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

Eberhard Gischler[1], Andre W. Droxler[2], Jody Webster[3], and Expedition 325 Scientists[4]

Search and Discovery Article #50433 (2011)
Posted June 30, 2011

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Houston, Texas, USA, April 10-13, 2011

[1]Geosciences, Goethe University, Frankfurt, Germany (gischler@em.uni-frankfurt.de)
[2]Rice University, Houston, TX
[3]University of Sydney, Sydney, NSW, Australia
[4]IODP 325, Edinburgh, United Kingdom

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

Braithwaite, C.J.R., H. Dalmasso, M.A. Gilmour, D.D. harkness, G.M. Henderson, R.L.F. Kay, D. Kroon, L.F. Montaggioni, and P.A. Wilson, 2004, The Great Barrier Reef; the conronological record from a new borehole: JSR, v. 74/2, p. 298-310.

International Consortium for Great Barrier Reef Drilling, 2001, New constraints on the origin on the Australian Great Barrier Reef: Results from an international project of deep coring: Geology, v. 29, p. 483-486.

Webster, J.M., and P.J. Davies, 2003, Coral variation in two deep drill cores; significance for the Pleistocene development of the Great Barrier Reef, *in* P. Blanchon, and L. Montaggioni, (eds.) Late Quaternary reef development: Sedimentary Geology, v. 159/1-2, p. 61-80.

Webster, J.M., Y. Yokoyama, and C. Cotterill, 2009, Scientific Prospectus Integrated Ocean Drilling Program, 325, *in* J.M. Webster, Y. Yokoyama, and C. Cotterill, (eds.), Integrated Ocean Drilling Program Expedition 325 scientific prospectus; Great Barrier Reef environmental changes; the last deglacial sea level rise in the South Pacific; offshore drilling northeast Australia 2009.

Facies and diagenesis of older Pleistocene coral reefs, Great Barrier Reef, Australia (IODP 325)

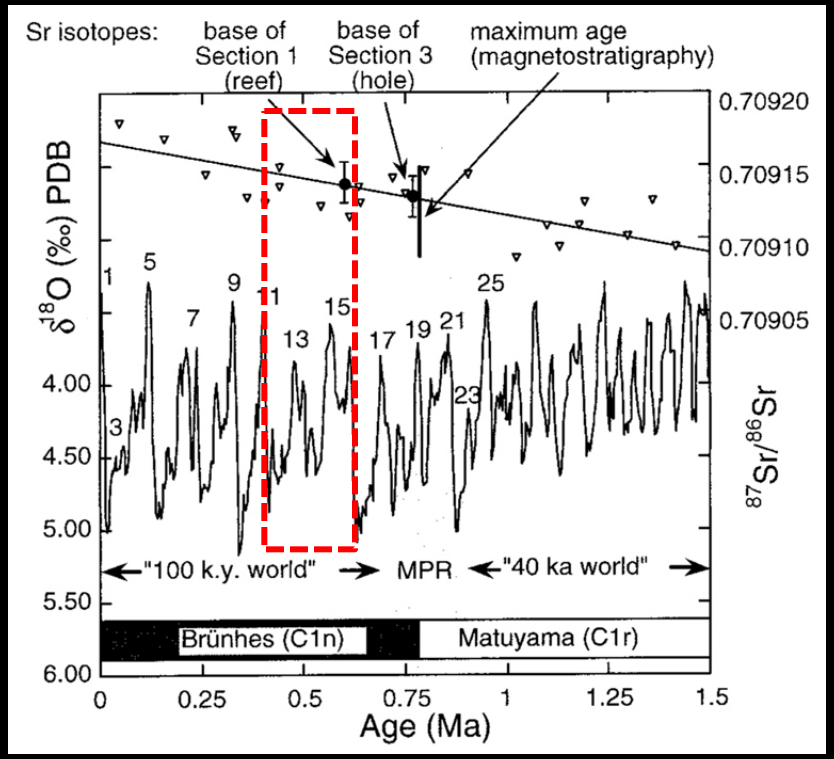
E. Gischler, A. Droxler, J. Webster, and Expedition 325 Scientists

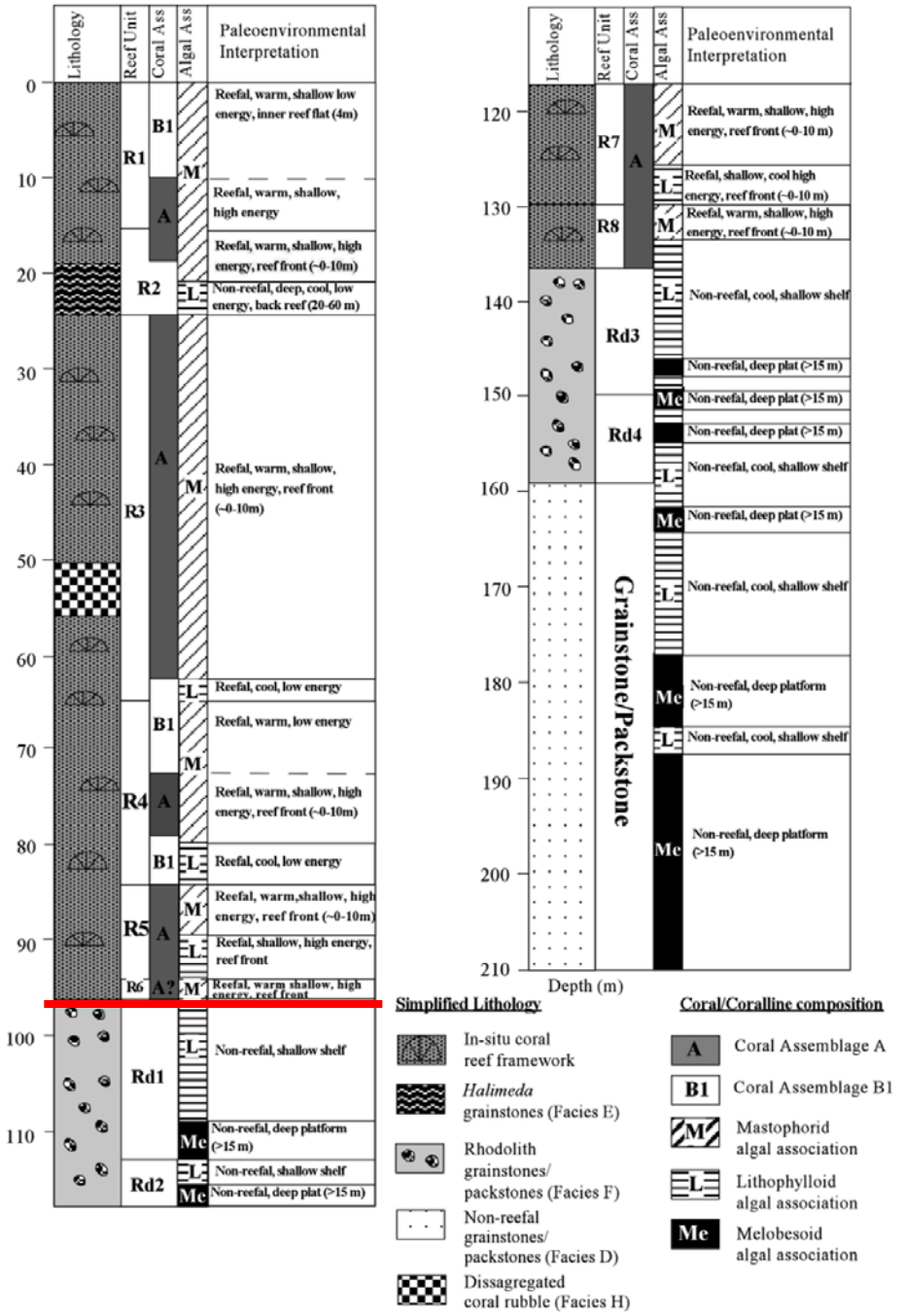
Session on modern and Pleistocene carbonates: sedimentology, diagenesis, and processes; AAPG Houston, April 2011

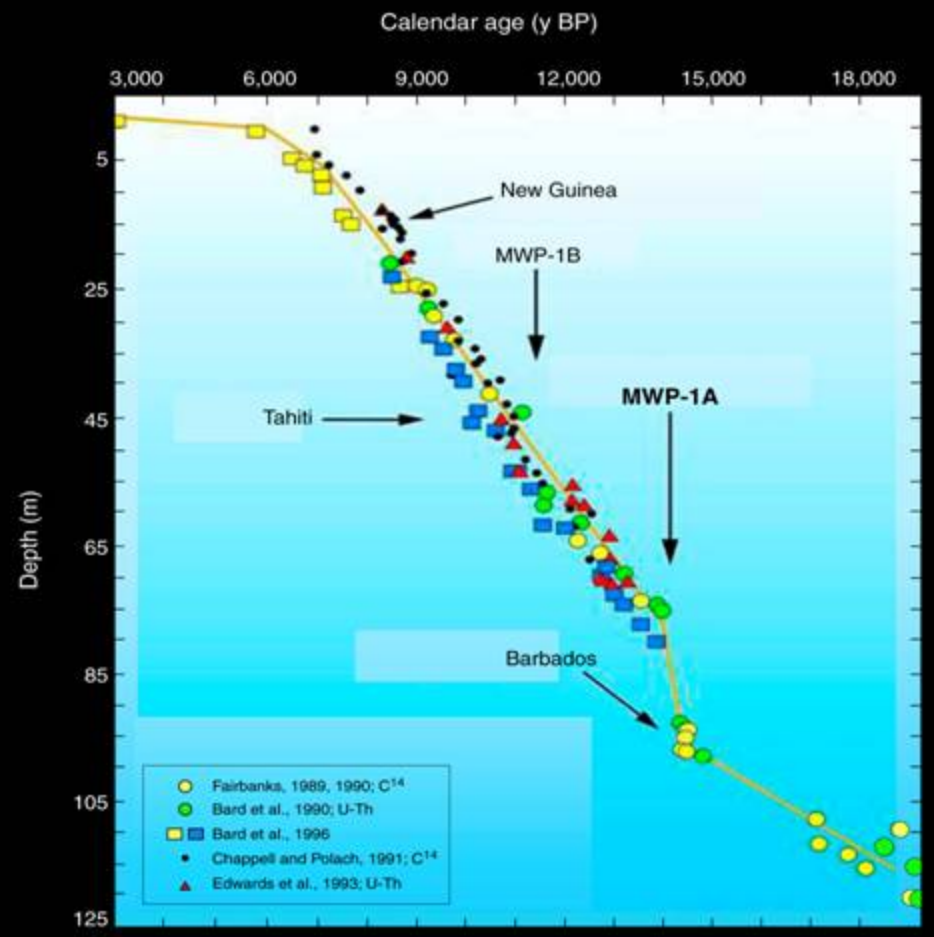
Previous studies: establishment of the Great Barrier Reef: during MIS 11

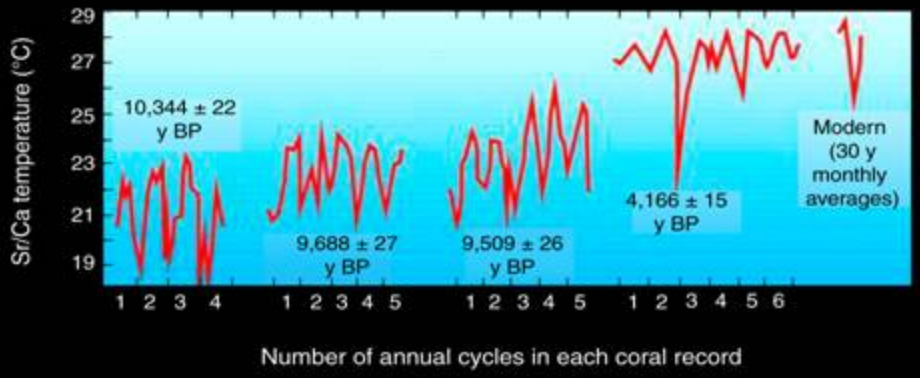
Ribbon Reef 5

International Consortium GBR Drilling (2001)
Webster & Davies (2003)
Braithwaite et al. (2004)







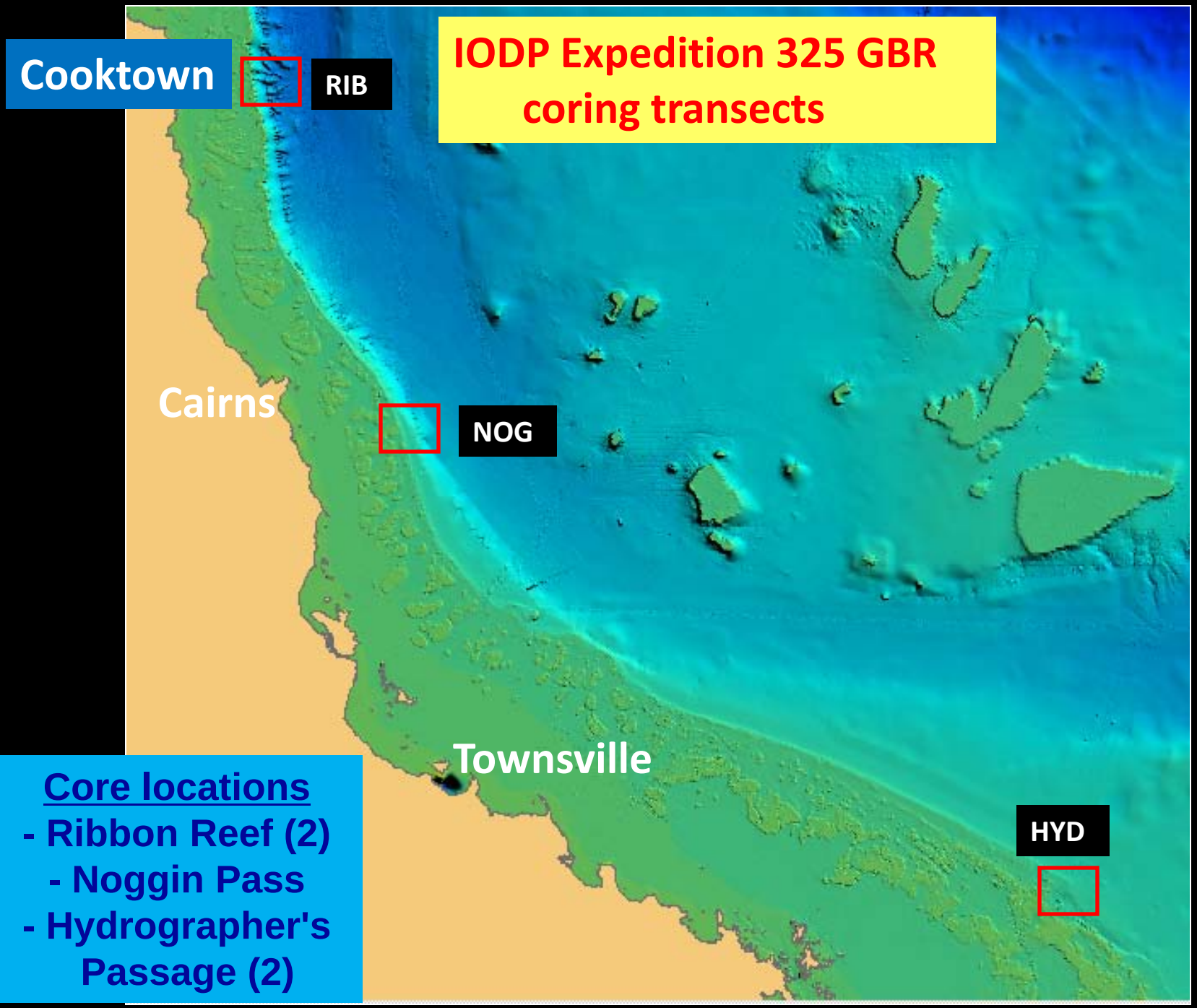


Objectives of IODP leg 325

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

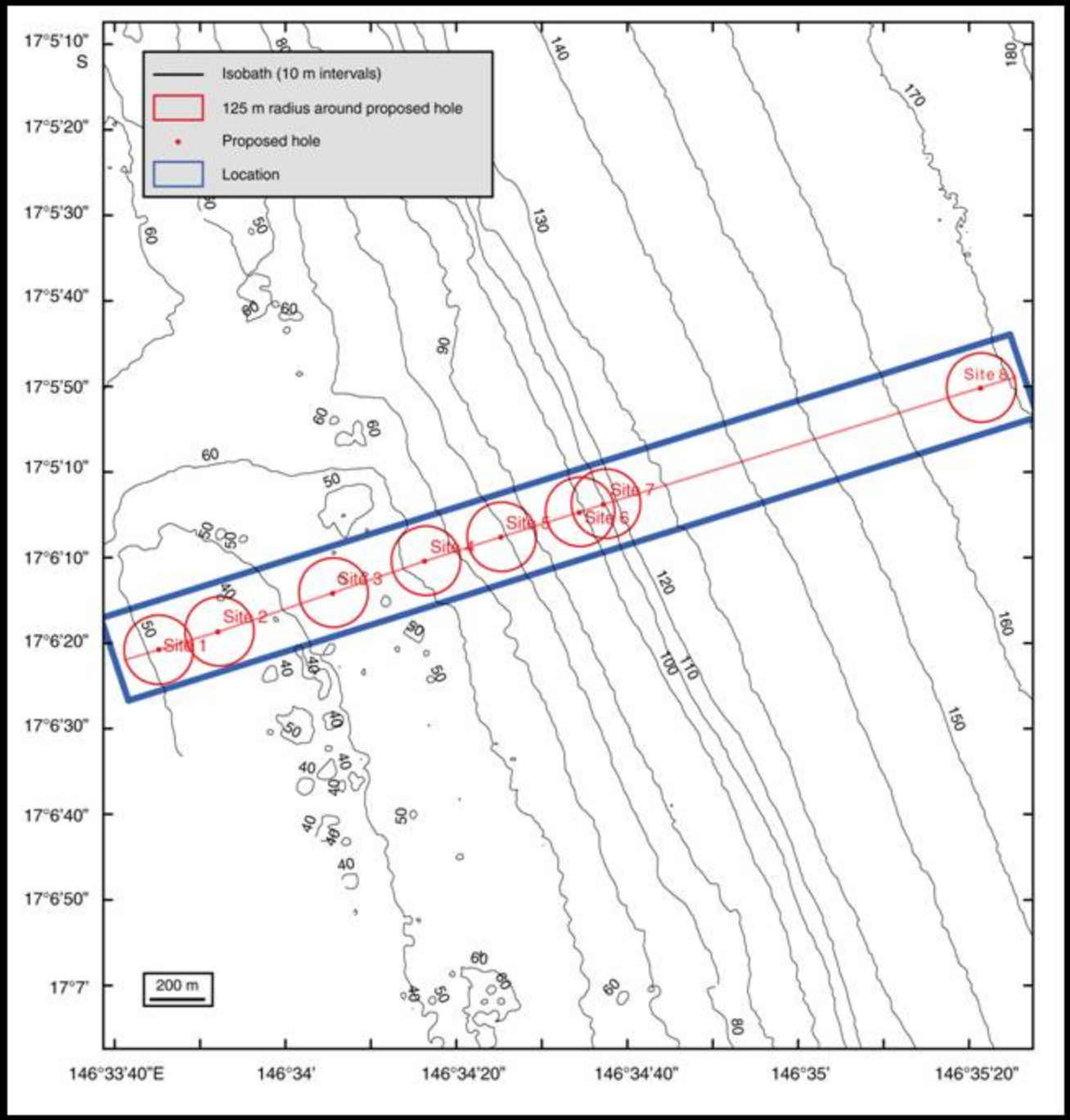
2. define SST-variation in same time interval

3. analyze impact of sealevel change on reef growth and geometry
   - drowning events
   - foreslope processes
   - reef modelling


Cooktown
RIB
IODP Expedition 325 GBR
coring transects
Cairns
NOG
Townsville
HYD
Core locations
- Ribbon Reef (2)
- Noggin Pass
- Hydrographer's
Passage (2)

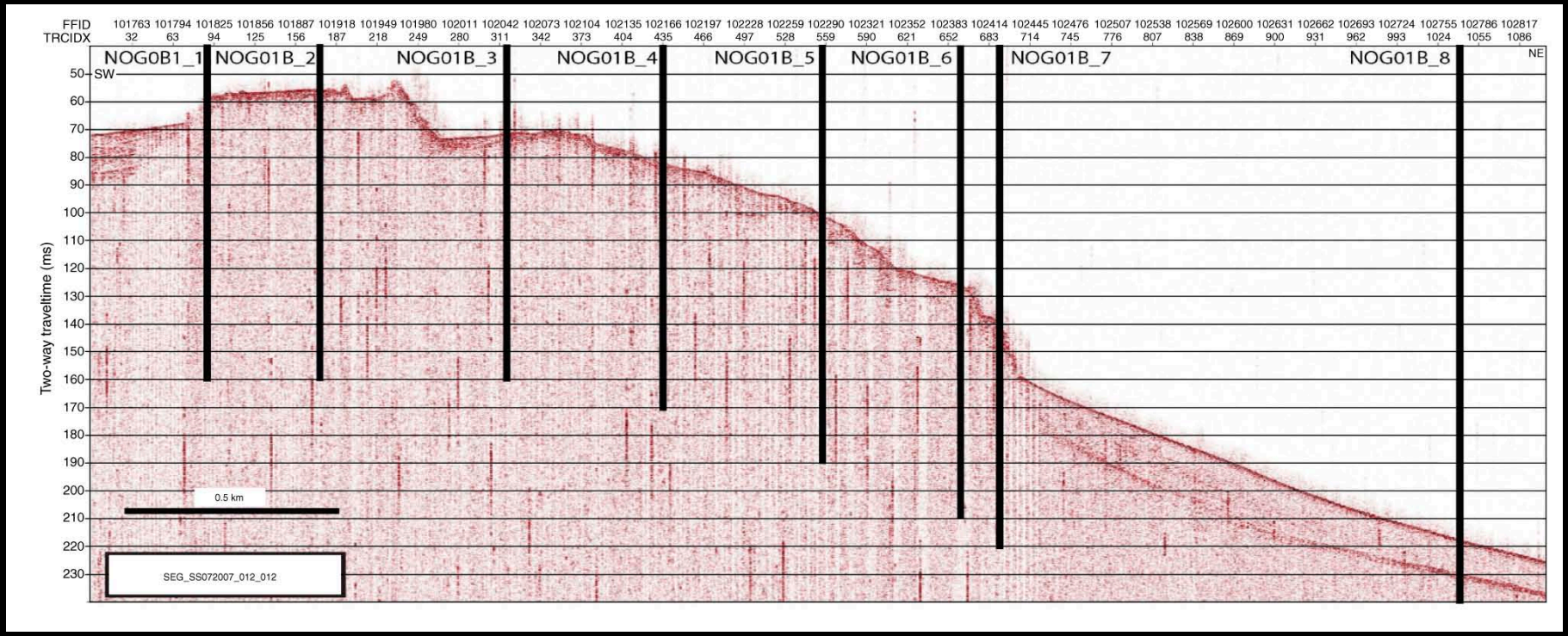
Greatship Maya **(Bluestone Offshore, Singapore)**

93 m long, 19 m wide, 32 m high
draft 6.3 m; 4.840 tons
66 berths
operational to 1.800 m depth



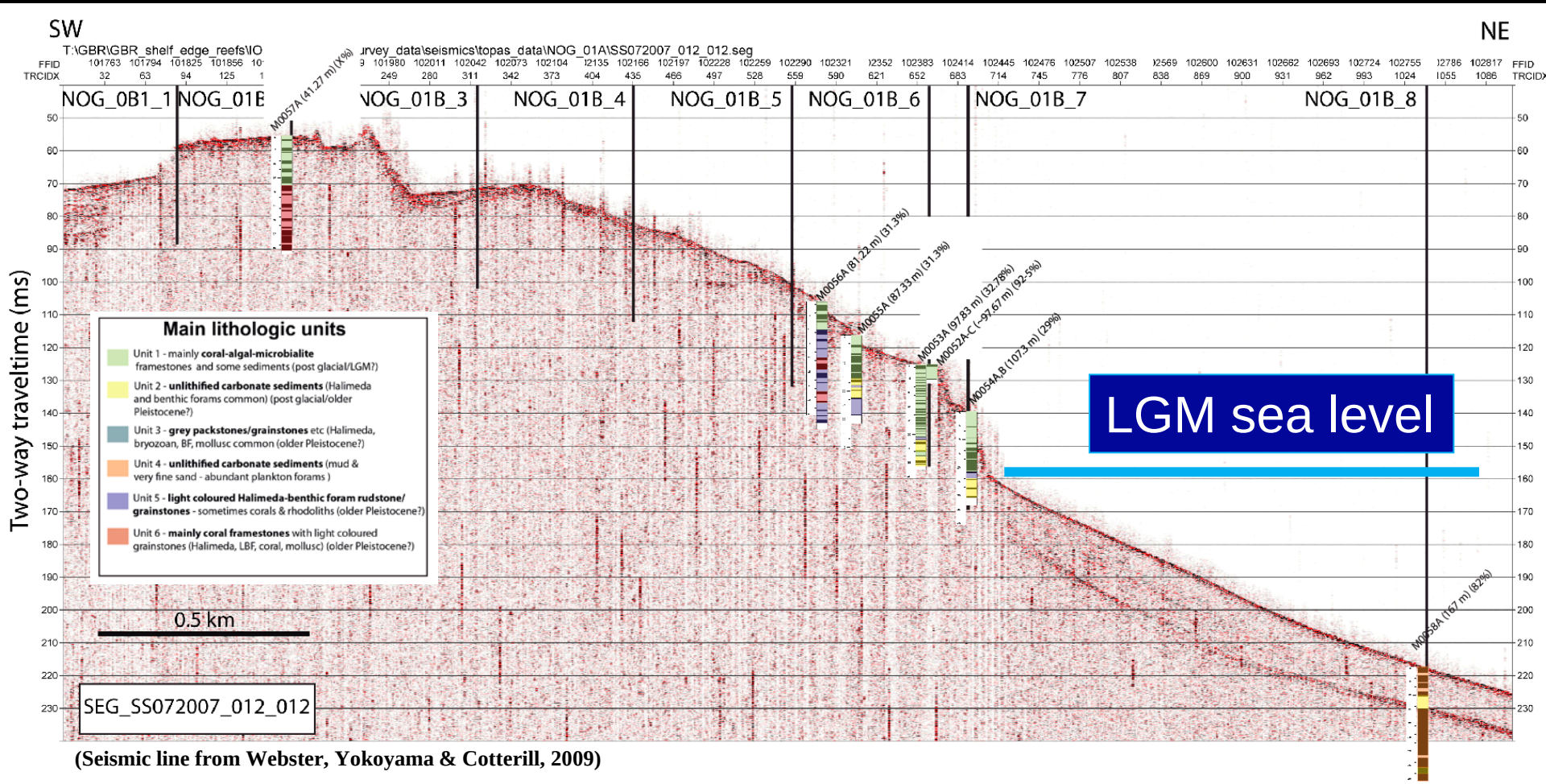
Noggin Pass

planned drill sites

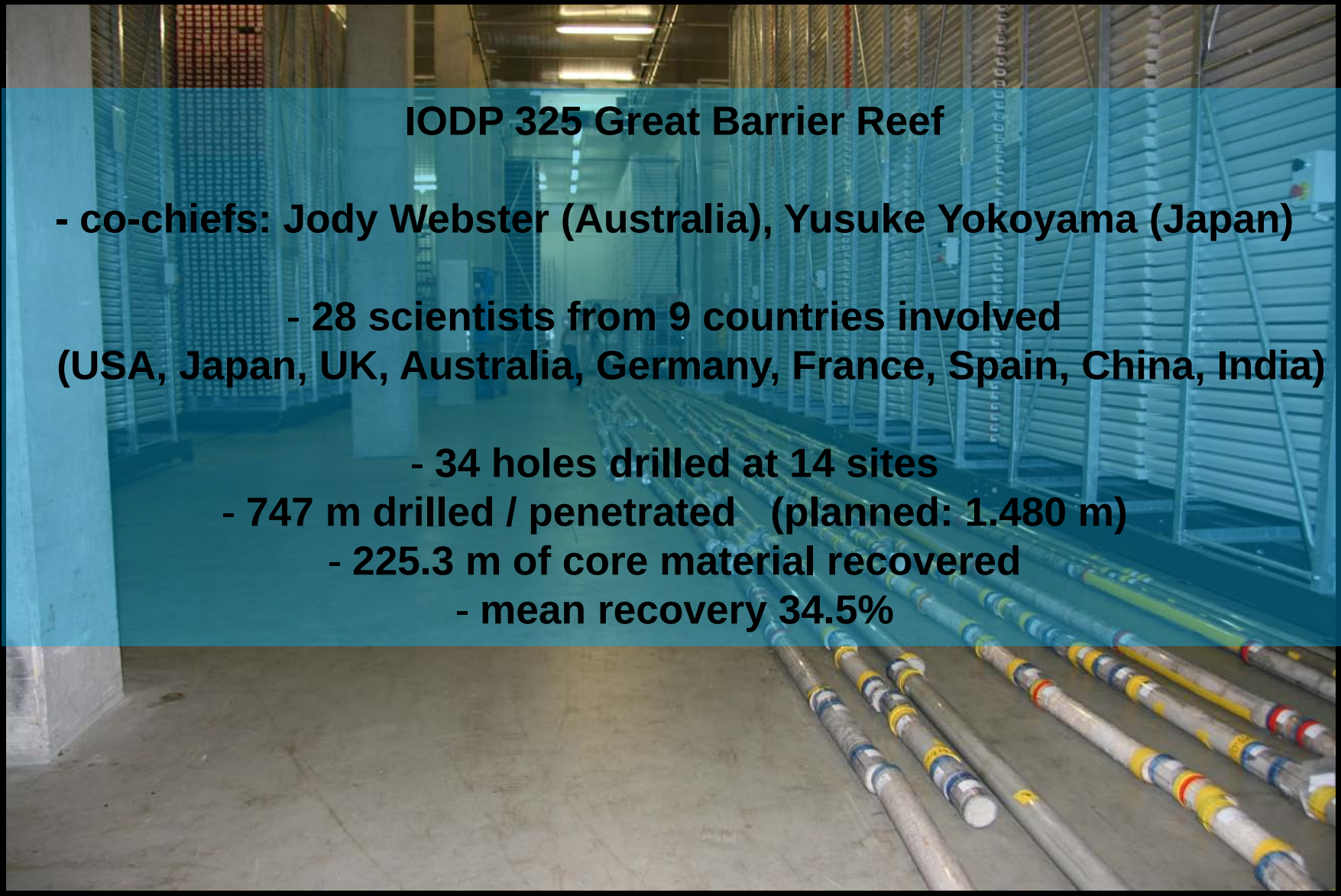


Noggin Pass, seismics with planned drill sites

NOG-01B



(Seismic line from Webster, Yokoyama & Cotterill, 2009)



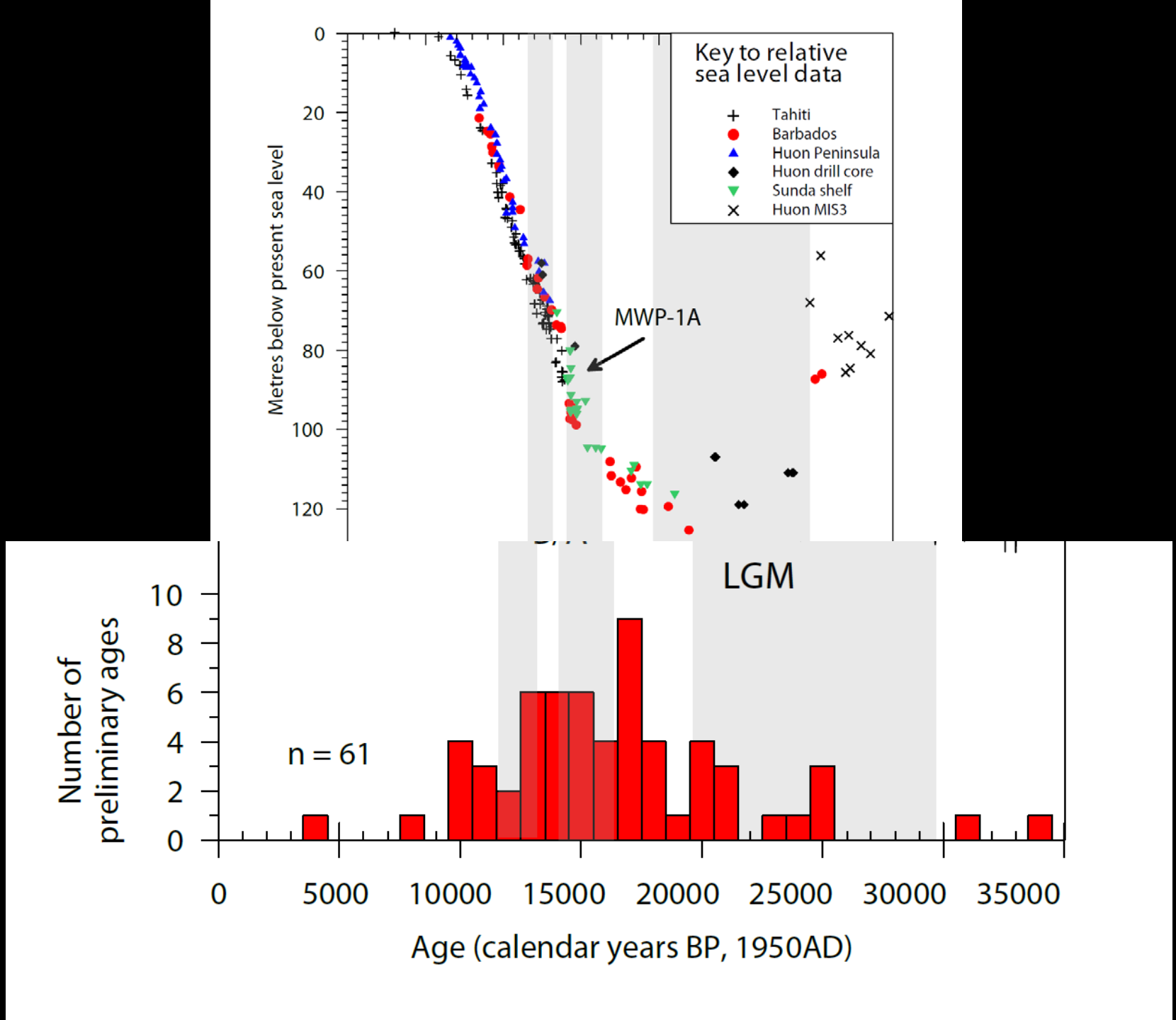
IODP 325 Great Barrier Reef

- 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!


Key to relative sea level data
Tahiti
Barbados
Huon Peninsula
Huon drill core
Sunda shelf
Huon MIS3
Metres below present sea level
0
20
40
60
80
100
120
MWP-1A
LGM
Number of preliminary ages
10
8
6
4
2
0
n = 61
0
5000
10000
15000
20000
25000
30000
35000
Age (calendar years BP, 1950AD)

Facies

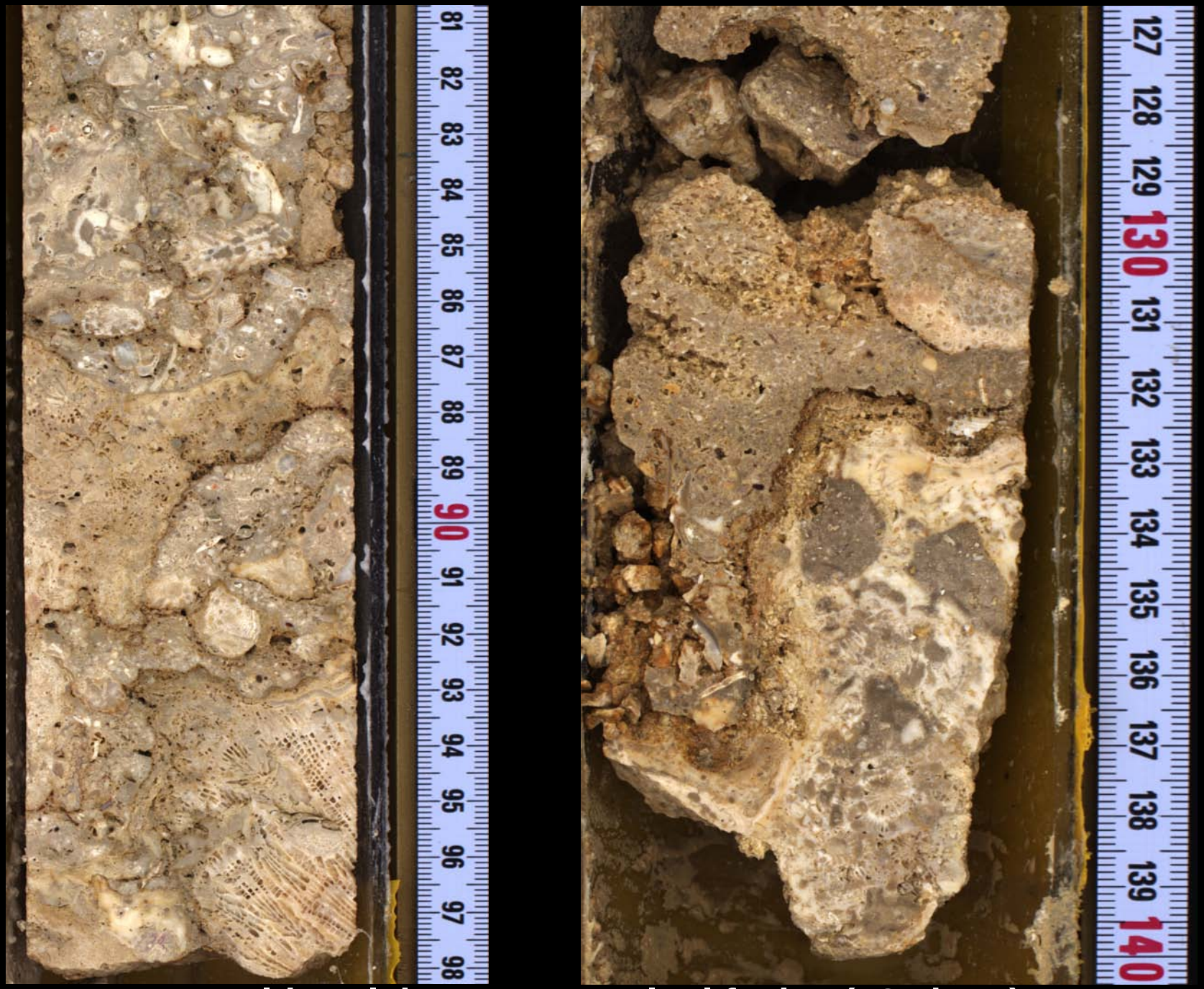
late Pleistocene coralgal facies (25-10 kyrs)

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

TOP

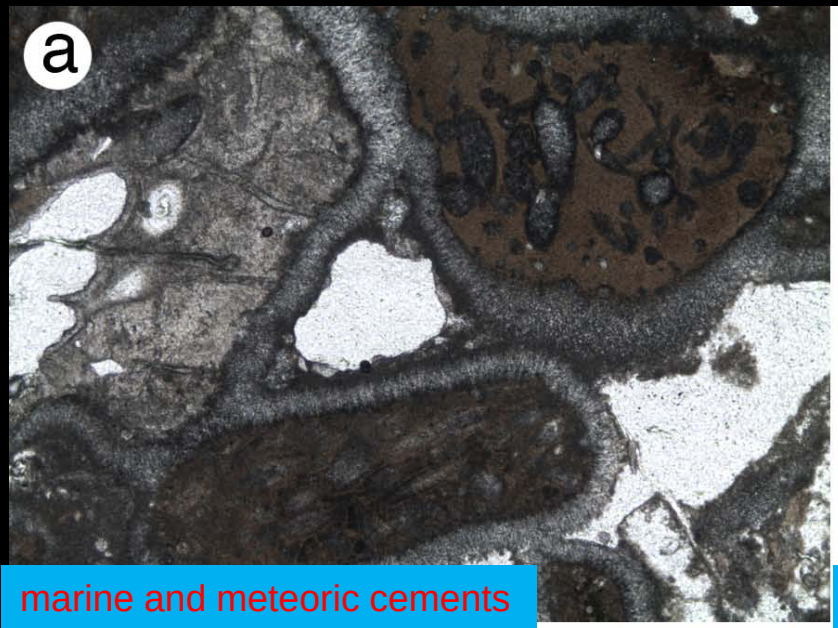


older Pleistocene coralgal facies (>25 kyrs)

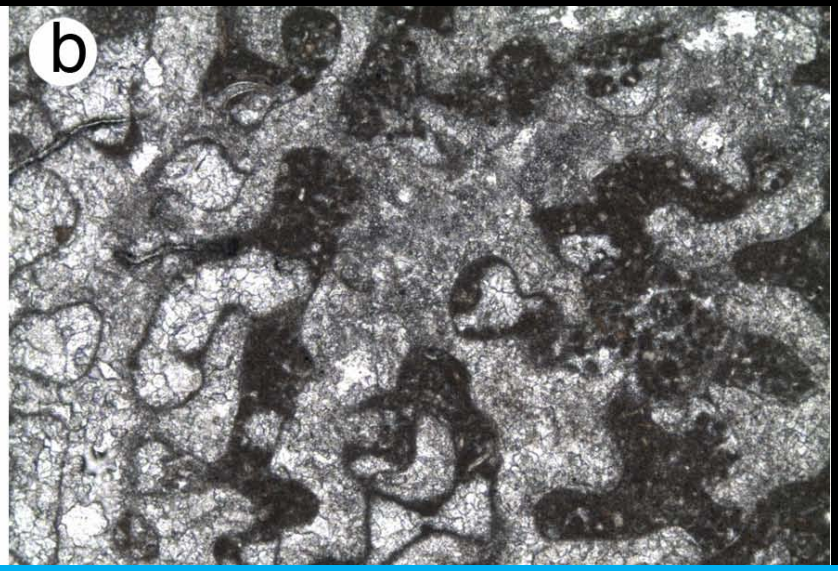
older Pleistocene
grainstone facies (>25 kyrs)

older Pleistocene
subaerial exposure horizons

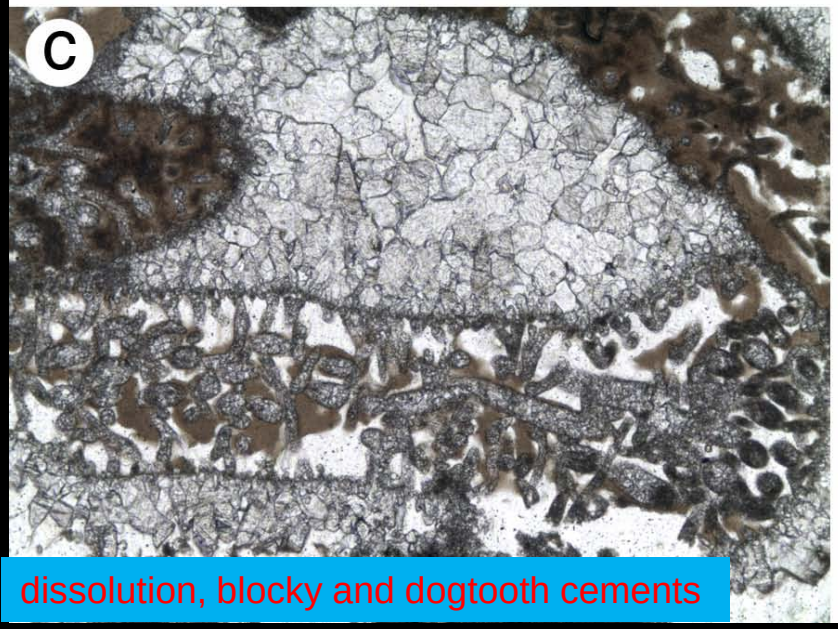
Thin-section micrographs 1; older Pleistocene facies



marine and meteoric cements



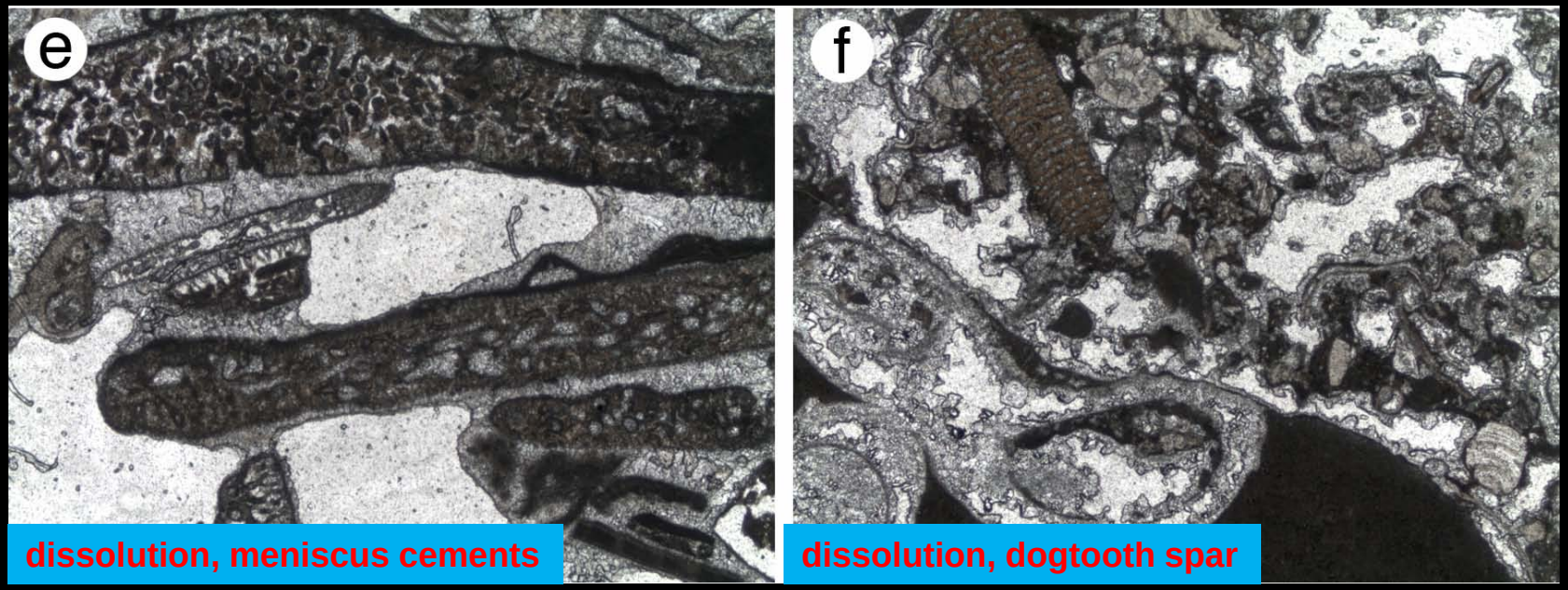
neomorphosed coral; peloidal and blocky cement



dissolution, blocky and dogtooth cements

marine and meteoric cements

Thin-section micrographs 2; older Pleistocene facies

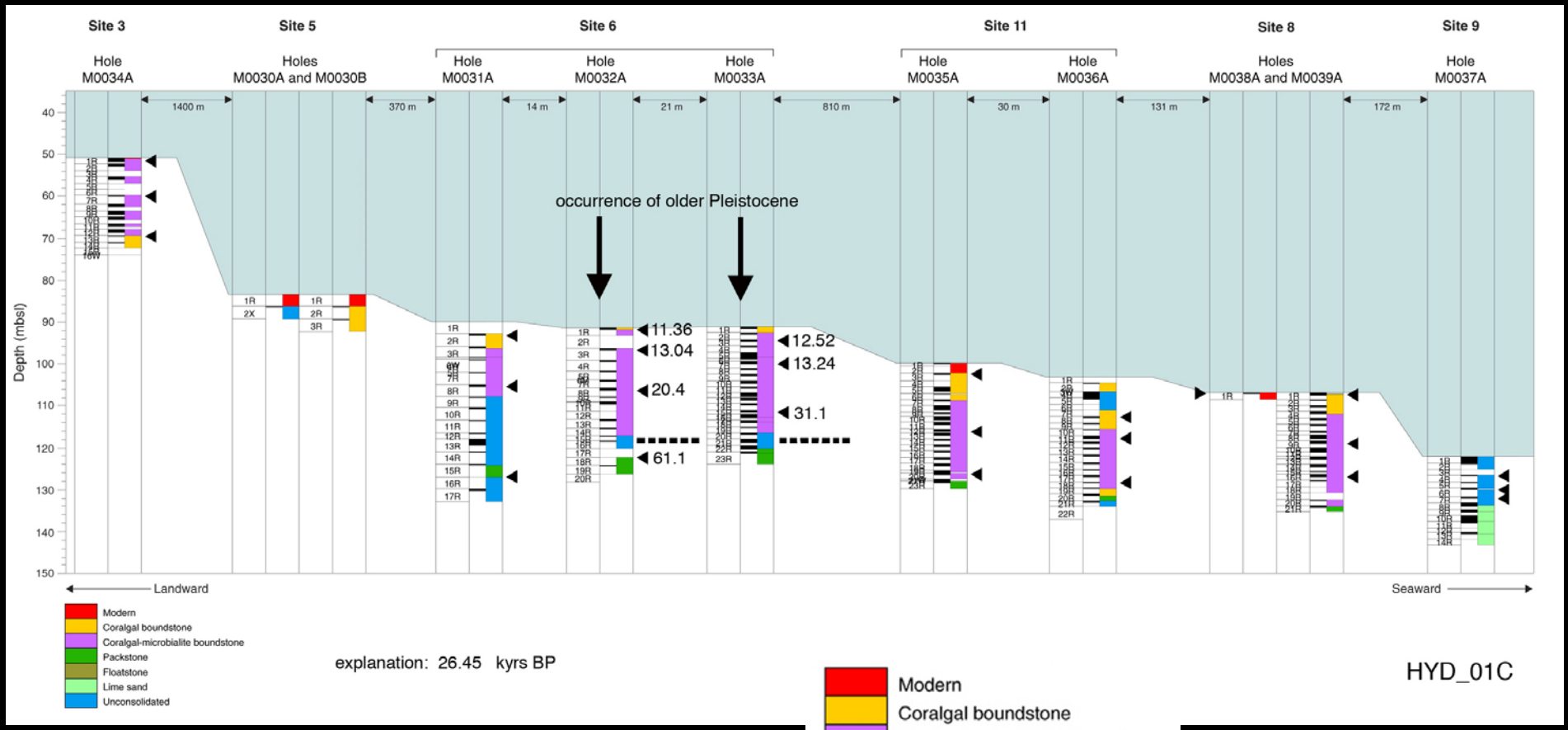


widths of pictures 5 mm

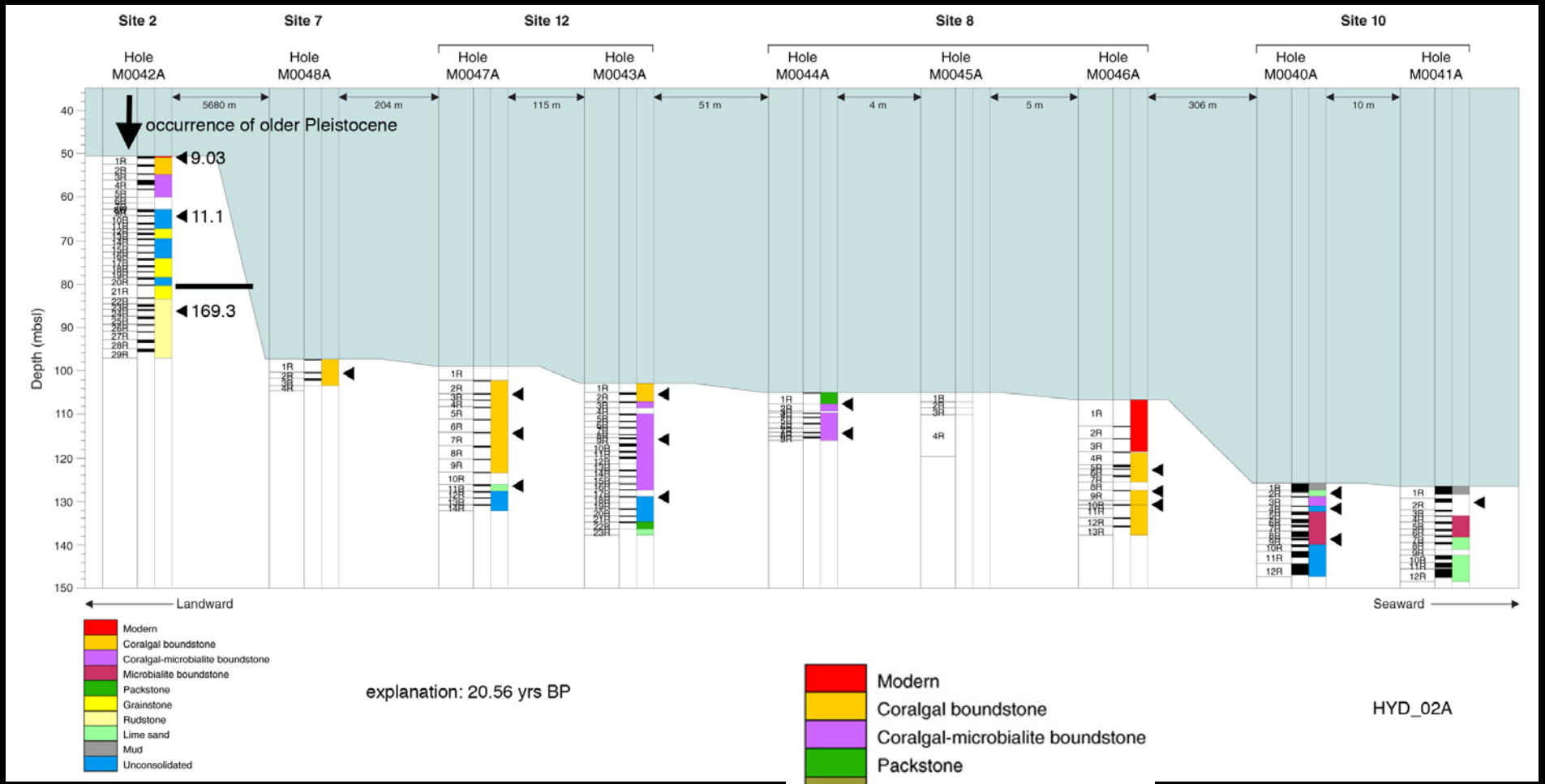
Diagenetic features observed:

- early marine cements (acicular, peloidal, microcrystalline)
- meteoric-phreatic and meteoric vadose cements (blocky, meniscus, scalenohedral or dog-tooth)
- dissolution
- neomorphism

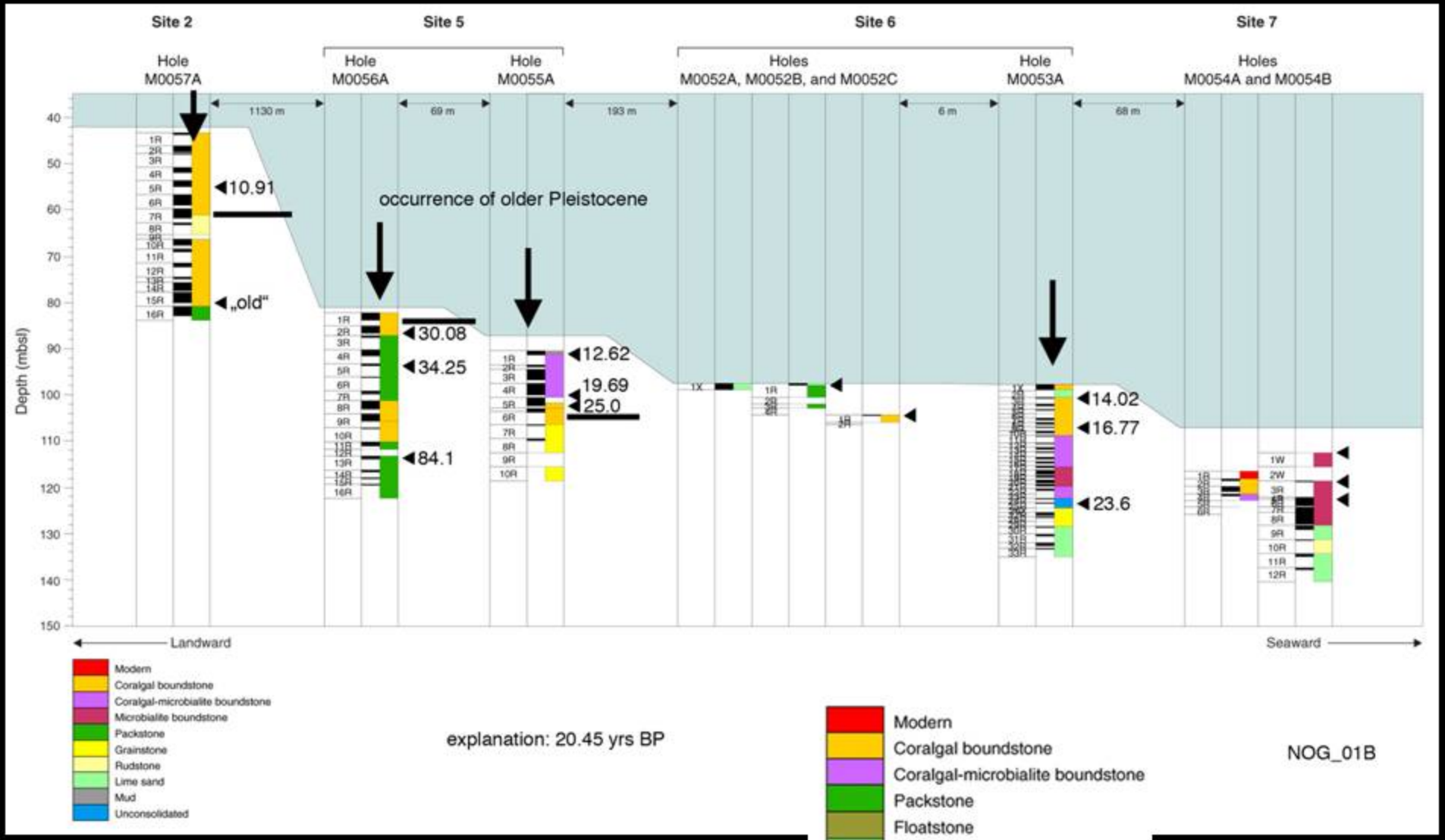
Sedimentology and chronology 1



Sedimentology and chronology 2

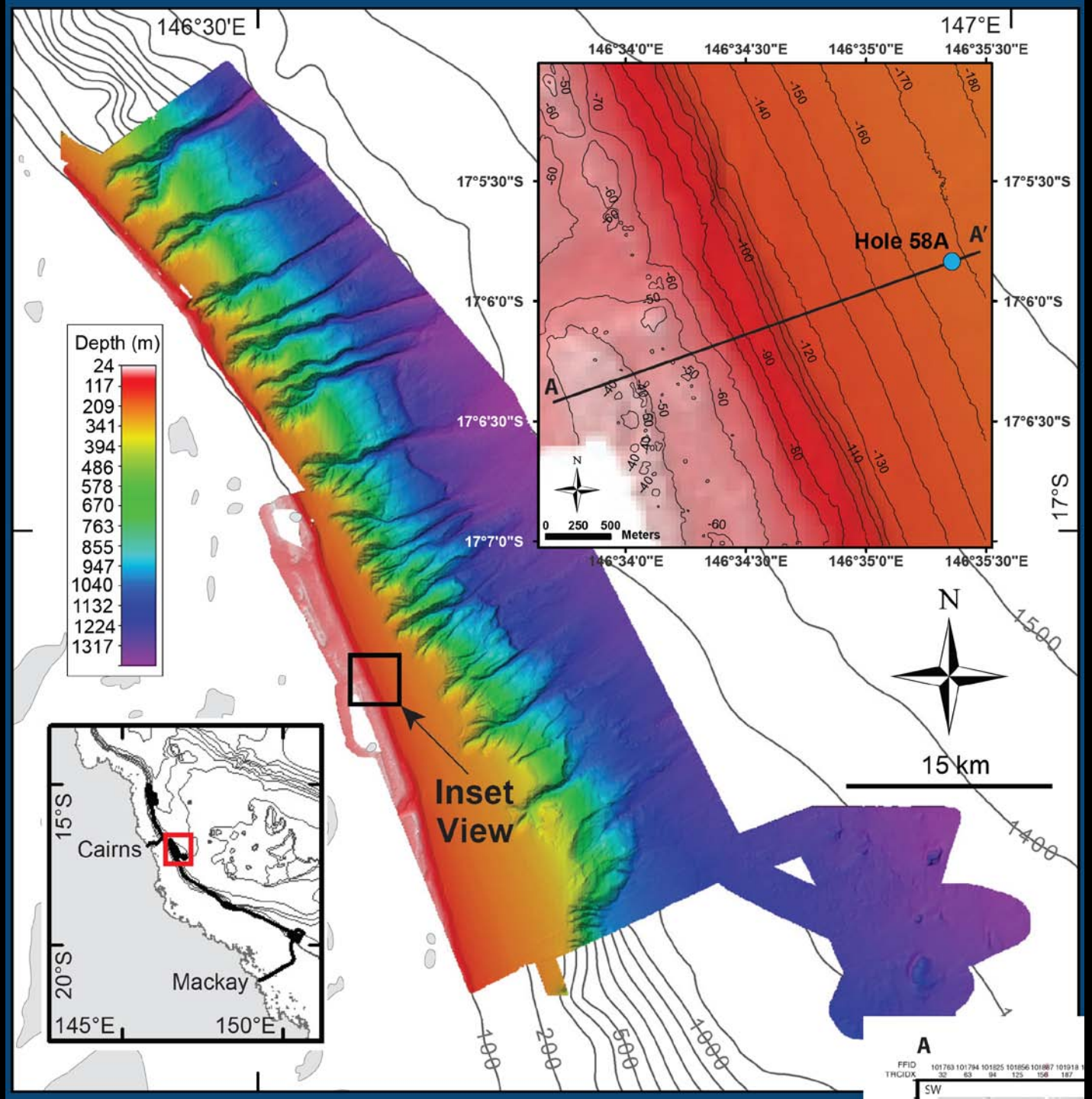


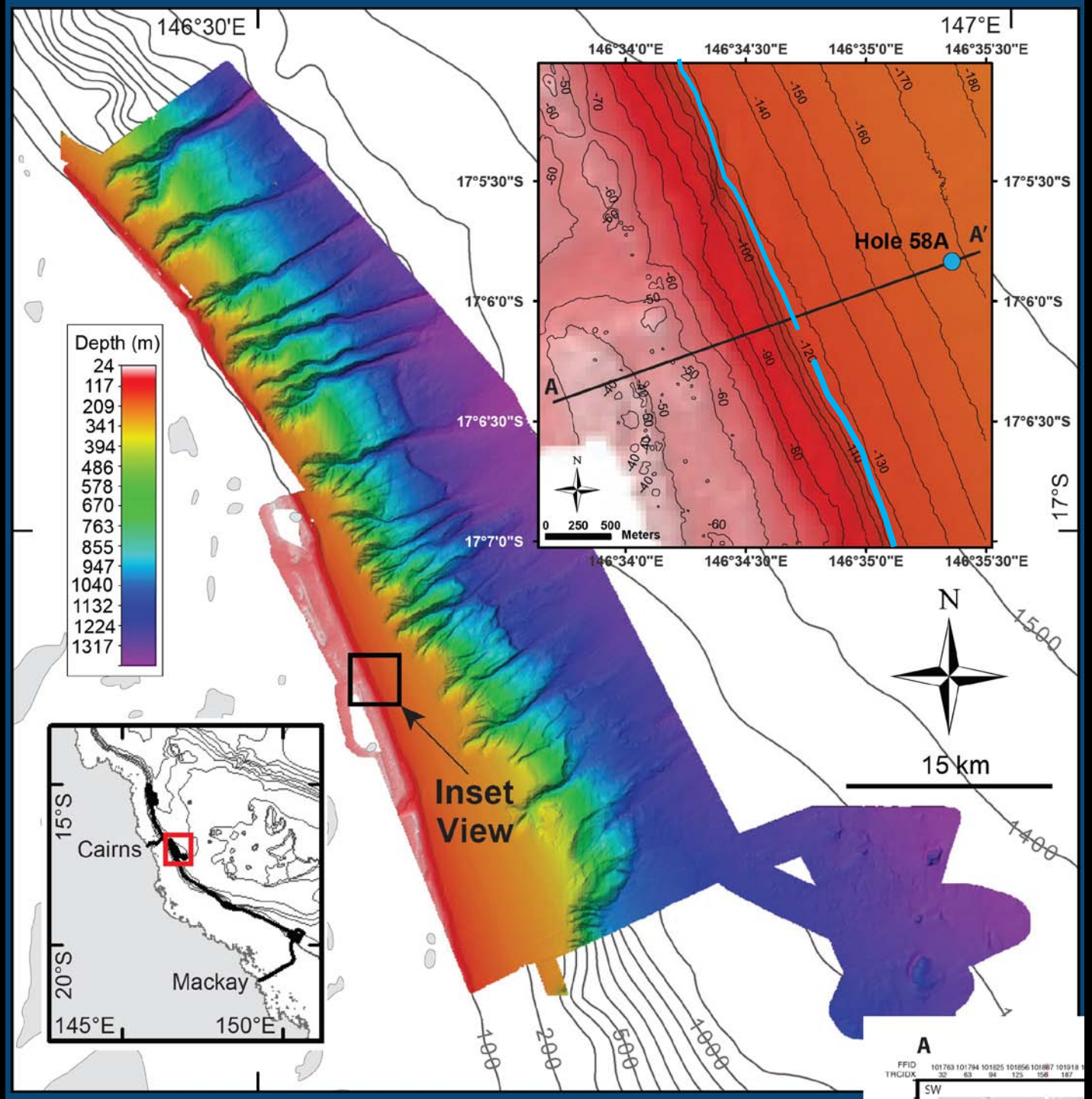
Sedimentology and chronology 3

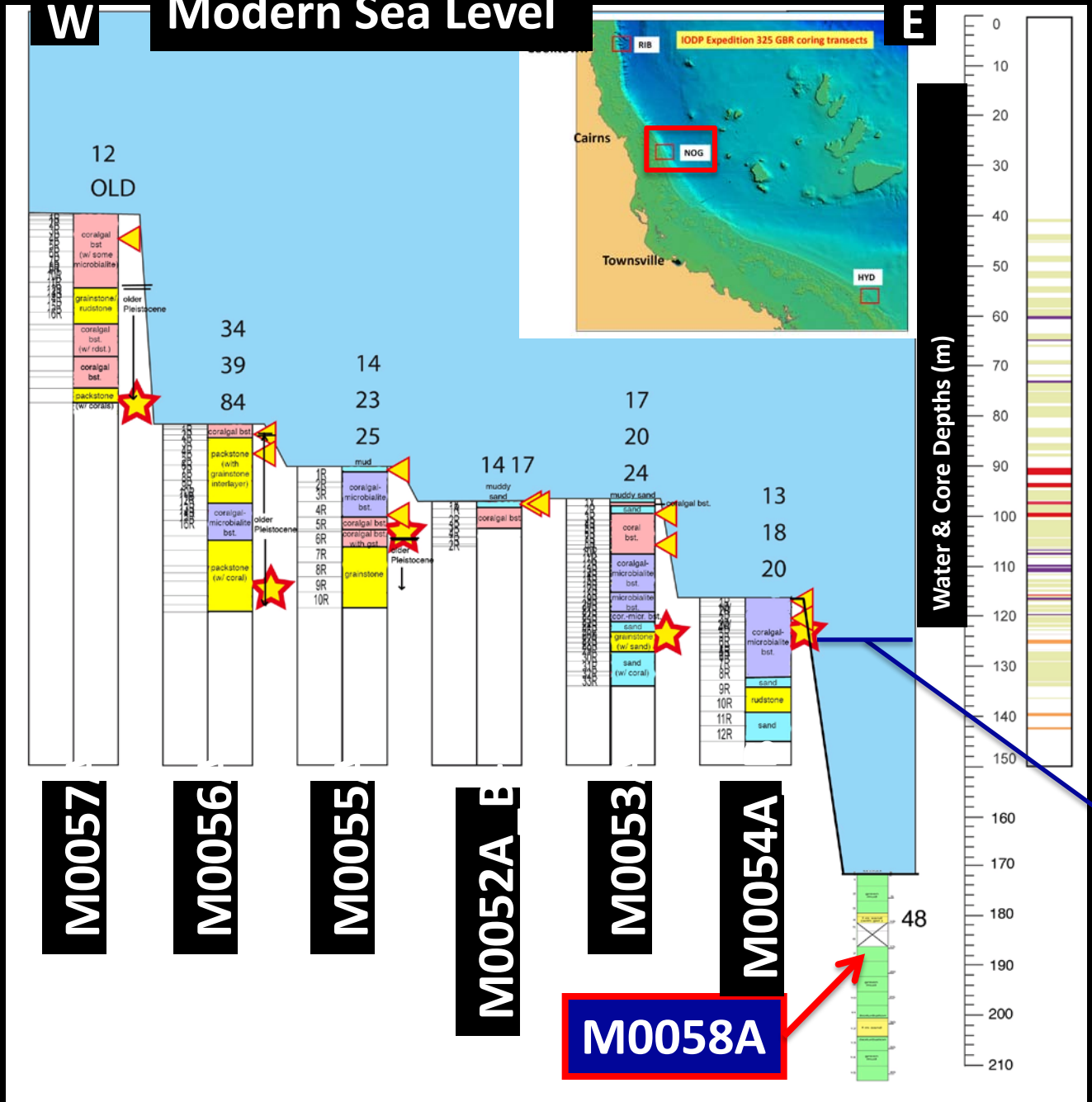


2E. Late Quaternary Upper Slope Deepening (Fining) Upward Sequences Offshore the Great Barrier Reef, IODP 325 Expedition

B.B. Harper; A.W. Droxler; E. Gischler; J.M. Webster; Á.p. Bernabéu; E. Herrero-Bervera ; T. Lado-Insua ; L. Jovane; E. Scientists

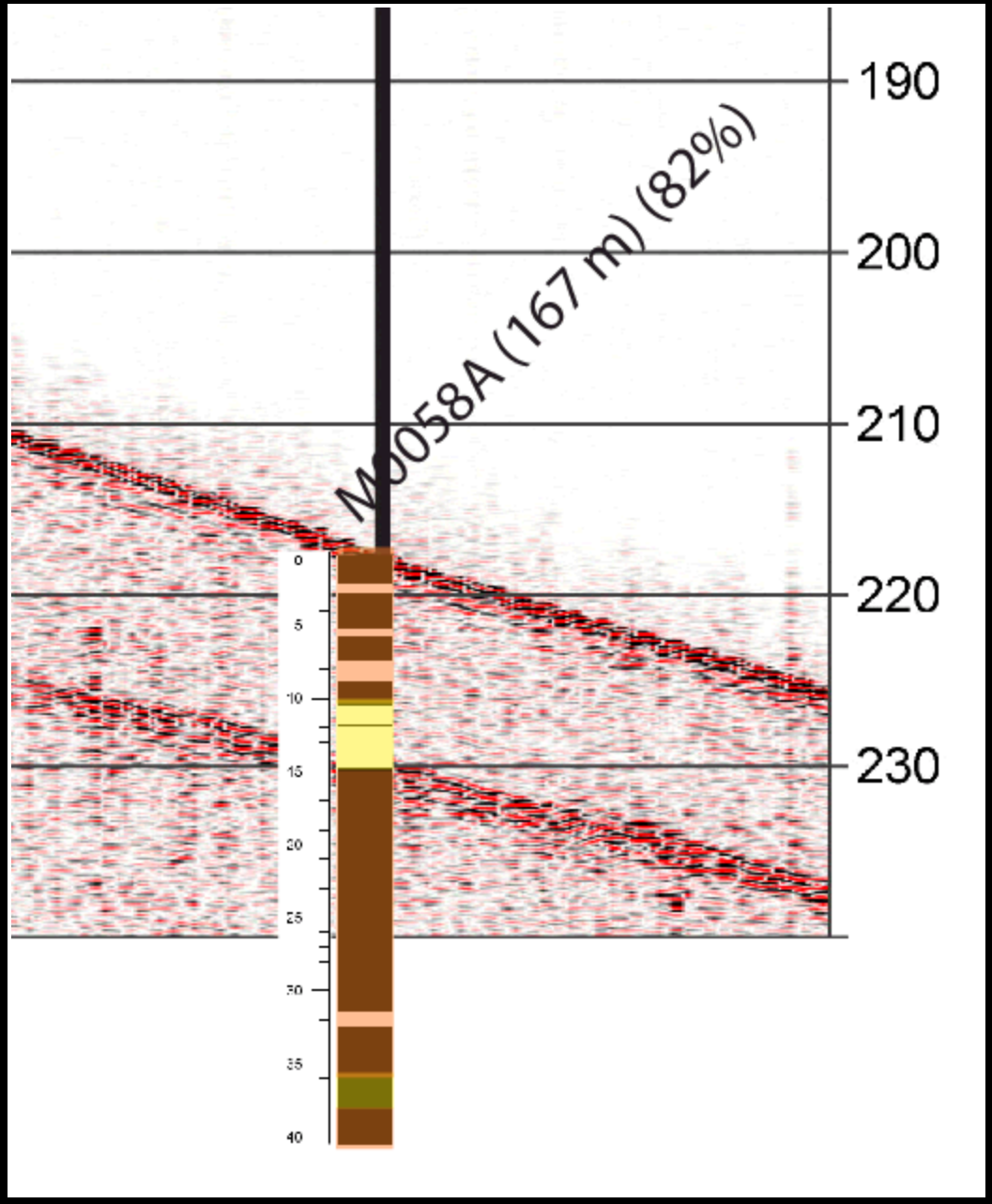

146°30'E
147°E
146°34'0"E
146°34'30"E
146°35'0"E
146°35'30"E
17°5'30"S
17°6'0"S
17°6'30"S
17°7'0"S
17°S
Hole 58A
A
A'
Depth (m)
24
117
209
341
394
486
578
670
763
855
947
1040
1132
1224
1317
0 250 500 Meters
N
15 km
Inset View
1500
4400
100
200
500
1000
15°S
20°S
145°E
150°E
Cairns
Mackay
SW


146°30'E
147°E
146°34'0"E
146°34'30"E
146°35'0"E
146°35'30"E
17°5'30"S
17°6'0"S
17°6'30"S
17°7'0"S
17°S
Hole 58A
A
A'
N
0 250 500 Meters
Depth (m)
24
117
209
341
394
486
578
670
763
855
947
1040
1132
1224
1317
Inset View
15 km
1500
4400
100
200
500
1000
15°S
20°S
145°E
150°E
Cairns
Mackay
A
SW



NOG_01B Drilling Transect

NOG-01B



Foreef slope (upper slope)

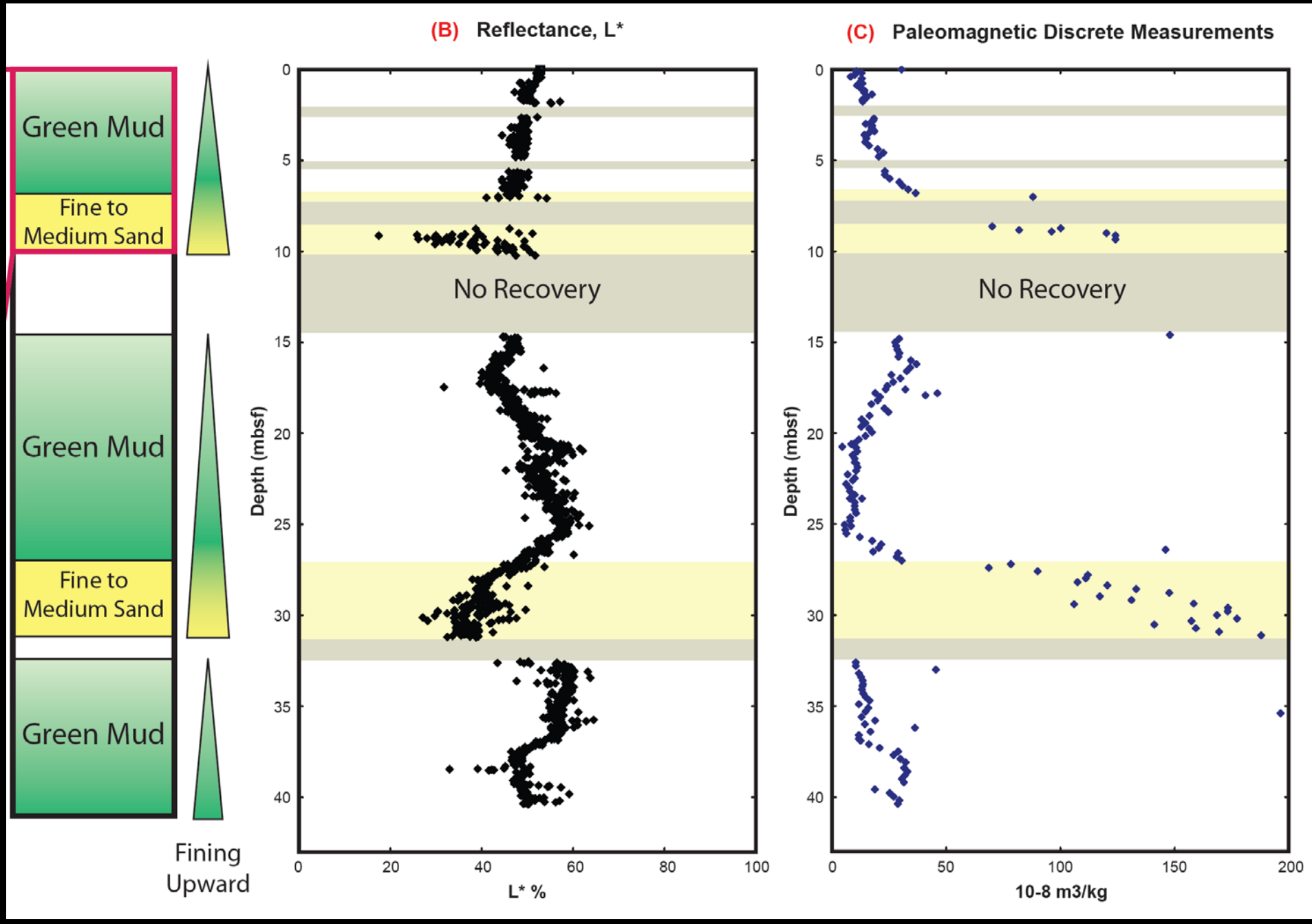
2 fining upward sedimentary cycles (deep and shallow components (eg. LBF).

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

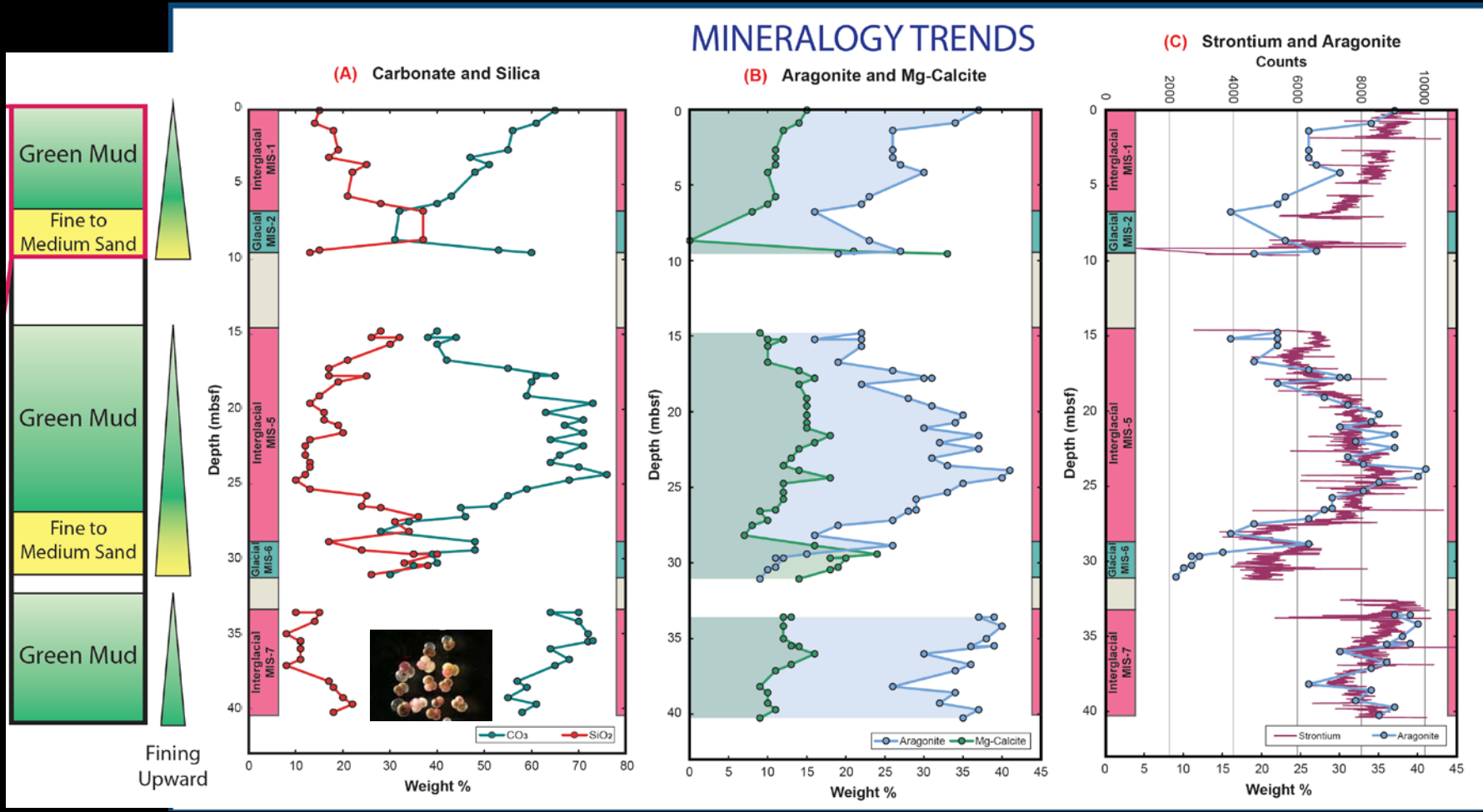
Continuous sedimentary and geochemical record of sedimentation last two glacial/interglacial cycles?

Main lithologic units

- Unit 1 - mainly **coral-algal-microbialite** framestones and some sediments (post glacial/LGM?)
- Unit 2 - **unlithified 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 - **unlithified carbonate sediments** (mud & very fine sand - abundant plankton forams)
- Unit 5 - **light coloured Halimeda-benthic foram rudstone/ grainstones** - sometimes corals & rhodoliths (older Pleistocene?)
- Unit 6 - **mainly coral framestones** with light coloured grainstones (Halimeda, LBF, coral, mollusc) (older Pleistocene?)


(B) Reflectance, L*
(C) Paleomagnetic Discrete Measurements
Green Mud
Fine to Medium Sand
Green Mud
Fine to Medium Sand
Green Mud
Fining Upward
No Recovery
No Recovery
Depth (mbsf)
Depth (mbsf)
L* %
10-8 m3/kg
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
0
50
100
150
200

MINERALOGY TRENDS



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!