An overview of the scientific exploration of the Demerara plateau

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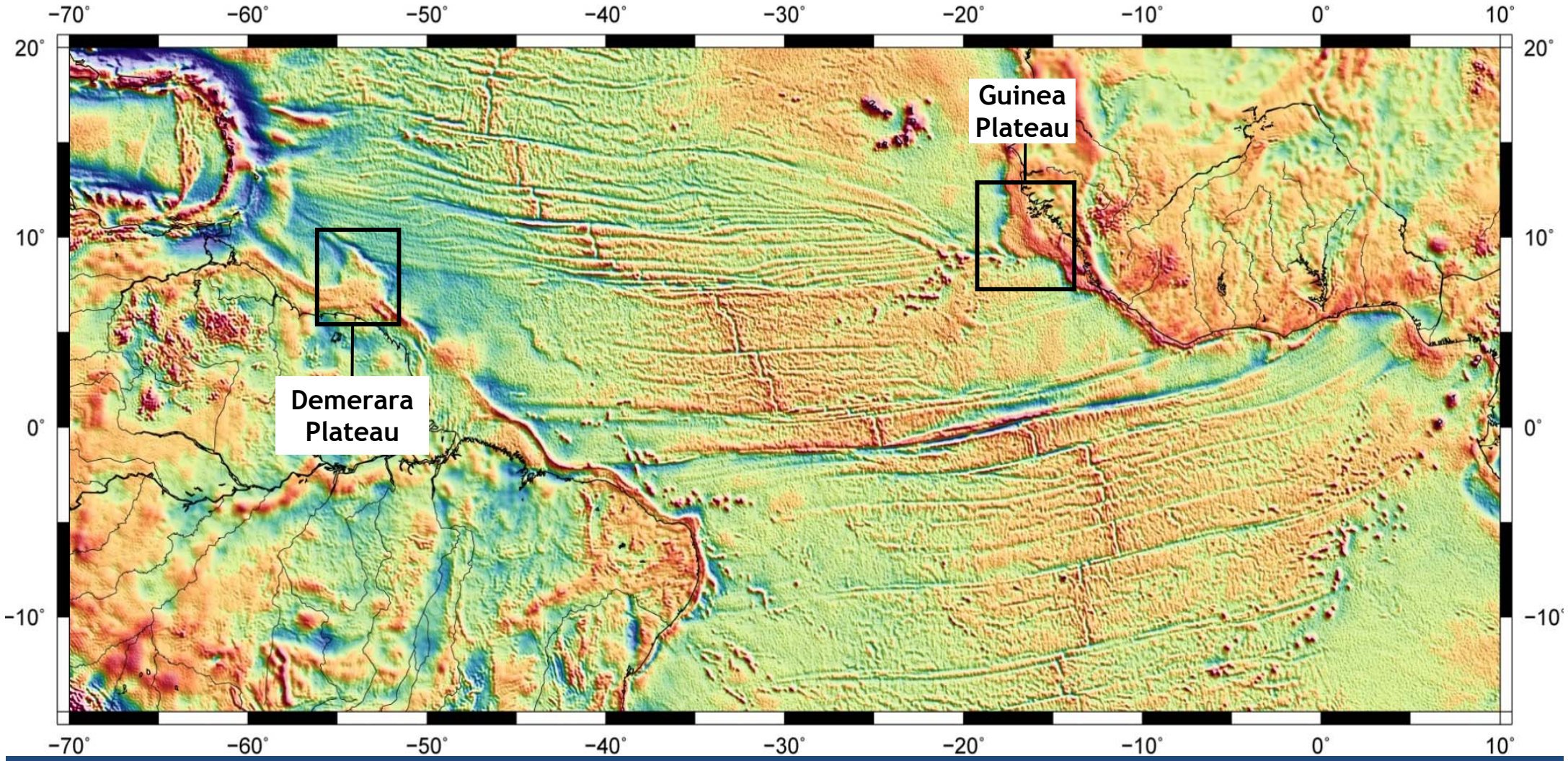
and

the GUYAPLAC, IGUANES, DRADEM and MARGATS Shipboard Parties

Outline

- Introduction
- Continental Shelf beyond 200 nautical miles
- Recent French scientific cruises
- Future plans

Equatorial Atlantic Ocean



(Mercier de Lépinay et al., In Prep)

1988

PhD Gouyet
(data TOTAL)

2003

GUYAPLAC
(Ifremer)

2003

Forage ODP 207 (International Drilling)

2013

2016

2016

IGUANES **DRADEM** **MARGATS**

(Perpignan/Ifremer/Univ Brest/ Univ Grenoble/Univ Antilles Guyane)


Joides Resolution

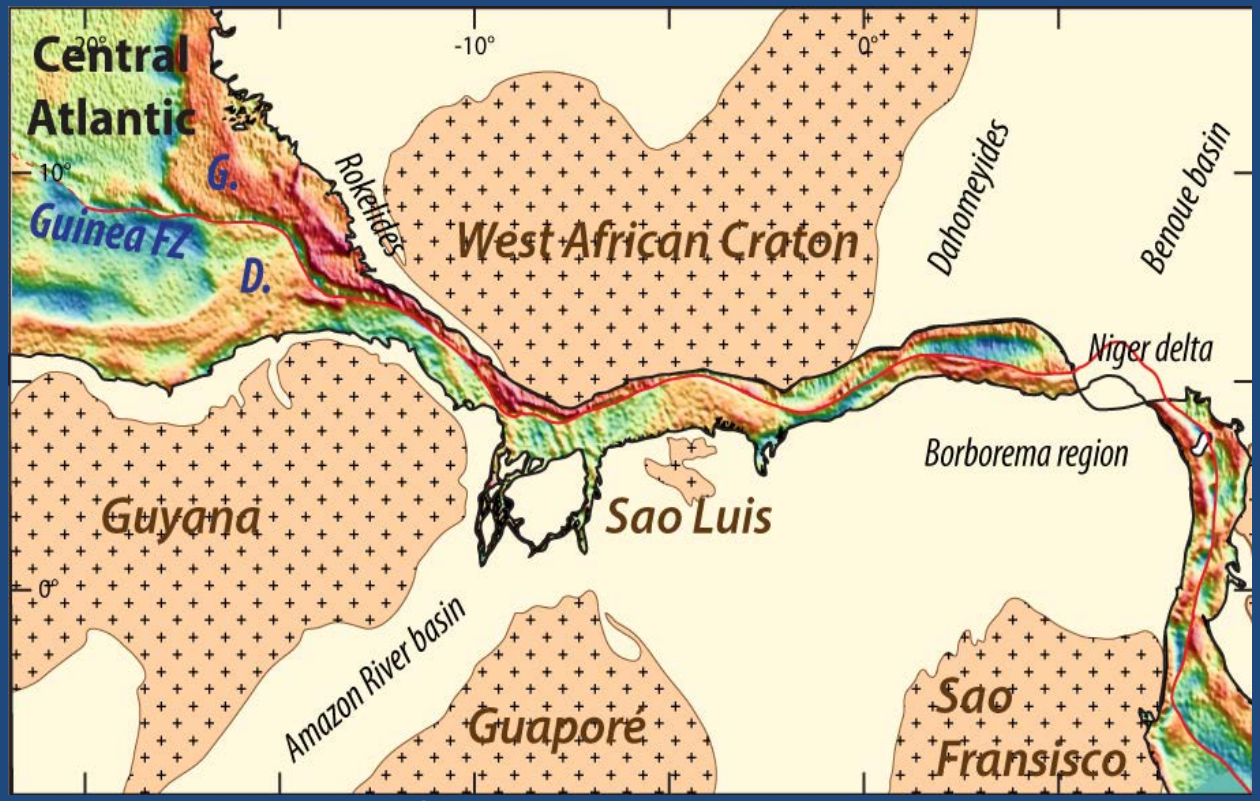

R/V L'Atalante


R/V Pourquoi pas?

PhD Thesis Gouyet, 1988

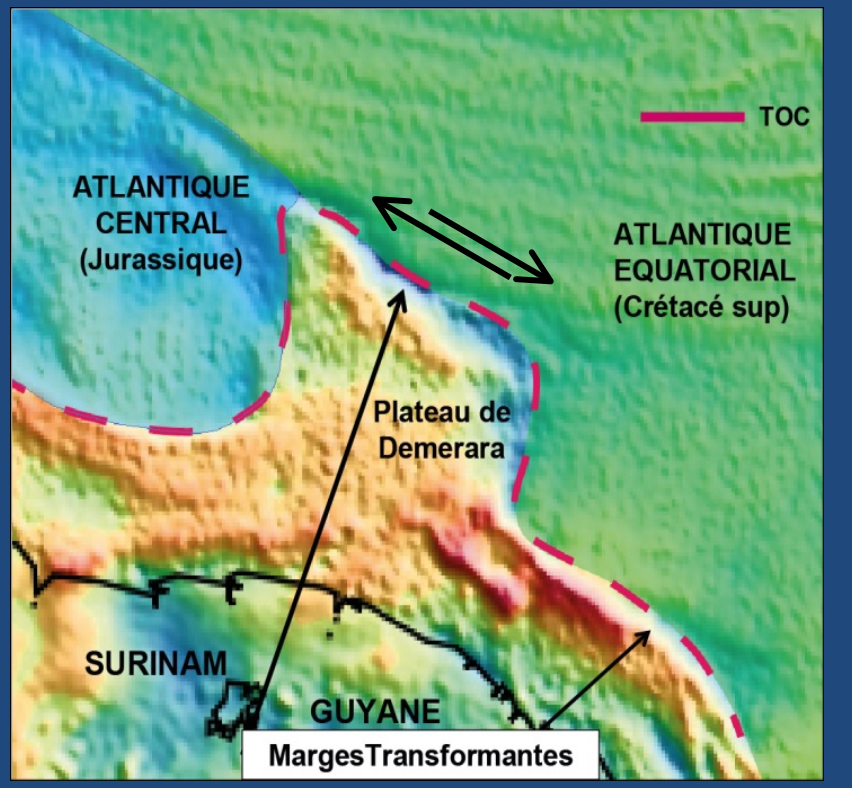
The geologic history of the margin [*of French Guiana*] can be divided into two main stages. In Jurassic and early Cretaceous times, the northwestern part of the margin (Demerara Rise) is believed to have represented the southern extremity of the Central Atlantic Rift and Ocean. Sedimentation at that time on the Demerara rise occurred mainly in an inner shelf environment, with significant continental influxes. As early as middle Albian times, shallow marine to open marine environments of deposition prevailed in response to the opening of the E-W-trending Equatorial Ocean and margins along a dextral shear zone between South America and Africa.

(From Gouyet et al., 1994)



(Mercier de Lépinay, 2016; modified from Moulin et al., 2010)

1- **Jurassic:**
Central Atlantic
→ **divergent**



2- **Early Cretaceous:**
Equatorial Atlantic
→ **divergent/transform**

UN Law of the Sea

- Attributes maritime zones with specific sovereign rights to coastal States
- Territorial Sea to 12 Nautical Miles
- EEZ to 200 Nautical Miles
- Continental Shelf beyond 200 Nautical Miles if natural prolongation extends that far
- To be examined by a Commission established to that effect

UNCLOS Art 76: Continental Shelf

1. **The continental shelf** of a coastal State comprises the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the **natural prolongation of its land territory** to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance.

(From Mercier de Lepinay, 2016)

UNCLOS Art 76: Continental Shelf

4.(a) For the purposes of this Convention, the coastal State shall establish the outer edge of the continental margin wherever the margin extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, by either:

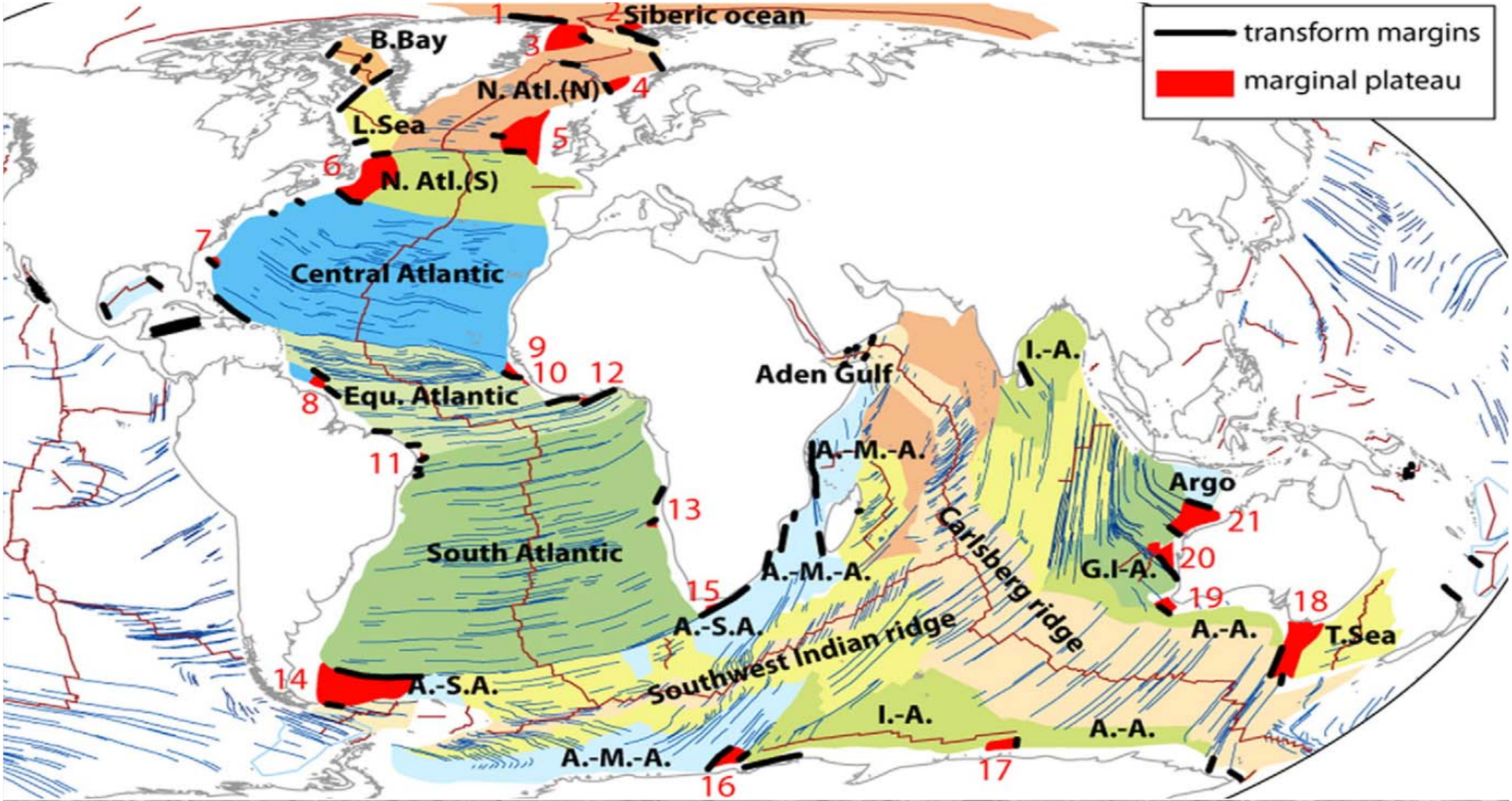
(i) a line delineated in accordance with paragraph 7 by reference to the outermost fixed points at each of which the **thickness of sedimentary rocks** is at least 1 per cent of the shortest distance from such point to the foot of the continental slope; or

(ii) a line delineated in accordance with paragraph 7 by reference to fixed points not more than **60 nautical miles from the foot of the continental slope**.

(b) In the absence of evidence to the contrary, the **foot of the continental slope** shall be determined as the **point of maximum change in the gradient at its base**.

(From Mercier de Lepinay, 2016)

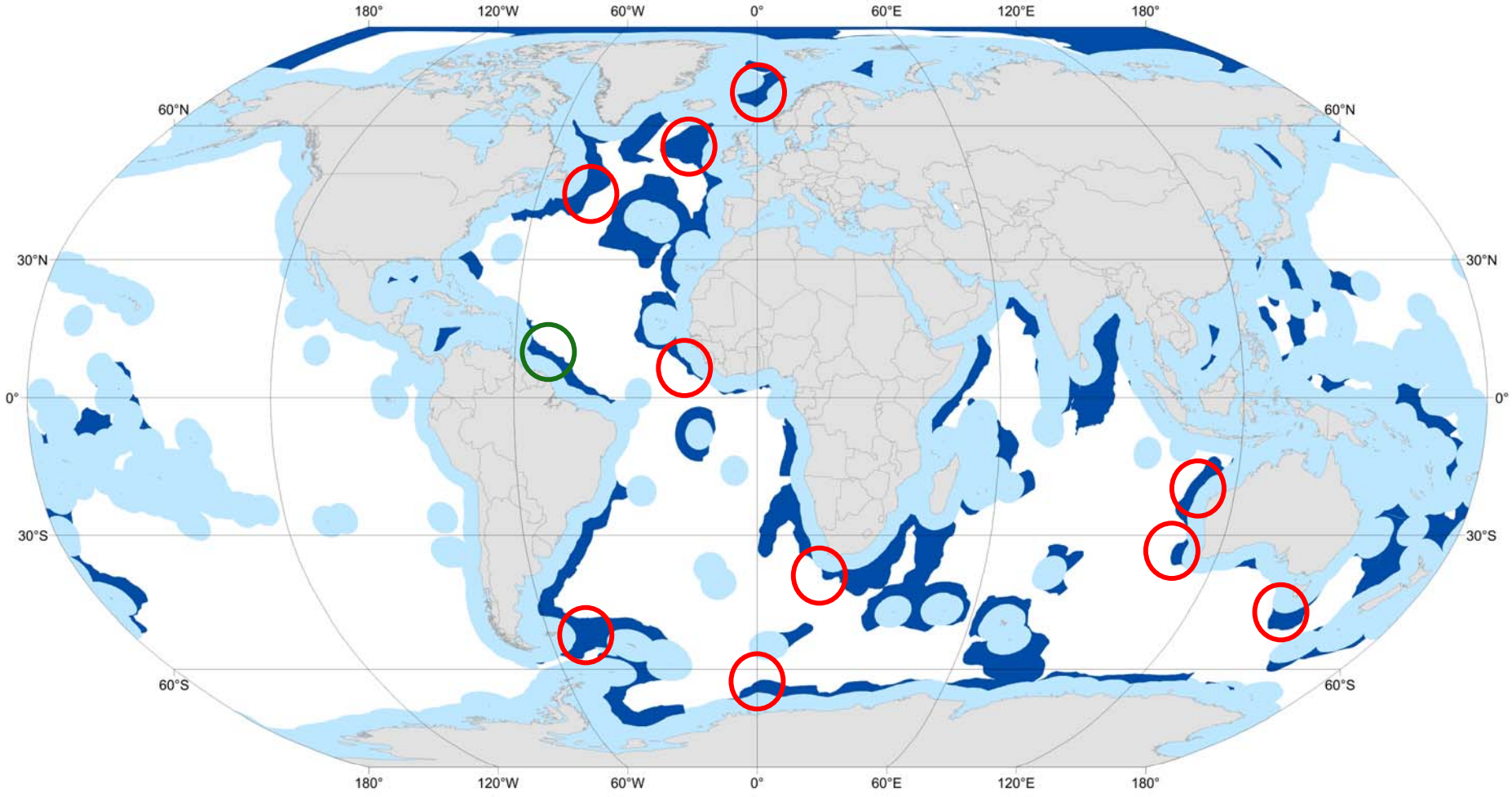
Marginal Plateaus



(From Mercier de Lepinay, 2016)

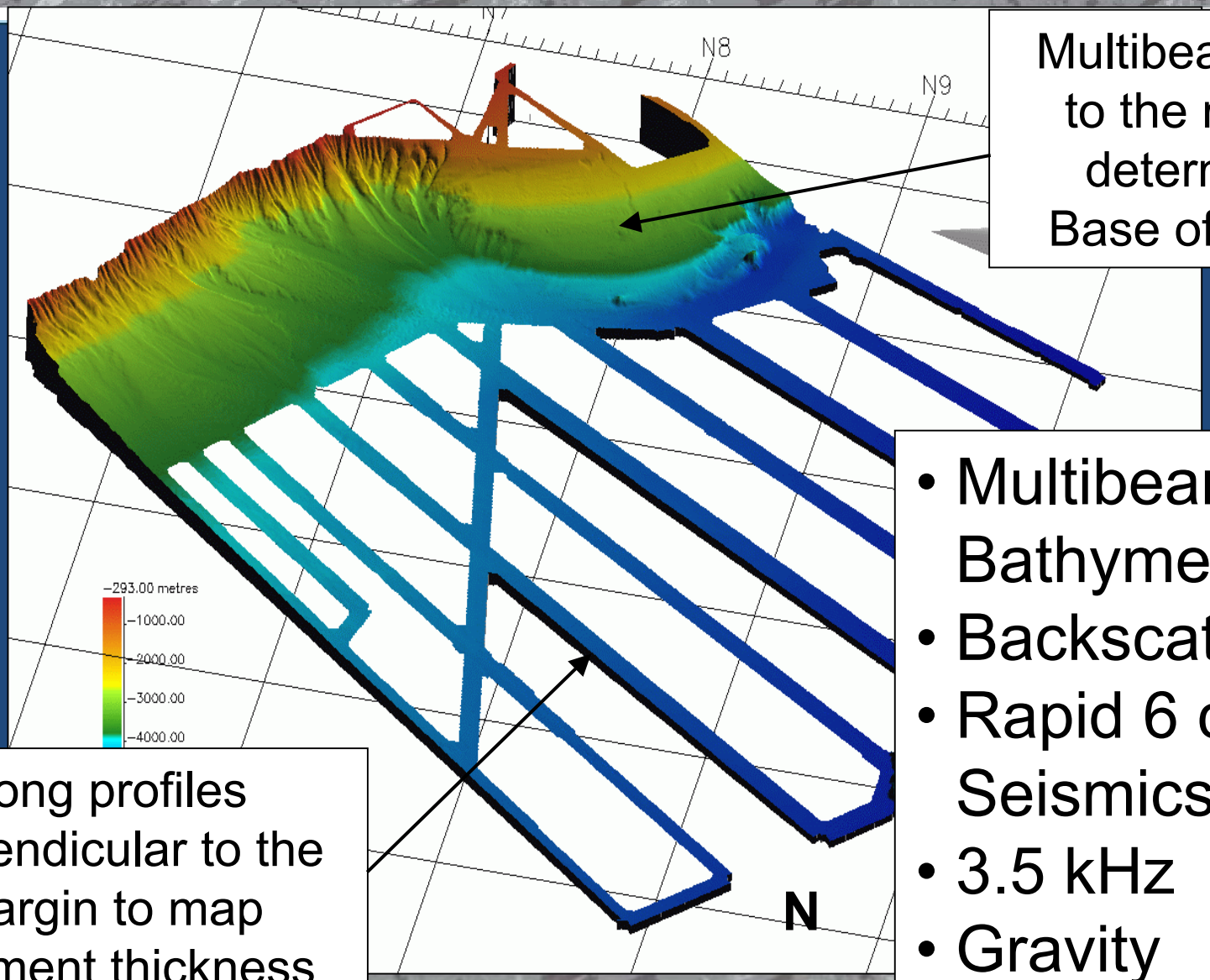
Continental Shelf Submissions

May 2017



info@maritimezonesolutions.com

GuyaPLAC Cruise 2003, R/V L'Atalante



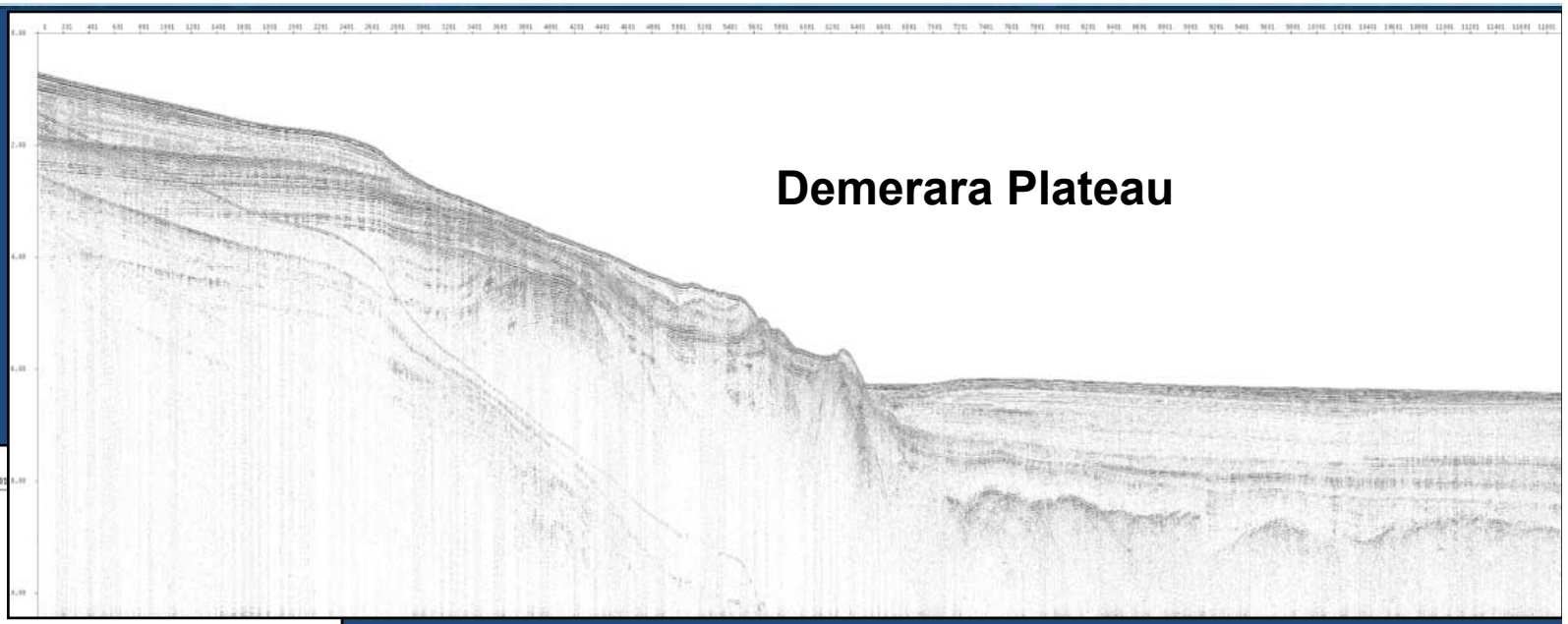
Multibeam parallel to the margin to determine the Base of the Slope

Long profiles perpendicular to the margin to map sediment thickness

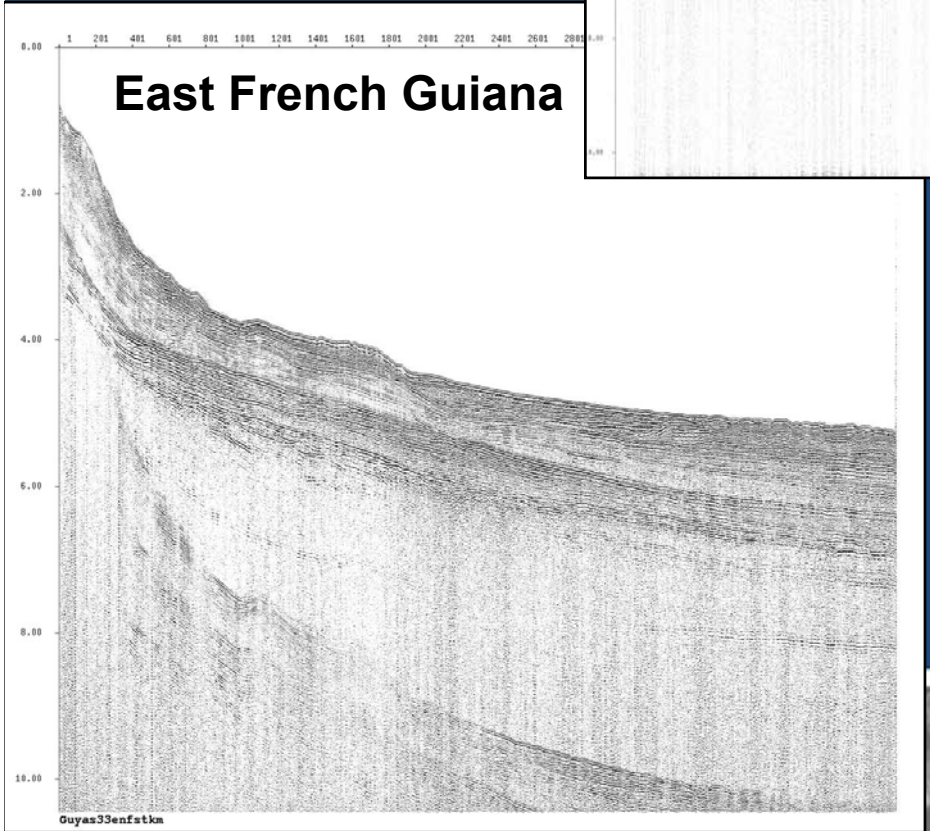
- Multibeam Bathymetry
- Backscatter Imagery
- Rapid 6 channel Seismics
- 3.5 kHz
- Gravity
- Magnetics

GuyaPLAC Cruise 2003, R/V L'Atalante

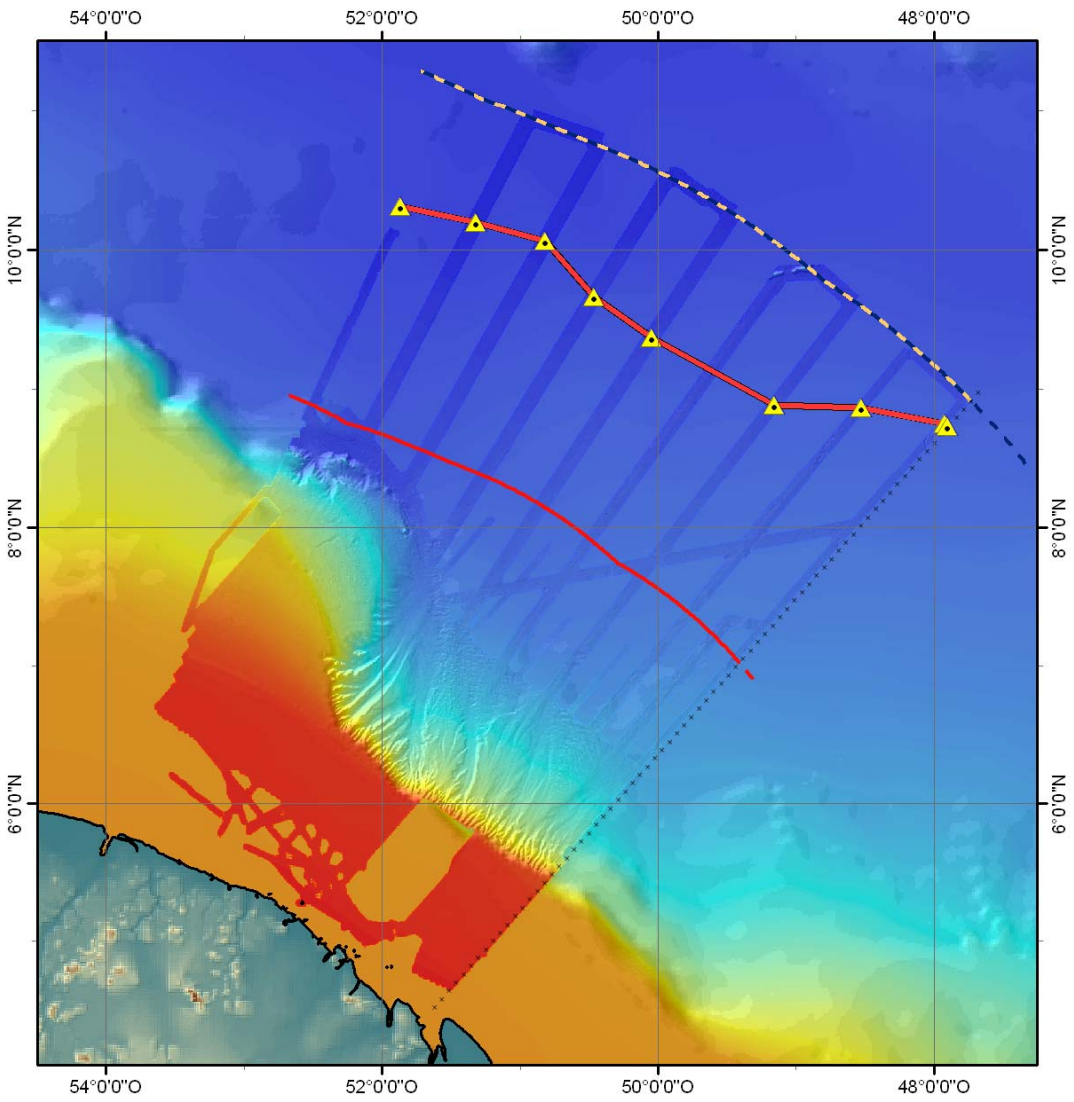
Seismic Data



Demerara Plateau



GuyaPLAC Cruise 2003, R/V L'Atalante

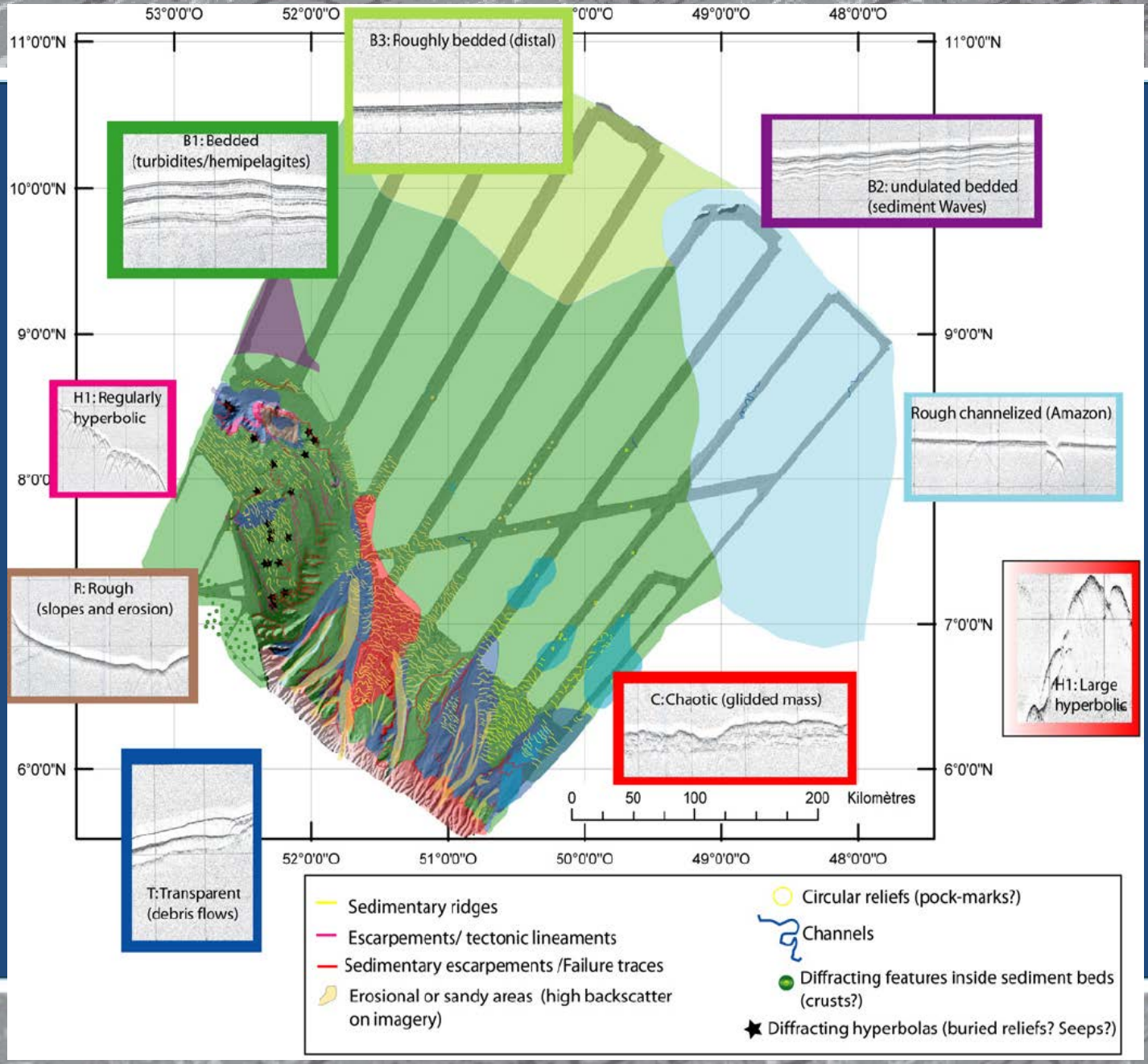


- Goal was to document the extent of the continental shelf beyond 200 M offshore French Guiana.
- Information was submitted to the UN in 2007
- Examination by the UN Commission on the Limits of the Continental Shelf: 2007 – 2009

GuyaPLAC Cruise 2003, R/V L'Atalante

- Dossier Submitted in 2007
- Examination by the UN Commission on the Limits of the Continental Shelf: 2007 – 2009
- Publication of Decrees establishing the outer limits of the continental shelf in 2015 for French Guiana, as well as Antilles, Bay of Biscay and New-Caledonia

French Guiana, EEZ 126 000 km² / CS 72 000 km²



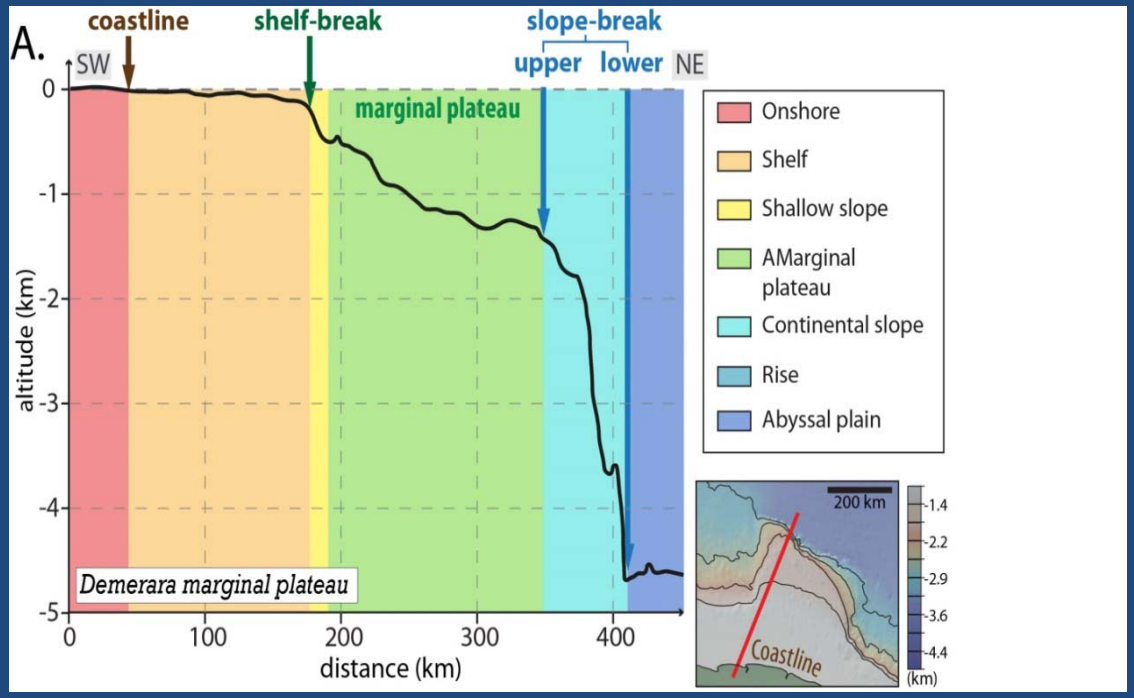
Scientific Collaboration Analyses of sub-bottom profiles and acoustic imagery

Results were also used in defending the identification of the continental slope for UNCLOS

Loncke et al., 2008, Mar. Petrol. Geol.

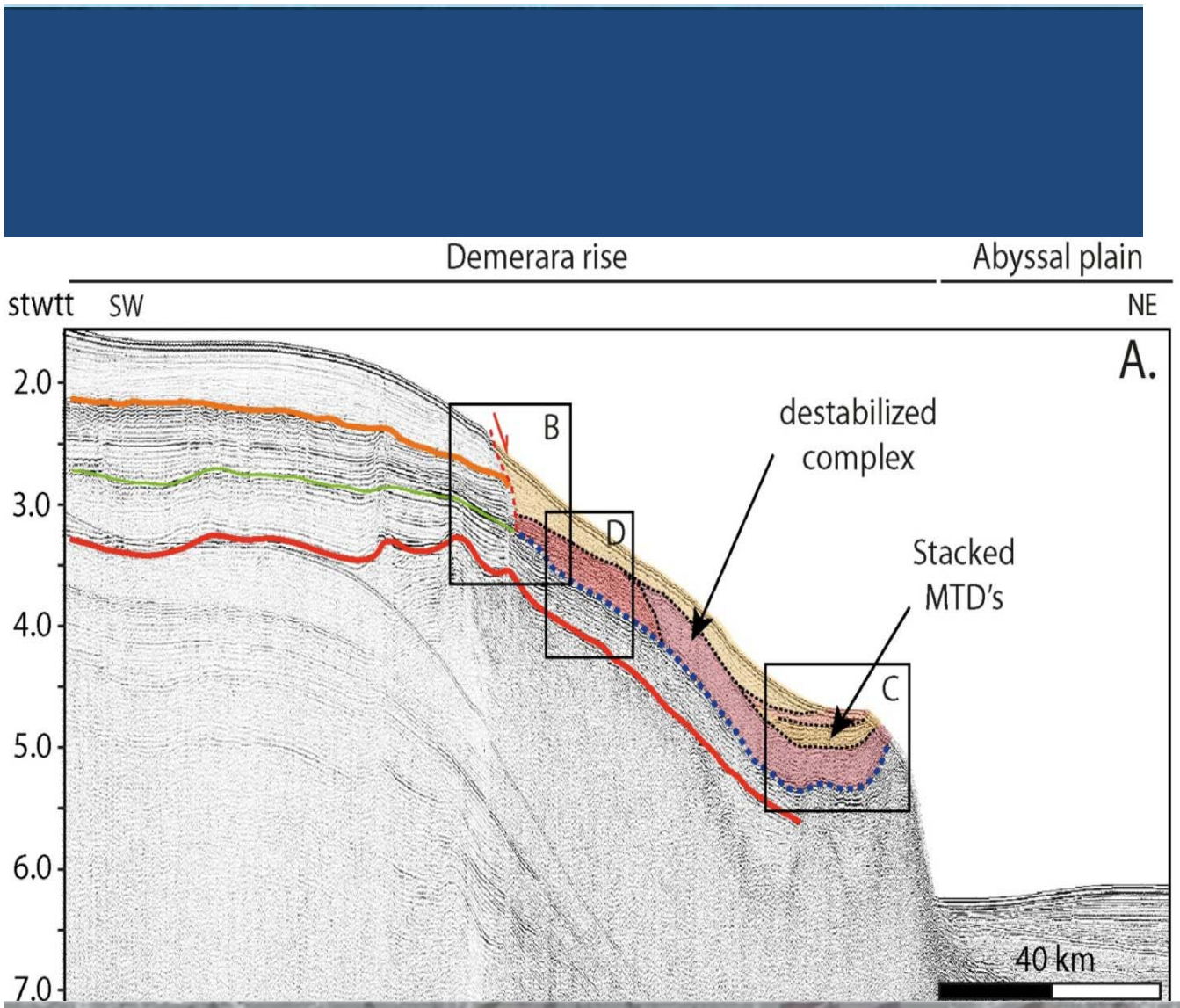
Marginal Plateaus

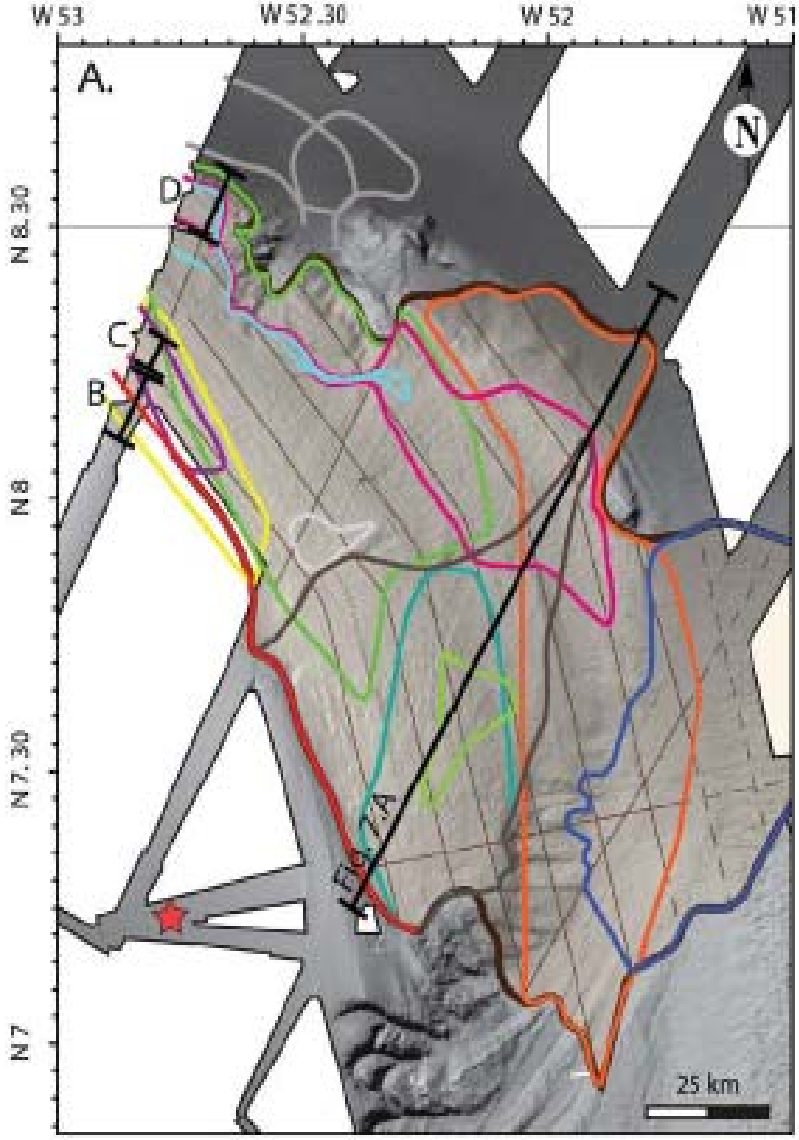
- Nature and evolution of marginal plateaus
- Specific sedimentary processes involved in transform continental margins with marginal plateaus



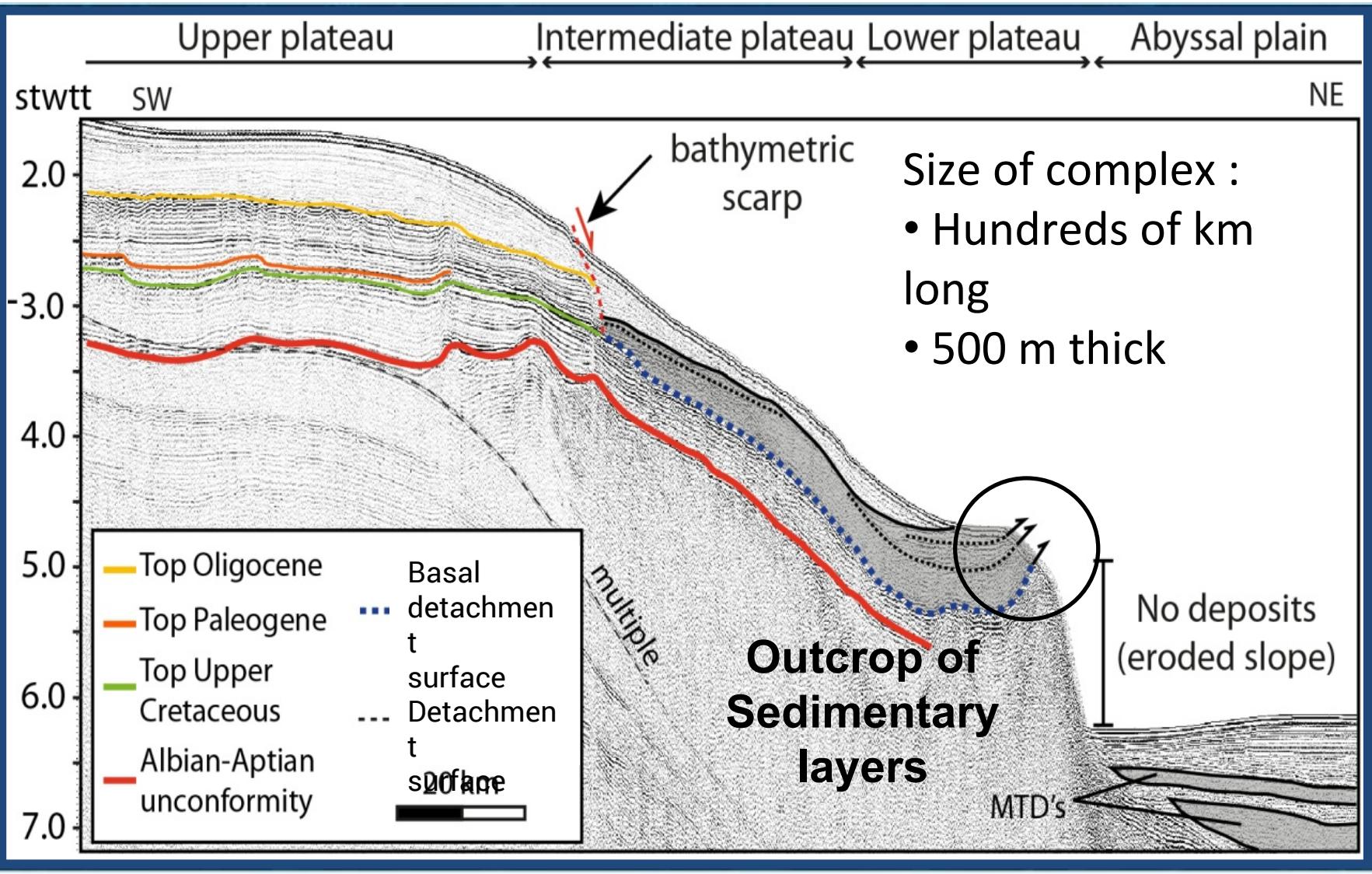
(From Mercier de Lepinay, 2016)

Mapping of submarine landslides



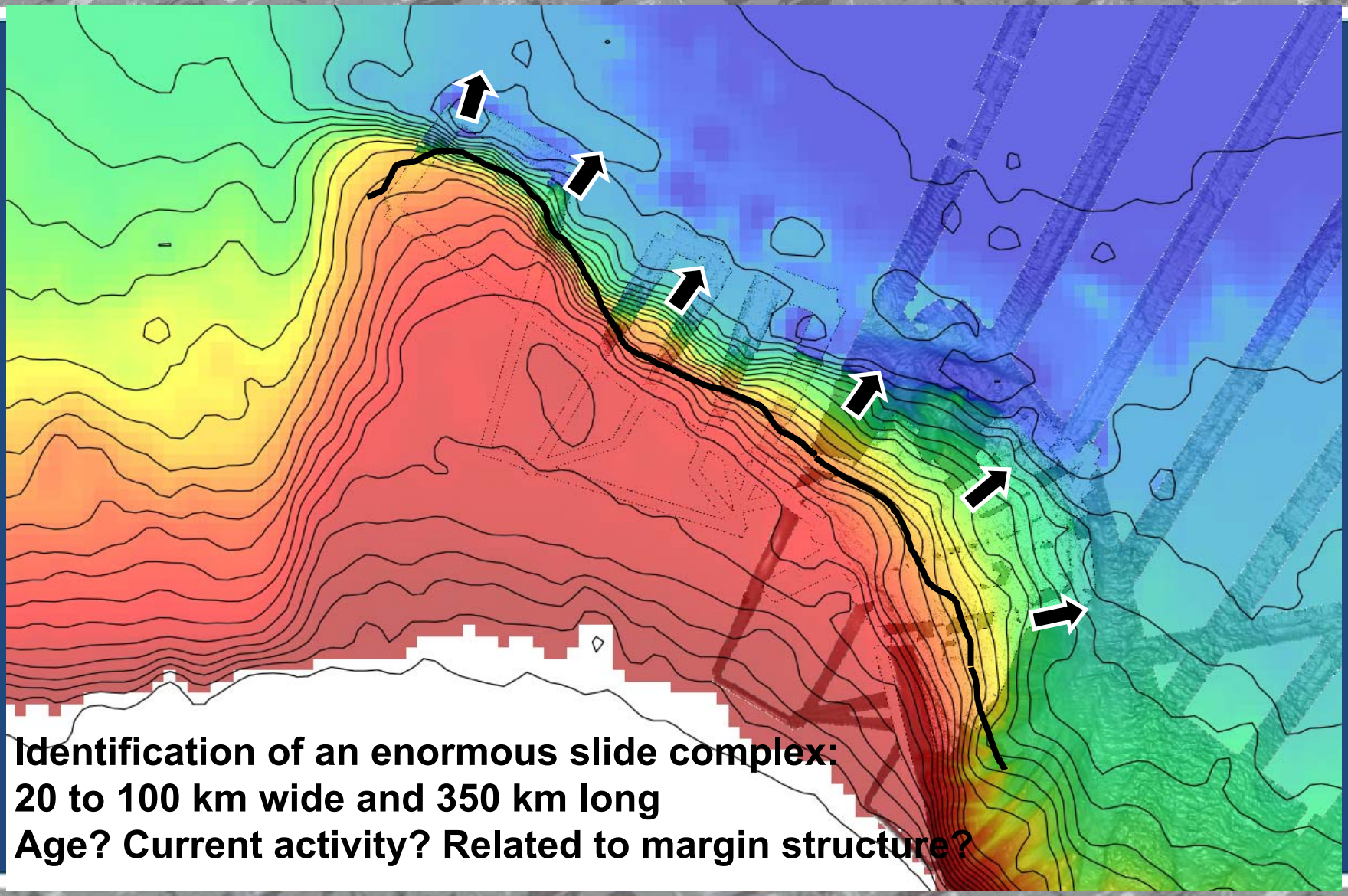


Pattier et al., 2011 et 2013

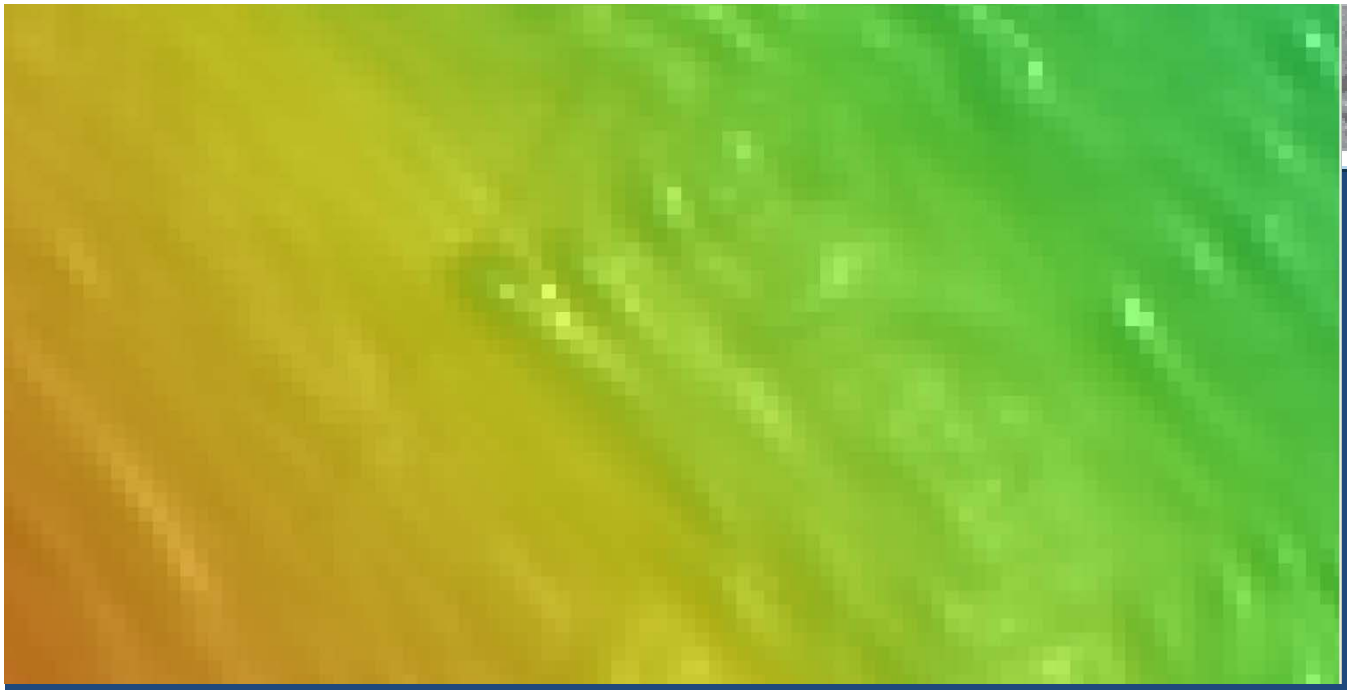


Pattier et al., 2011 et 2013

IGUANES Cruise 2013, R/V L'Atalante

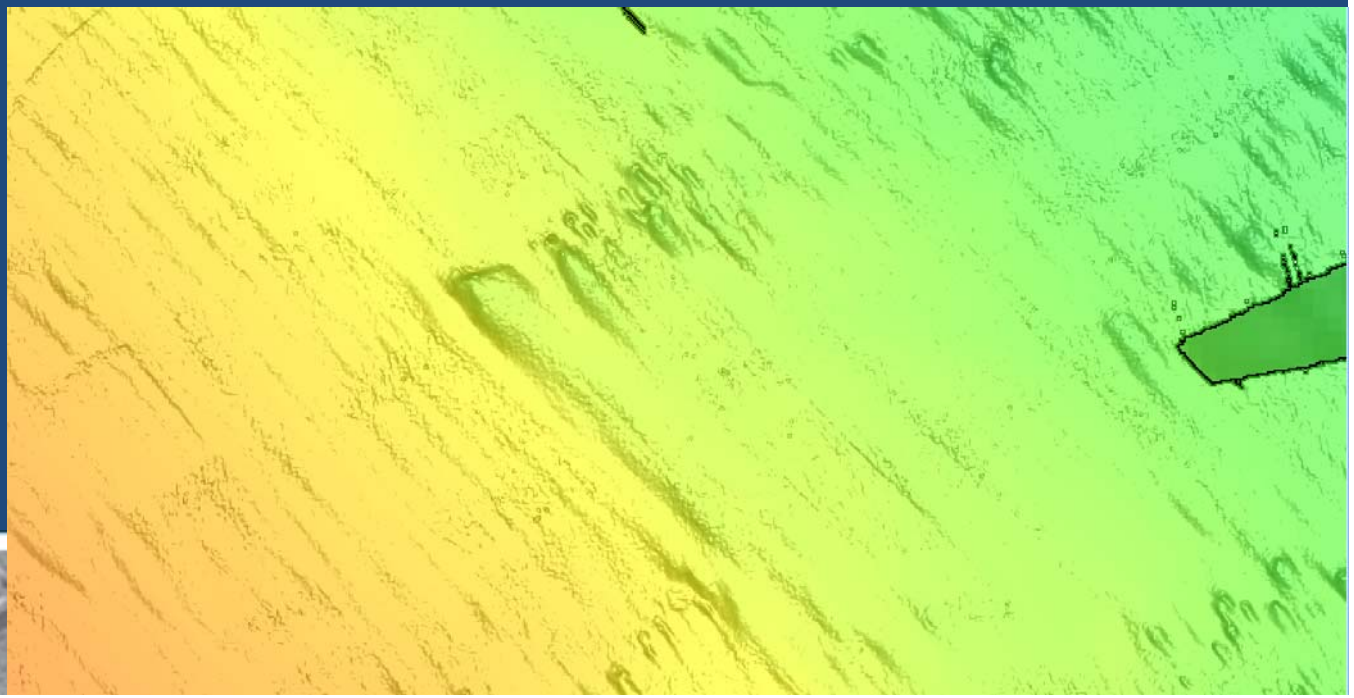


Identification of an enormous slide complex:
20 to 100 km wide and 350 km long
Age? Current activity? Related to margin structure?



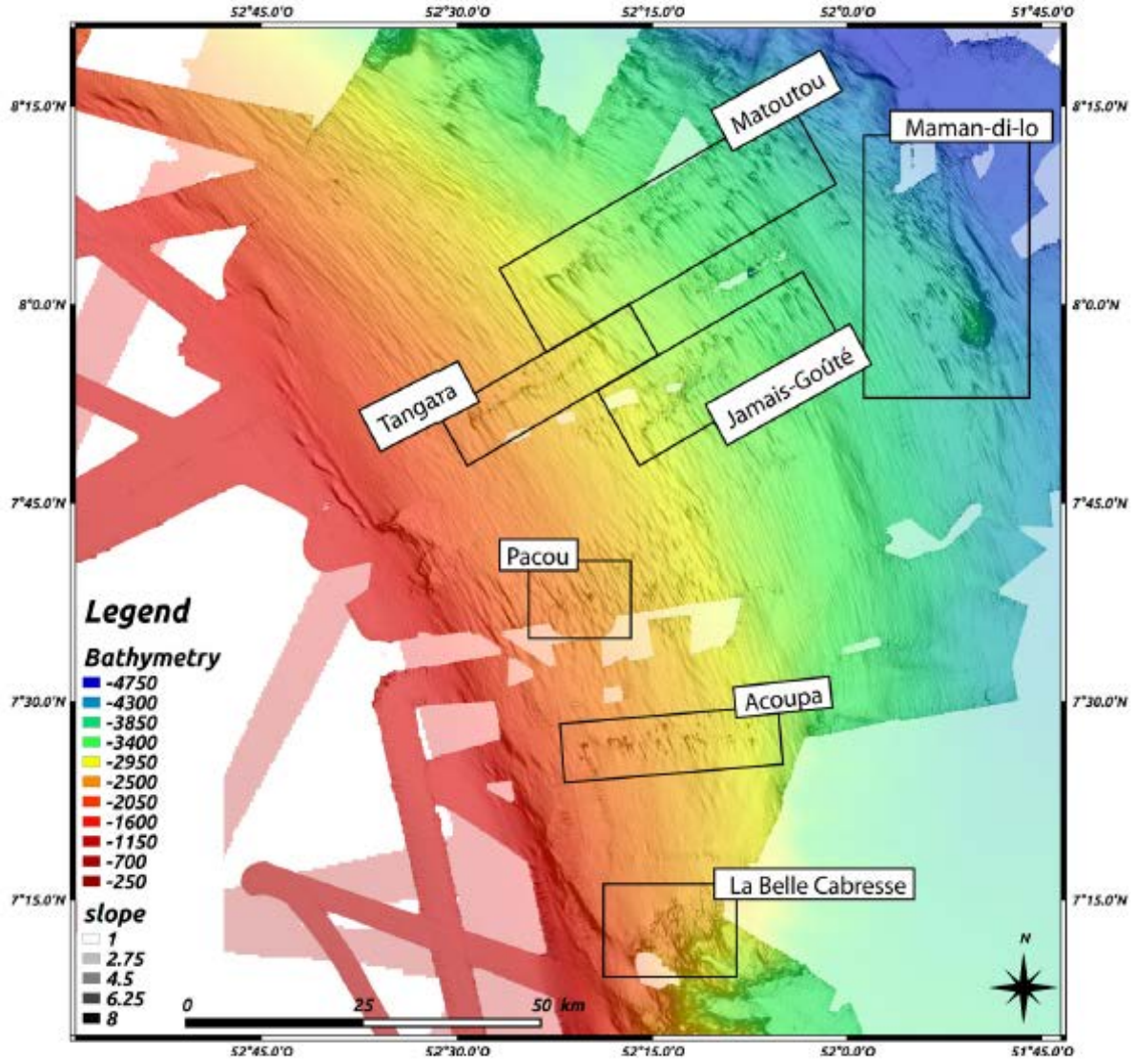
Guyaplac (DTM 150m)

Iguanes (DTM 25m)



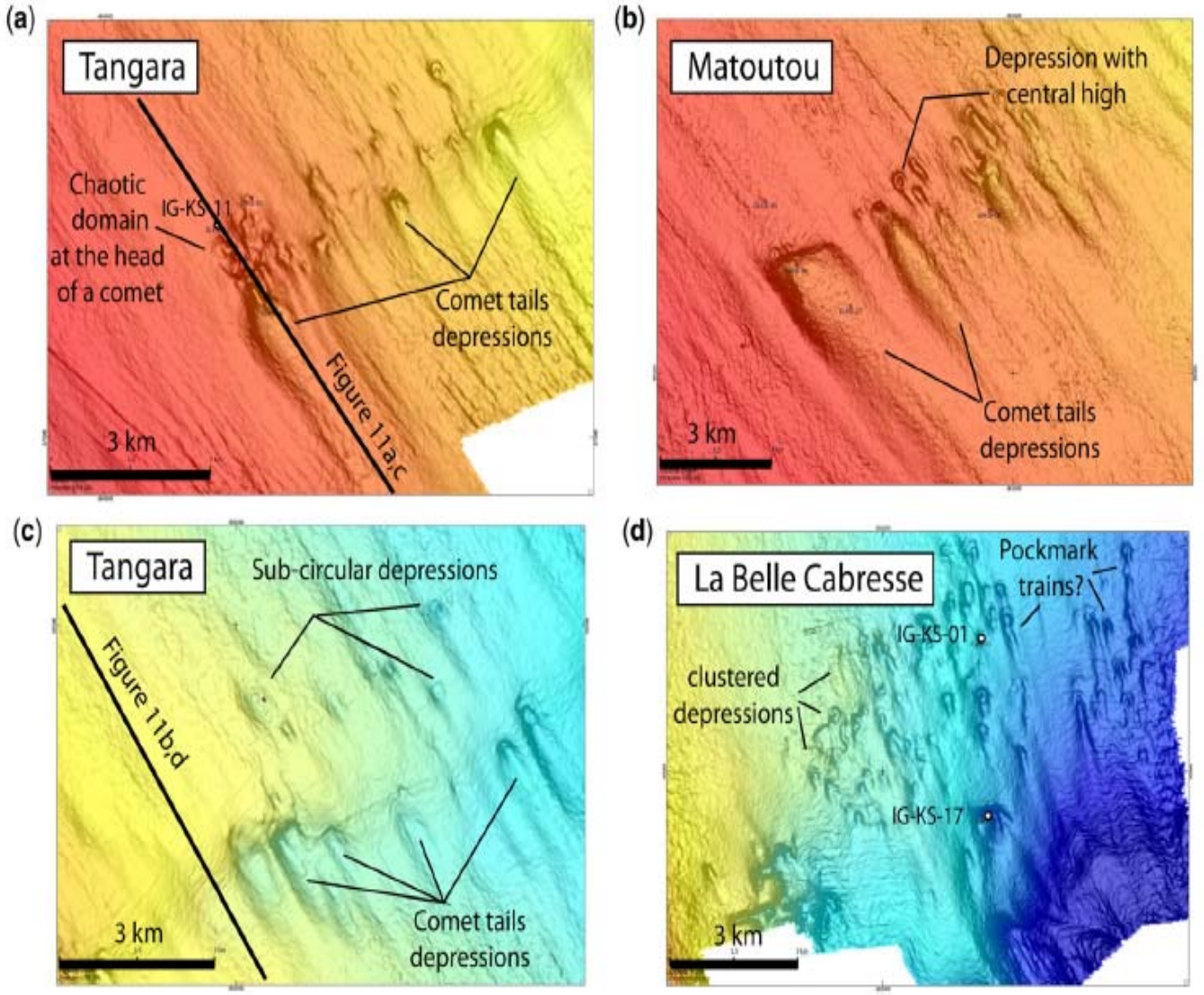
IGUANES Cruise 2013, R/V L'Atalante

Recent Sedimentary Processes



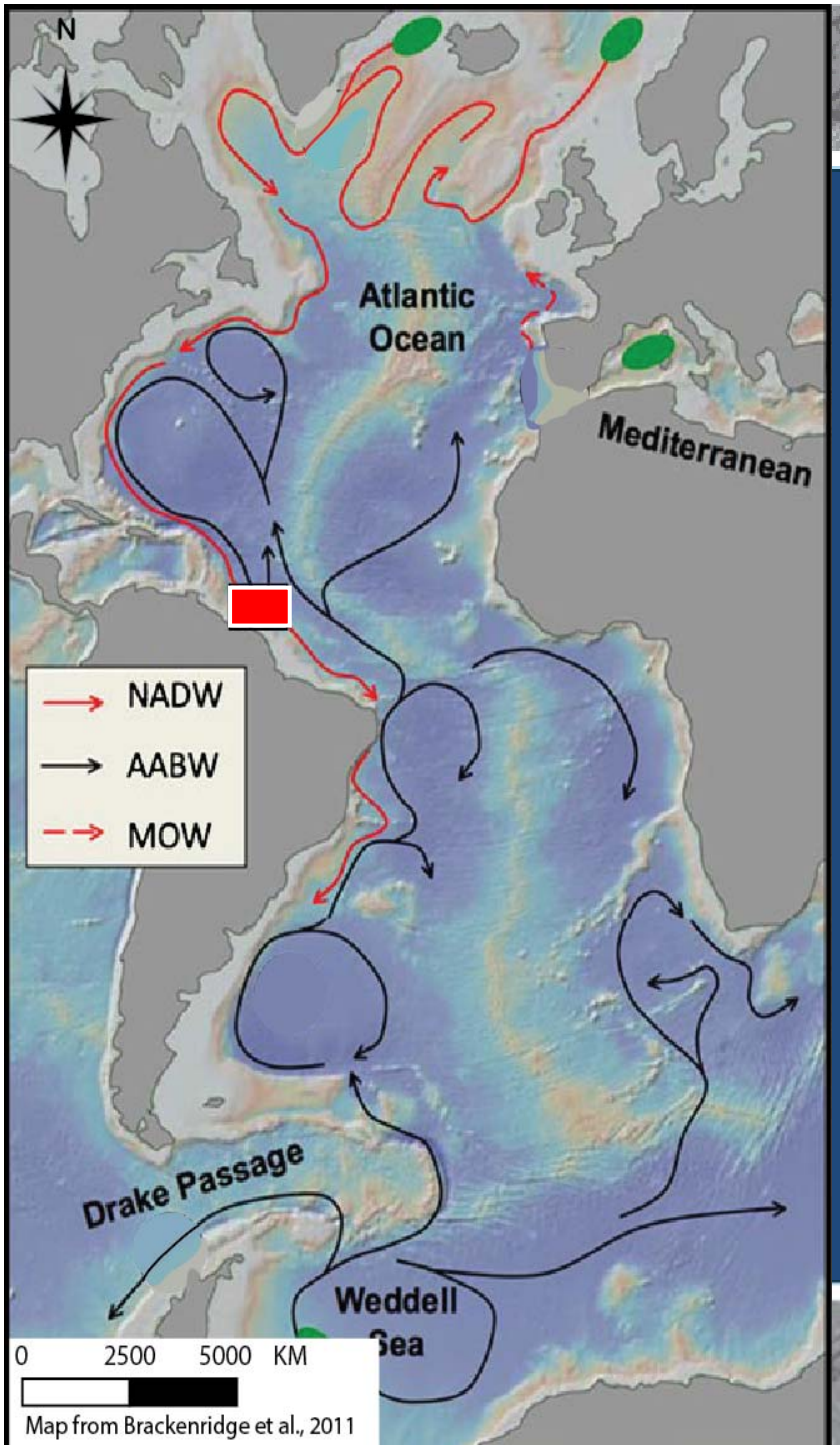
Loncke et al., GSL, 2016

IGUANES Cruise 2013, R/V L'Atalante



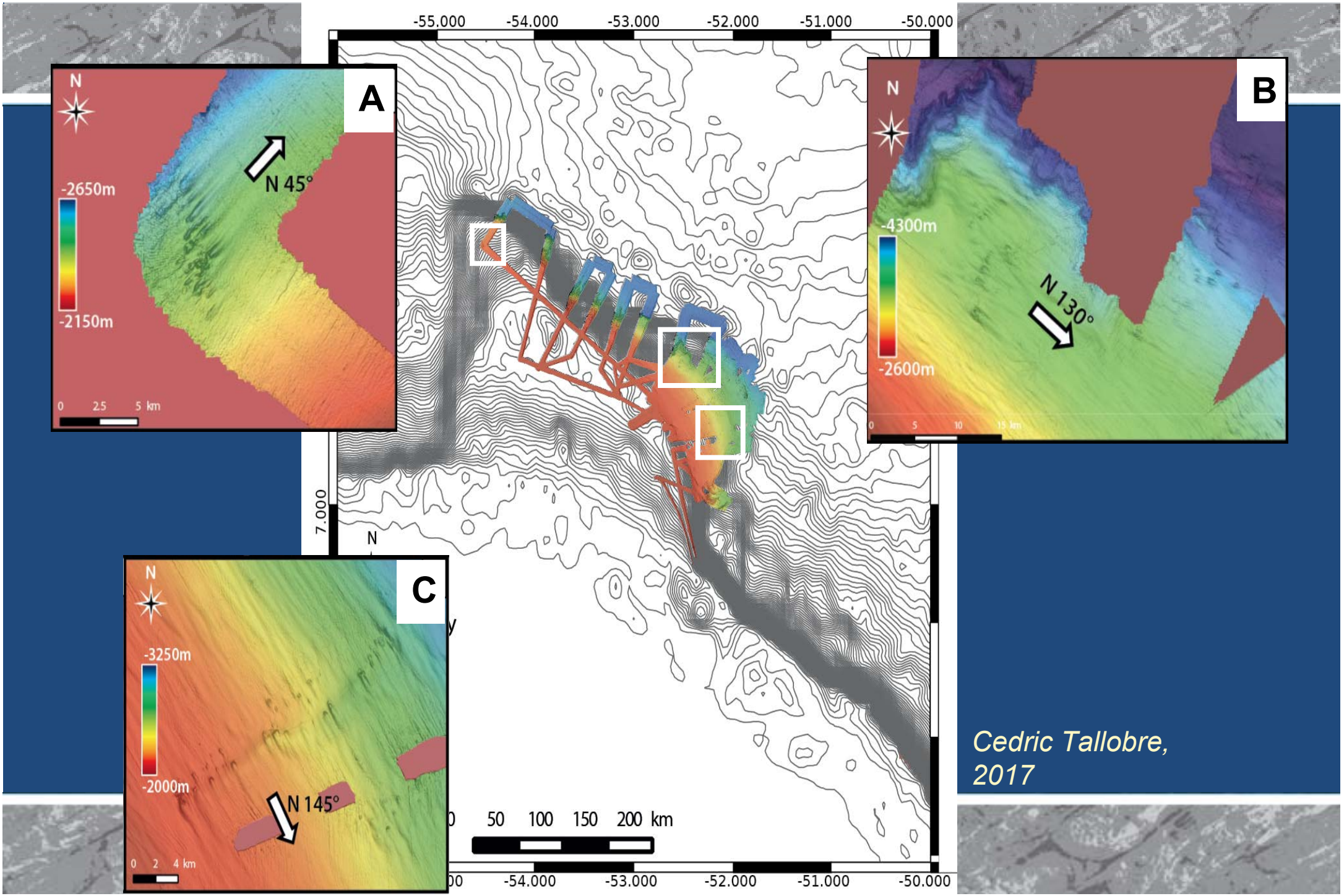
Seafloor Depressions

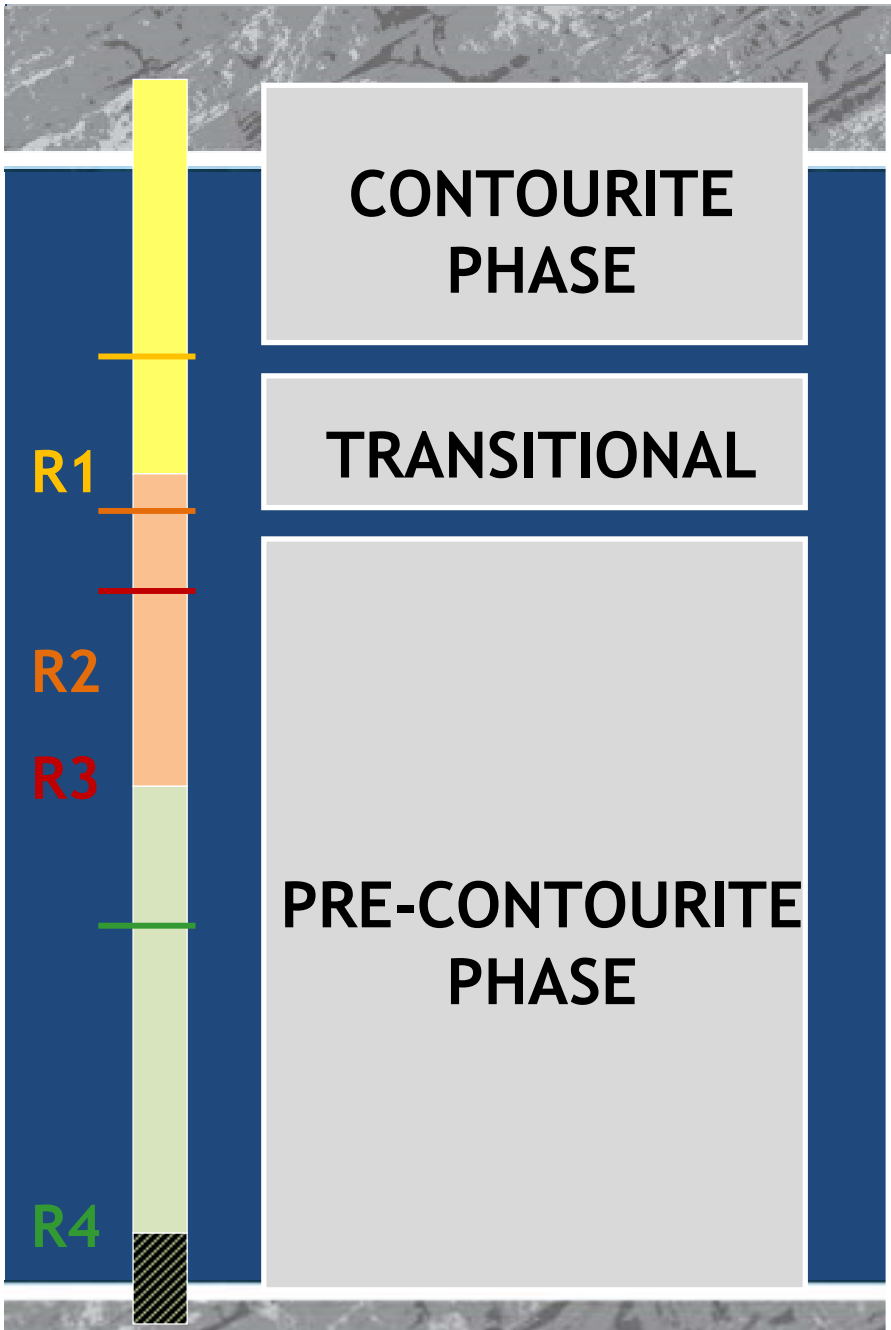
Loncke et al., GSL, 2016



Ocean currents, such as the NADW, can generate specific sedimentary deposits:
Contourites

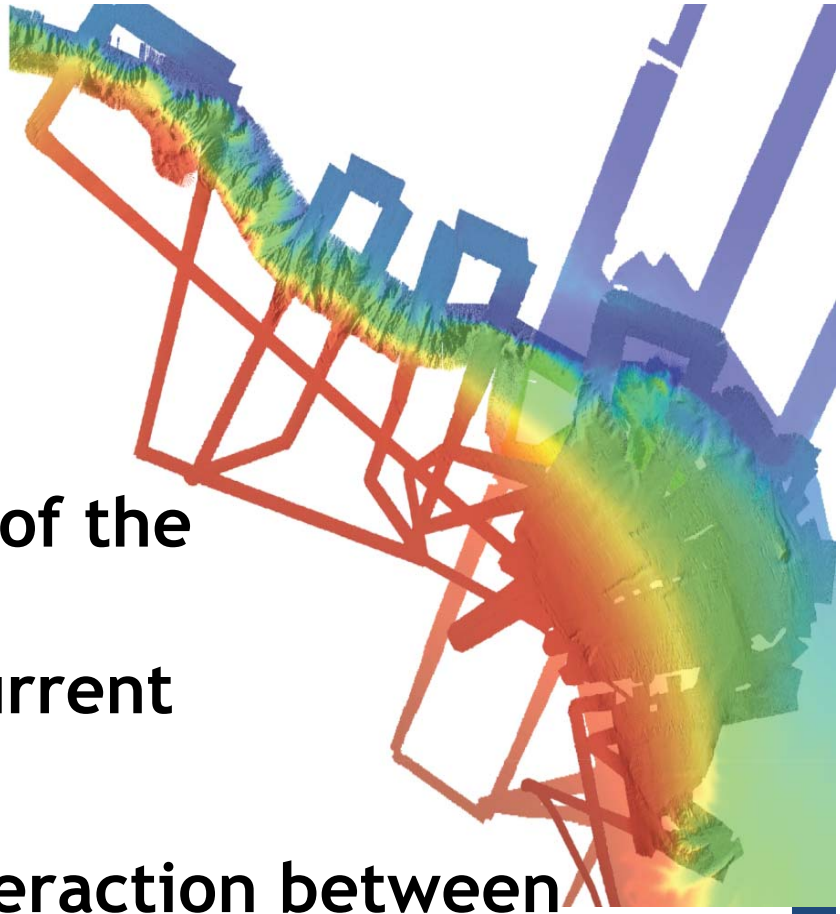
Tallobre, 2017


-55.000
-54.000
-53.000
-52.000
-51.000
-50.000
A
N
N 45°
-2650m
-2150m
0 2.5 5 km
B
N
-4300m
-2600m
N 130°
0 5 10 15 km
C
N
-3250m
-2000m
N 145°
0 2 4 km
7.000
50 100 150 200 km
Cedric Tallobre,
2017



Fanget et al, 2017, en prep

Demerara Plateau:



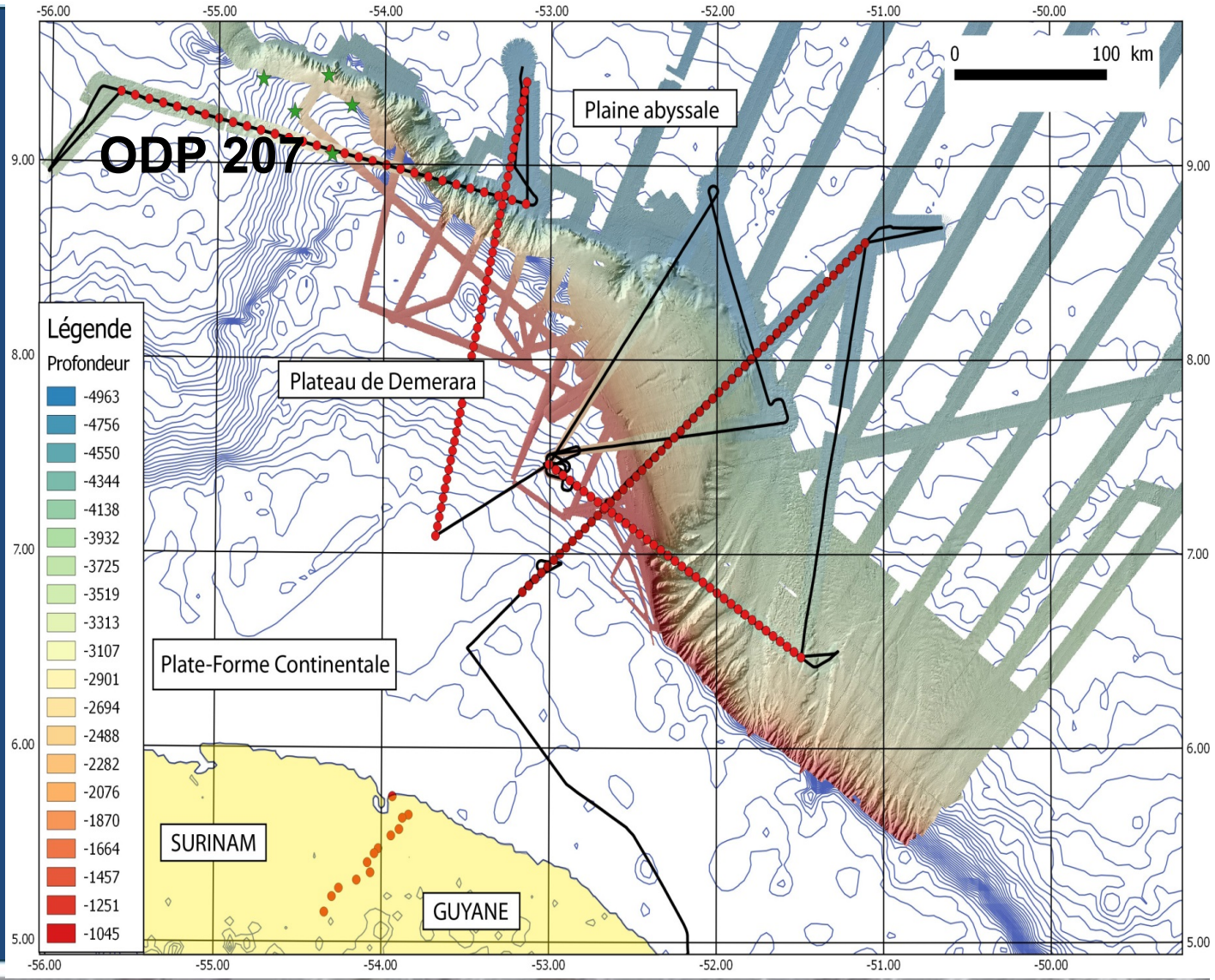
- Structure of the margin
- Bottom-current activities
- Strong interaction between slope destabilization and alongslope contour currents
- Interest of marginal plateaus for studying contourite processes

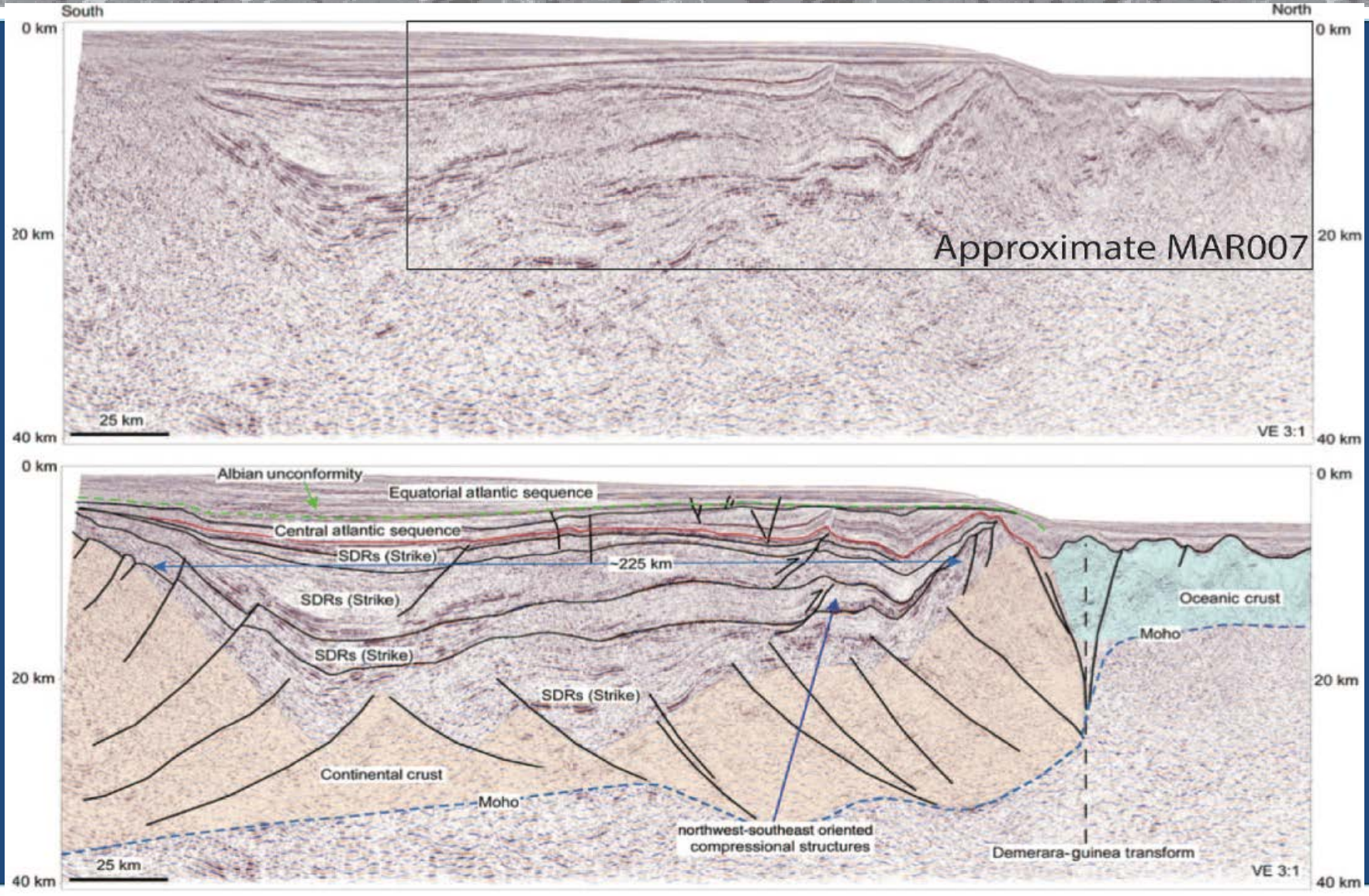
MARGATS Cruise 2016

Deep Structure of the Demerara Plateau

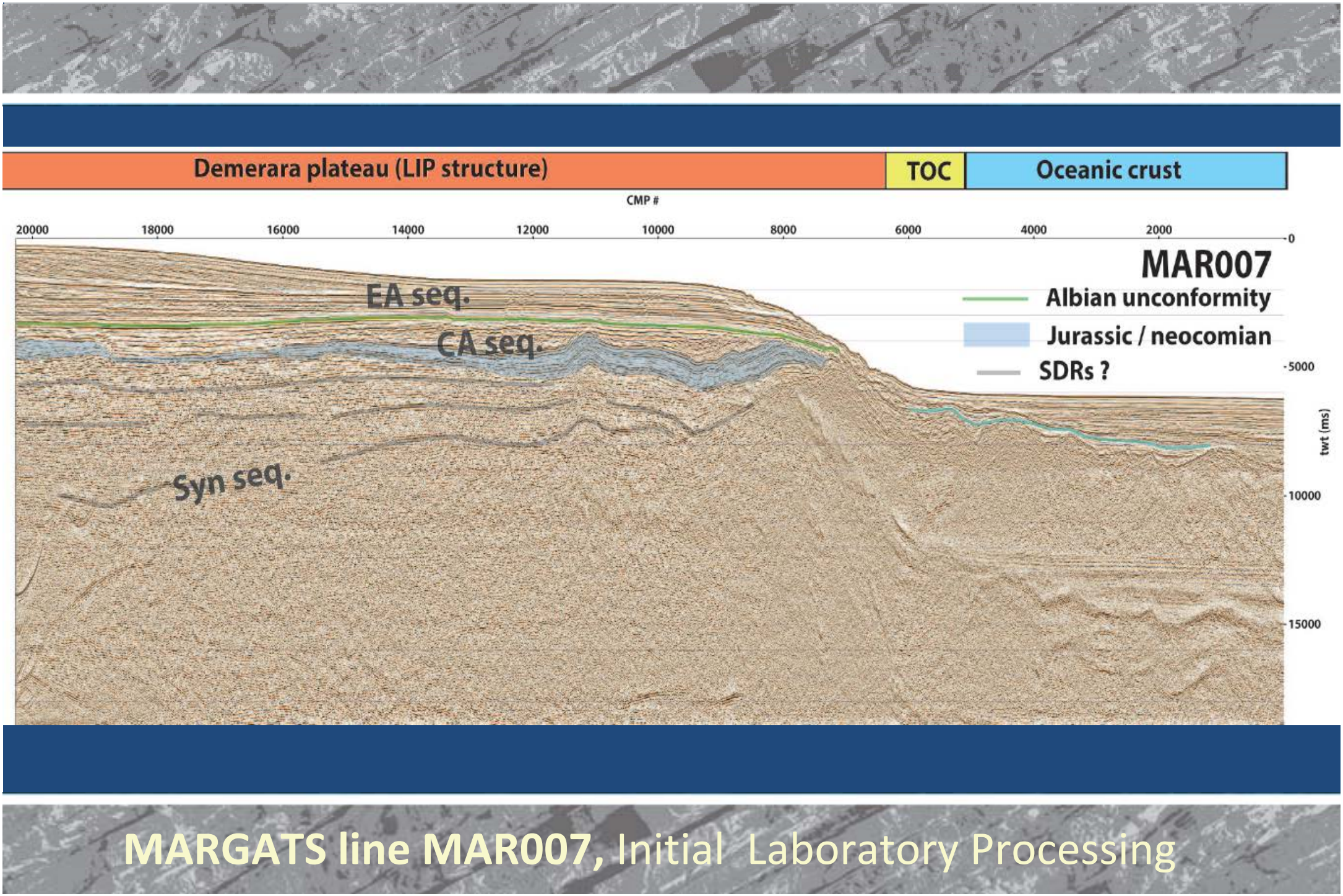
Multichannel Seismics, OBS

Bathymetry: GUYAPLAC 2003 , IGUANES 2013, DRADEM 2016, MARGATS 2016





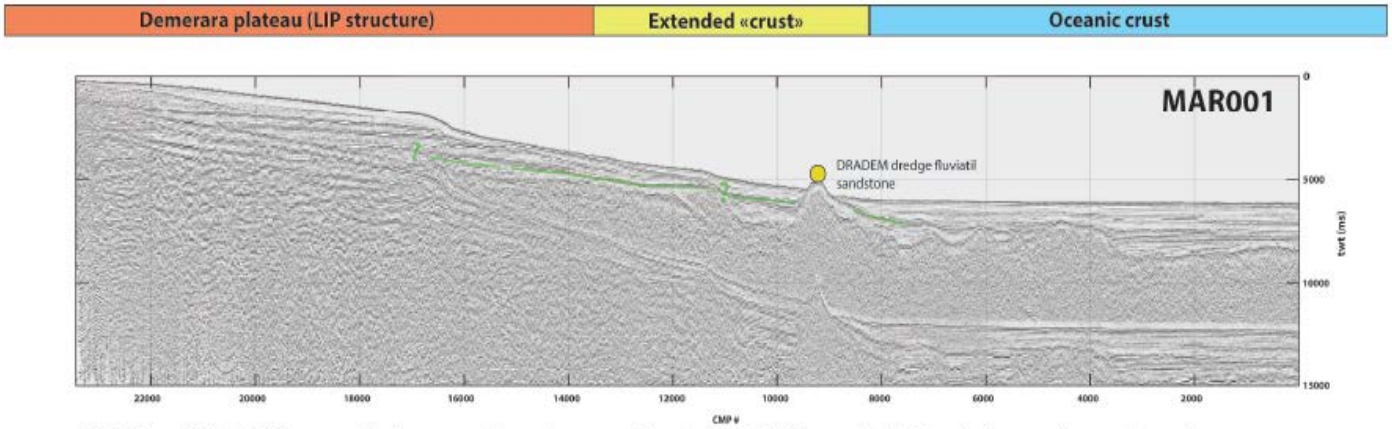
Seaward dipping reflectors - GuyanaSPAN data: Reuber et al., 2016



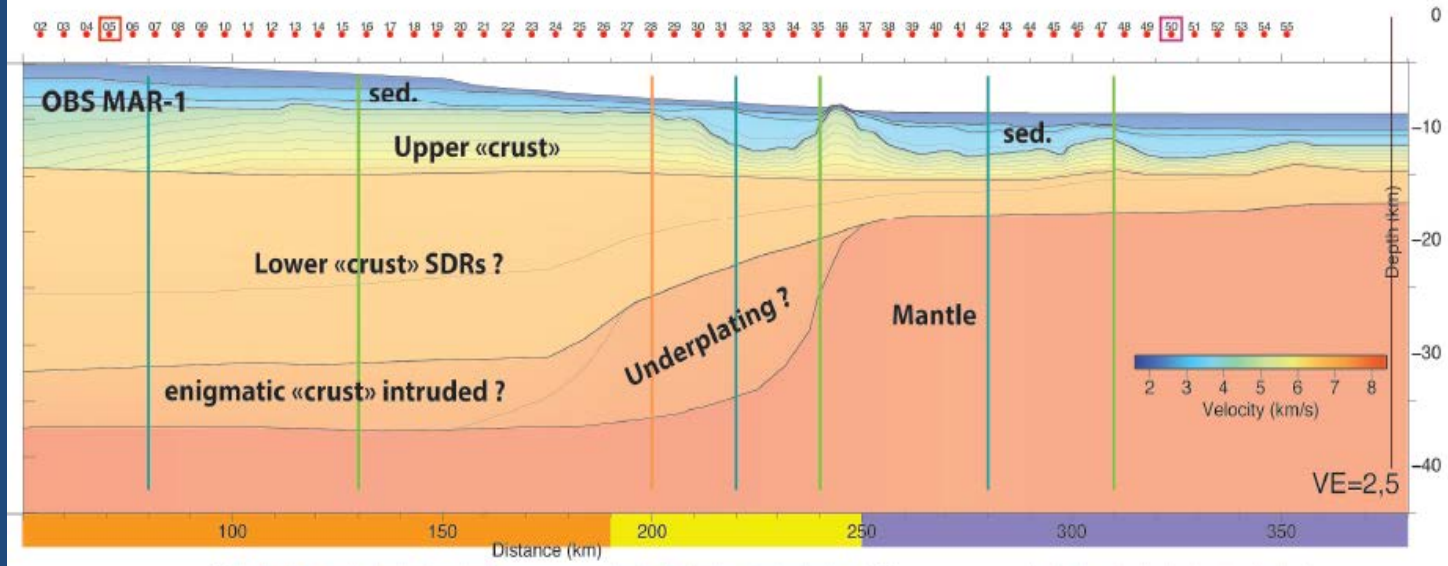
MARGATS line MAR007, Initial Laboratory Processing

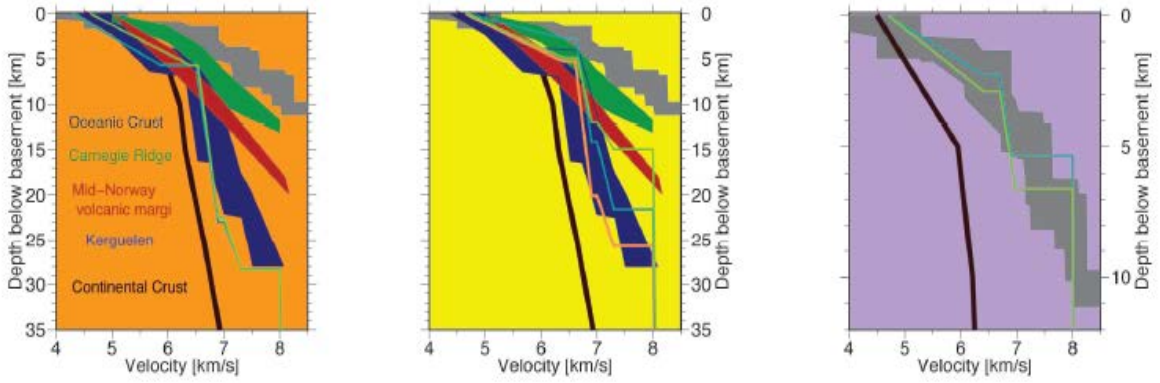
MARGATS cruise, R/V L'Atalante, 2016

Wide angle Refraction: Preliminary Velocity Model



MCS line MAR001 from preliminary onboard processing SolidQC (Ifremer), 1500 m/s time migrated section.





DRADEM Cruise 2016

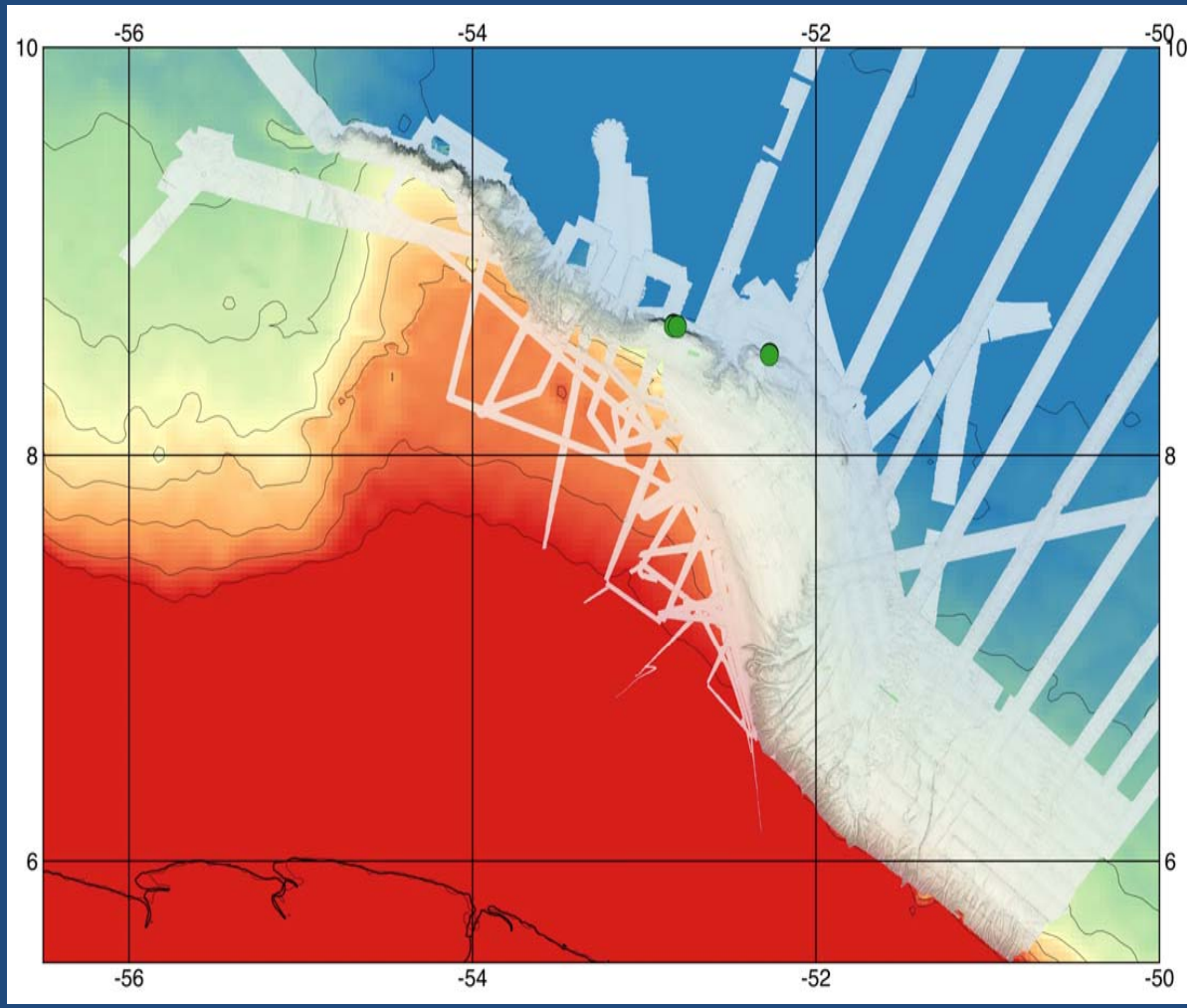
DRADEM sampling

- Magmatic rocks
(Basalt, trachy-basalt, rhyolite)

- Oceanic Island Basalts geochemical affinities

- Cristallisation age of magmatic zircons
173 Ma

Details and data in poster session



Background of the Demerara Plateau

- The Central Atlantic Magmatic Province (CAMP)

  201 Ma

- Jurassic opening of the Central Atlantic

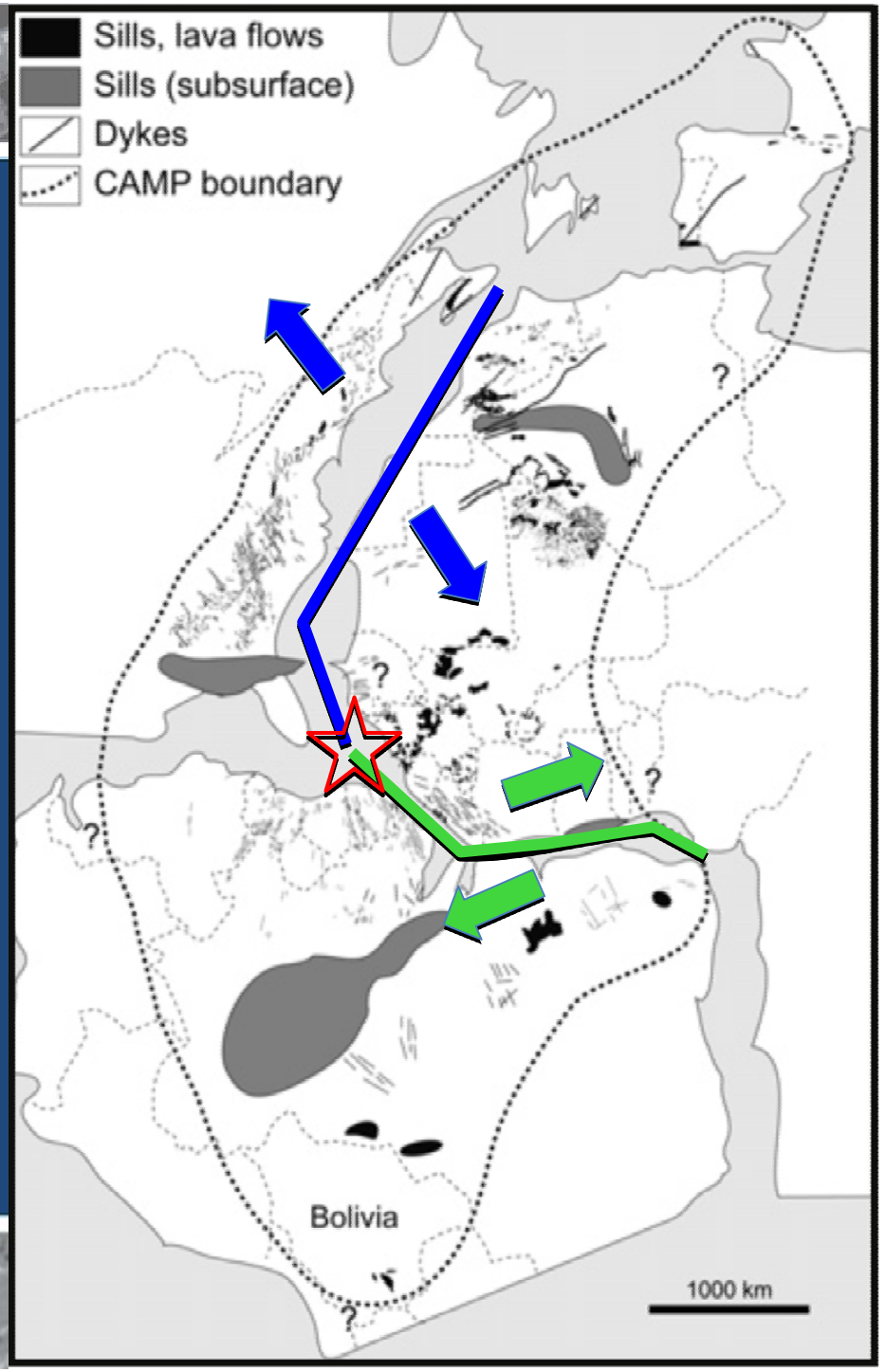
  190 Ma in the northern part

  170 Ma in the southern part

- Cretaceous opening of the Equatorial Atlantic

  ~ 120 Ma

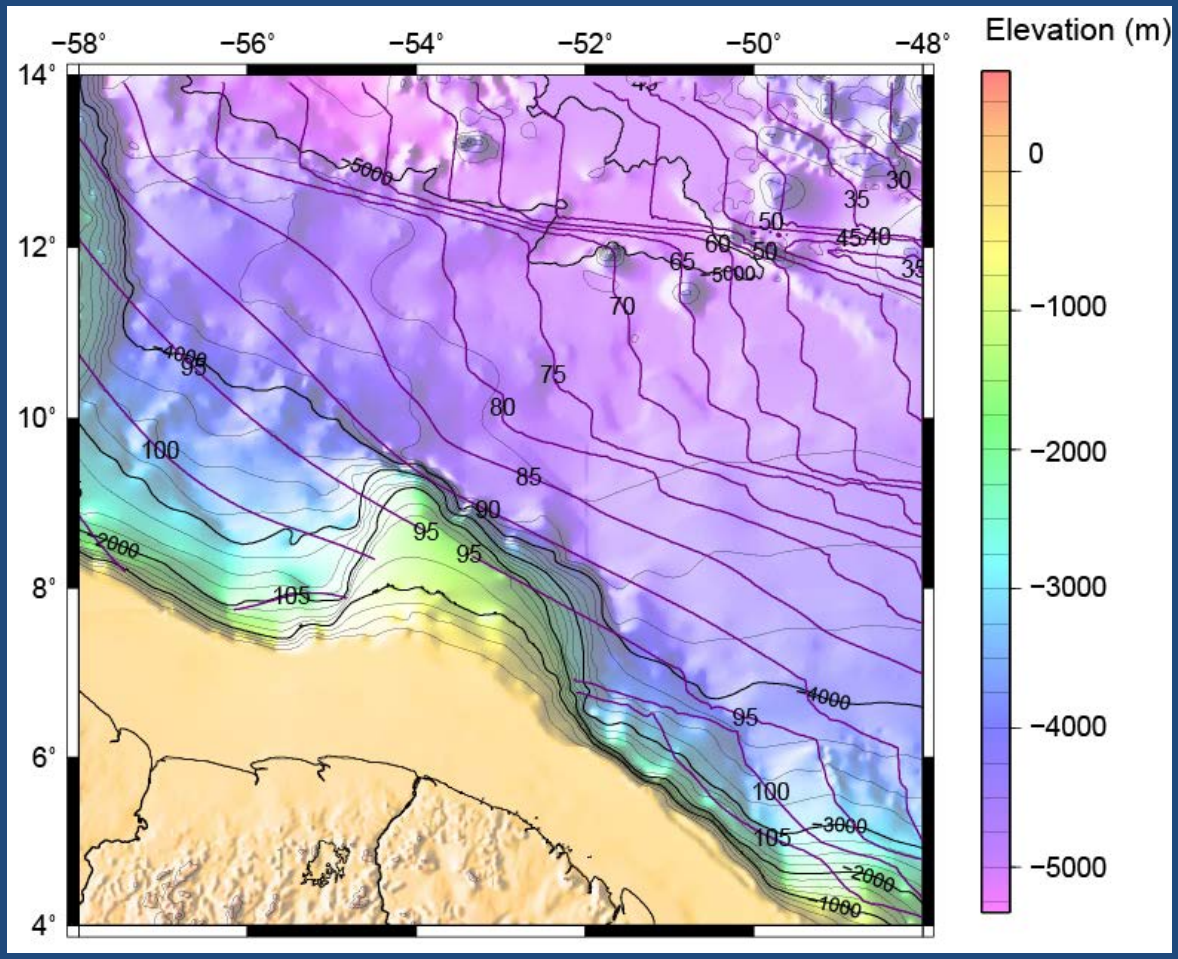
Bertrand et al., 2014



Next steps:

- Further processing of MARGATS seismic data (PhD Thesis)
- Cruise proposal DIADEM (Dive At Demerara) for 2019: Submersible Dives, Cores, ….
- New magnetic data compilation and refined plate kinematics

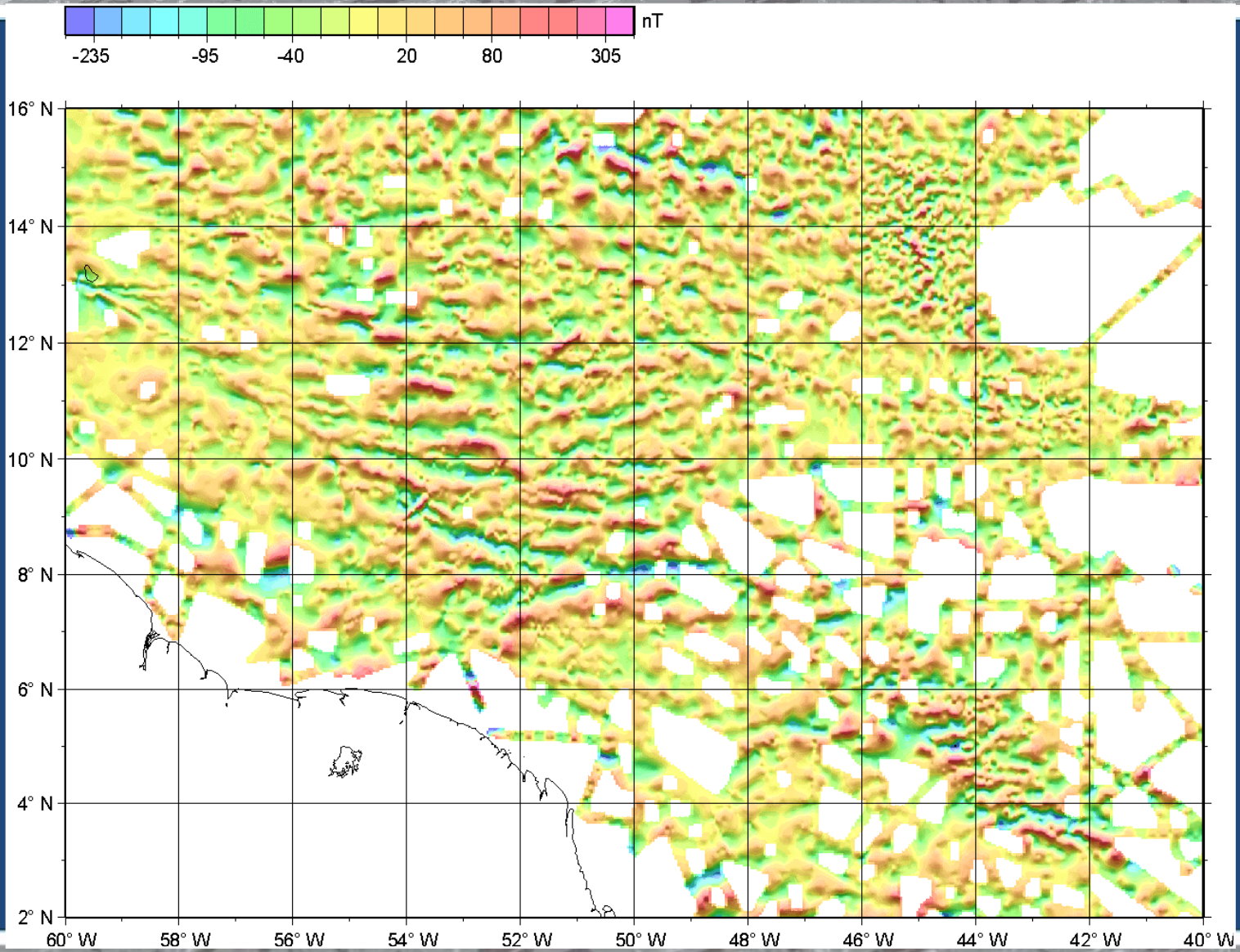
Magnetics of the margin and the Demerara Plateau

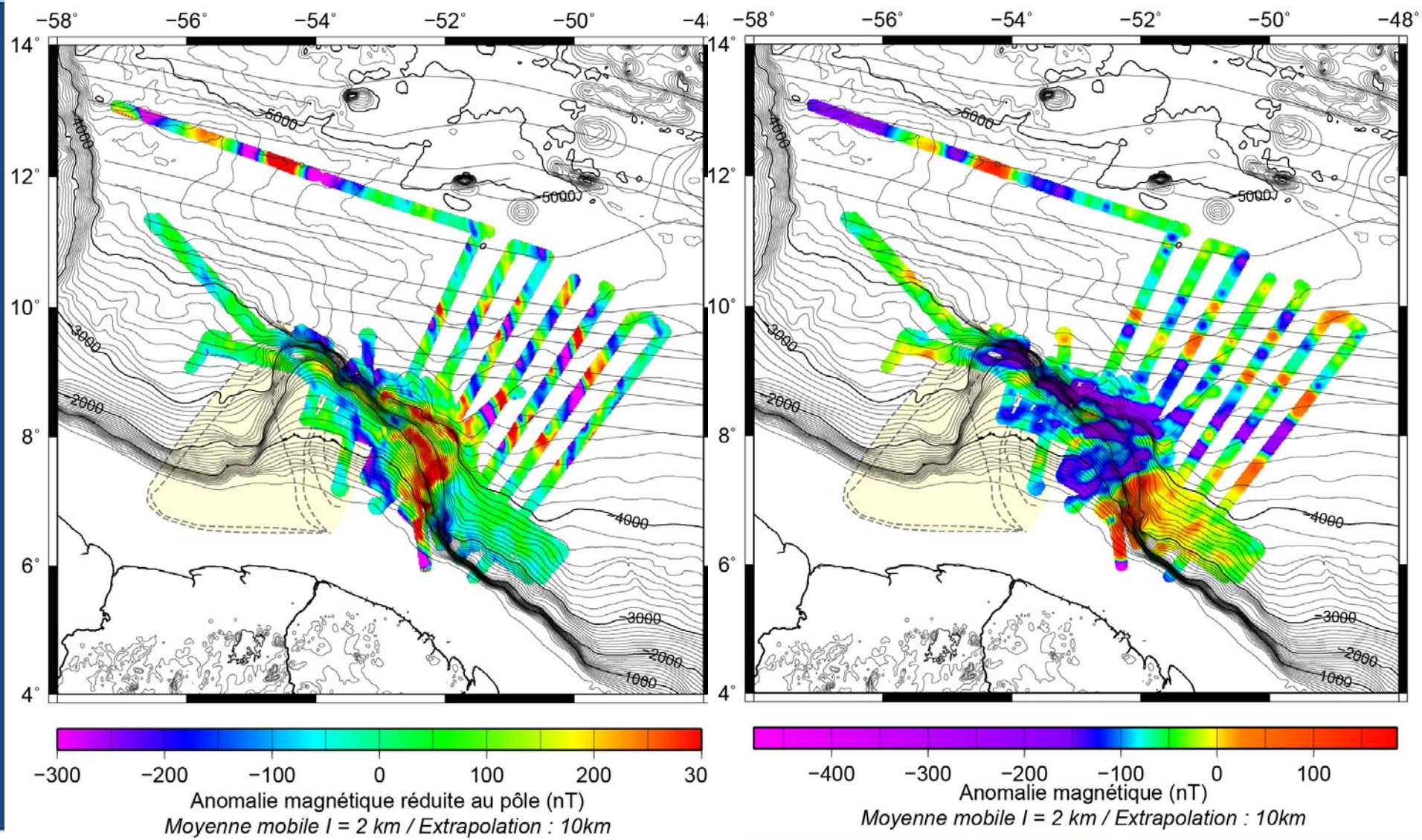


Chauvet, 2017

Isochrones océaniques (Müller et al., 2008)

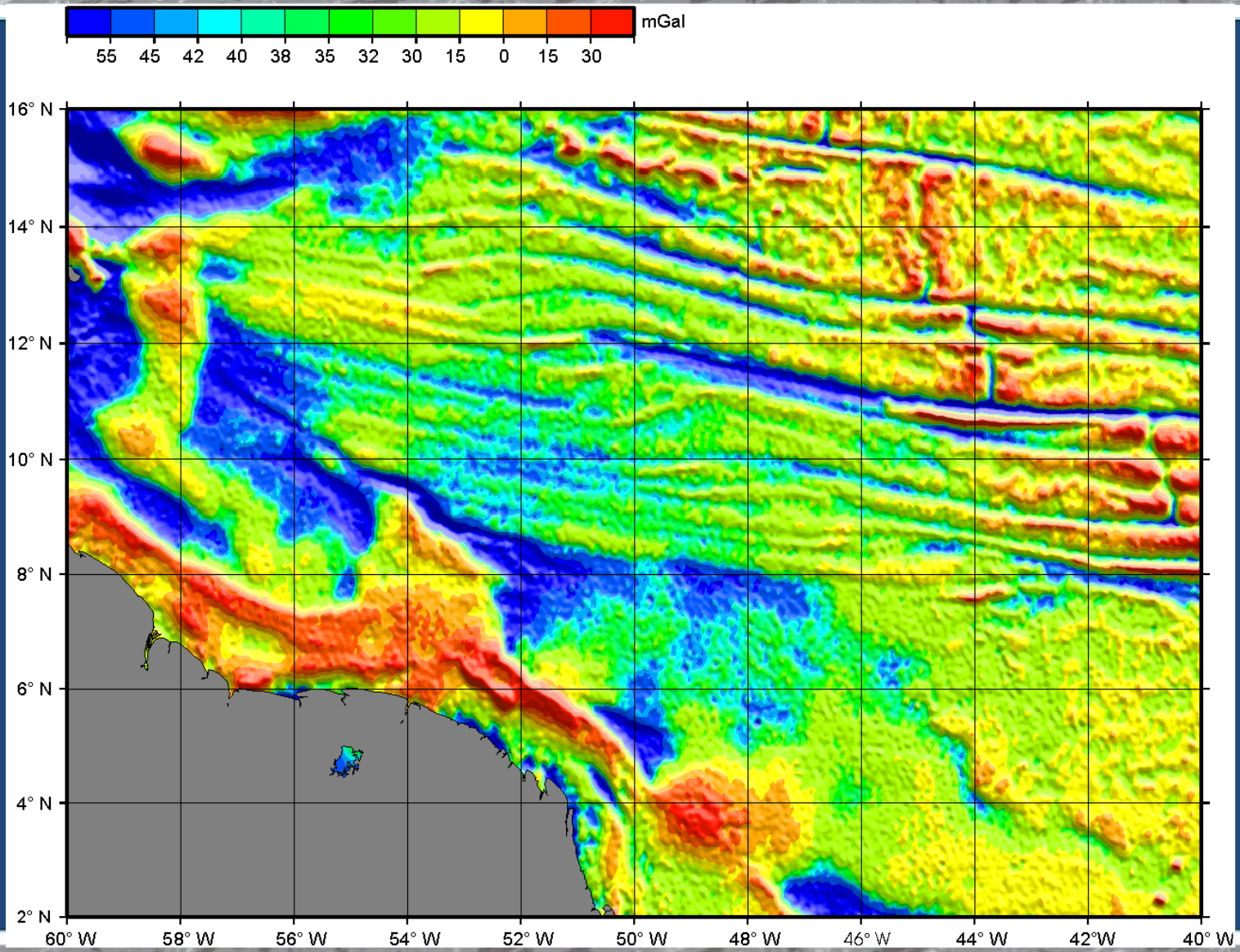
Magnetics


nT
-235
-95
-40
20
80
305
16° N
14° N
12° N
10° N
8° N
6° N
4° N
2° N
60° W
58° W
56° W
54° W
52° W
50° W
48° W
46° W
44° W
42° W
40° W



Chauvet, 2017

Gravity


mGal
55 45 42 40 38 35 32 30 15 0 15 30
16° N
14° N
12° N
10° N
8° N
6° N
4° N
2° N
60° W
58° W
56° W
54° W
52° W
50° W
48° W
46° W
44° W
42°W
40° W

CONCLUSIONS

- French ECS work has led to significant data acquisition, particularly in remote and poorly known overseas areas
- Sedimentary processes on the Demarara Plateau are characterised by large submarine landslides and contourites
- Demerara Plateau is a Volcanic Passive Margin segment with enigmatic deeper crust (LIP structure)
- Evolution of transform margins and marginal plateaus
- Results of IGUANES, DRADEM and MARGATS cruises are presented in talks and posters

PRESENTATIONS ON THE DEMERARA PLATEAU

Thomas Museur, Deep structure of the Demerara marginal plateau from MARGATS cruise academic wide-angle and multi-channel seismics, insights on the origin of the plateau

Christophe Basile, Where was the CAMP hotspot, and how it controlled the opening of the Central and Equatorial Atlantic oceans around the Demerara plateau

Anne Sophie Fanget, The Demerara Plateau: a case study of the initiation and evolution of a contourite depositional system on a marginal plateau

And 5 posters .