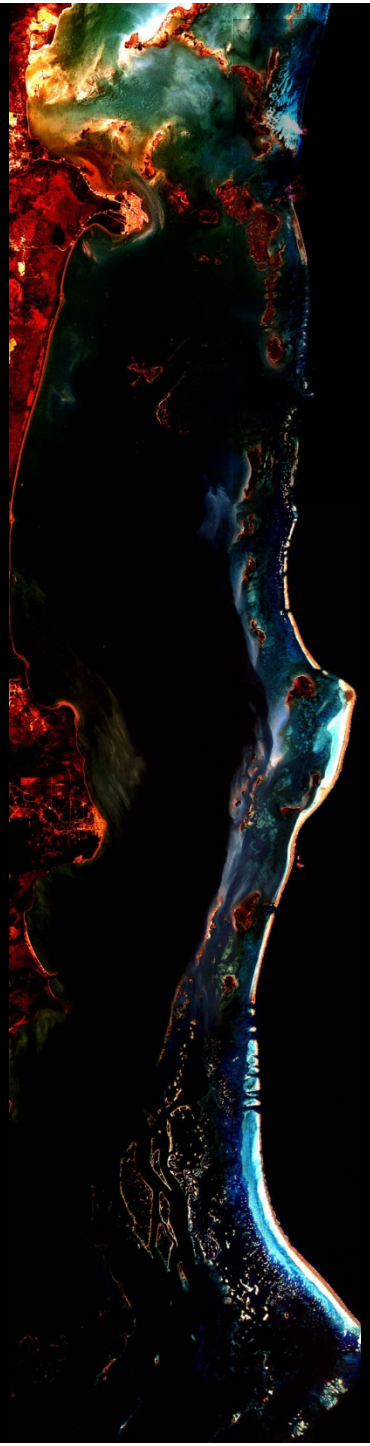


"Establishment and Influence of Coralgal Barrier Reefs in Mixed Carbonate Siliciclastic Systems"

Jerry Dickens
John Anderson
Sam Bentley
Larry Peterson
Brad Opdyke

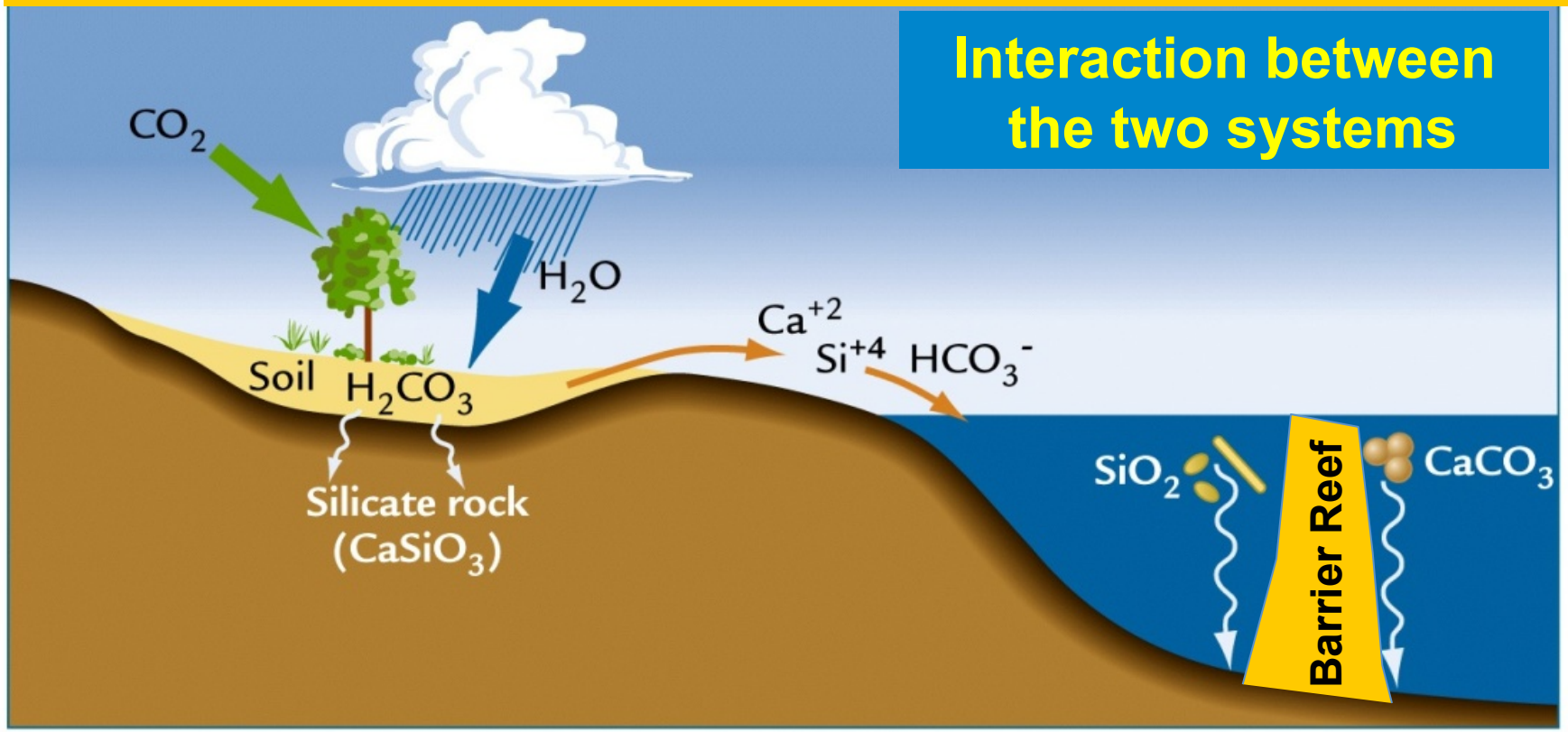
And former & Current graduate students

RICE
Unconventional Wisdom

André W. Droxler
Department of Earth Science
andre@rice.edu

Chapman Conference
Jan. 25, 2011

"Carbonate sediments are born within the oceans, not made as siliciclastics not transported as particulates, but as solute" Noel James



$CaSiO_3$ + H_2CO_3

Silicate bedrock + Carbonic acid in soils

Weathering on land

Ca^{+2} Si^{+4} HCO_3^-

Ions dissolved in river water

Transport in rivers

$SiO_2 + CaCO_3$

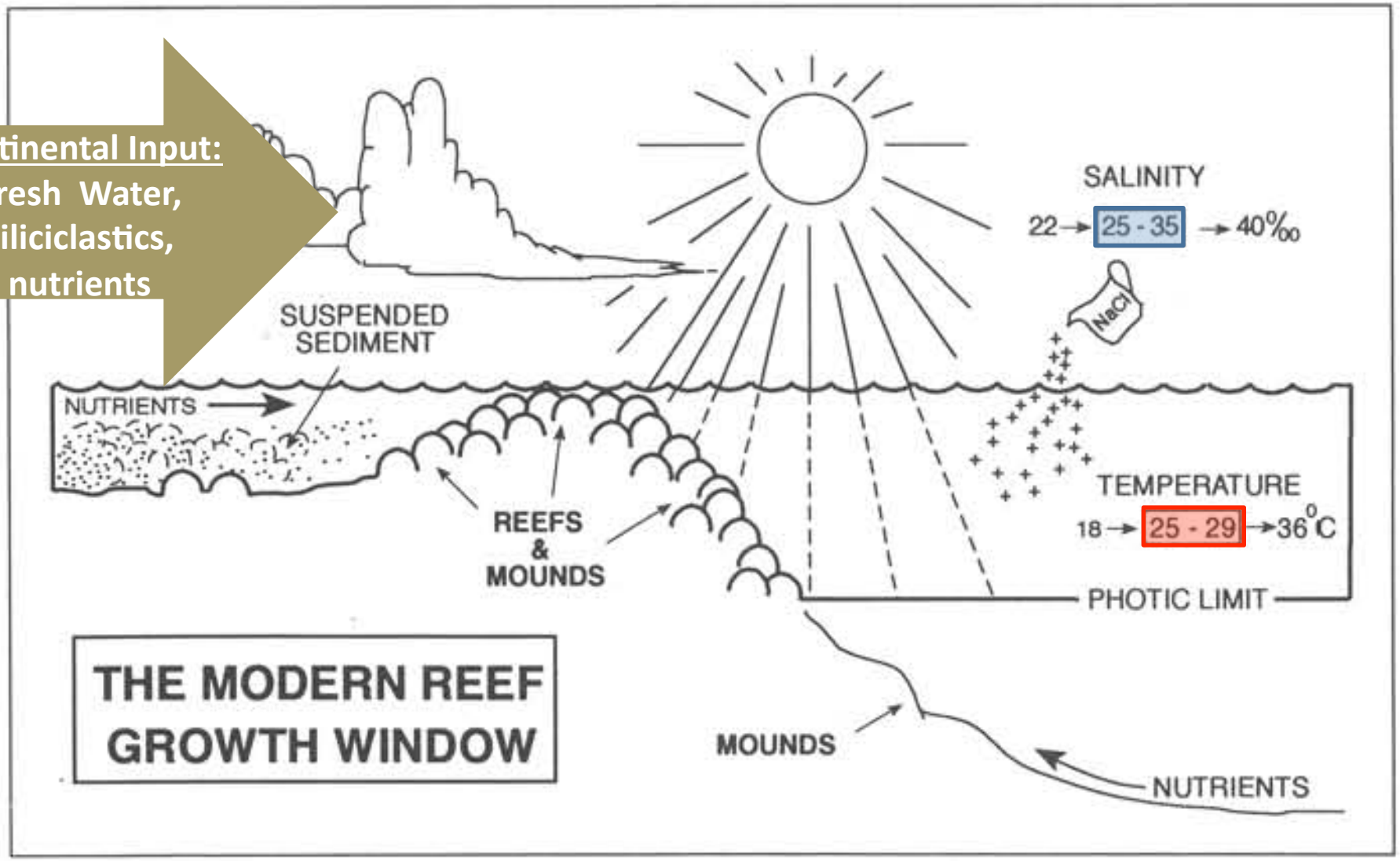
Shells of ocean plankton

Deposition in ocean

+ neritic benthic carbonates

Ruddiman (2001)

Mixed Carbonate Siliciclastic Sedimentary Systems in Low Latitudes



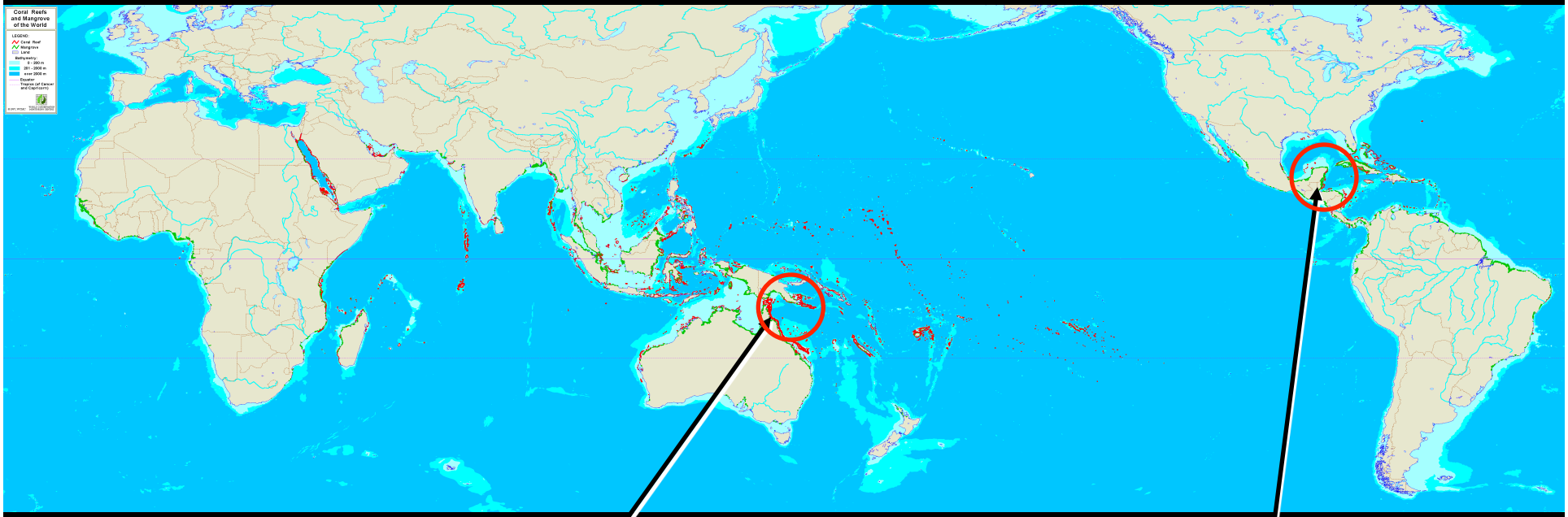
Recent Flooding in Queensland

http://earthsky.org/earth/swollen-rivers-in-queensland-carry-heavy-sediments-to-australian-coast

http://www.esri.com/events/uc/results/graphics/5_belize_city-lg.jpg

Belize River Delta, Belize City

Mixed Carbonate Siliciclastic Sedimentary Systems in Low Latitudes



Gulf of Papua

Central Belize Margin

Source of global reef map: http://www.wcmc.org.uk/marine/data/coral_mangrove/marine.maps.main.html

Road Map: Mixed Systems along Low Latitude Continental Margins

Short-Lived Carbonate Systems Along Siliciclastic Continental Margin Shelf Edges; their Morphologies Mimick the Underlying Lowstand Siliciclastic Coastal Deposits, Used as Substratum

Early Transgressions become a "Window of Opportunity" for the Barrier Reef Establishment on top of Lowstand Coastal Siliciclastic Deposits such as Elongated Barrier Islands, Linear Beach Ridges

Once Established during Transgression and Highstand, Exposed Shallow Carbonate Barriers, during Intervals of Sea Level Fall and Lowstand Influenced the Geometry of the Siliciclastic Drainage System.

Mixed Systems along Low Latitude Continental Margins

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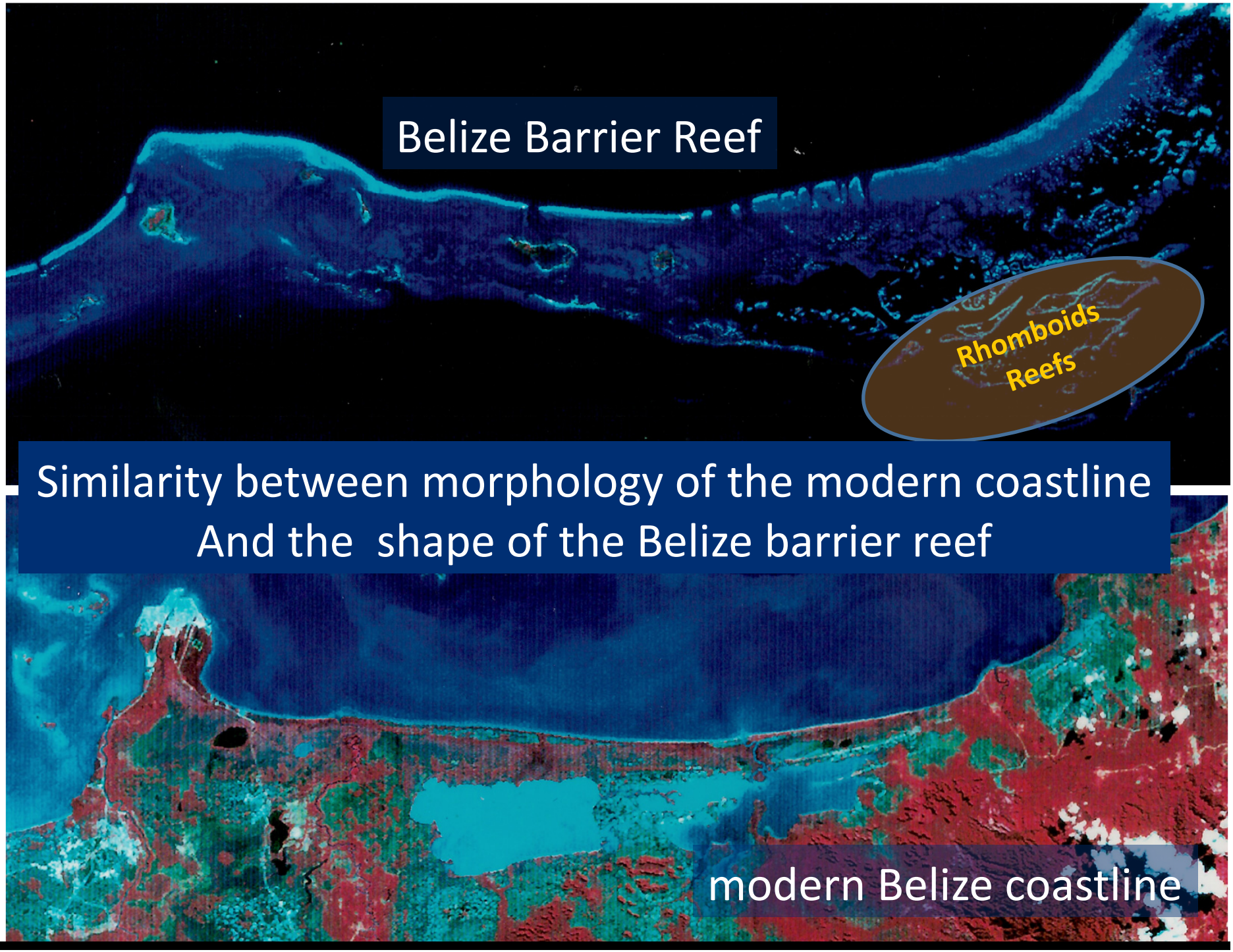
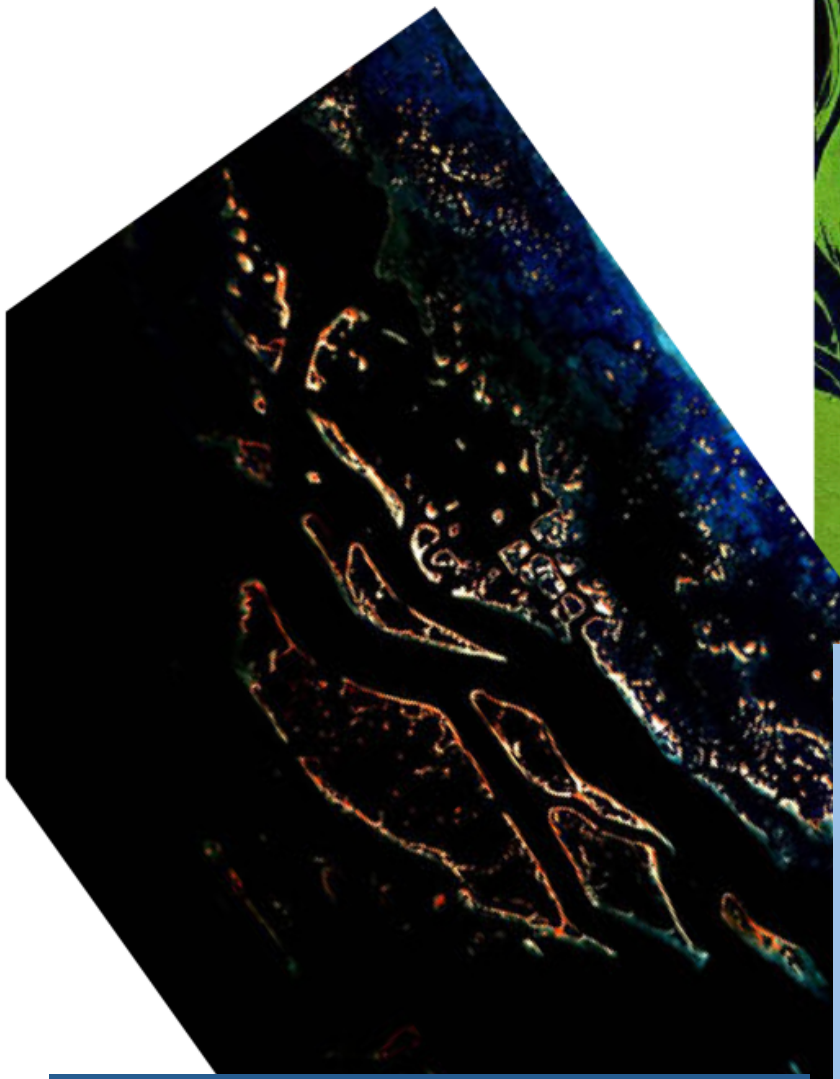
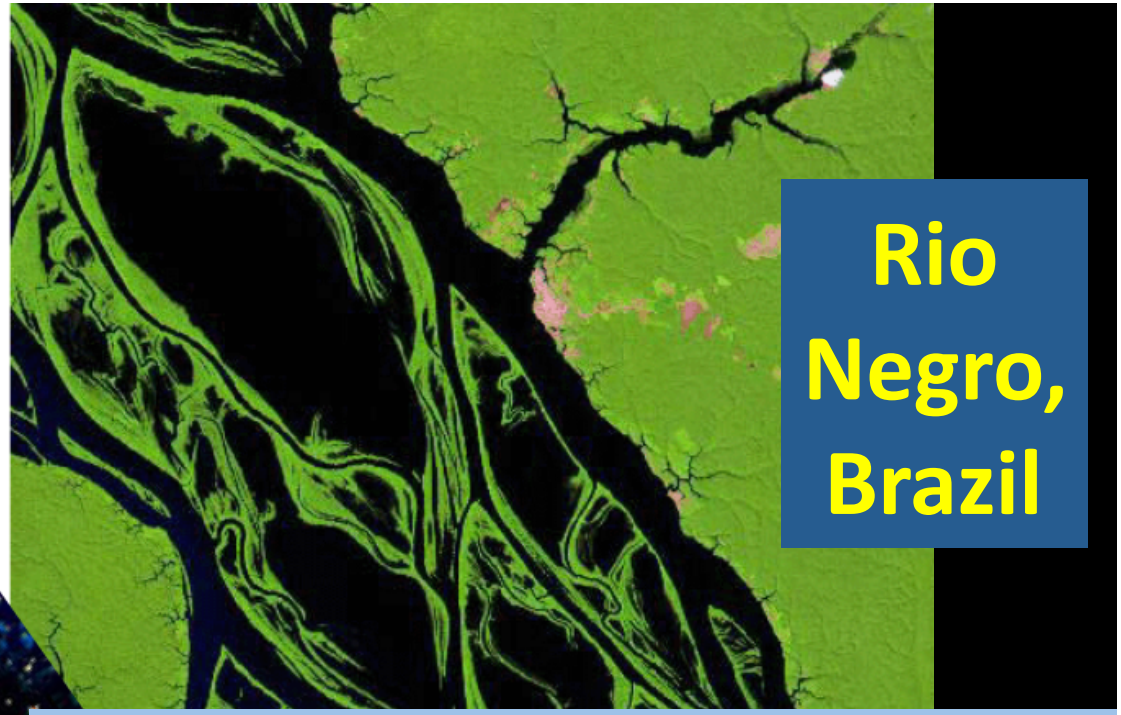

Belize Barrier Reef
Rhomboids Reefs
Similarity between morphology of the modern coastline
And the shape of the Belize barrier reef
modern Belize coastline

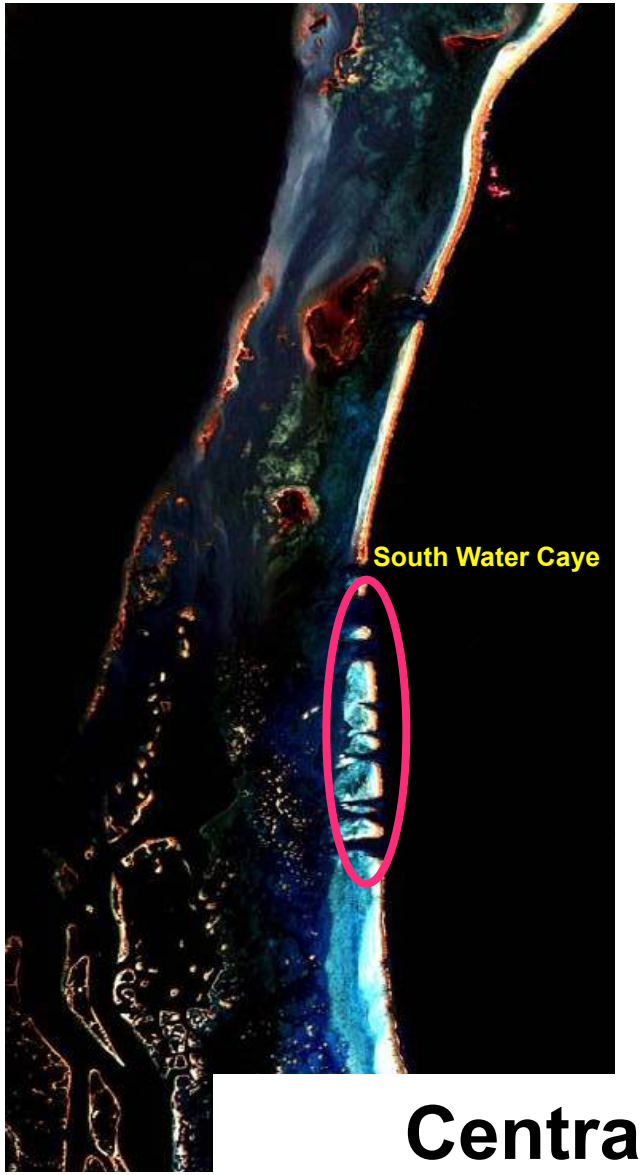


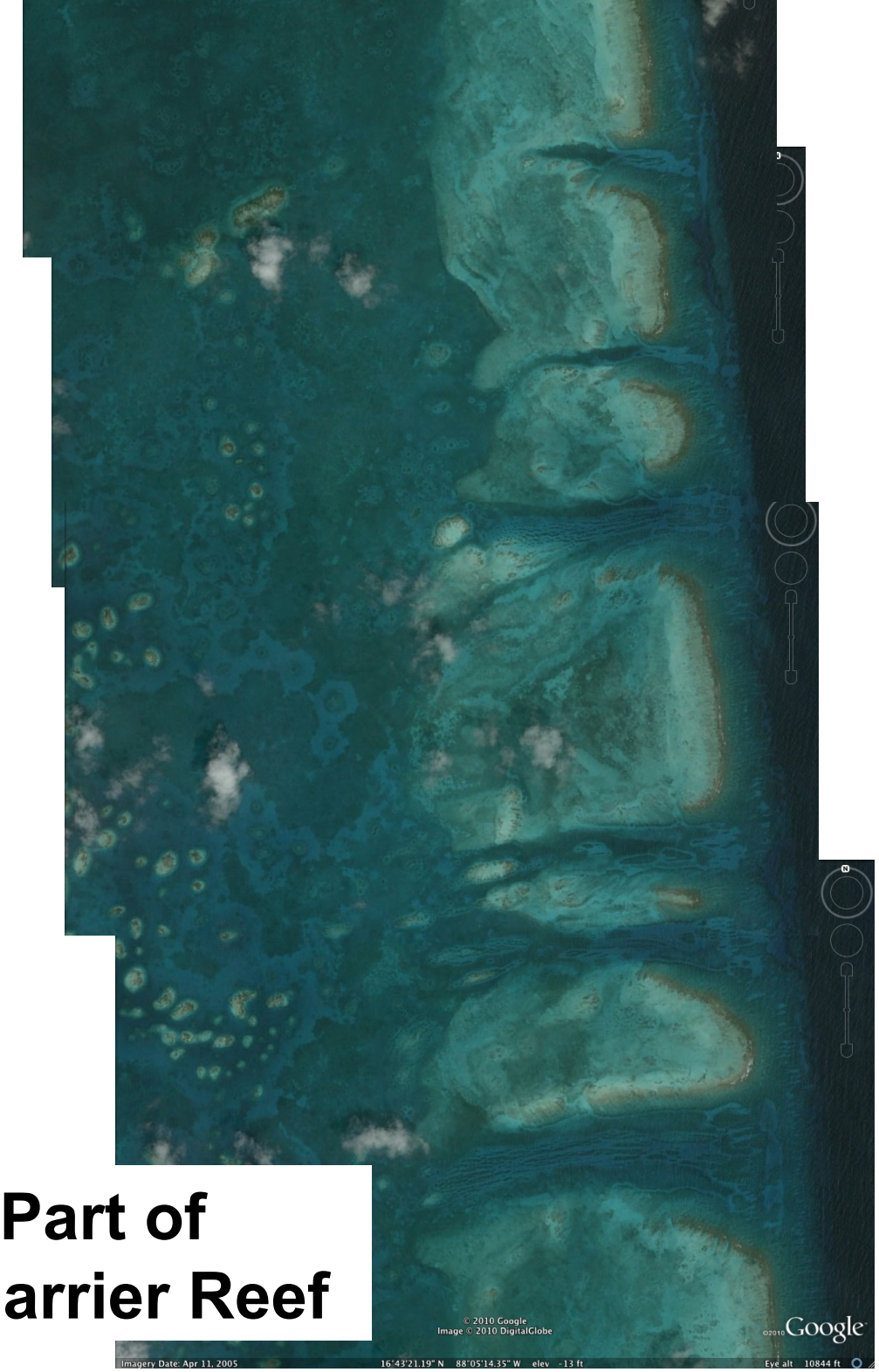
Rhomboids Reefs, Belize



Rio Negro, Brazil

the Rio Negro is a good analogue for previous lowstands [during Last Glacial Maximum (LGM) or early Brunhes fluvial system, Gischler et al. 2010]. On top of these levee system, the Rhomboid Reefs became established and stacked on top of one another during subsequent deglaciations, sea level transgressions.





Central Part of the Belize Barrier Reef

Chandeleur Islands

Mixed Systems along Low Latitude Continental Margins

Short-Lived Carbonate Systems Along Siliciclastic Continental Margin Shelf Edges; their morphologies mimick underlying lowstand siliciclastic coastal deposits, used as substratum

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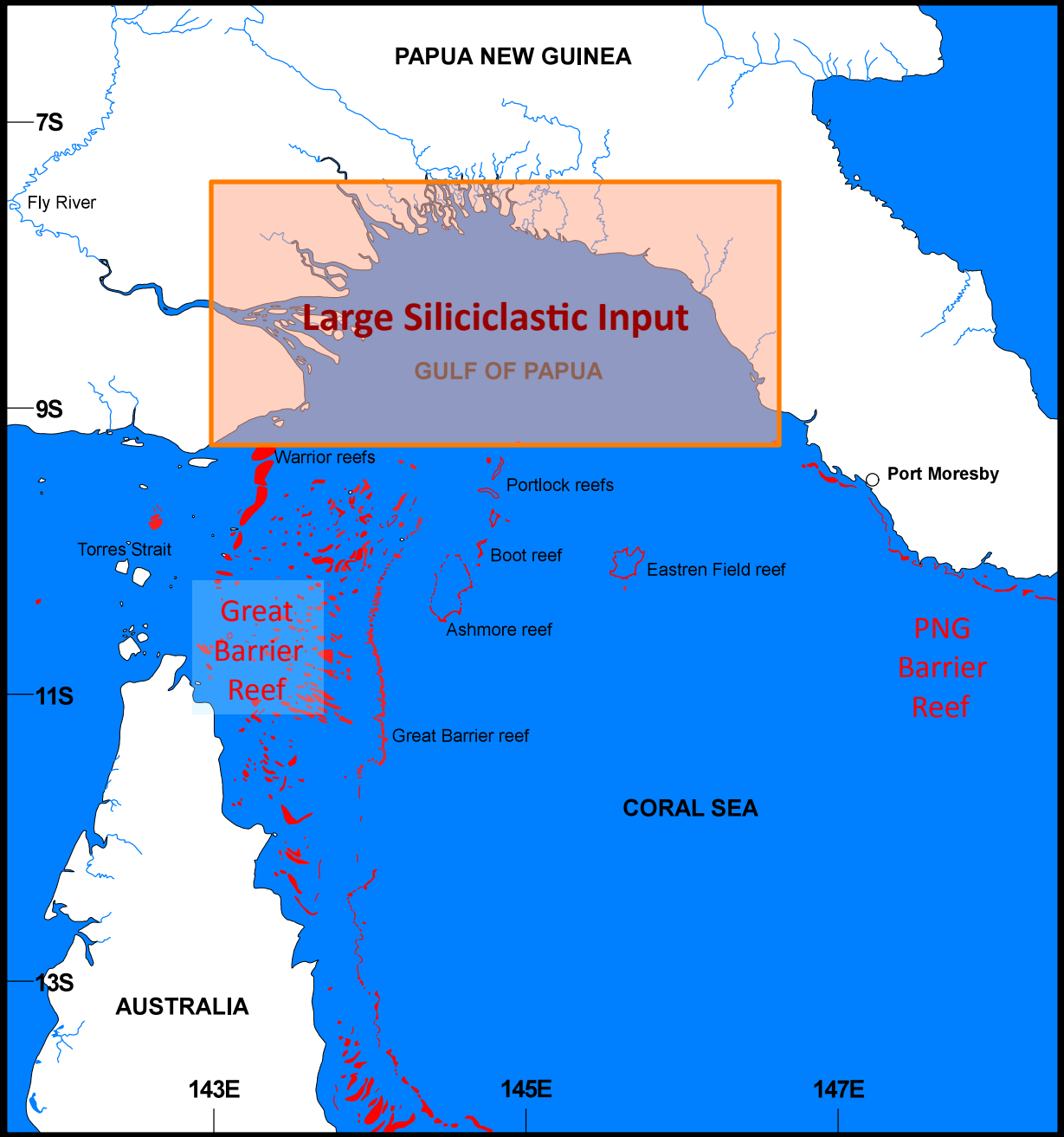
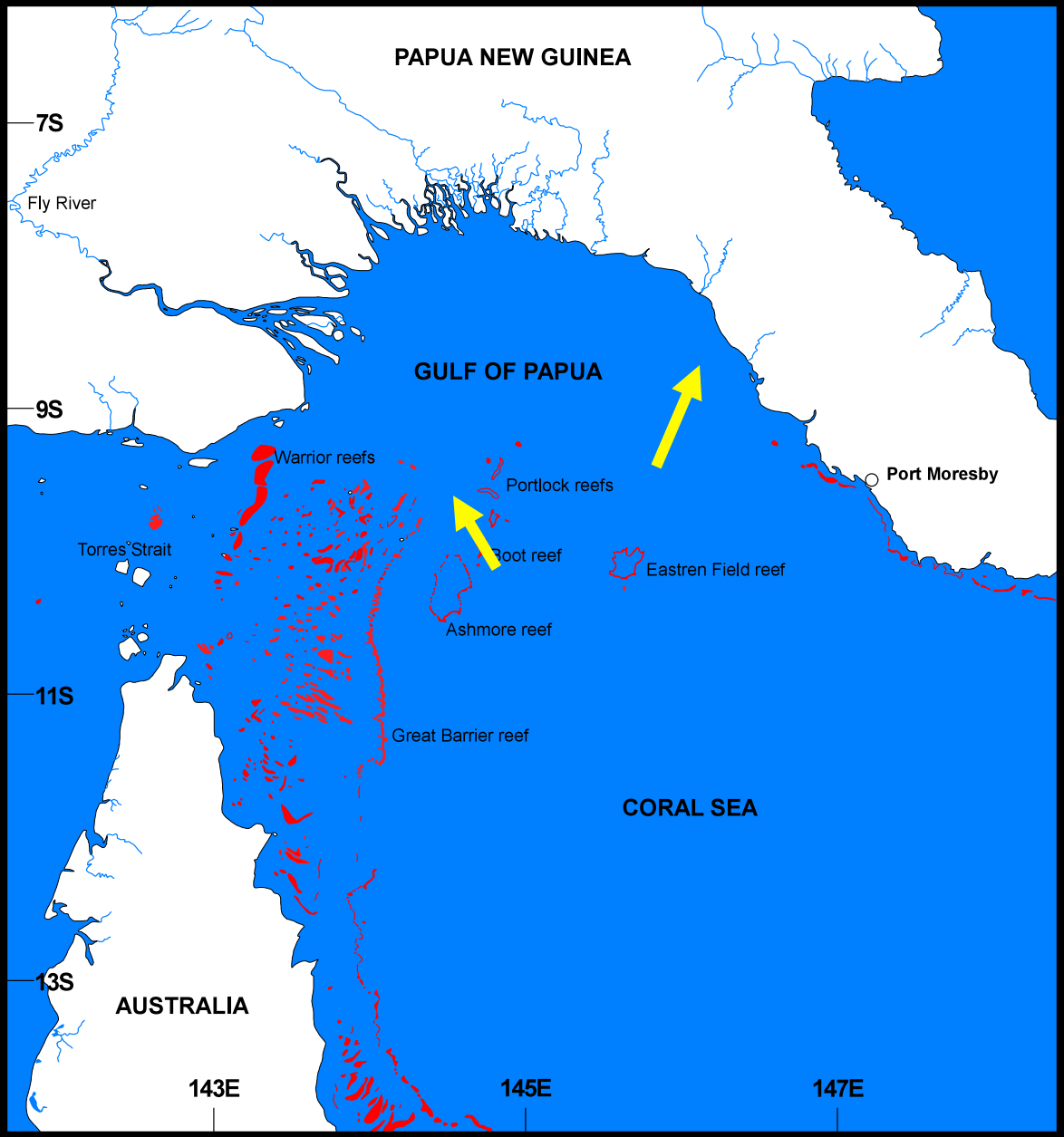
The Gulf of Papua



Sediments from the rivers =

200-300 Mt/y

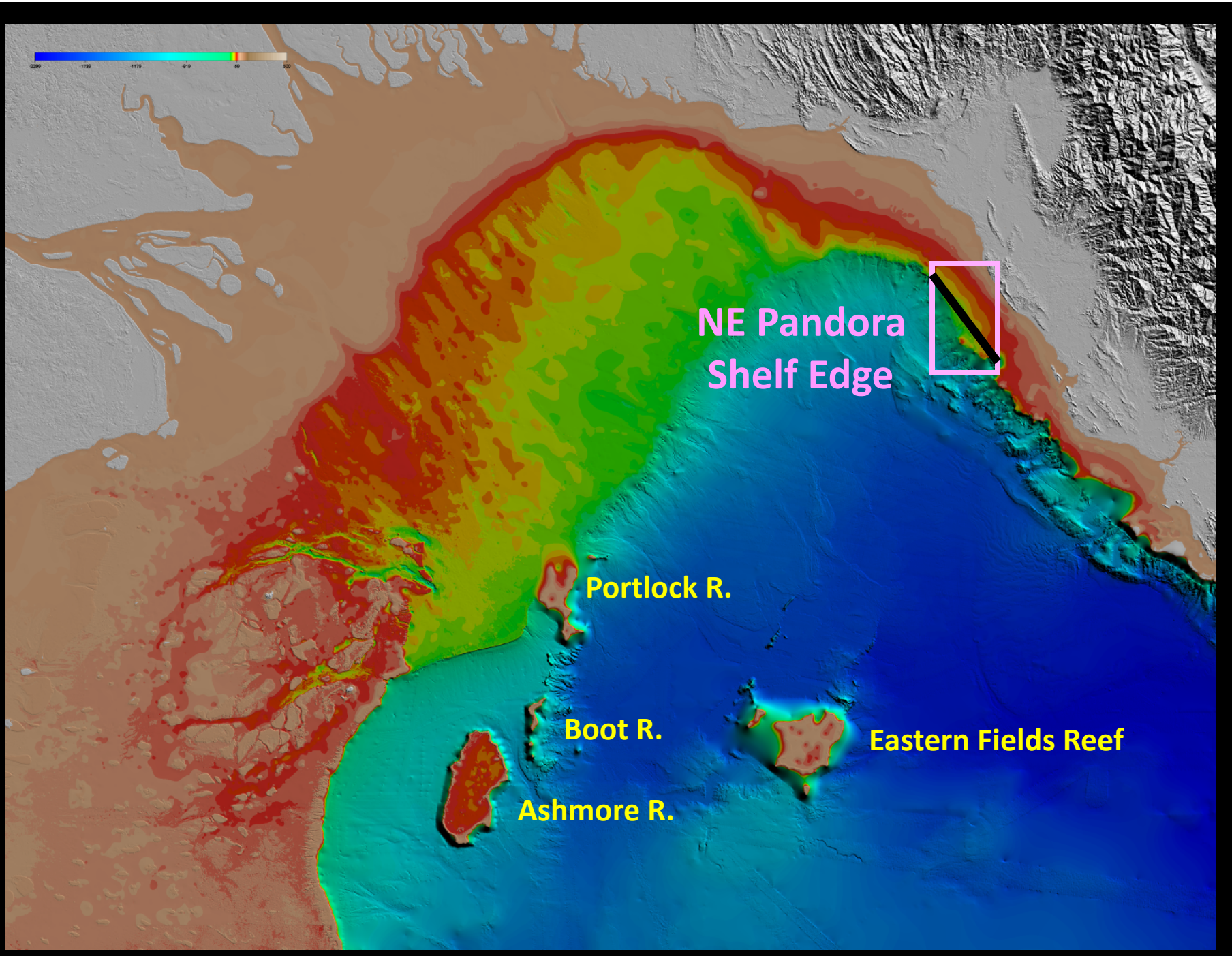
(*Harris et al.*, 1993; *Milliman*, 1995)

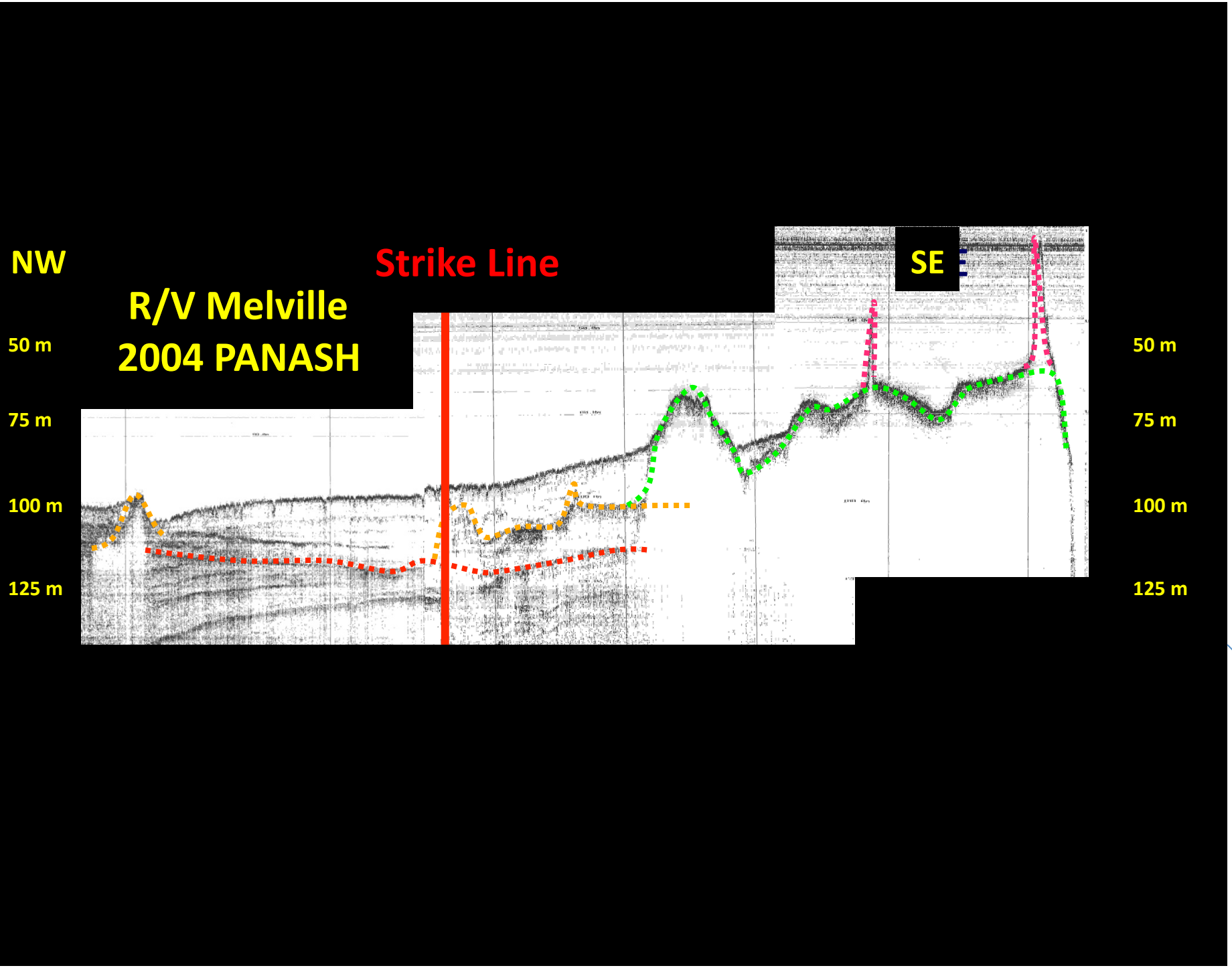


The Gulf of Papua

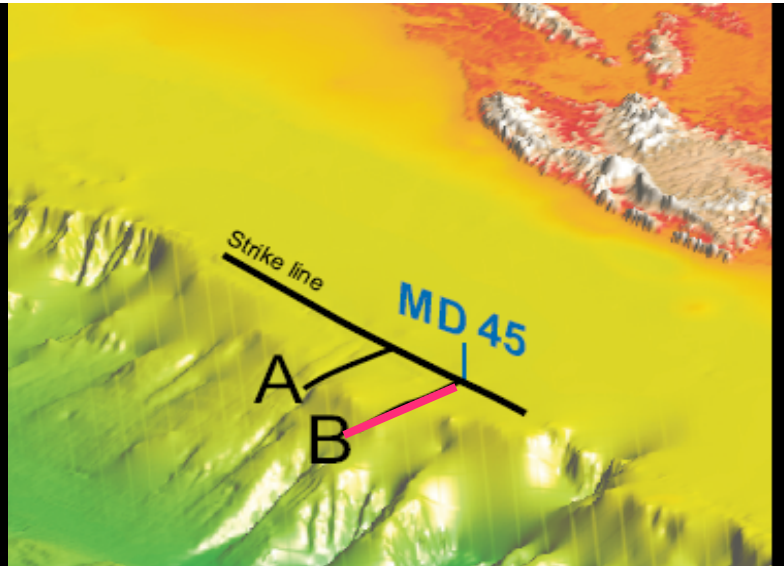
PNG BR & Geat BR

Short lived Drowned Barriers on their northern extremities


NE Pandora
Shelf Edge
Portlock R.
Boot R.
Ashmore R.
Eastern Fields Reef


NW
Strike Line
SE
R/V Melville
2004 PANASH
50 m
75 m
100 m
125 m
50 m
75 m
100 m
125 m

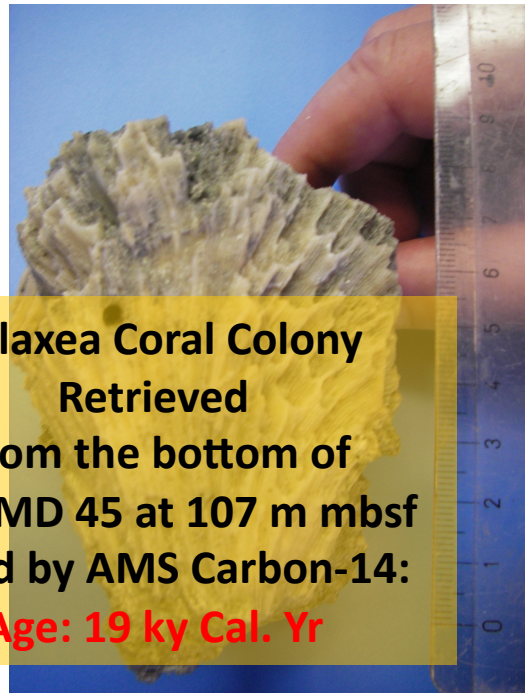
R/V Marion Dufresne
2005 PECTEN



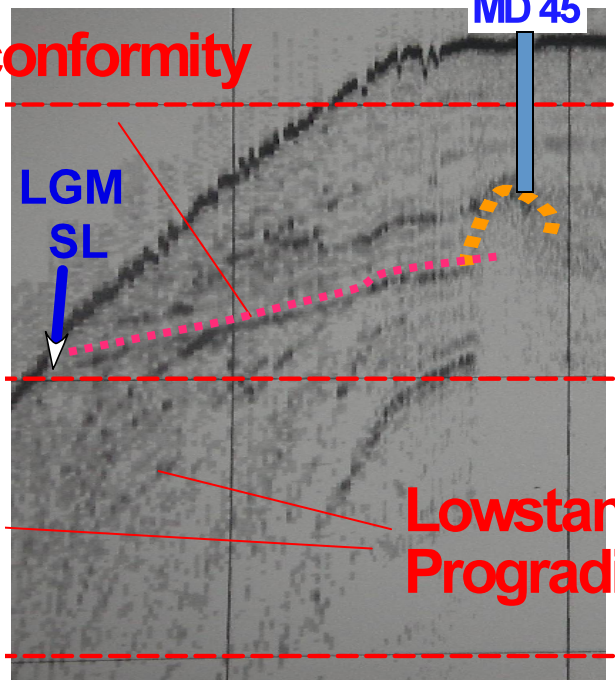
Dip Line A

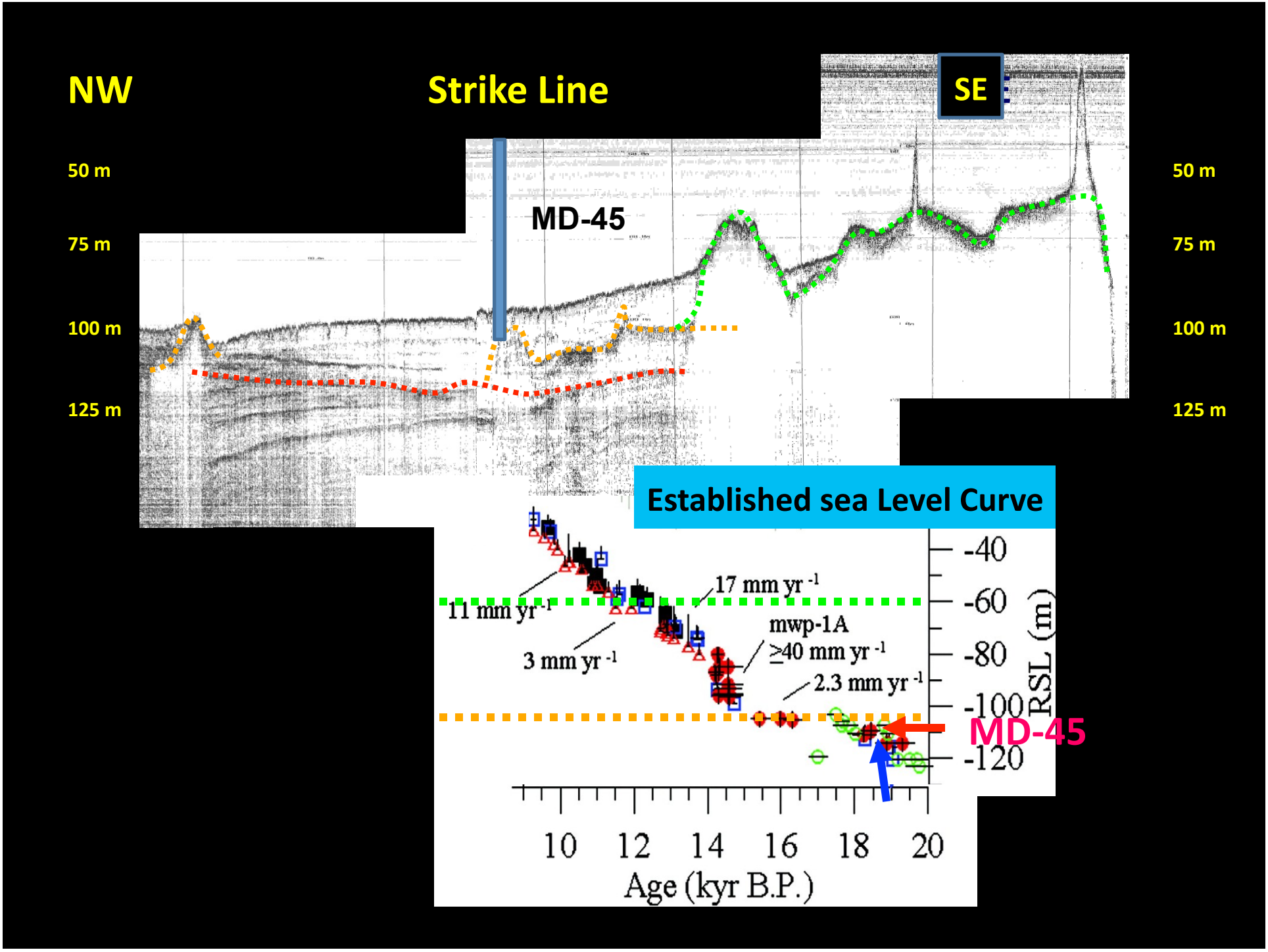
Dip Line B

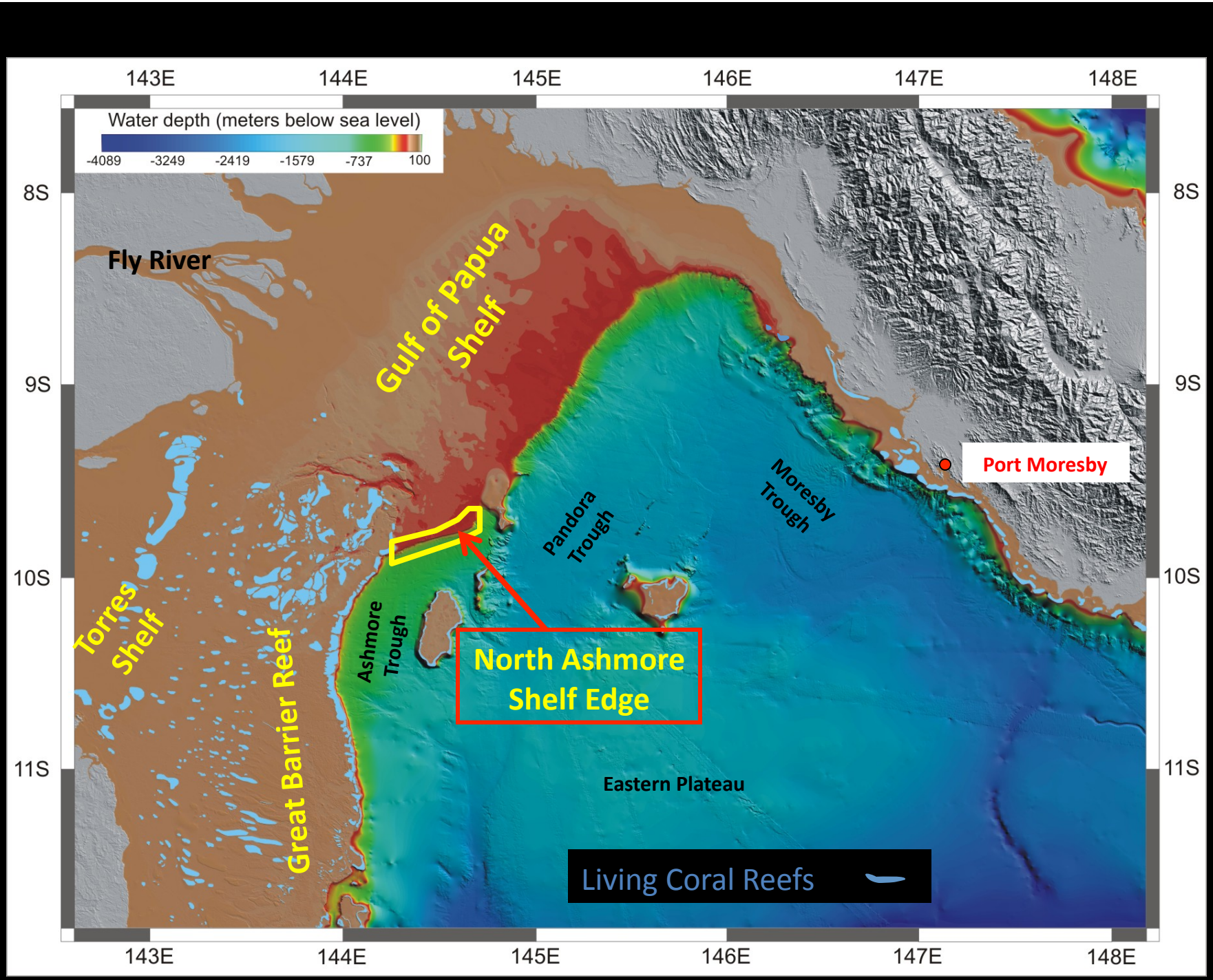
Erosional Unconformity

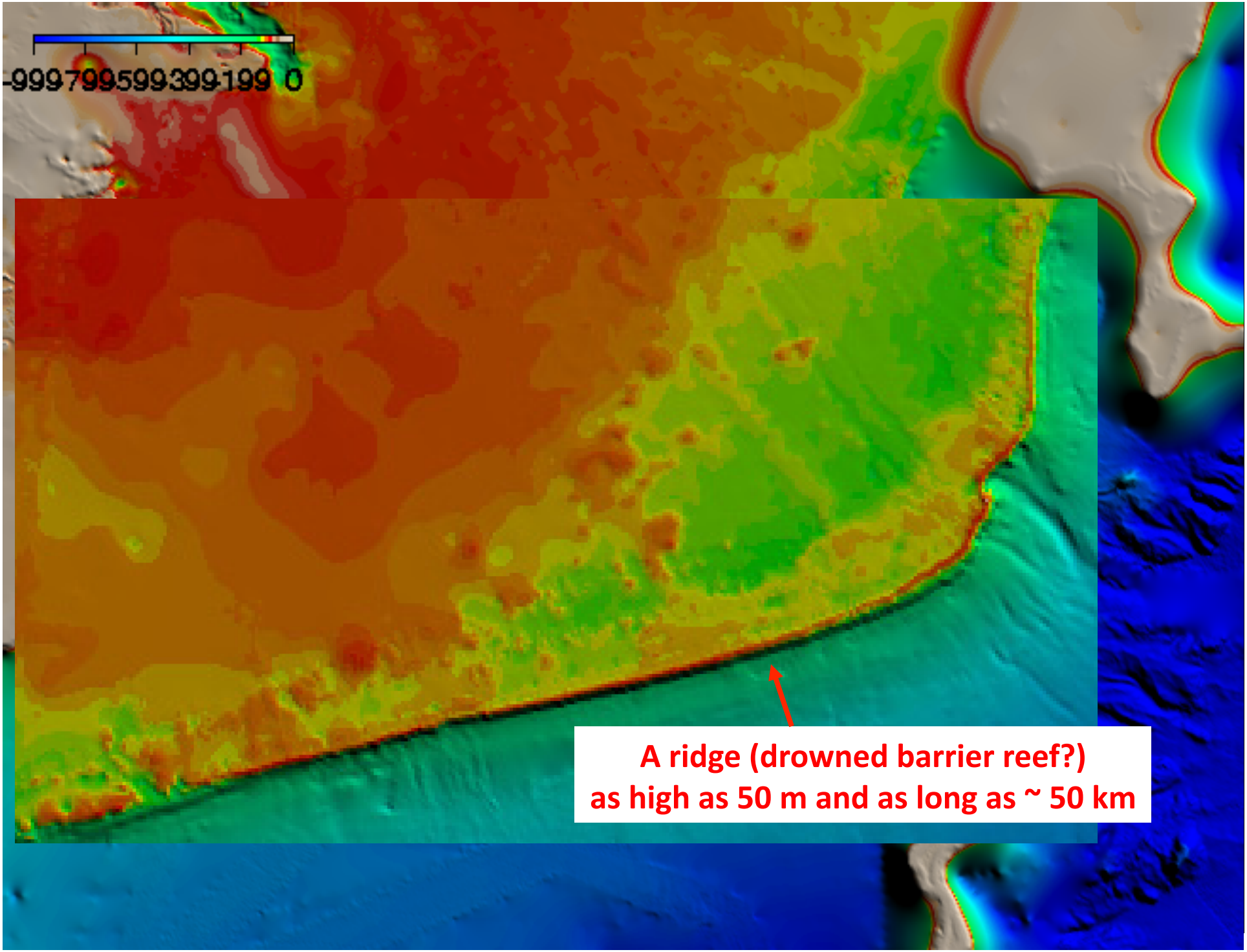


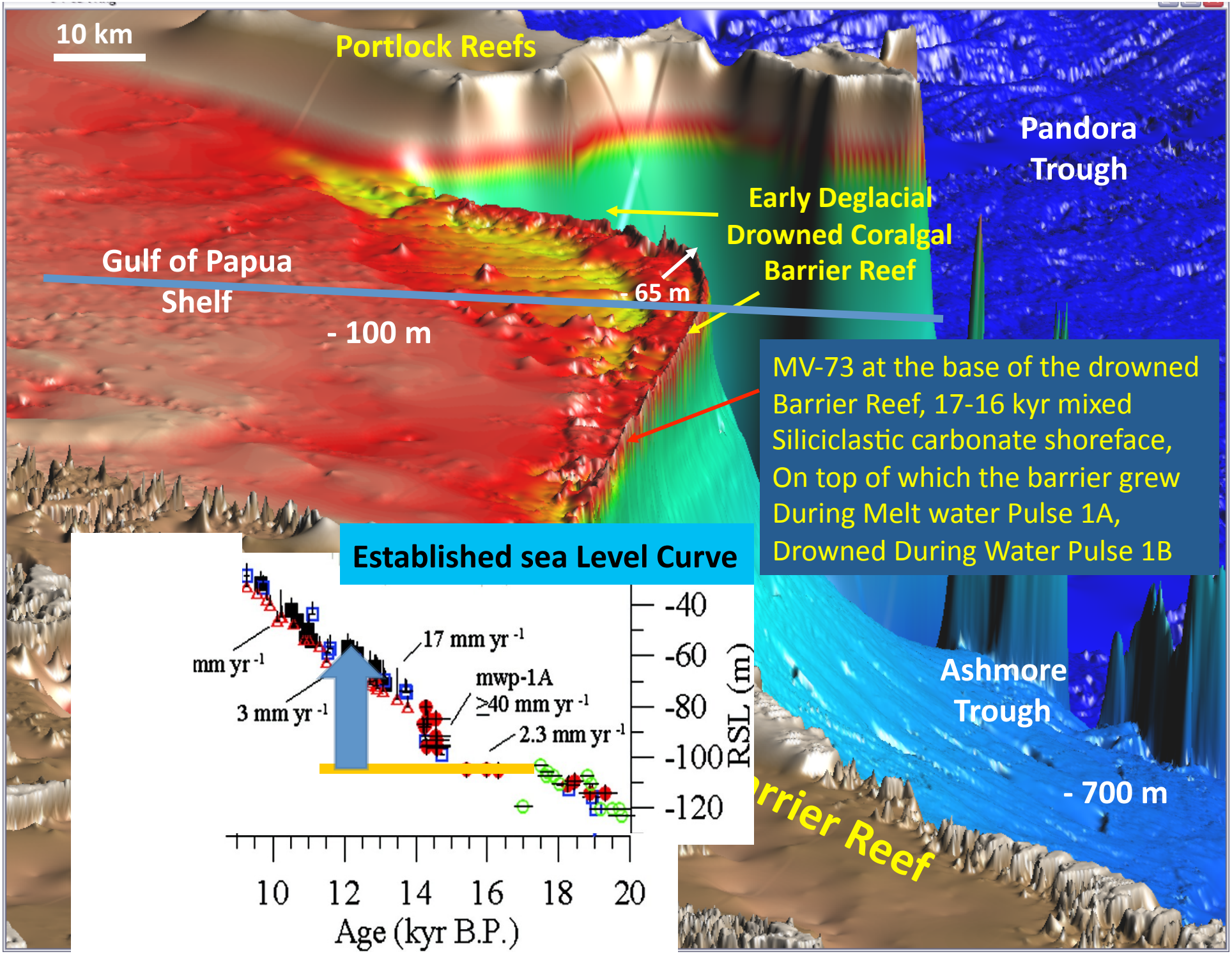
Galaxea Coral Colony
Retrieved
from the bottom of
Core MD 45 at 107 m mbsf
Dated by AMS Carbon-14:
Age: 19 ky Cal. Yr



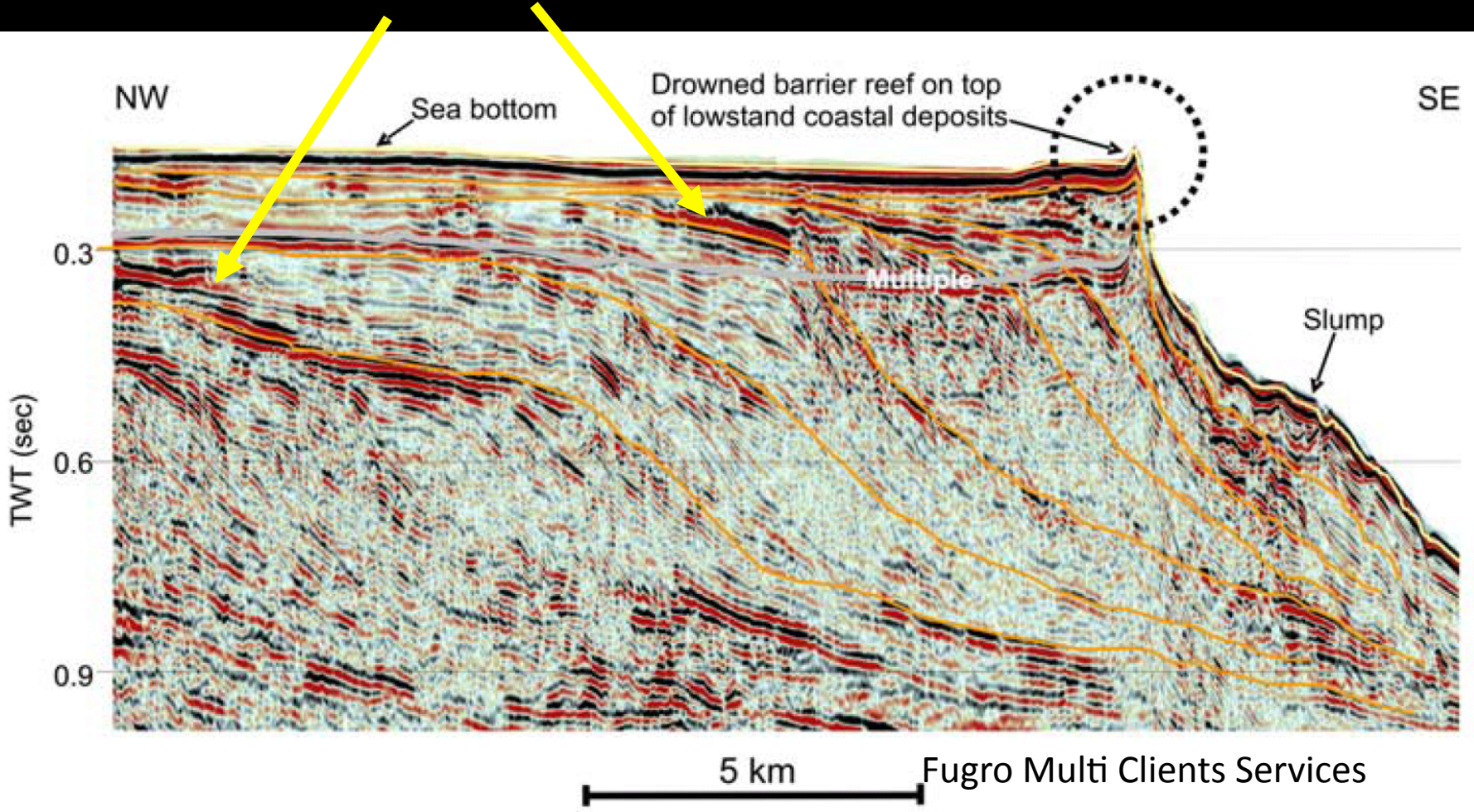

NW
Strike Line
SE
50 m
75 m
100 m
125 m
50 m
75 m
100 m
125 m
MD-45
Established sea Level Curve
11 mm yr -1
17 mm yr -1
3 mm yr -1
mwp-1A
≥40 mm yr -1
2.3 mm yr -1
-40
-60
-80
-100
-120
RSL (m)
MD-45
10
12
14
16
18
20
Age (kyr B.P.)

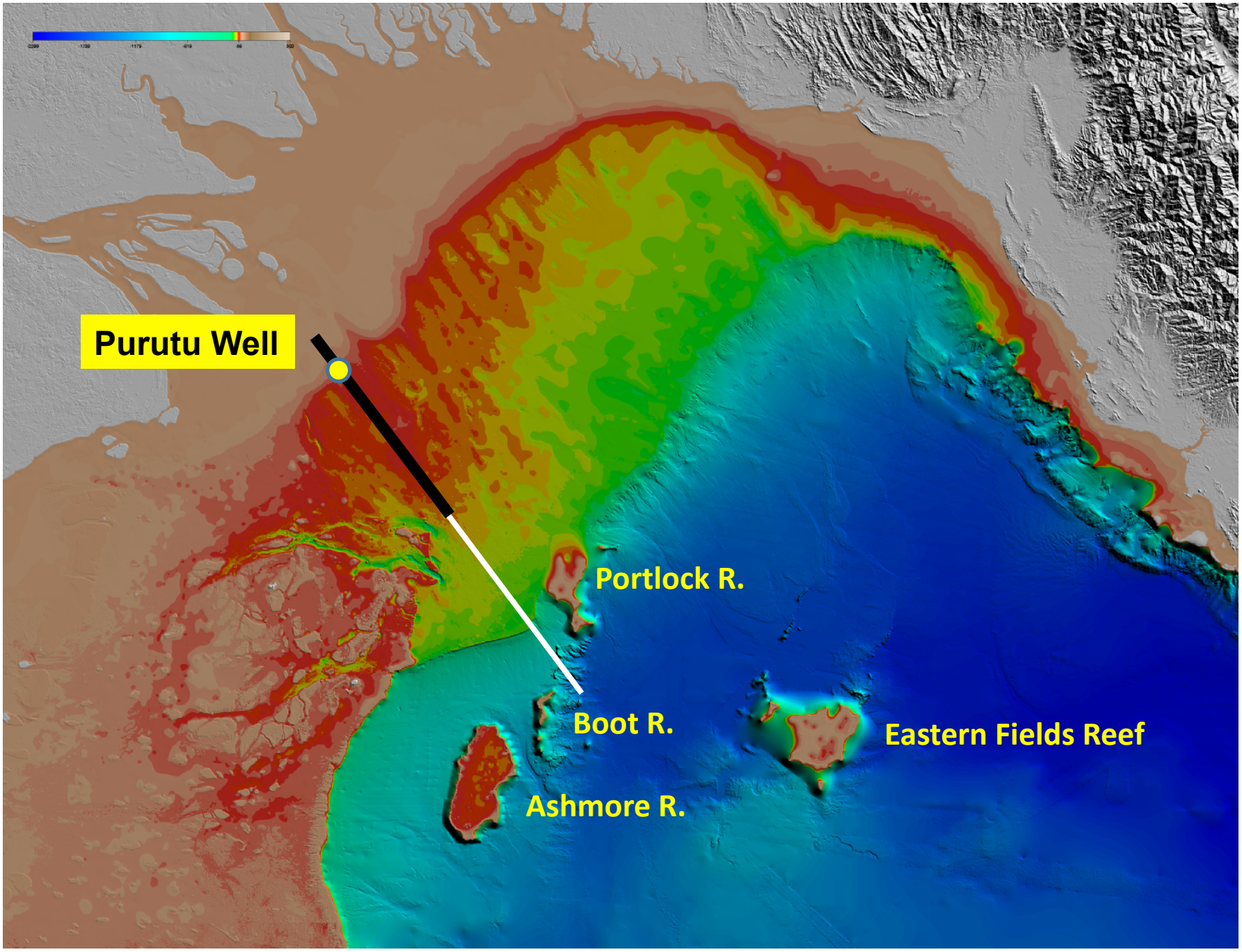

143E
144E
145E
146E
147E
148E
8S
9S
10S
11S
Water depth (meters below sea level)
-4089
-3249
-2419
-1579
-737
100
Fly River
Gulf of Papua Shelf
Port Moresby
Moresby Trough
Pandora Trough
Torres Shelf
Ashmore Trough
Great Barrier Reef
North Ashmore Shelf Edge
Eastern Plateau
Living Coral Reefs

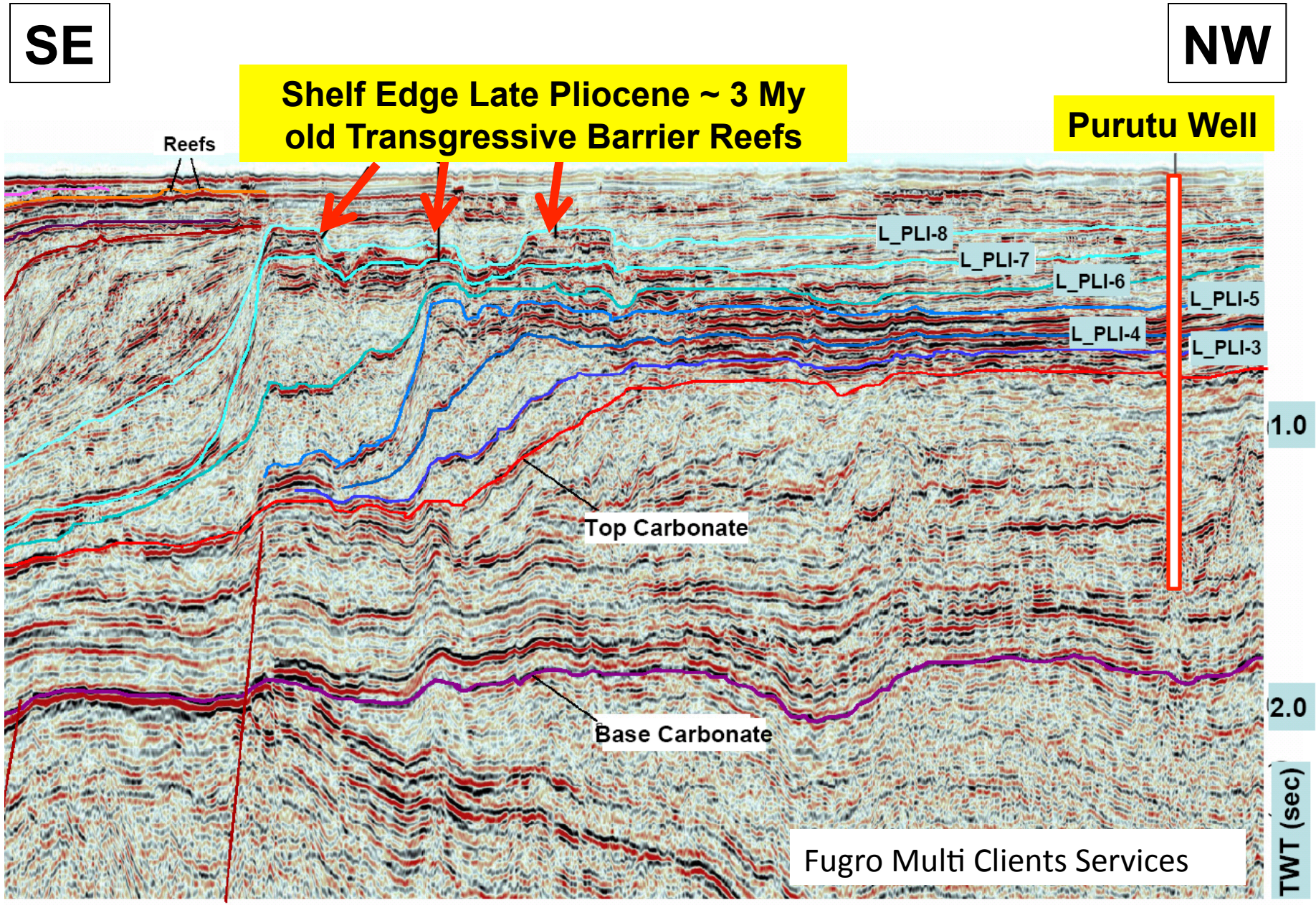

-9997995993991990
A ridge (drowned barrier reef?)
as high as 50 m and as long as ~ 50 km


10 km
Portlock Reefs
Pandora Trough
Early Deglacial Drowned Coralgal Barrier Reef
Gulf of Papua Shelf
- 65 m
- 100 m
MV-73 at the base of the drowned Barrier Reef, 17-16 kyr mixed Siliciclastic carbonate shoreface, On top of which the barrier grew During Melt water Pulse 1A, Drowned During Water Pulse 1B
Established sea Level Curve
mm yr -1
17 mm yr -1
mwp-1A
≥40 mm yr -1
3 mm yr -1
2.3 mm yr -1
-40
-60
-80
-100
-120
RSL (m)
10
12
14
16
18
20
Age (kyr B.P.)
Ashmore Trough
- 700 m
rrier Reef

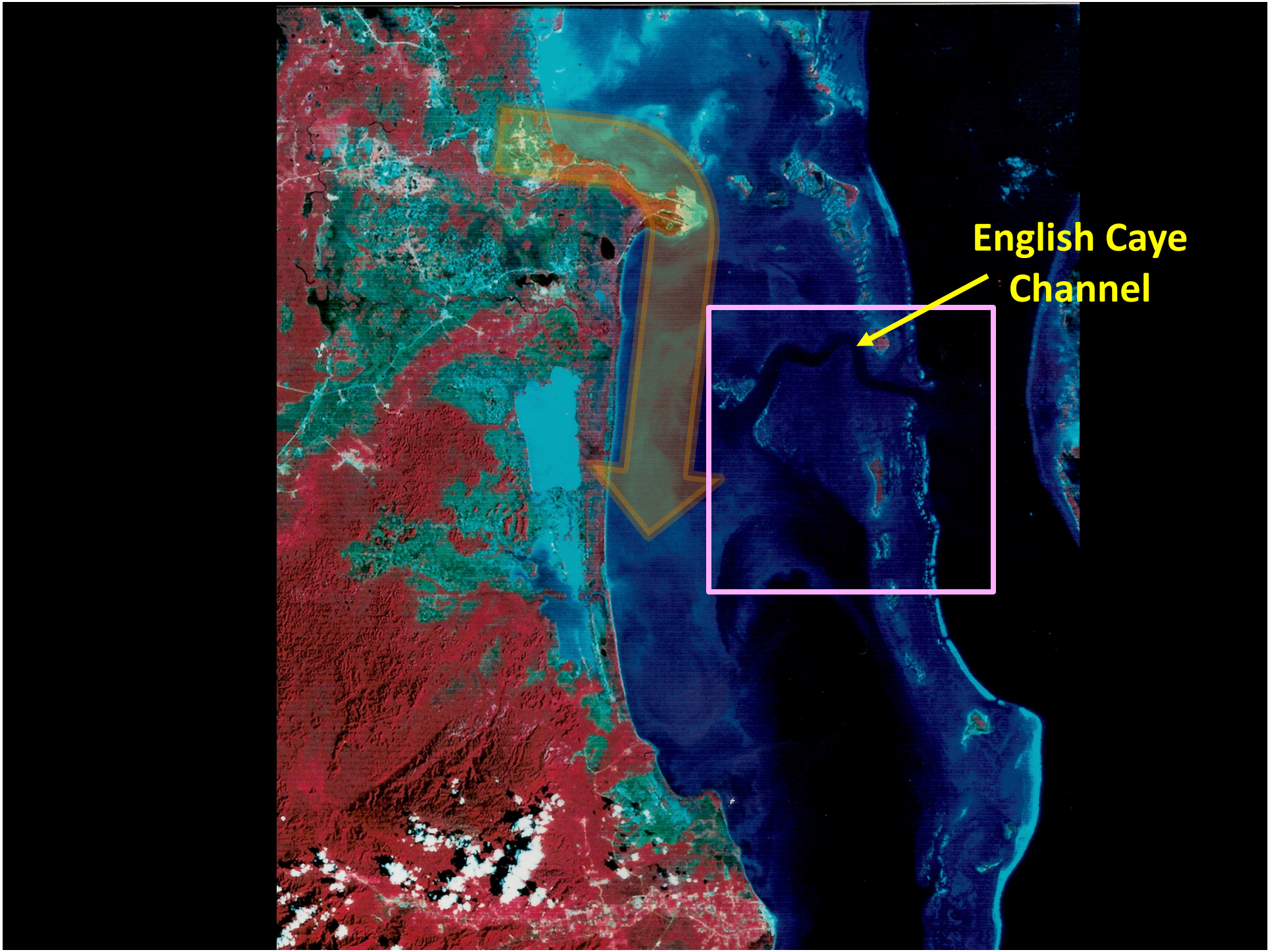
Buried Earlier Transgressive Barrier Reefs

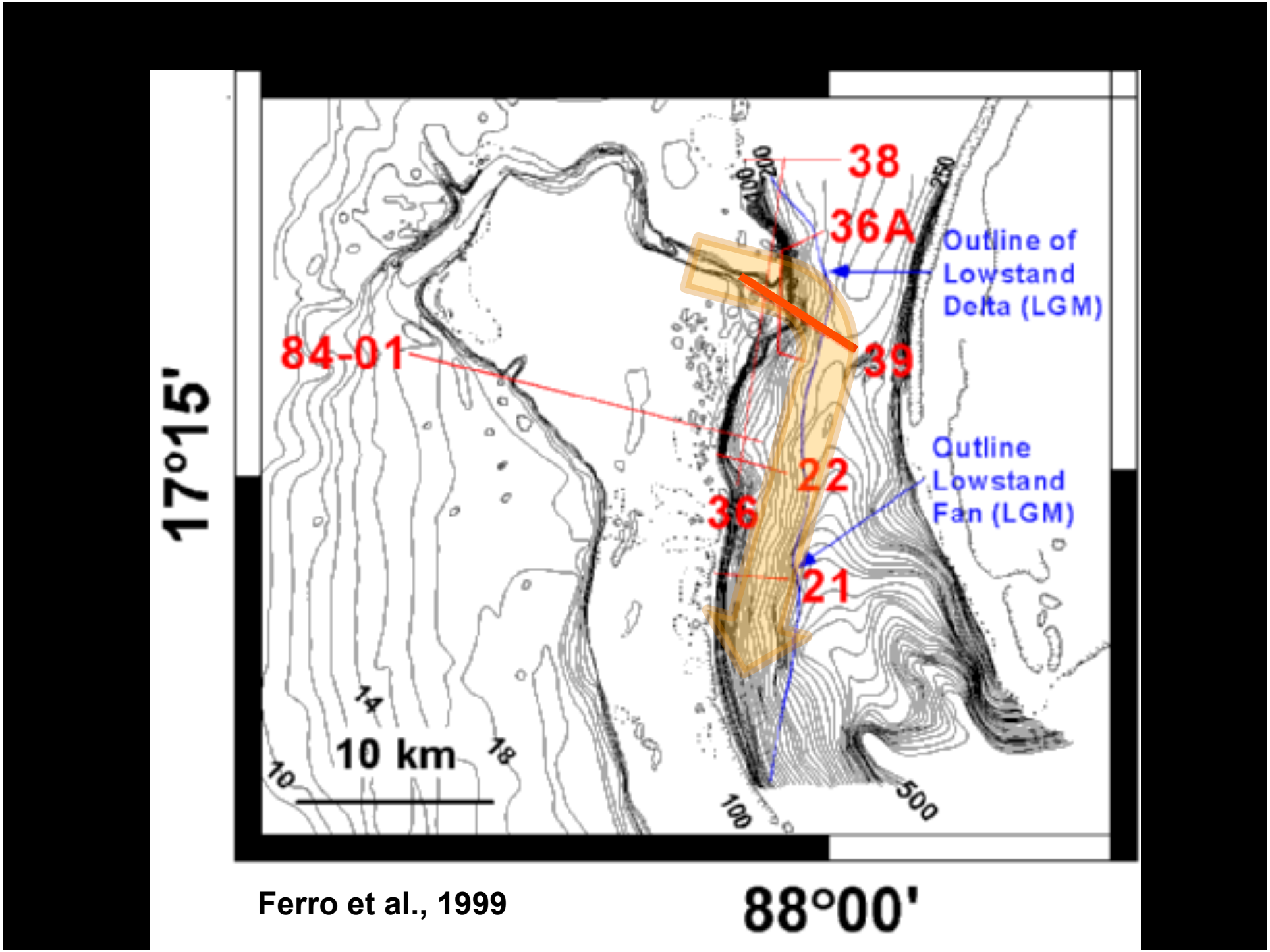



Purutu Well
Portlock R.
Boot R.
Eastern Fields Reef
Ashmore R.

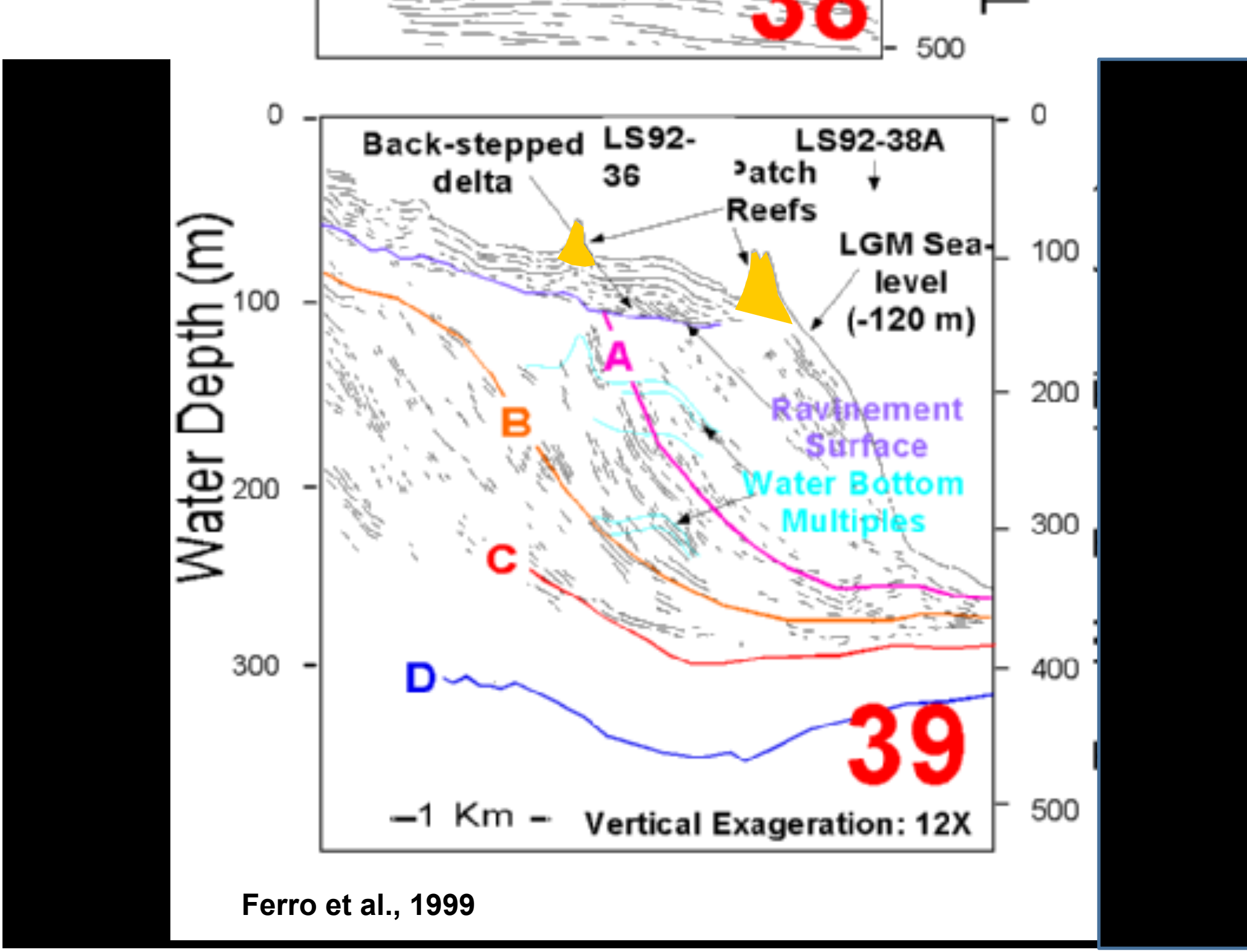


Tcherepanov et al., 2009

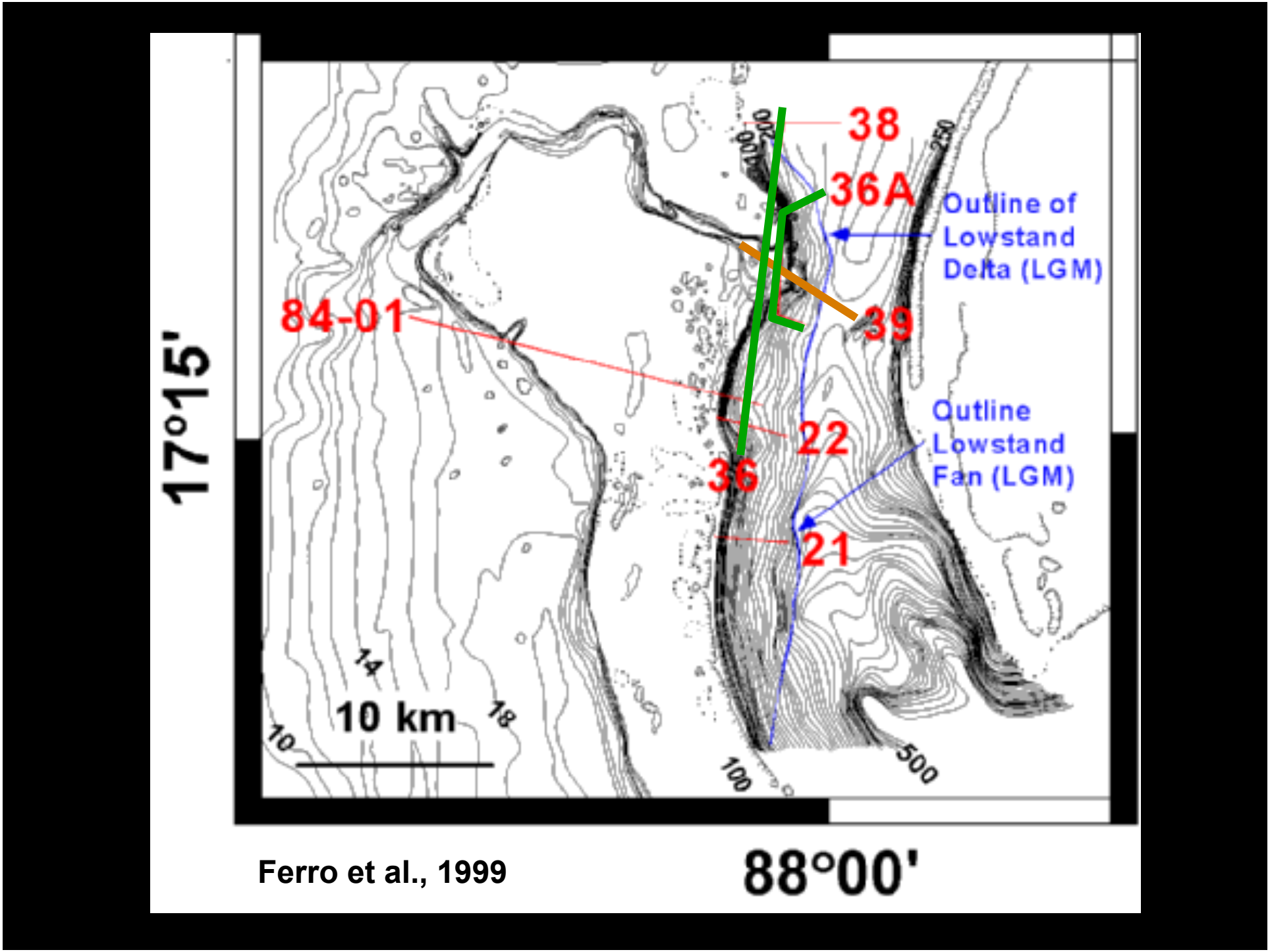

English Caye
Channel



Ferro et al., 1999



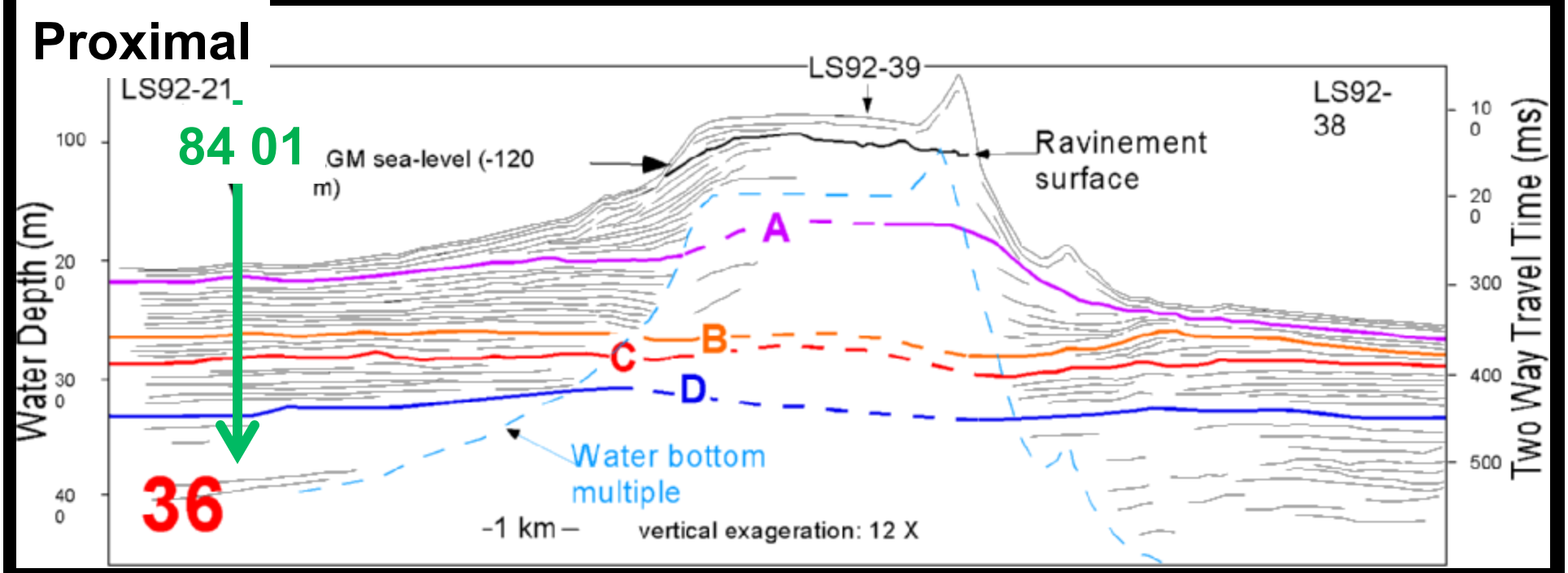
Ferro et al., 1999



Ferro et al., 1999

Strike Lines

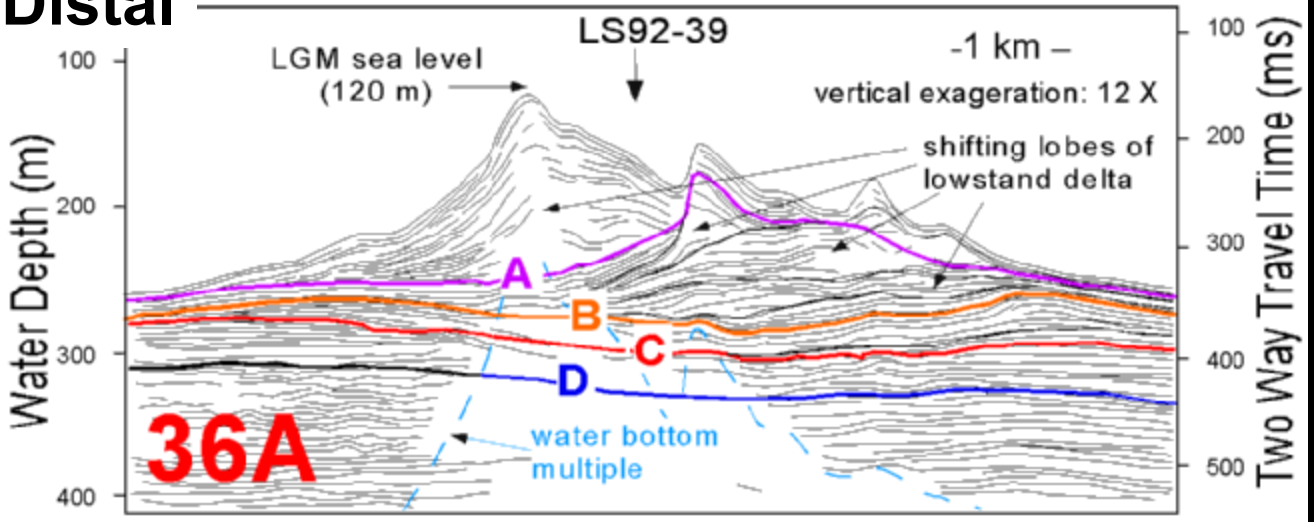
Proximal



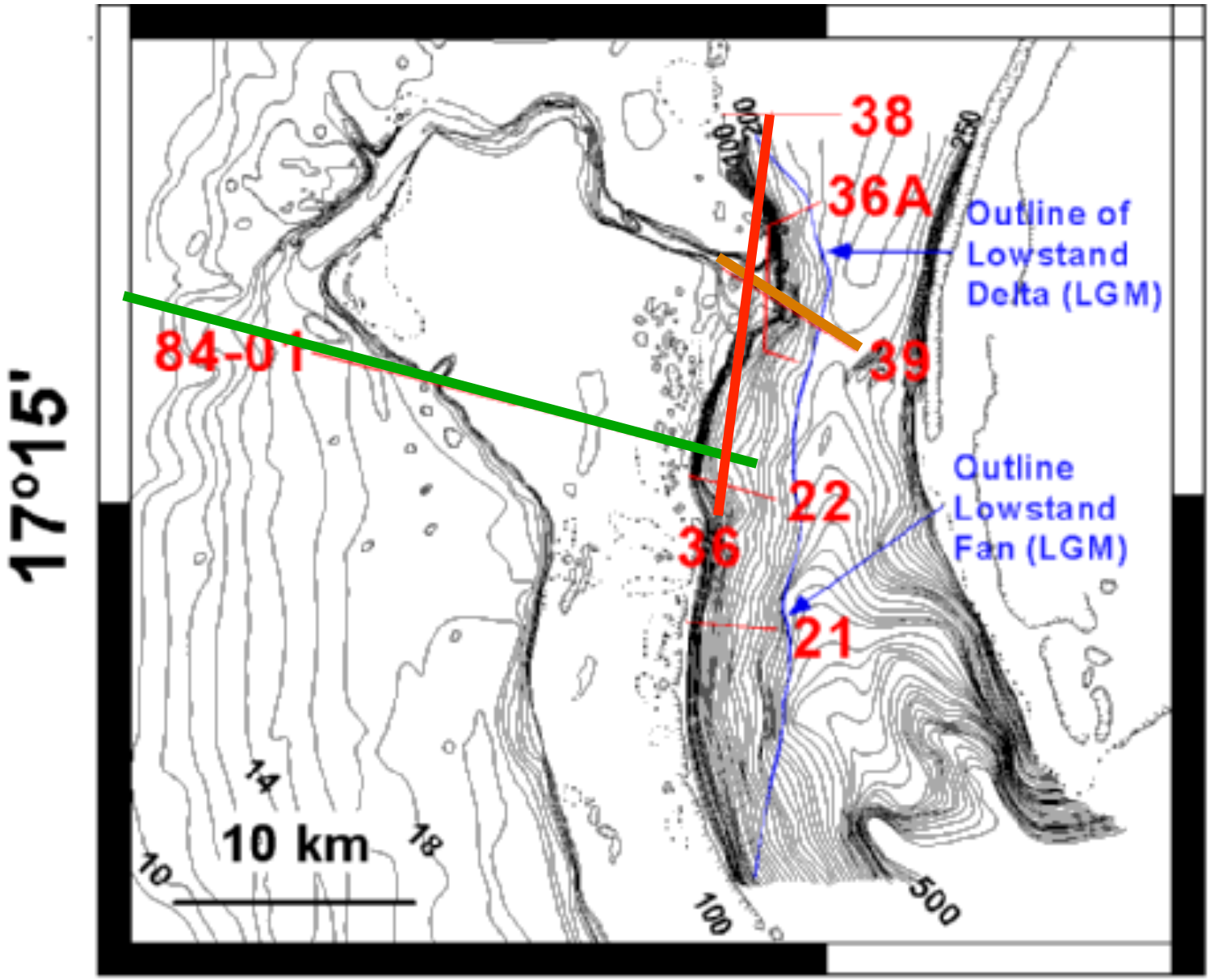
South

North

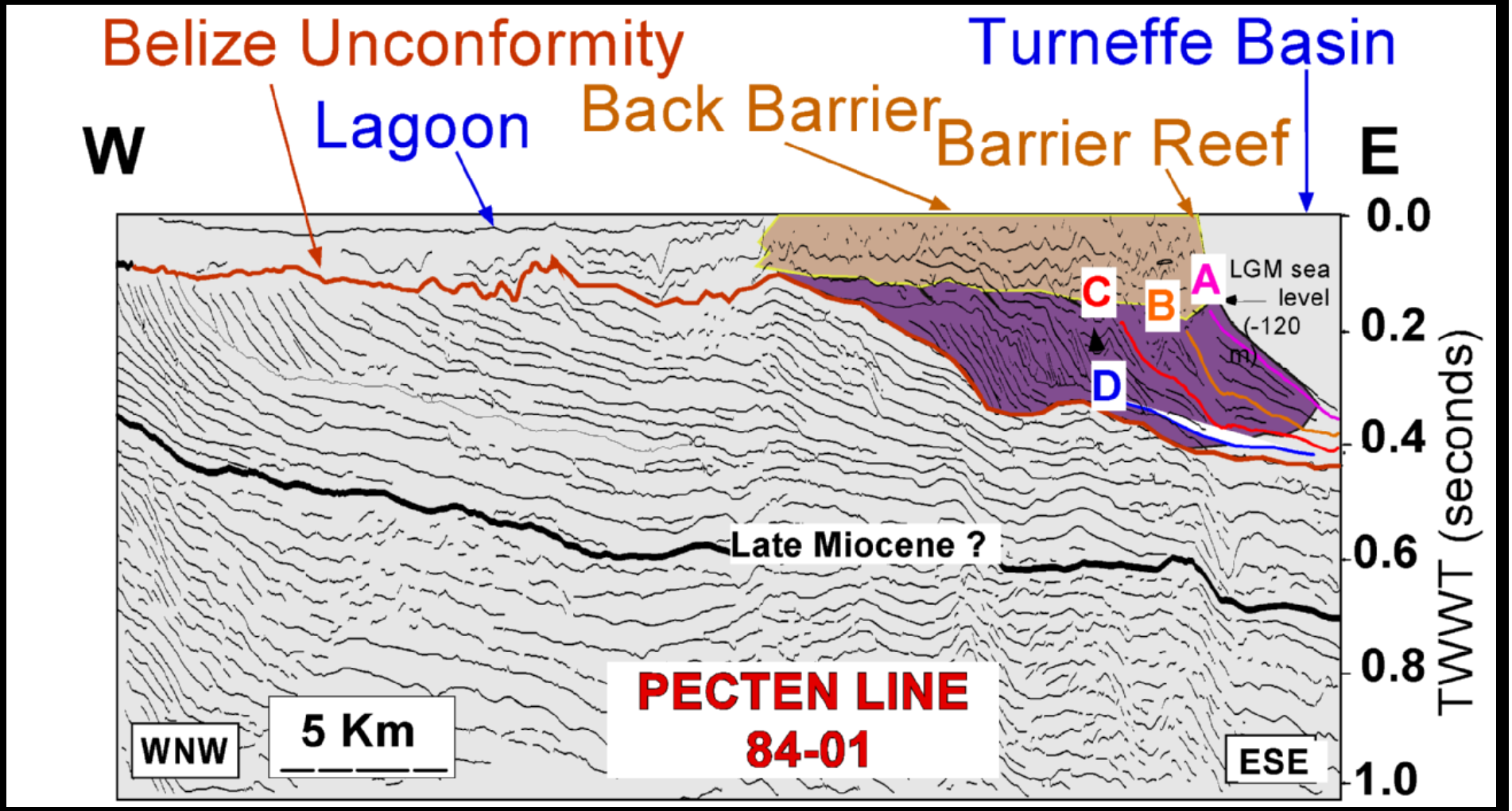
Distal



Ferro et al., 1999

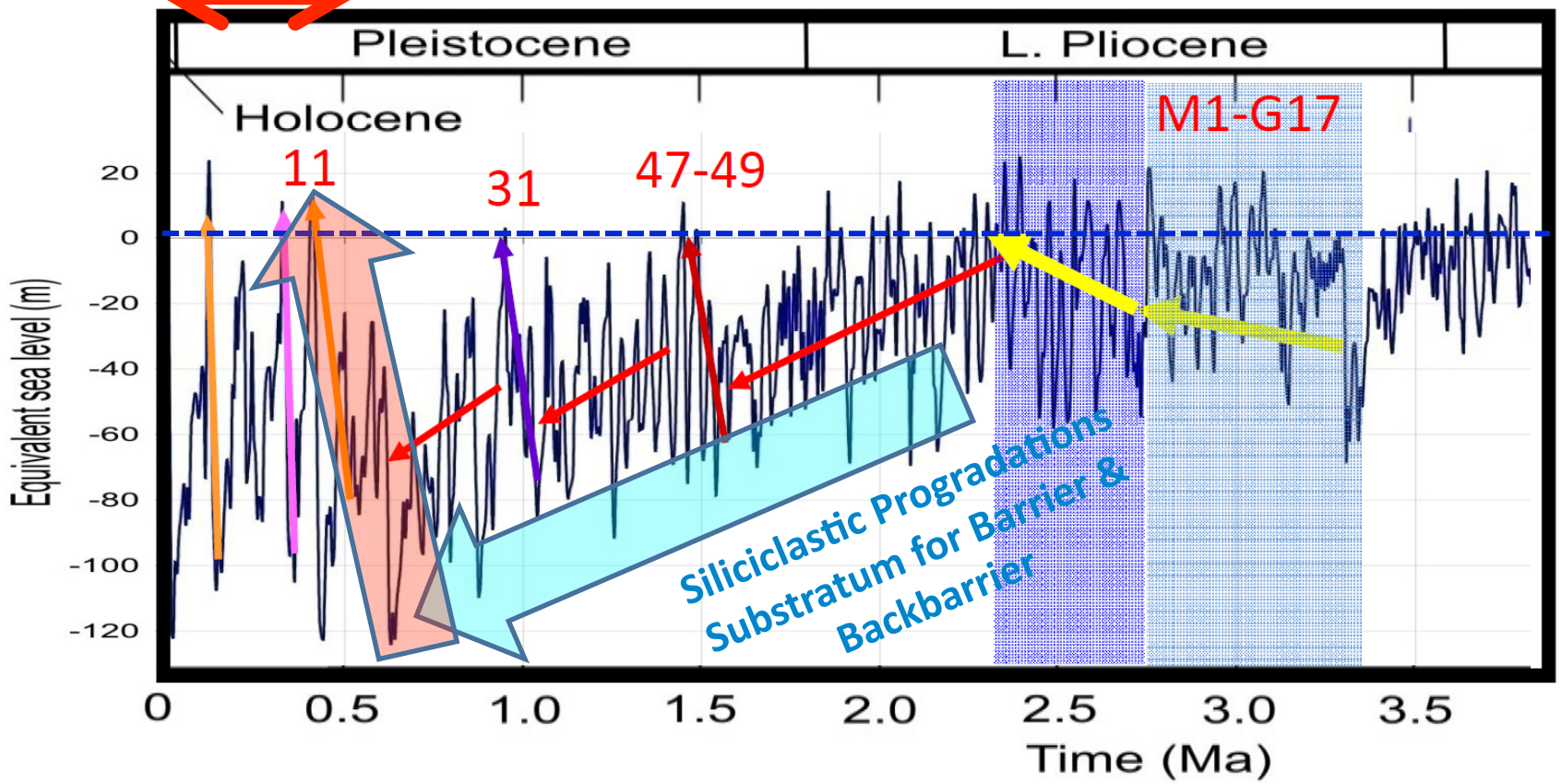


Ferro et al., 1999



Ferro et al., 1999

Last ~ 0.5 My Barrier & Backbarrier Reefs



Mixed Systems along Low Latitude Continental Margins

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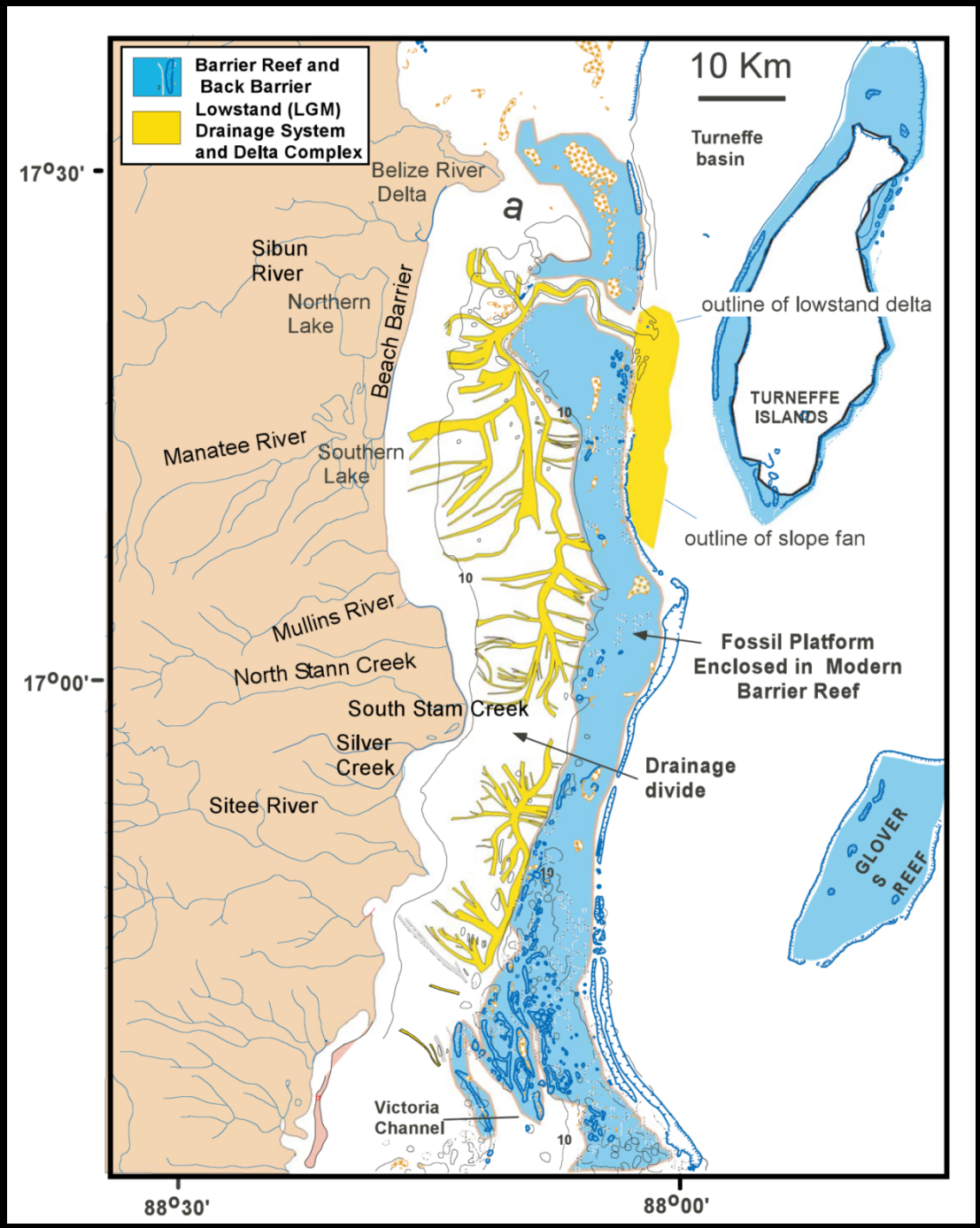
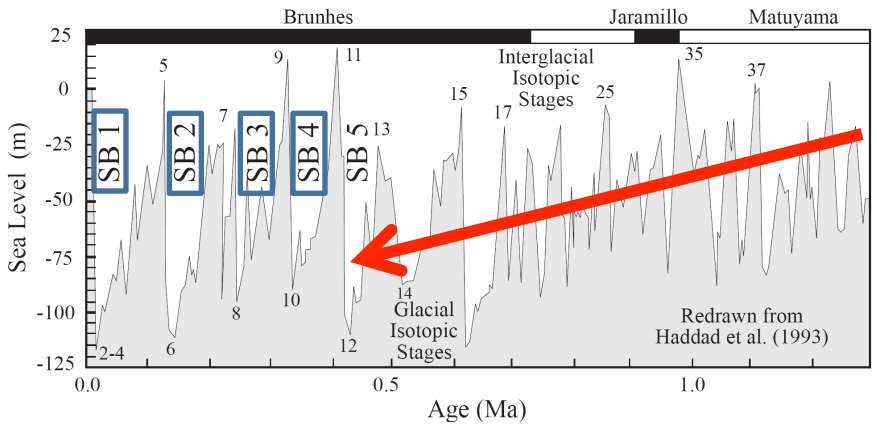


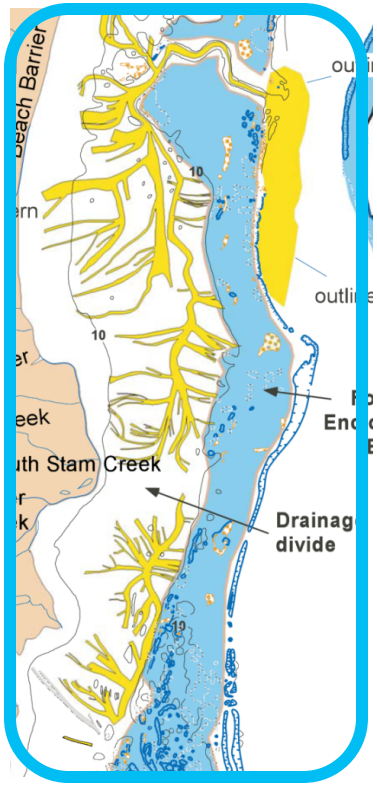
Ferro et al., 1999

The Structural and Sedimentological Controls on th Reoccupation of Quaternary Incised Valleys, Belize Southern Lagoon[1]

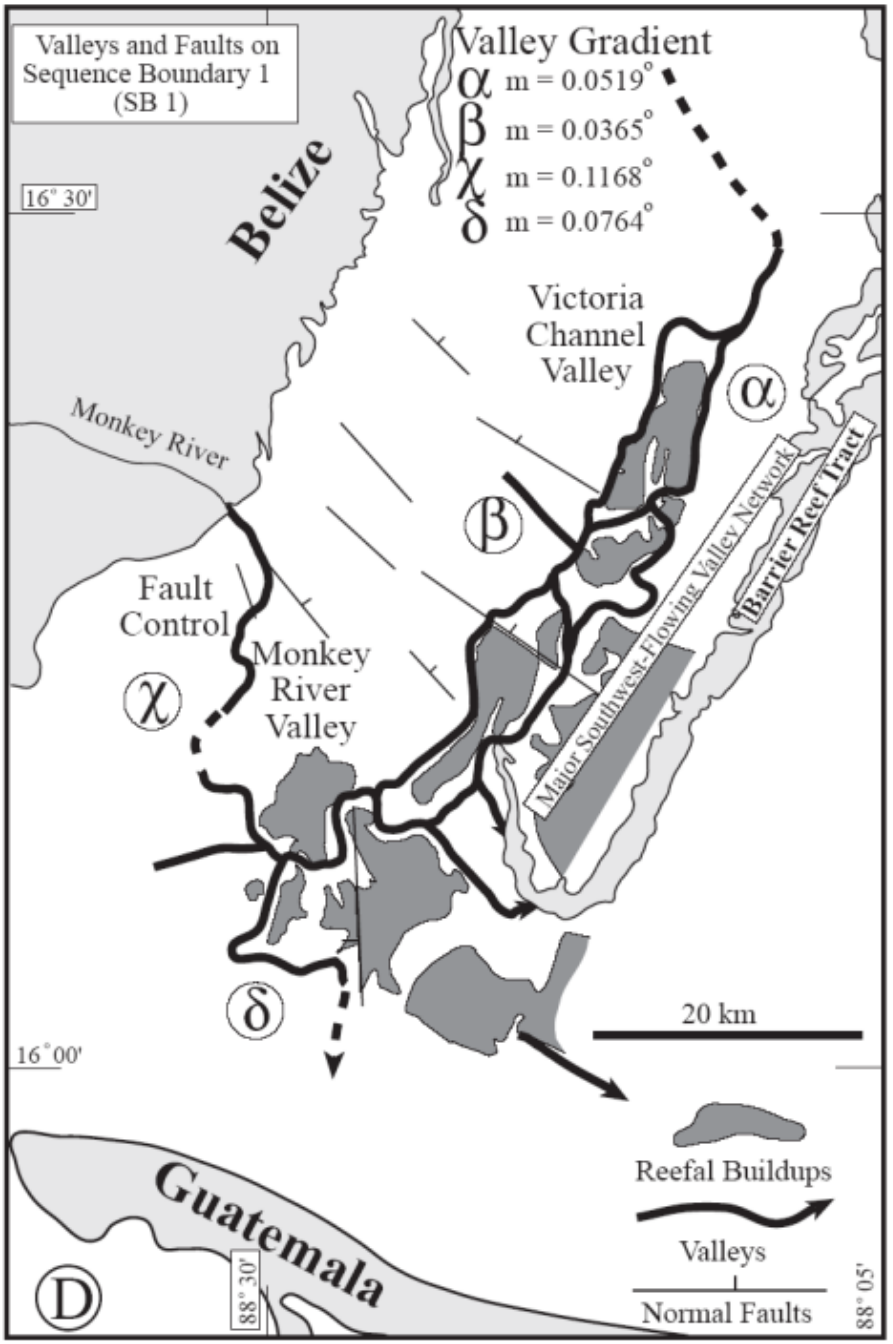
AAPG Bulletin, V. 82, No. 11 (November 1998), P. 2075–2109.

Dominic Esker, Gregor P. Eberli, and Donald F. McNeill[2]





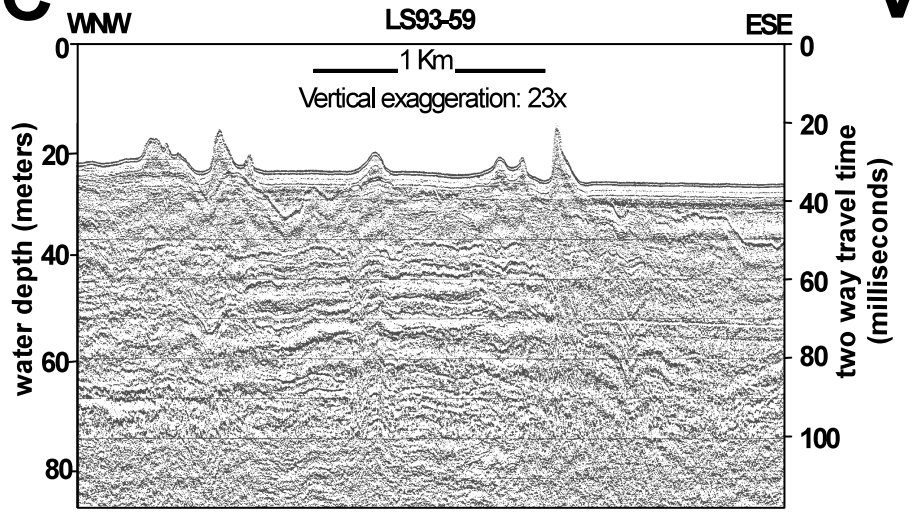
from seismic data and structural contour maps of sequence boundaries 4, 3, 2, and 1 (A–D, respectively). Note



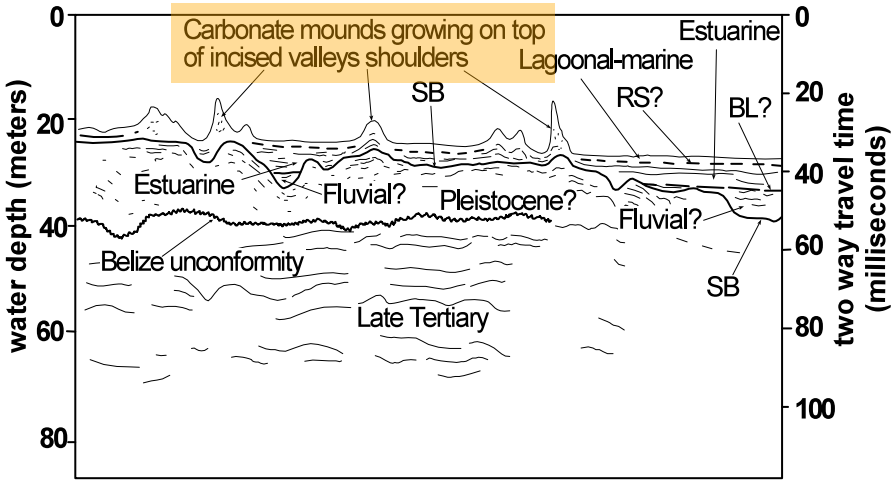

water
60
two
80

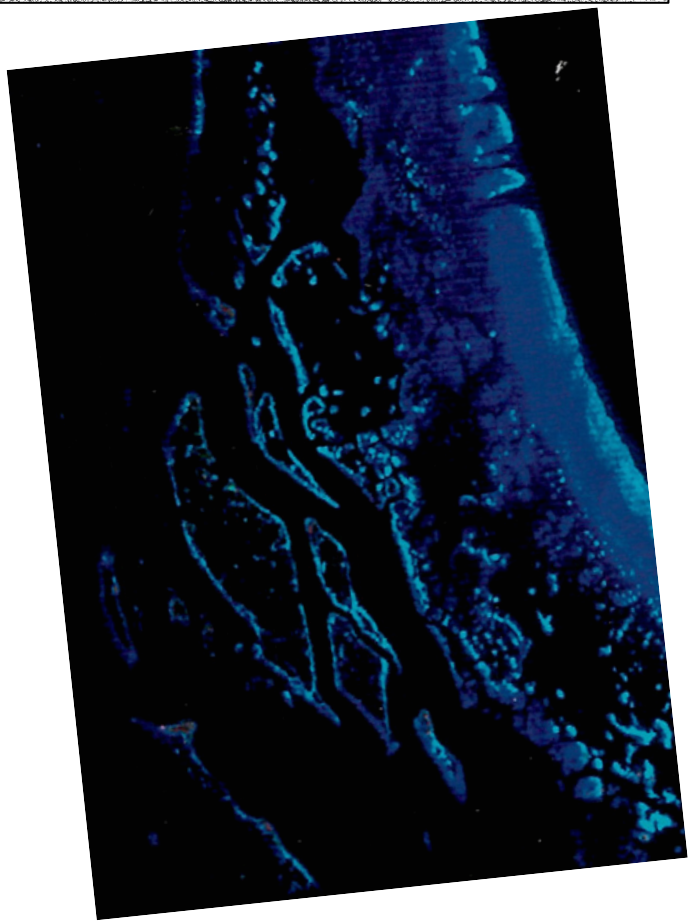

Late Tertiary
60
80

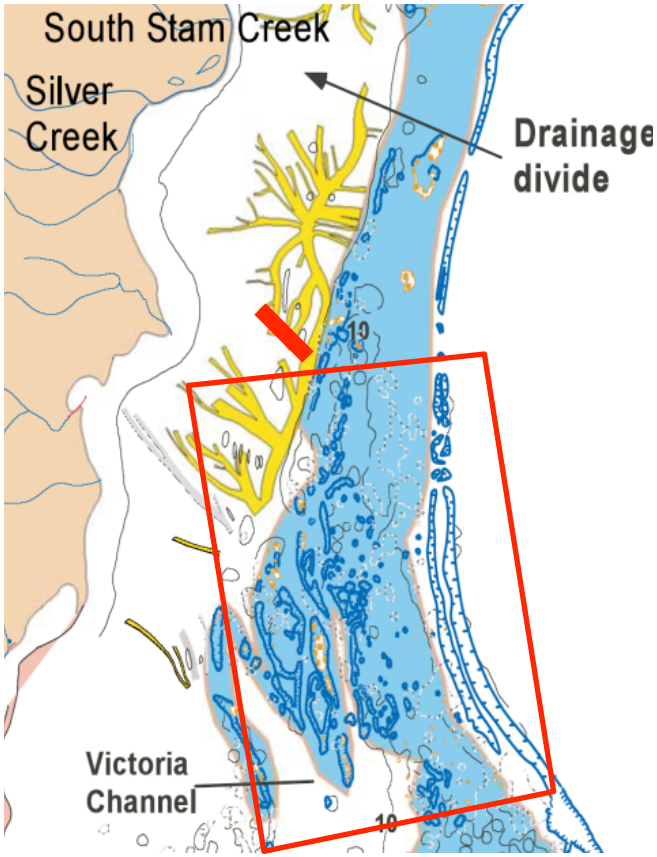
C


WNW
LS93-59
ESE
1 Km
Vertical exaggeration: 23x
water depth (meters)
two way travel time (milliseconds)
0
20
40
60
80
100

V

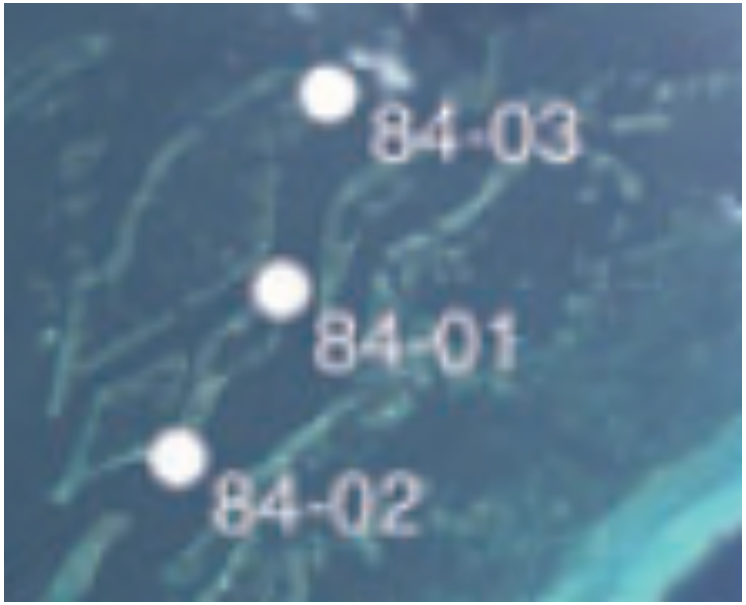

Carbonate mounds growing on top of incised valleys shoulders
Estuarine
Lagoonal-marine
SB
RS?
BL?
Estuarine
Fluvial?
Pleistocene?
Fluvial?
Belize unconformity
SB
Late Tertiary
water depth (meters)
two way travel time (milliseconds)
0
20
40
60
80
100




South Stam Creek
Silver Creek
Drainage divide
Victoria Channel
10
10

Gischler et al., 2010 Sedimentology

Mixed Carbonates and Siliciclastics in the Quaternary of Southern Belize: Pleistocene Turning Points in Reef Development Controlled by sea-level Change



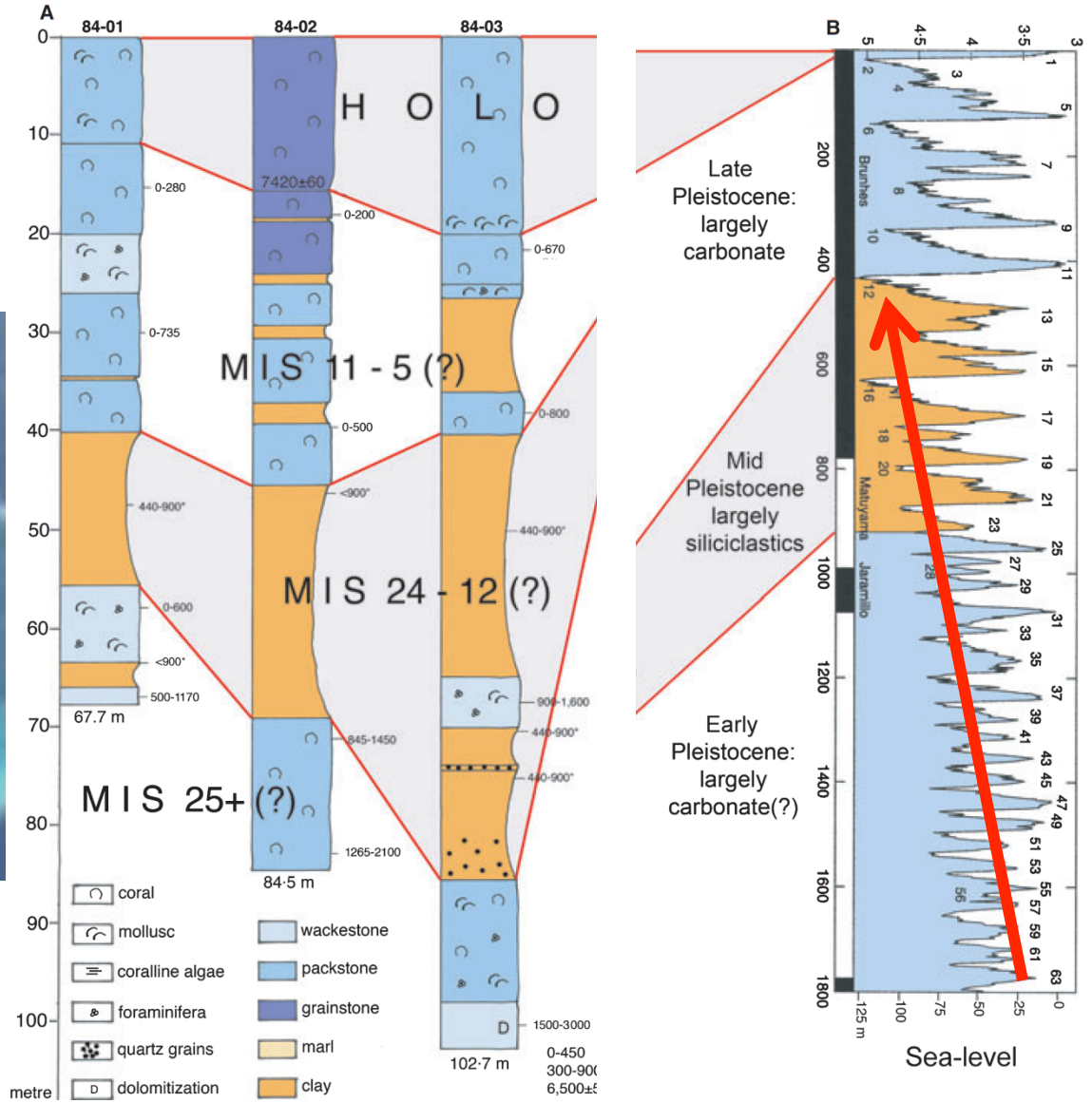


Fig. 7. (A) Stratigraphic model including (B) Pleistocene s

Take Home Message:
Mixed Systems along Low Latitude Continental Margins

Short-Lived Carbonate Systems Along Siliciclastic Continental Margin Shelf Edges; their Morphologies Mimick the Underlying Lowstand Siliciclastic Coastal Deposits, Used as Substratum

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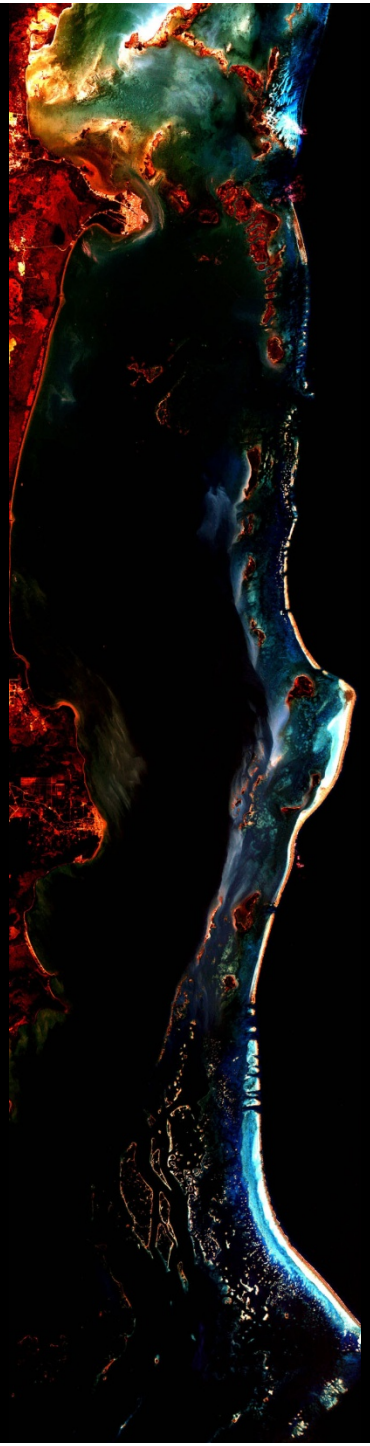
Once established during transgression and highstand, exposed shallow carbonate barriers, during intervals of sea level fall and lowstand influenced the geometry of the siliciclastic drainage system.



Thank You!