Sea Level Induced Carbonate/Siliciclastic Switch Along the Gulf of Papua Shelf Edge: Last Glacial Cycle (150 ky) and Plio-Pleistocene (3.5 My) Records*

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Abstract

The Gulf of Papua (GoP) is one of the best modern examples of low latitude mixed carbonate/siliciclastic system where the northern extremity of the Great Barrier Reef meets huge volumes of siliciclastics dumped by the Fly and other PNG rivers. Results of studies, focusing on the GoP shelf edges and adjacent upper slopes, demonstrate a clear switch from thick prograding muddy early sea level fall siliciclastic wedges and lowstand shelf edge deltas to transgressive growth of healthy coralgal edifices.

In Ashmore Trough, a proximal slope basin adjacent to the southern GoP shelf edge, a siliciclastic mud unit, well imaged in 3.5 kHz profiles as a distinctive semi-transparent homogeneous 18 to 50 m-thick package, was deposited during an early sea level fall interval. Based upon 3.5 kHz profiles, industry seismic lines, and one piston core, the shelf edge itself consists also of partially eroded siliciclastic prograding lowstand shelf edge deltas and coastal sediment accumulation.

Along the southwestern GoP shelf edge, the surveys uncovered a 30 to 50 m-high ridge that parallels the shelf edge with linear segments exceeding 10 km in length. Analyses of a core, recovered in a re-entrant in front of the ridge, demonstrate that a coastline, essentially siliciclastic, reached the present-day shelf break during Last Glacial Maximum - LGM (23 cal. Ka) and the Oldest Dryas - OD (17.5-16.5 cal. ka). During a major pulse of sea level rise, between ~ 15.0 and 13.0 cal. ka, a coralgal reef established itself on top

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of a LGM/OD siliciclastic beach barrier complex, and subsequently drowned. On the northwest PNG shelf edge, an early transgressive, as thick as 80 m, coralgal edifice complex, established itself on top of a LGM shelf edge delta lobe. A piston core sampled the flank of one of the coralgal edifices and recovered a coral colony in growth position at ~ 107 m below modern sea level and dated at 19 cal. Ka.

The siliciclastic/carbonate switch observed during the last glacial sea level cycle in the GoP was repeated several times during the last 4 My. On seismic lines provided by Fugro/Finder Exploration Ltd, high-amplitude mounded seismic facies are overlying a series of prograding transparent/low amplitude wedges. These features are interpreted, as in the late Quaternary, to represent early transgressive shelf edge carbonate edifices, established and growing on top of siliciclastic muddy wedges deposited during intervals of forced regressions.

References

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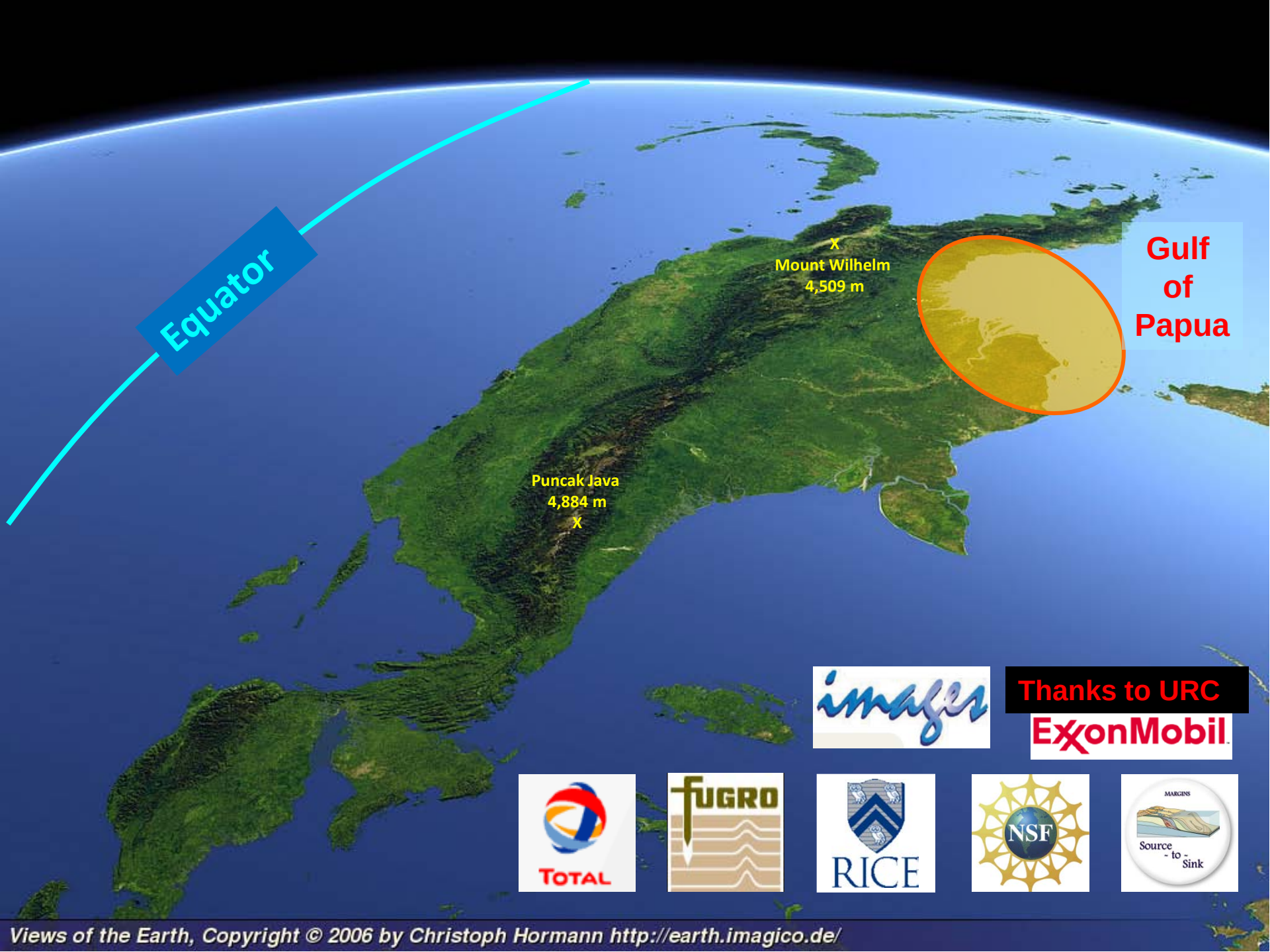

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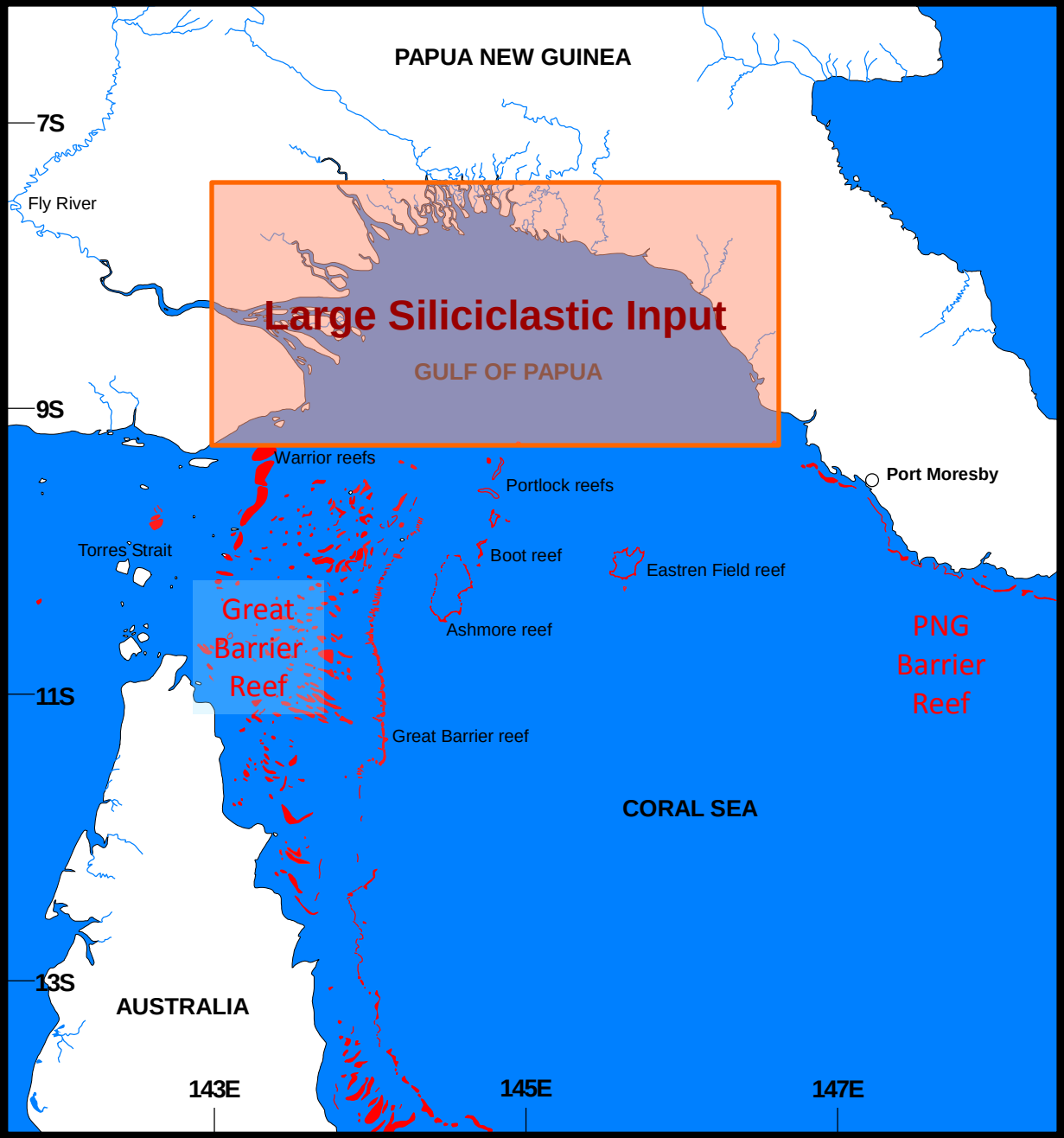
Notes by Presenter: This slide shows the regional tectonic setting of the study area. On this figure you can see major tectonic plates in the region which include Australian, Pacific, Philippine, and Eurasian plates. You can see Papua New Guinea, Coral Sea Basin, and Australia.



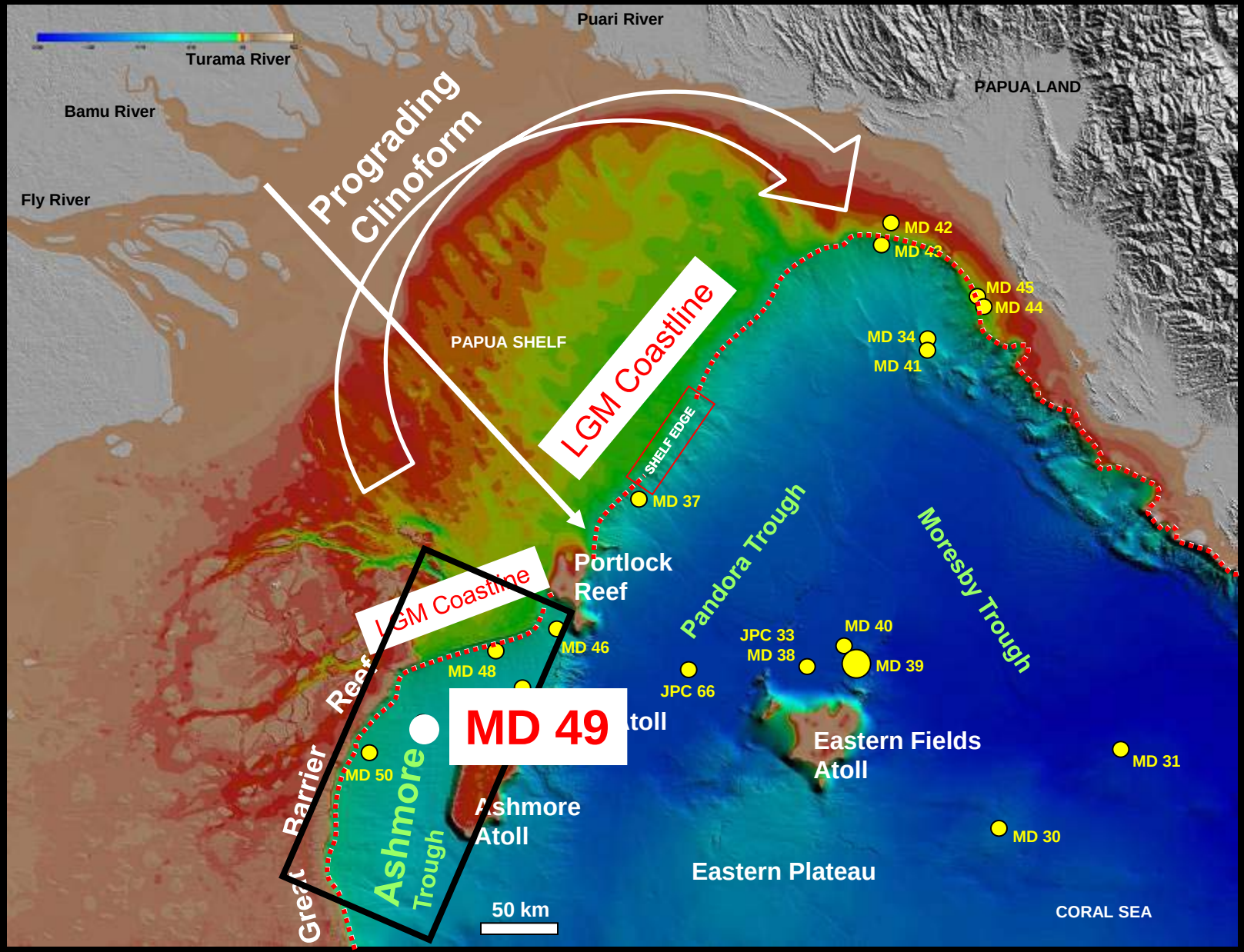
The Gulf of Papua

Sediments from the rivers =

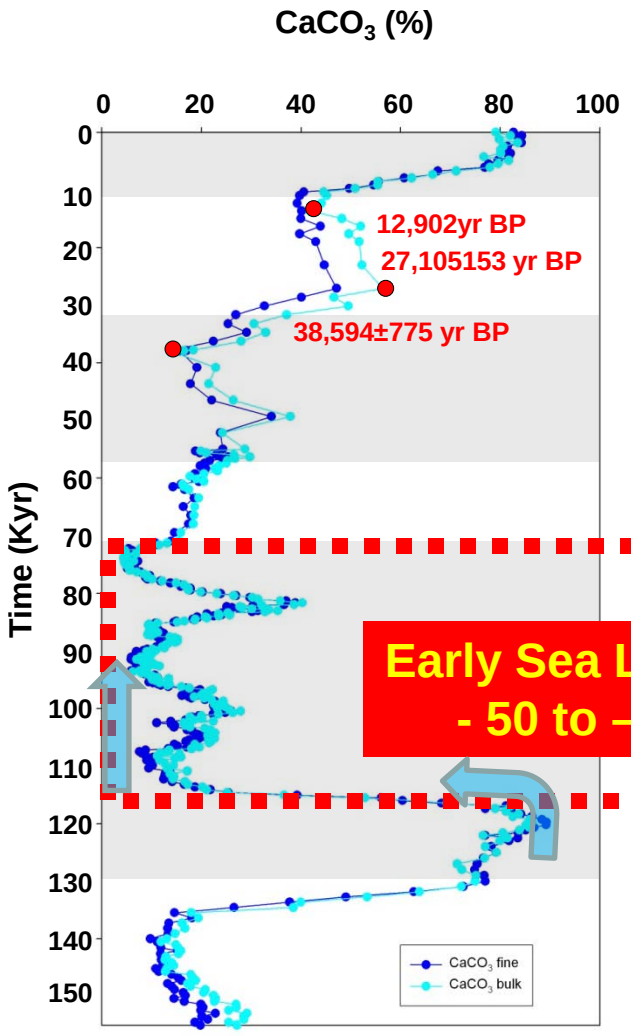
200-300 Mt/y

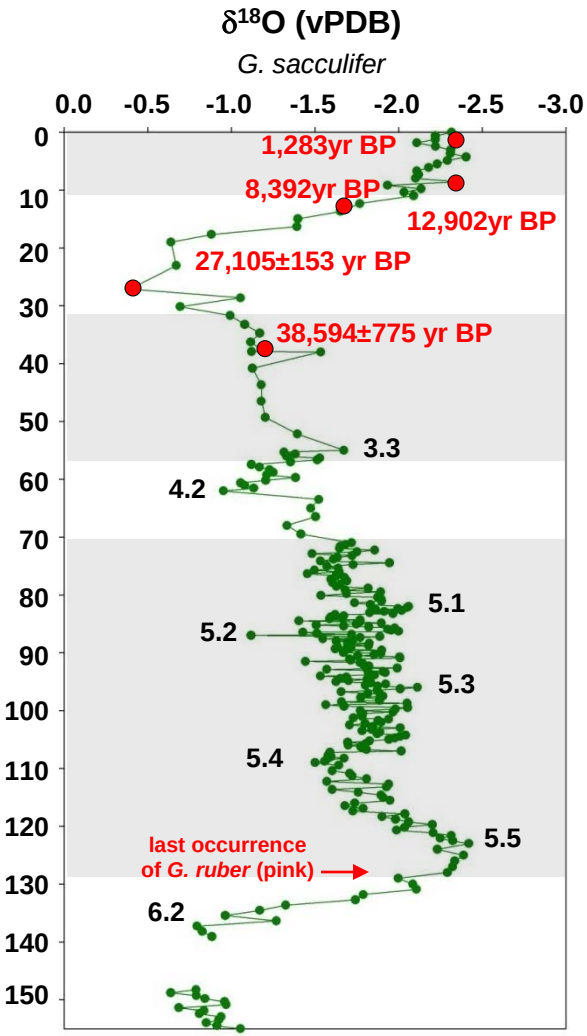
(*Harris et al.*, 1993; *Milliman*, 1995)

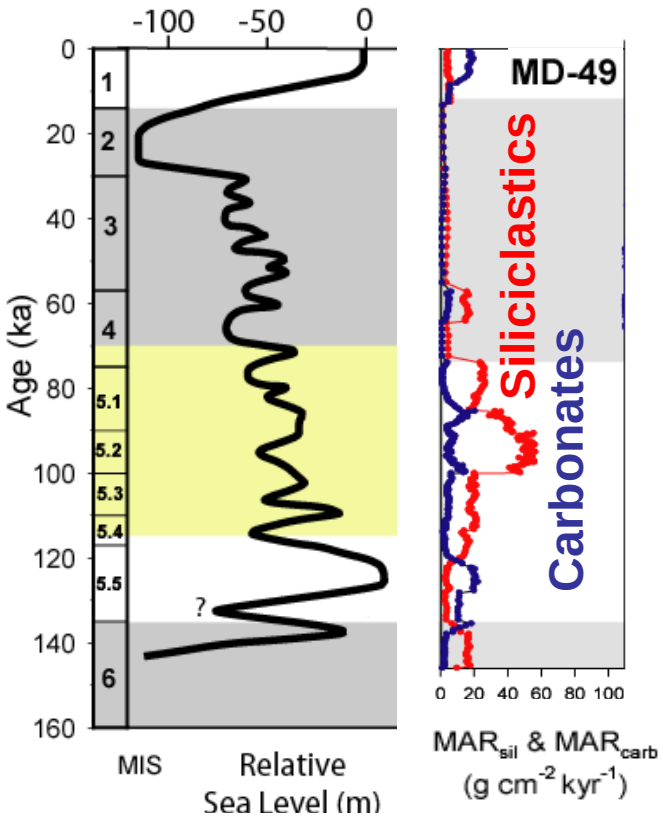
Mixed Siliciclastic Carbonate

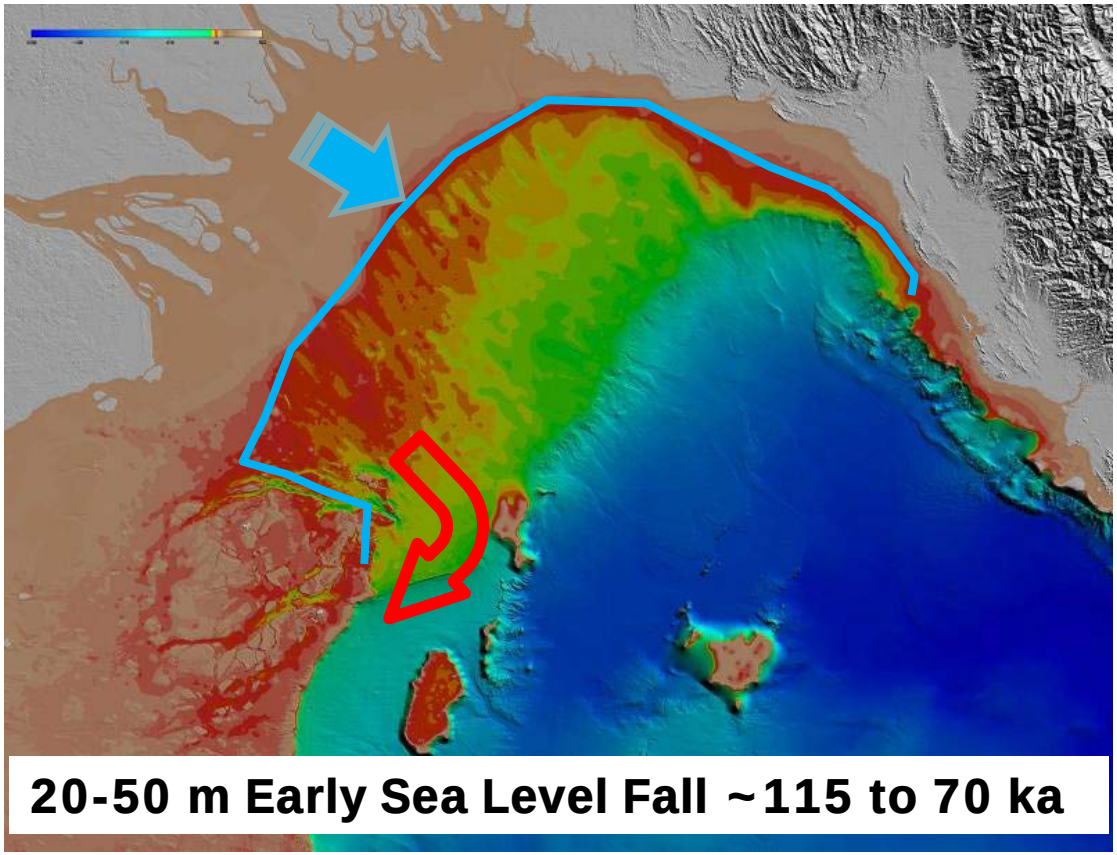


Siliciclastic Carbonate Switch

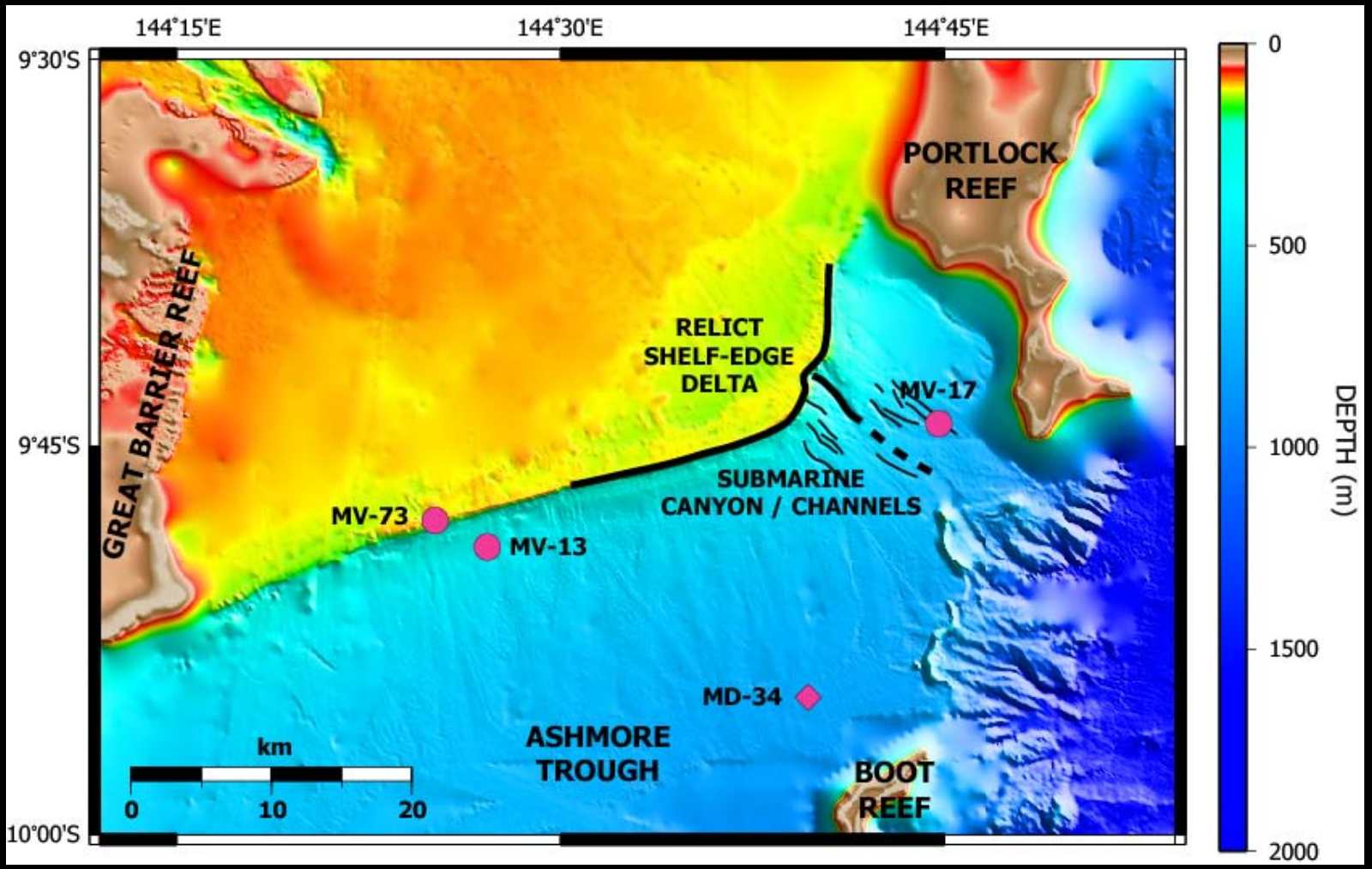




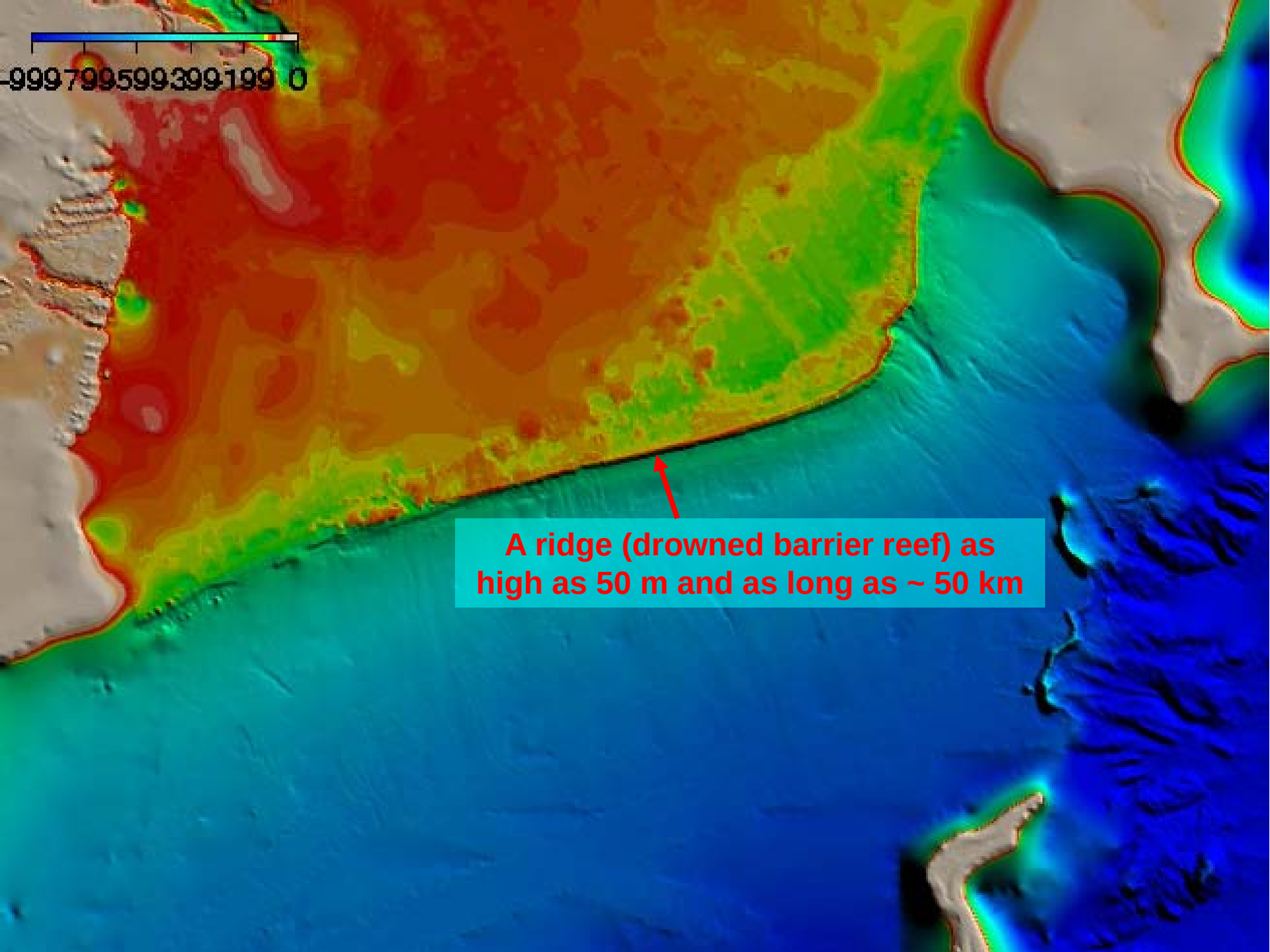

-100
-50
0
0
20
40
60
80
100
120
140
160
Age (ka)
1
2
3
4
5.1
5.2
5.3
5.4
5.5
6
?
MIS
Relative
Sea Level (m)
MD-49
Siliciclastics
Carbonates
0 20 40 60 80 100
MAR$_{sil}$ & MAR$_{carb}$
(g cm^{-2} kyr^{-1})


20-50 m Early Sea Level Fall ~115 to 70 ka

LGM Lowstand Shelfedge Delta



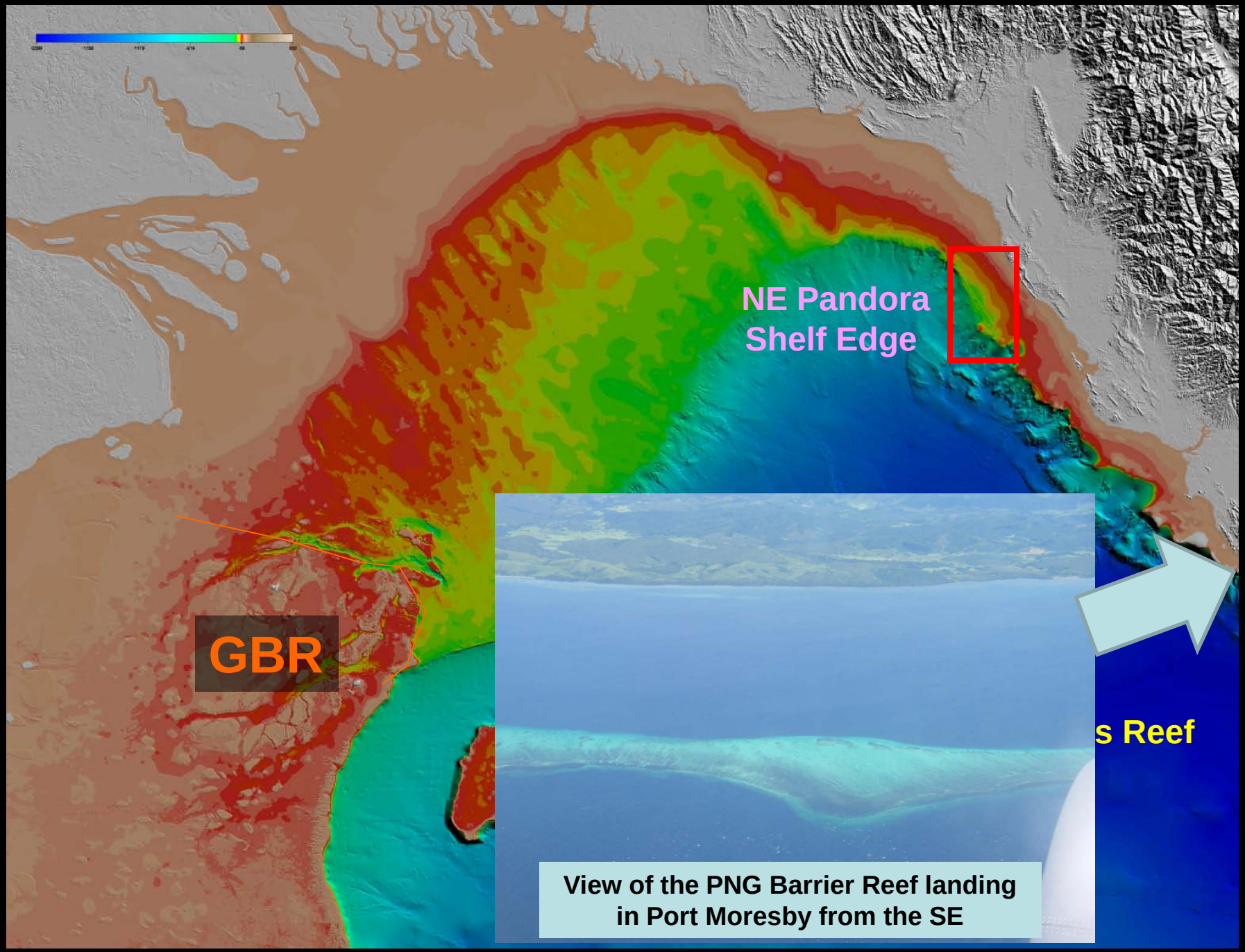
Maximum Lowstand (Last Glacial Maximum) ~30 to 16 ka


-9997995993991990
A ridge (drowned barrier reef) as high as 50 m and as long as ~ 50 km

Several drowned coralgal reefs are observed along the edges of the GoP low latitude siliciclastic continental shelf.

Responding to
the initial sea level rise,
these coralgal reefs
established themselves on top of
former lowstand siliciclastic
coastal deposits
(siliciclastic beach ridges/deltas)
once the new coast line
had migrated further towards land.

These transgressive coralgal reefs first thrived during the early part of the last deglaciation by growing vertically as much as 50 to 70 m, but finally drowned not being capable to continuously keep up with the rise of sea level.


NE Pandora
Shelf Edge
GBR
s Reef
View of the PNG Barrier Reef landing
in Port Moresby from the SE

NW

Strike Line

SE

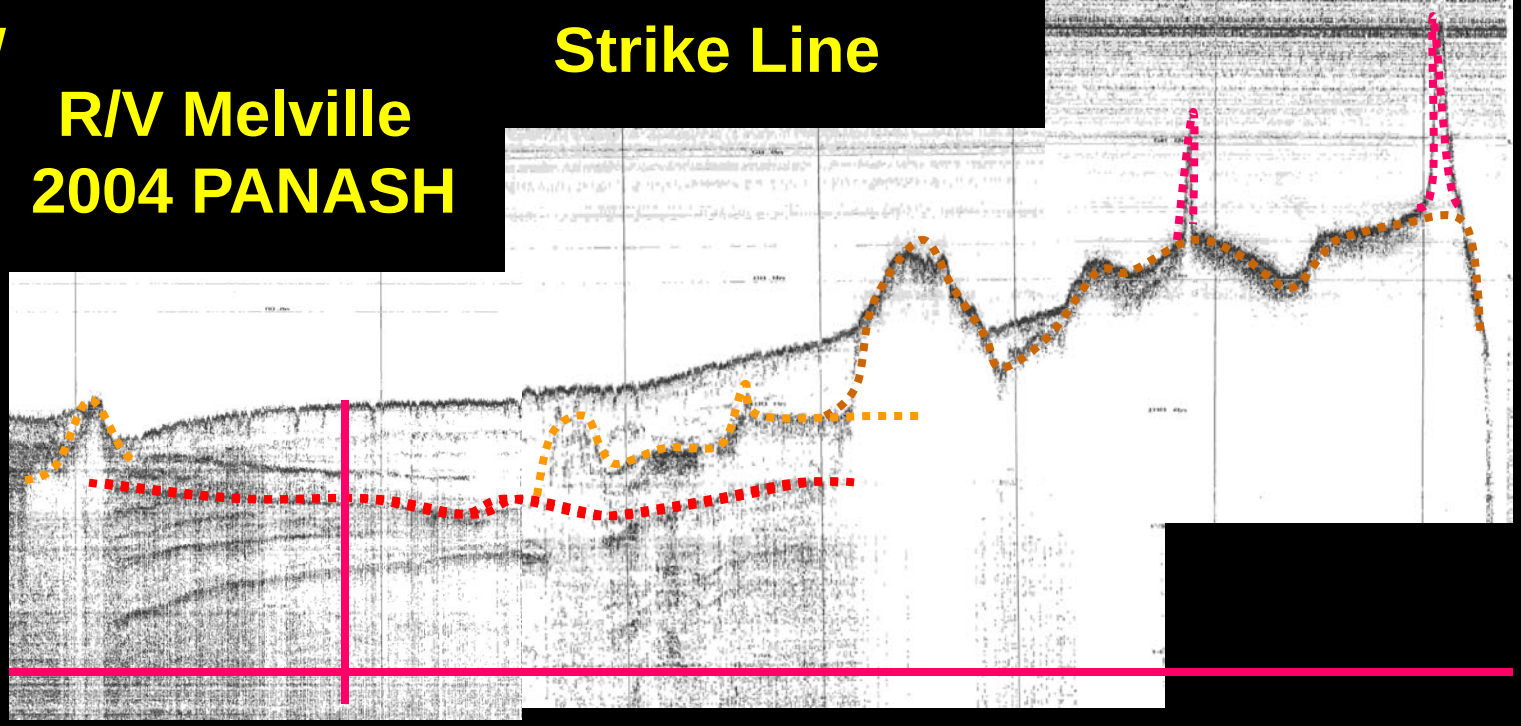
R/V Melville
2004 PANASH

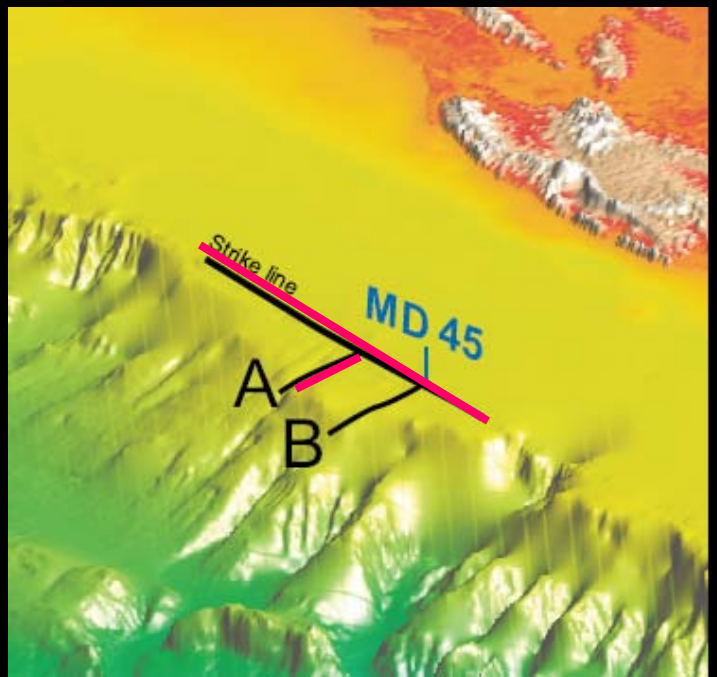
50 m

75 m

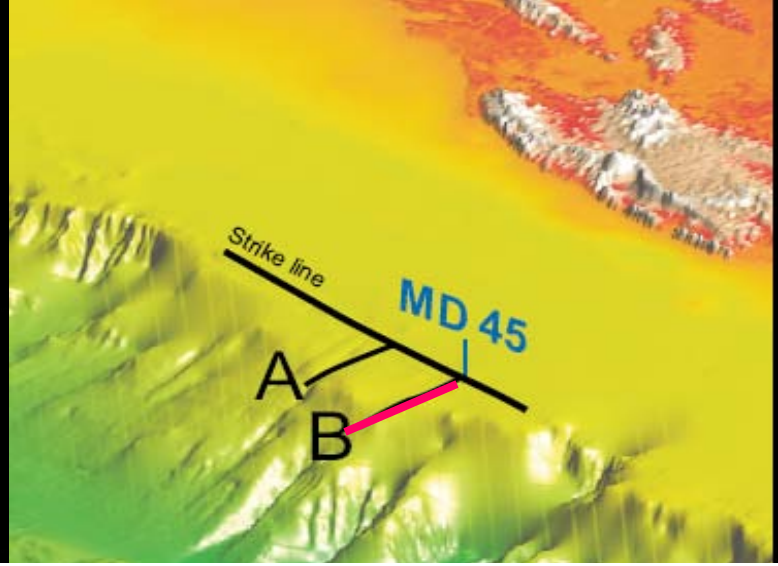
100 m

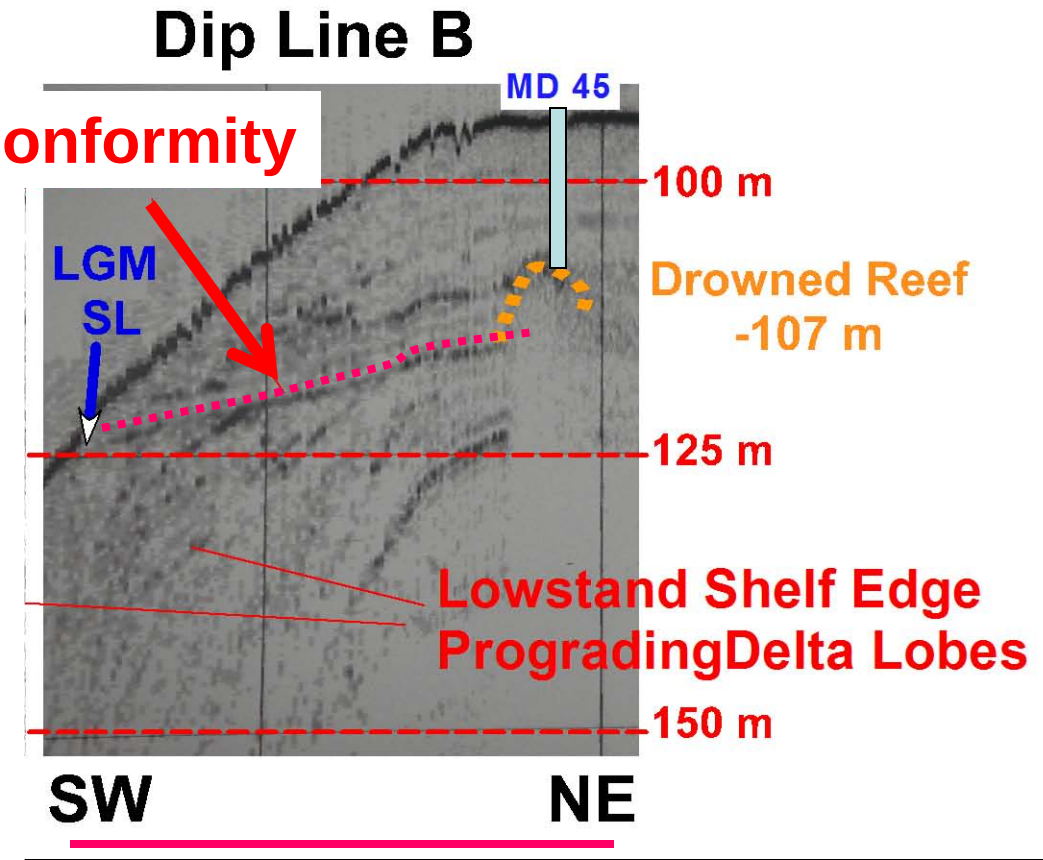
125 m

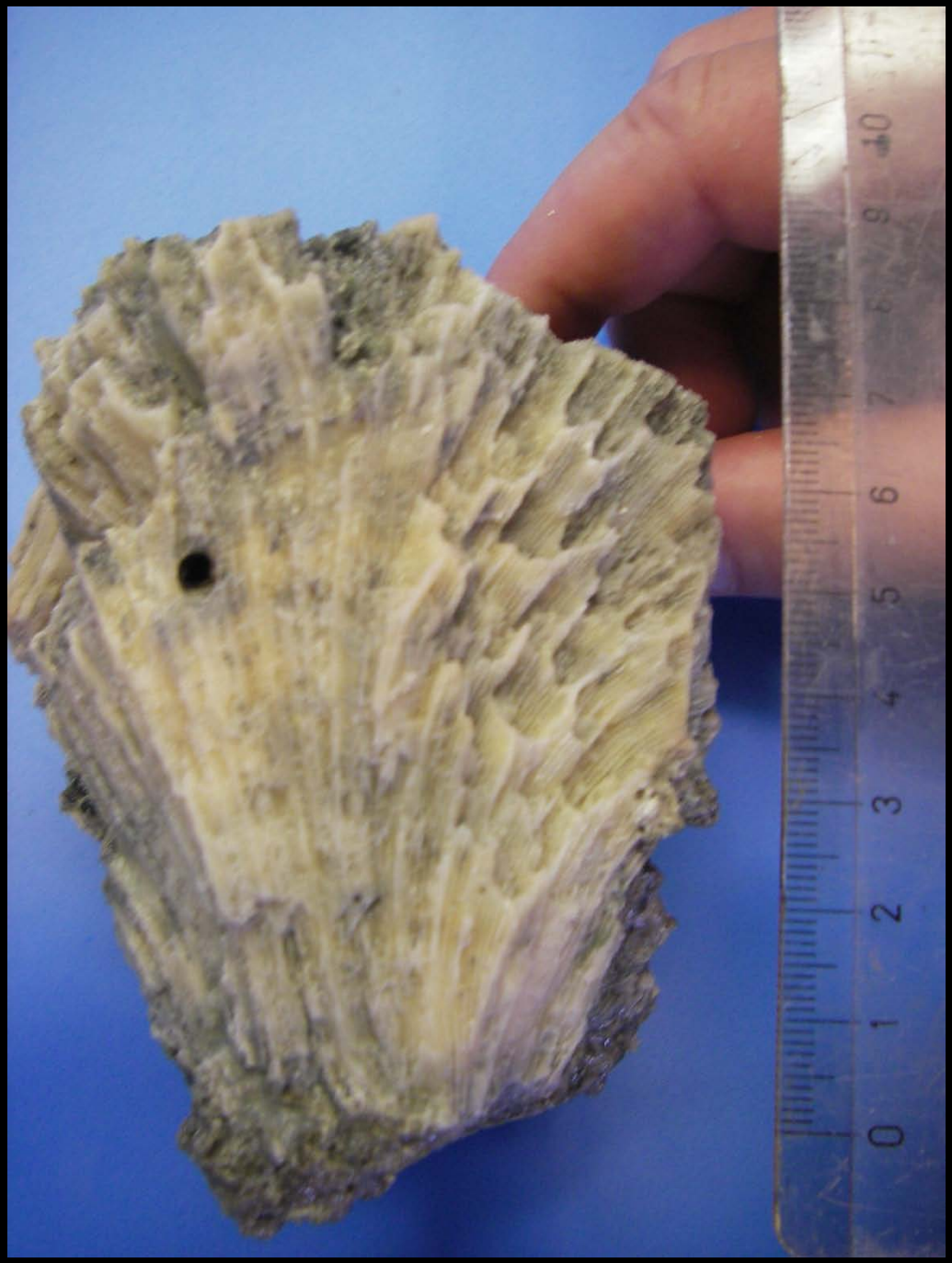




R/V Melville
2004 PANASH
R/V Marion Dufresne
2005 PECTEN







Galaxea Coral Colony Retrieved from the bottom of Core MD 45 at 107 m mbsf Dated by AMS Carbon-14:

Age: 19 ky Cal. Yr.

Identification by Charlie Veron & Eric Borneman

NW

Strike Line

SE

R/V Melville
2004 PANASH

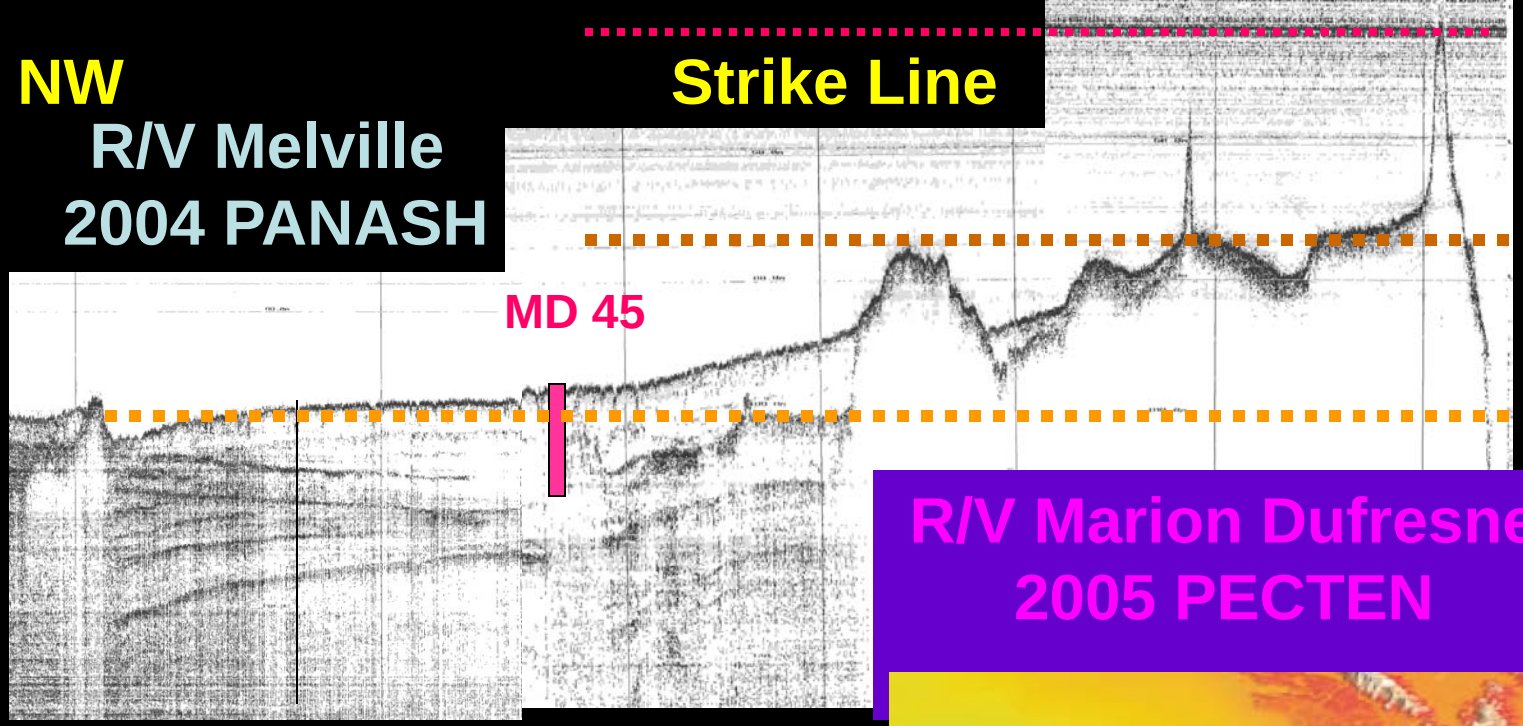
50 m

75 m

100 m

125 m

MD 45



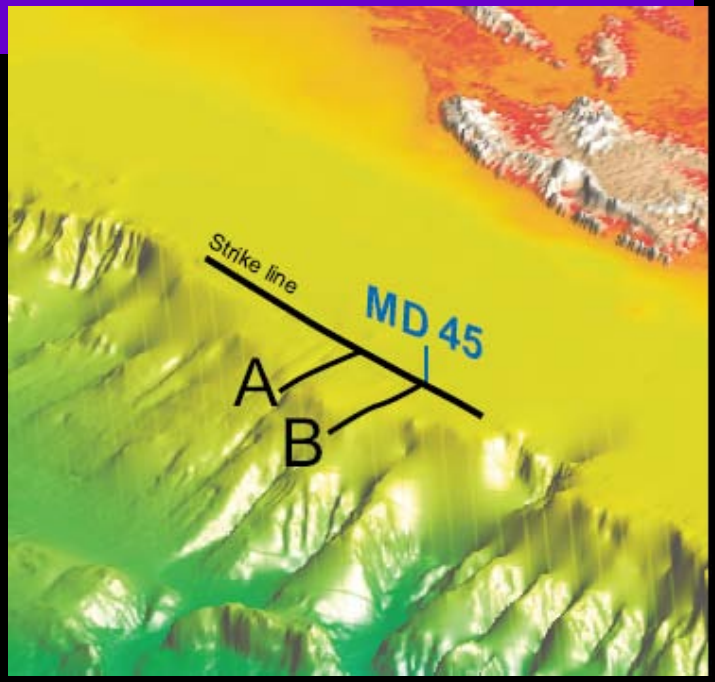
50 m

75 m

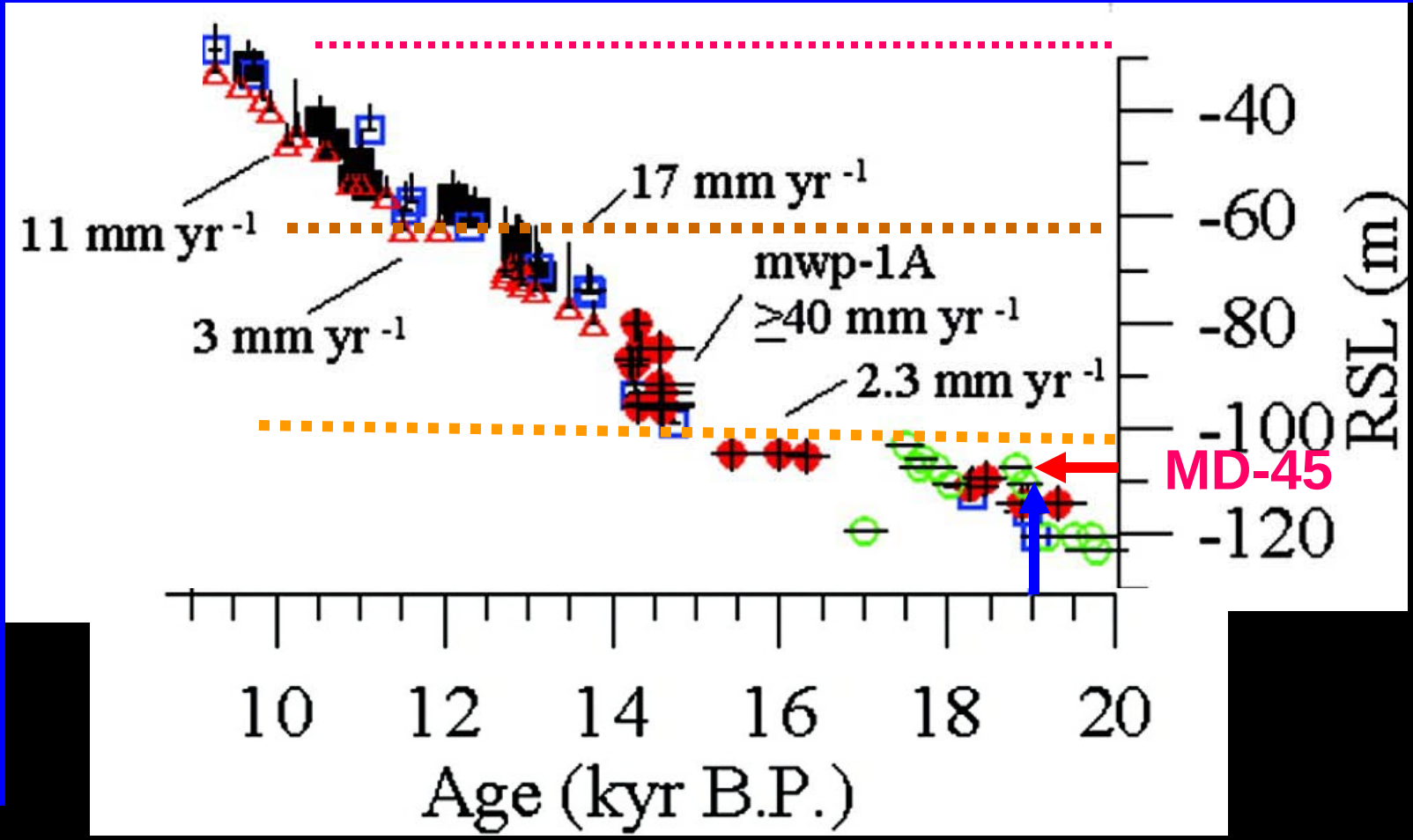
100 m

125 m

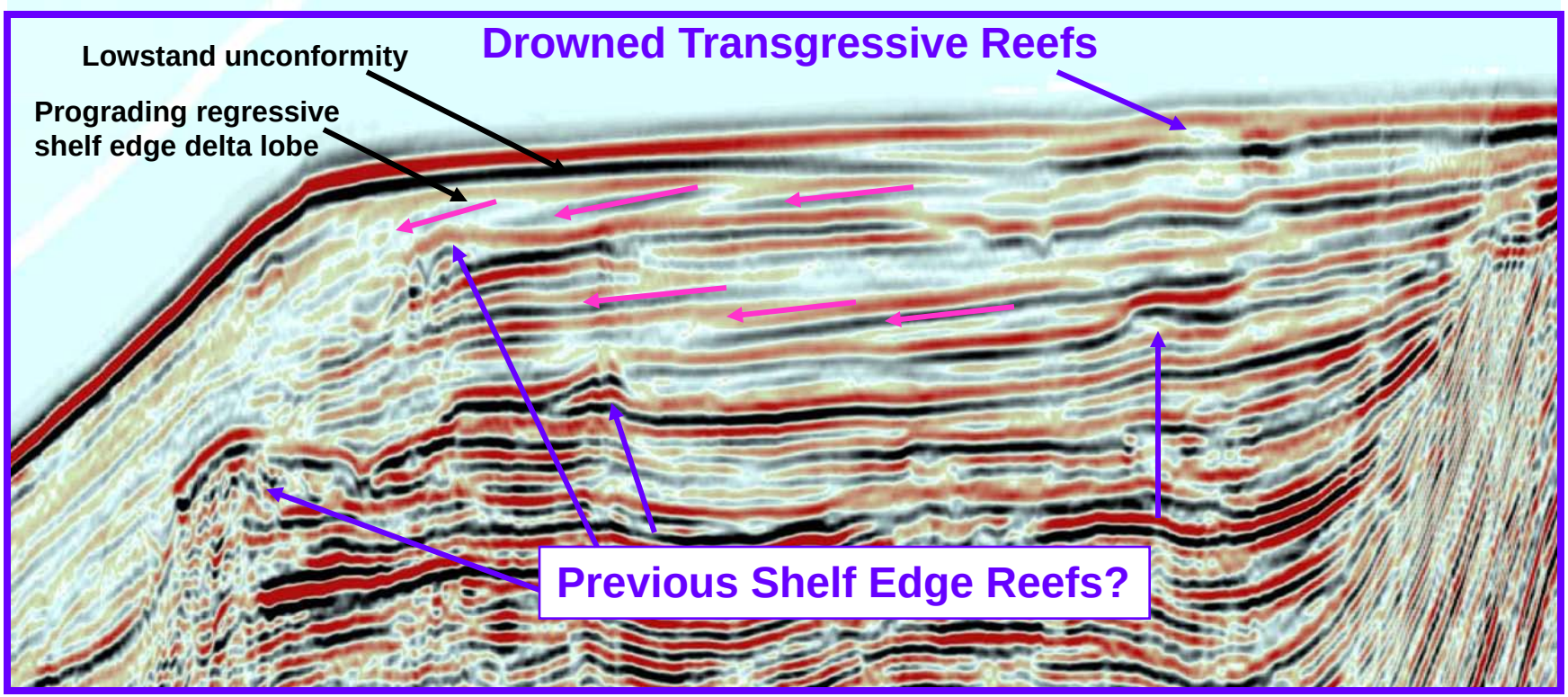
R/V Marion Dufresne
2005 PECTEN



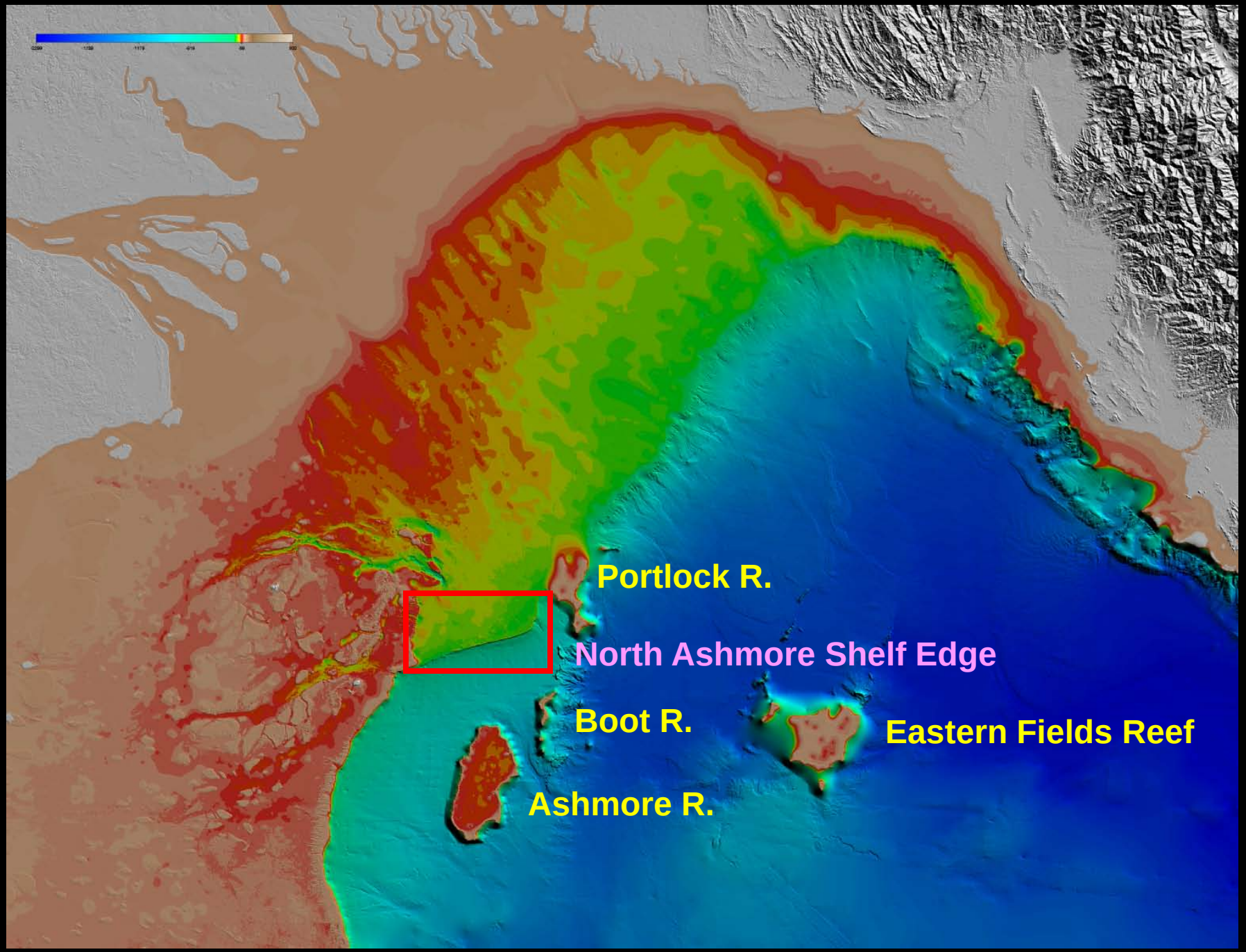
Last Deglacial Sea Level Curve Weaver et al., 2003

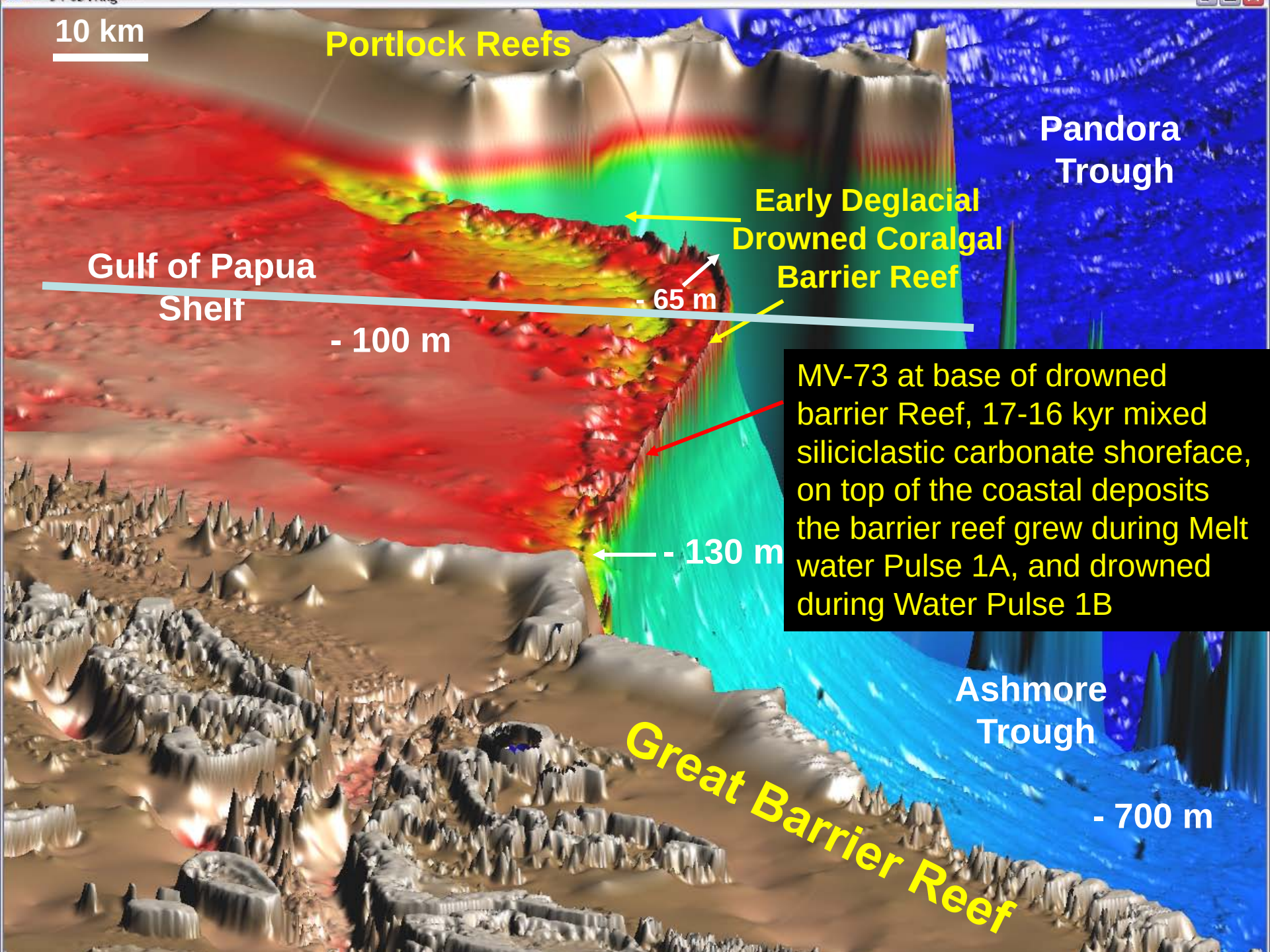


PNG Peninsula Shelf Dip Line

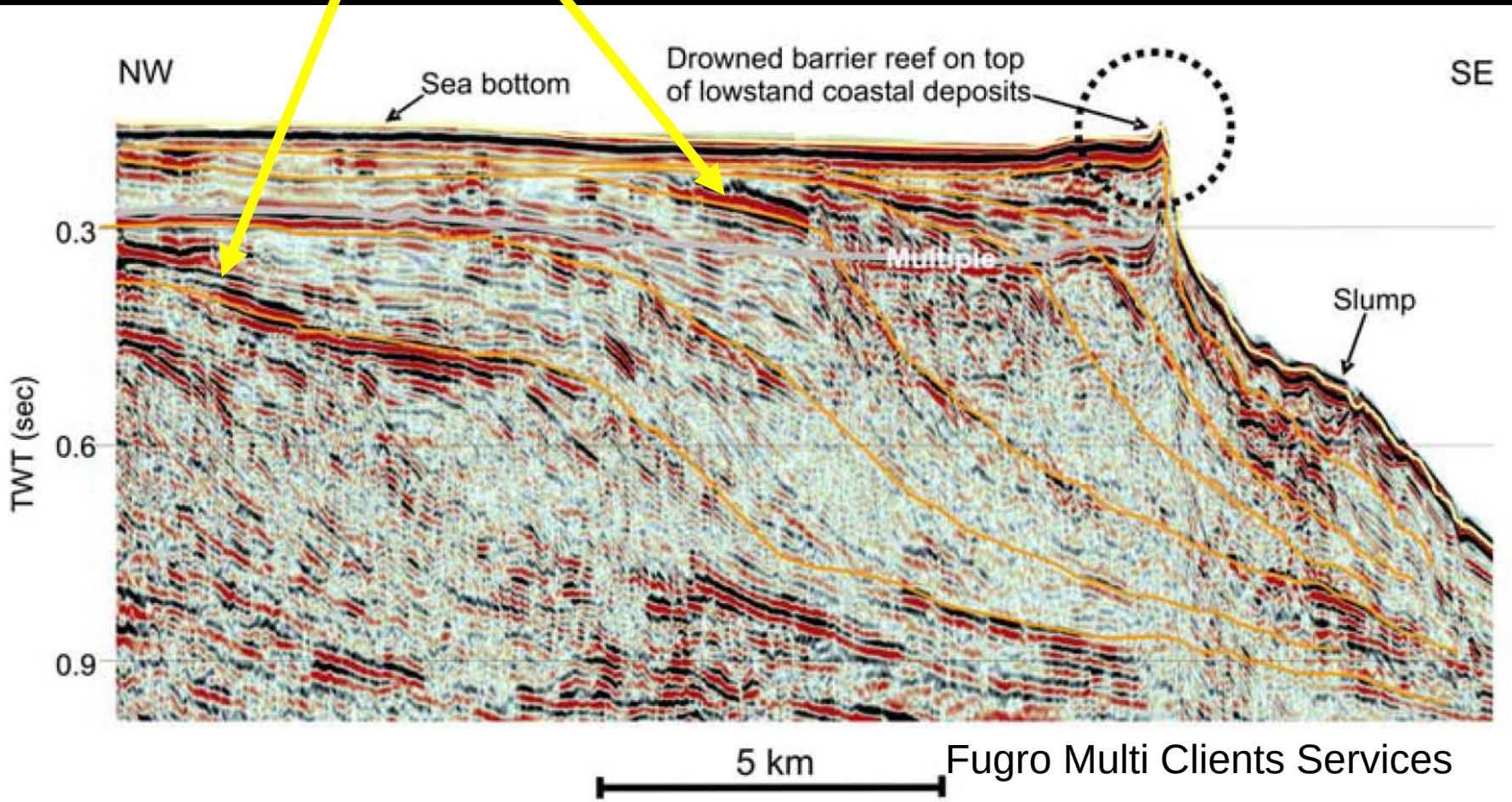


Fugro Multi Clients Services


Portlock R.
North Ashmore Shelf Edge
Boot R.
Eastern Fields Reef
Ashmore R.


10 km
Portlock Reefs
Pandora Trough
Early Deglacial Drowned Coralgal Barrier Reef
Gulf of Papua Shelf
- 65 m
- 100 m
MV-73 at base of drowned barrier Reef, 17-16 kyr mixed siliciclastic carbonate shoreface, on top of the coastal deposits the barrier reef grew during Melt water Pulse 1A, and drowned during Water Pulse 1B
- 130 m
Ashmore Trough
Great Barrier Reef
- 700 m

Buried Earlier Transgressive Barrier Reefs on top of lowstand shelfedge delta

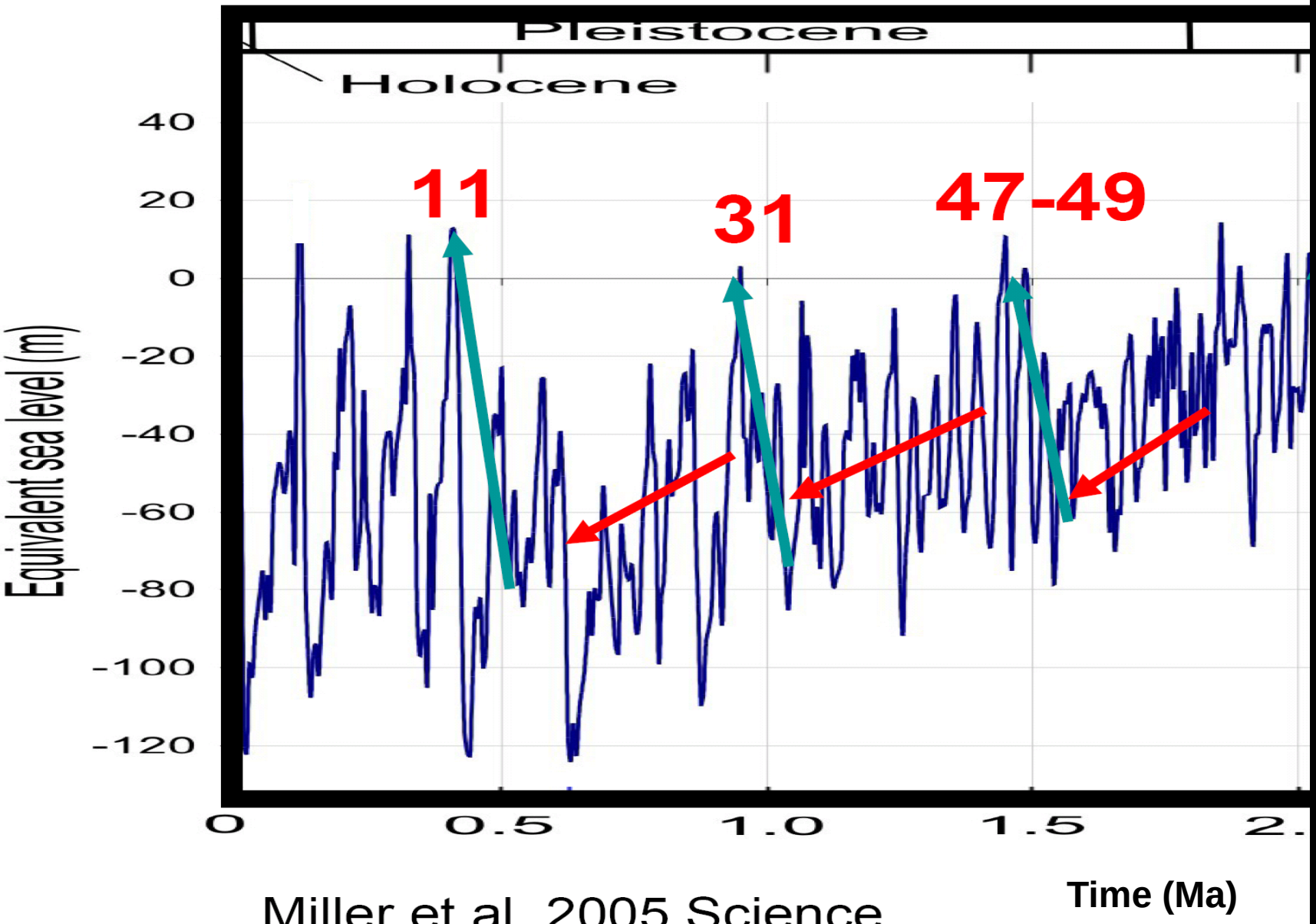


This simple scenario for coralgal reef establishment and growth during the last early sea level transgression subsequent to the last Glacial Maximum sea level lowstand, was apparently repeated in the Quaternary during intervals marked by major transgressions.

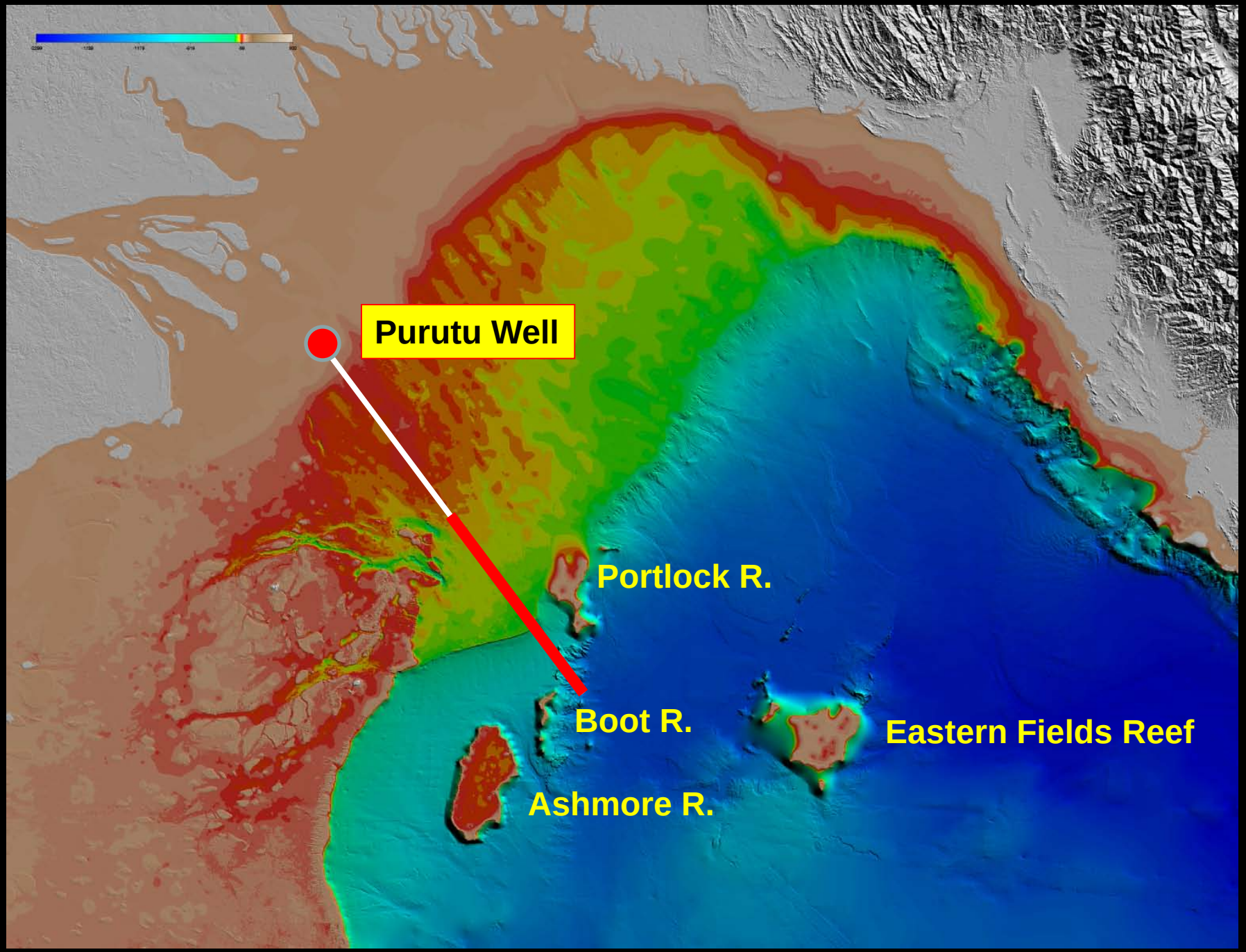
In the Quaternary, at least three major sea level transgressions (~ 400-500 ky) terminated long intervals of significant sea level fall and lowstand,

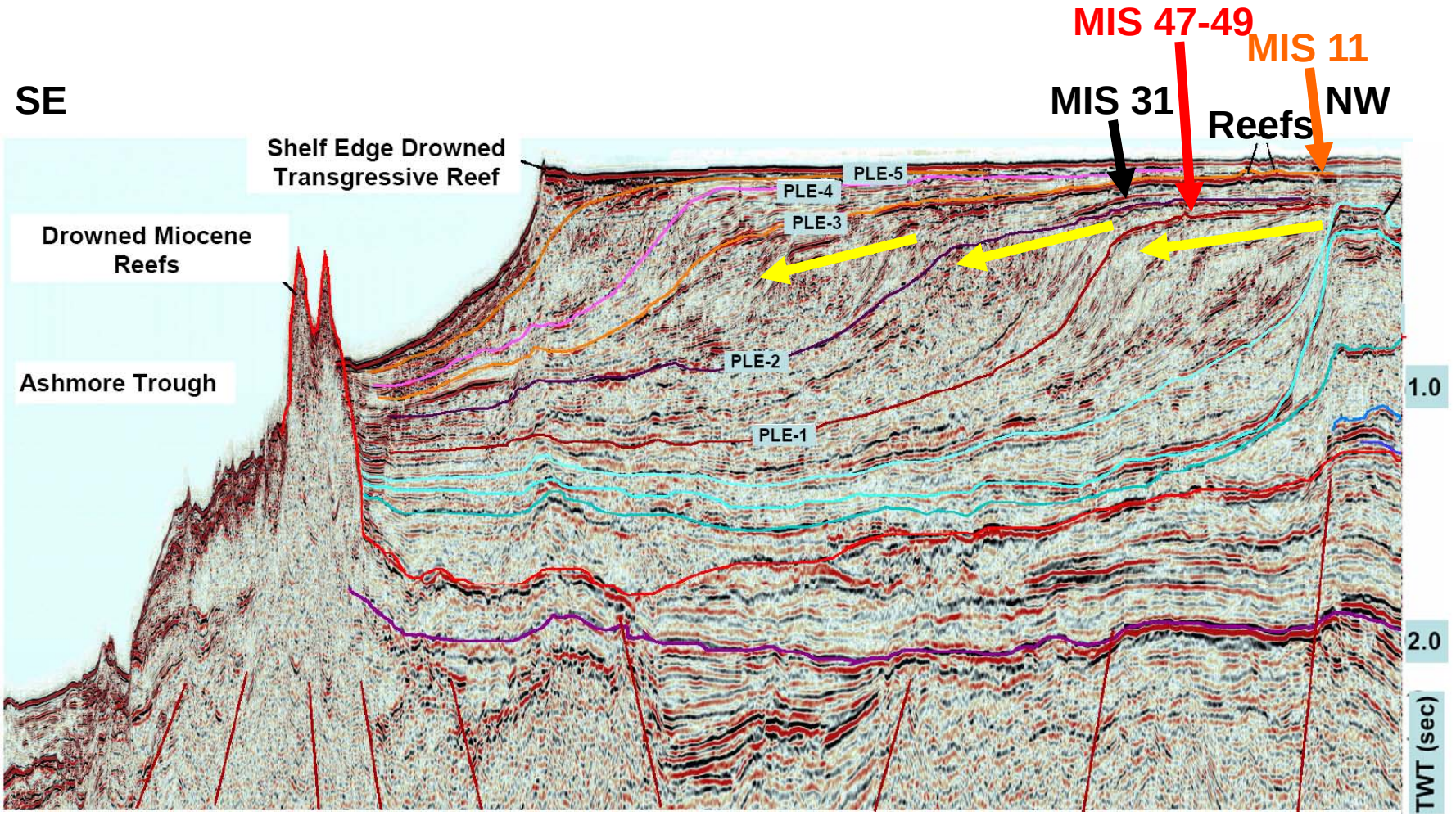
1) during the Mid-Brunhes (Marine Isotope Stage MIS 12 to 11, about 450 ka; i.e. Great Barrier Reef, Florida Keys, Belize and New Caledonia),

2) during two other transgressive intervals at about 1.0 and 1.5 Ma (MIS 34 to 31 and MIS 52 to 47, respectively; observed in the Gulf of Papua.



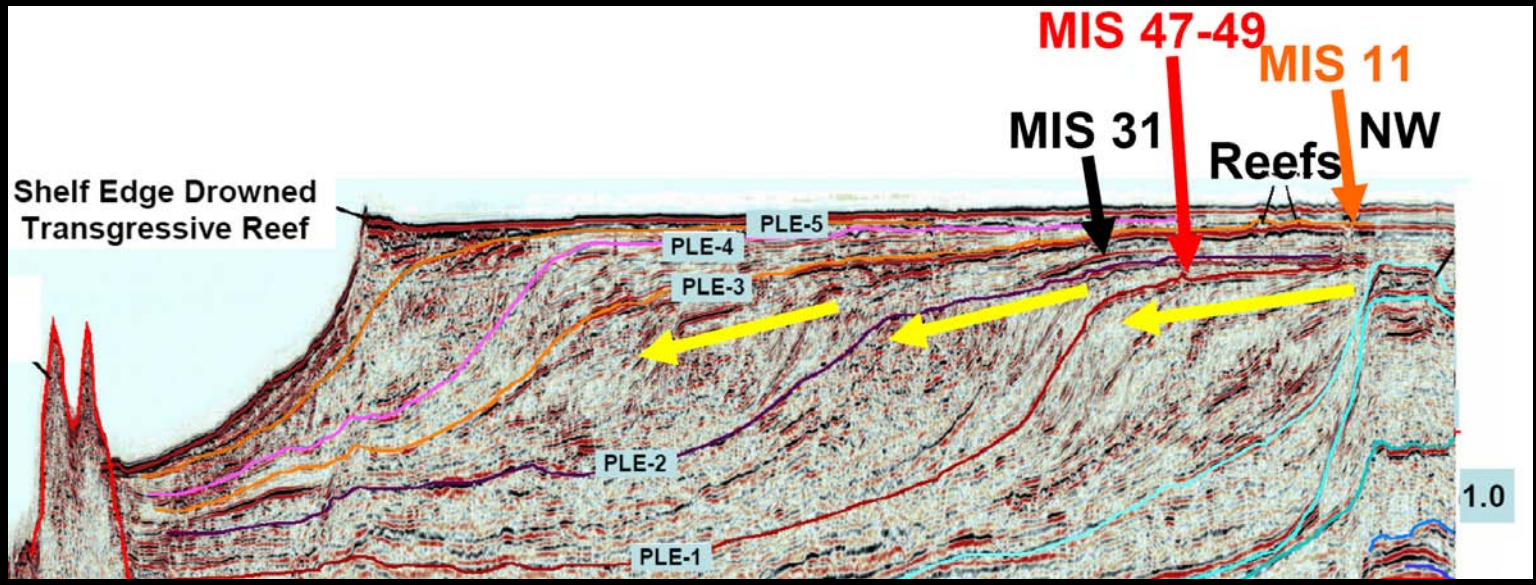
Miller et al. 2005 Science

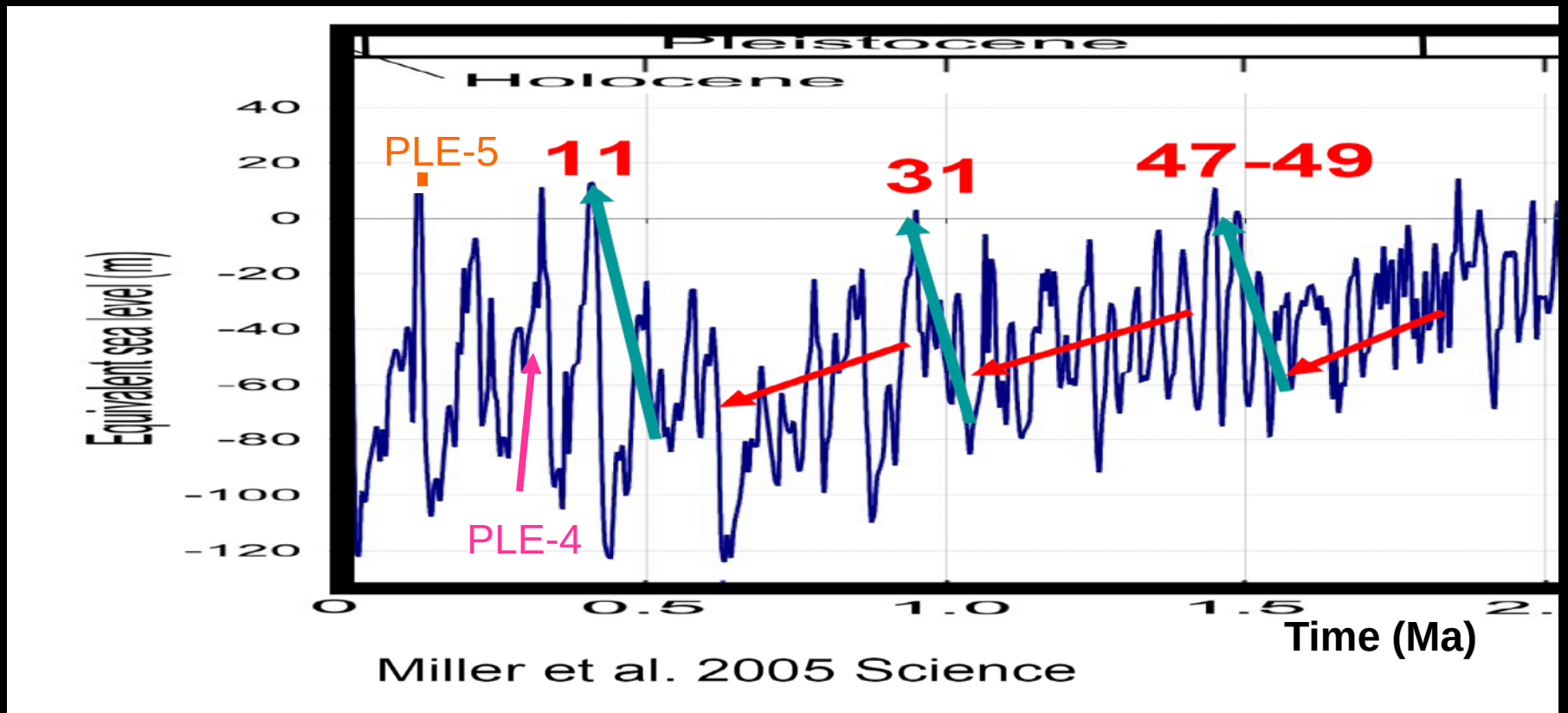

Purutu Well
Portlock R.
Boot R.
Eastern Fields Reef
Ashmore R.



Fugro Multi Clients Services

Purutu Well

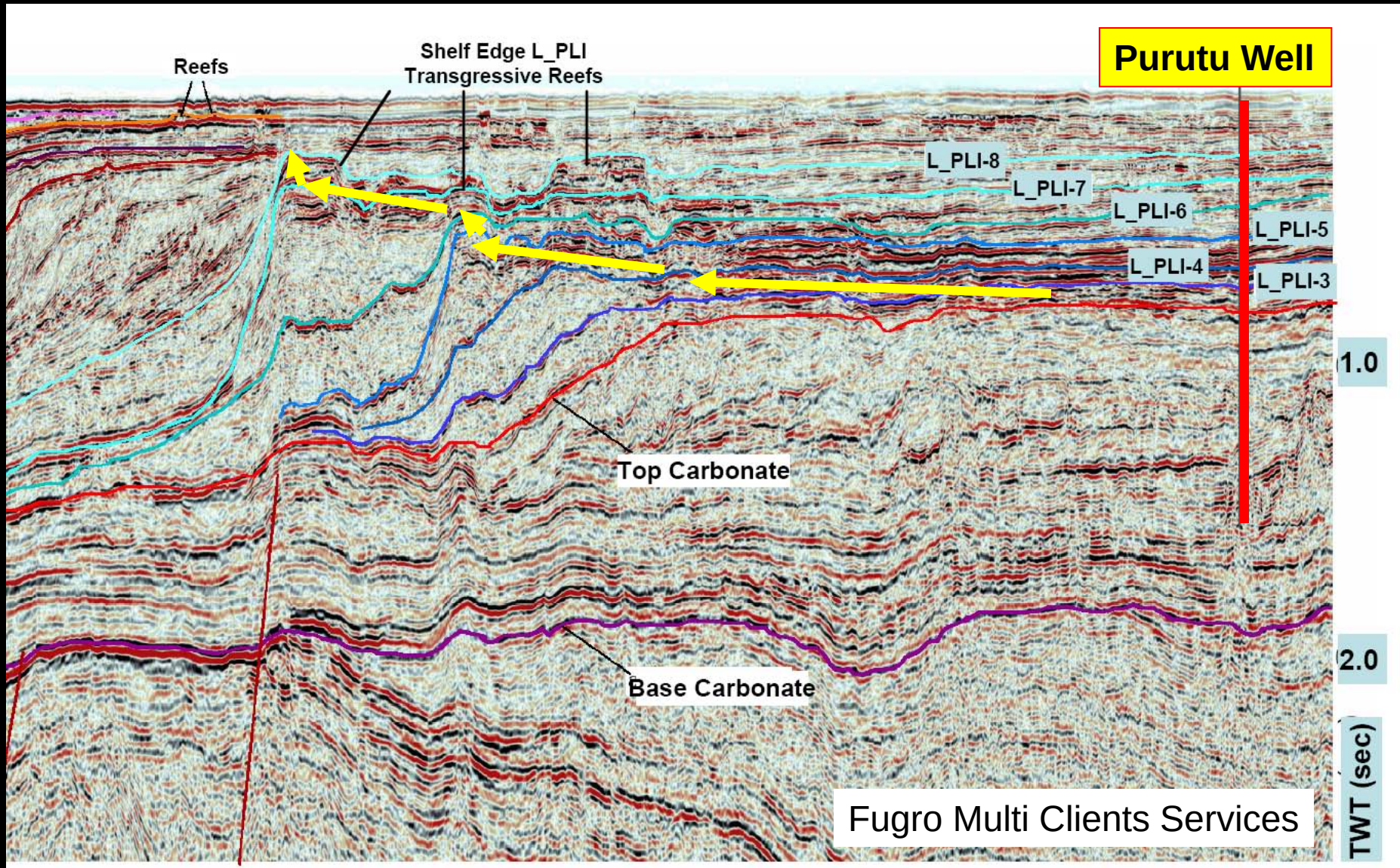

MIS 47-49
MIS 11
MIS 31
Reefs
NW
Shelf Edge Drowned
Transgressive Reef
PLE-5
PLE-4
PLE-3
PLE-2
PLE-1
1.0

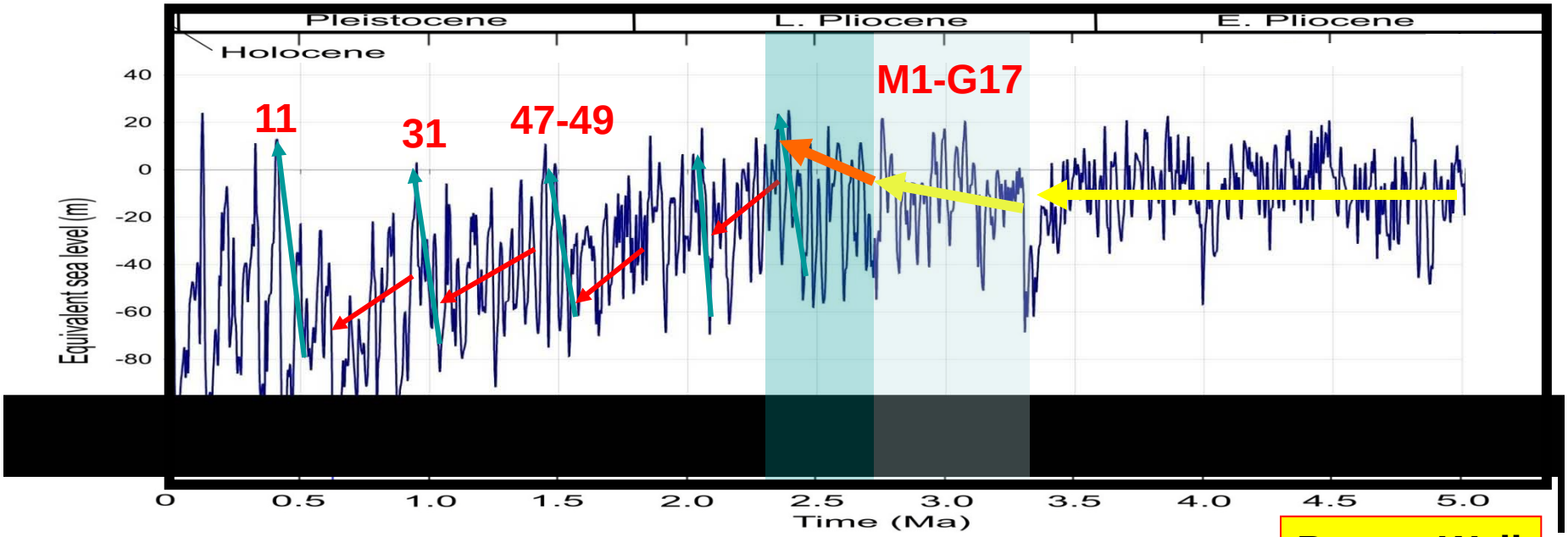

Pleistocene
Holocene
PLE-5
11
31
47-49
PLE-4
Equivalent sea level (m)
40
20
0
-20
-40
-60
-80
-100
-120
0
0.5
1.0
1.5
2.
Time (Ma)
Miller et al. 2005 Science

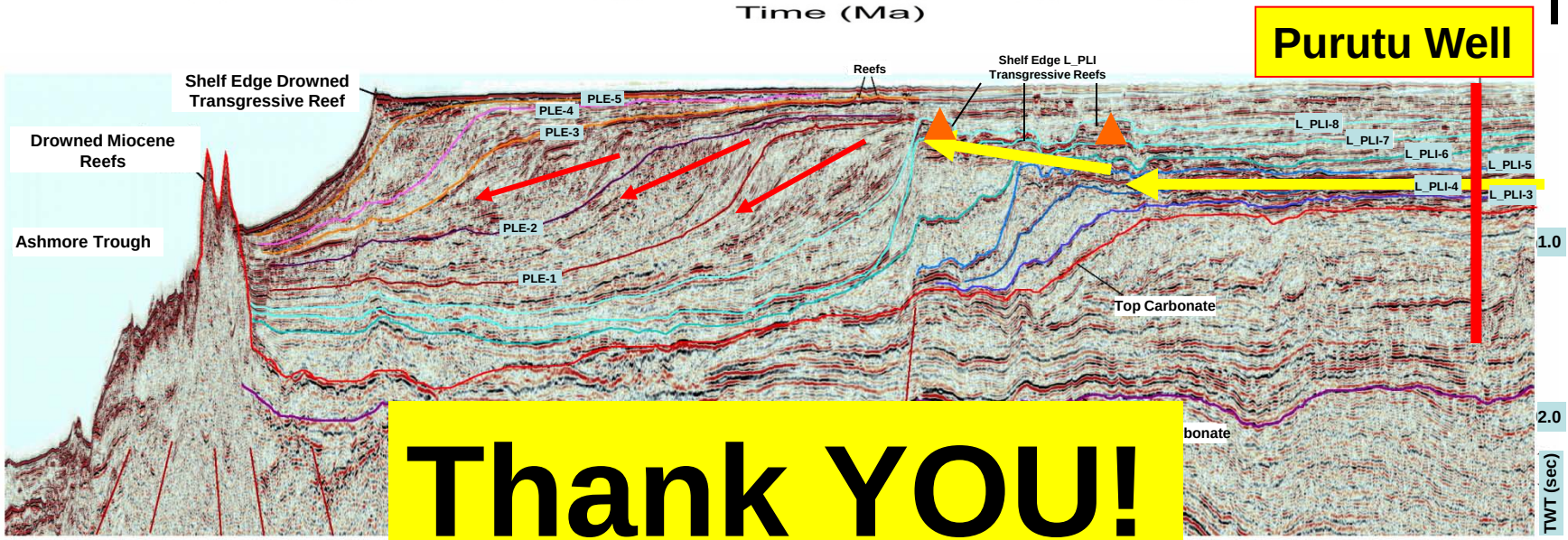
During the late Pliocene, several ephemeral, but well-developed, phases of neritic carbonate growth are observed on the edges of the Gulf of Papua siliciclastic shelf, at the times when shelf edges were simultaneously prograding and aggrading (relative sea level transgressions).

The best developed late Pliocene neritic carbonate edifices on top of shelf edge siliciclastic sediments in the Gulf of Papua have occurred during the transgressions leading to the "mid-Pliocene warm interval“ (~3.1 to 2.8 Ma).

SE NW


Reefs
Shelf Edge L_PLI
Transgressive Reefs
Purutu Well
L_PLI-8
L_PLI-7
L_PLI-6
L_PLI-5
L_PLI-4
L_PLI-3
1.0
Top Carbonate
2.0
Base Carbonate
TWT (sec)
Fugro Multi Clients Services





Thank YOU!

SE

NW