á.p. Bernabéu; E. Herrero-Bervera; T. Lado-Insua; L. Jovane; E. Scientists
NOG-01B

Foreef slope (upper slope)

2 fining upward sedimentary cycles (deep and shallow components (eg. LBF).

Changes in lithologies directly tied to seismics (ie. date reflectors)

Continuous sedimentary and geochemical record of sedimentation last two glacial/interglacial cycles?

Main lithologic units

- Unit 1 - mainly coral-algal-microbialite framestones and some sediments (post glacial/LGM?)
- Unit 2 - un lithified carbonate sediments (Halimeda and benthic forams common) (post glacial/older Pleistocene?)
- Unit 3 - grey packstones/grainstones etc (Halimeda, bryozoan, BF, mollusc common (older Pleistocene?)
- Unit 4 - un lithified carbonate sediments (mud & very fine sand - abundant plankton forams )
- Unit 5 - light coloured Halimeda-benthic foraminifera rudstone/ grainstones - sometimes corals & rhodoliths (older Pleistocene?)
- Unit 6 - mainly coral framestones with light coloured grainstones (Halimeda, LBF, coral, mollusc) (older Pleistocene?)
Proposed research

- 24 sample requests that stand for individual projects:
  dating and sea level
  taxonomy of corals, coralline algae, foraminifera
  sedimentology, facies, diagenesis, poro-perm
  taphonomy
  microbialite question
  paleoclimate studies of corals, deeper water muds
  reconstruction of late Quaternary reef growth (general)

our research includes:

  older Pleistocene facies and diagenesis (cores 32, 33, 42, 53, 55-57)
  stratigraphy and sedimentology fore reef slope (core 58)
  overall reef growth history with relation to sea level

- second post-cruise meeting and session planned for July 2012
  (back to back with Int. Coral Reef Symposium in Cairns)
Thank you!