The Demerara Marginal Plateau: A Case Study of a Distal Marginal Plateau Dominated by Contouritic Processes and Gravity Instability*


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Abstract

Mercier de Lépinay et al. published in 2016 an updated inventory of transform passive margins in the world. This inventory shows that those margins represent 30% of continental passive margins and a cumulative length of 16% of non-convergent margins. It also highlights the fact that many submarine plateaus prolong transform continental margins, systematically at the junction of oceanic domains of different ages. In the world, we identified twenty of those continental submarine plateaus (Falklands, Voring, Demerara, Tasman, etc.). The understanding of the sedimentary evolution of those marginal plateaus has many scientific and economic issues.

The Demerara marginal plateau located off French Guiana and Surinam belongs to this category of submarine provinces. It is potentially fed by sediments from the Amazon, Orinoco, Maroni, and Oyapock rivers. The GUYAPLAC (2003), IGUANES (2013), MARGATS (2016), and DRADEM (2016) cruises allowed mapping the distal Demerara plateau with multibeam bathymetric data and acquiring high and very high resolution seismic data including chirp data. 20 piston cores were also collected during the IGUANES cruise that allowed to ground-truth and characterize deep sediments.

This dataset has been analyzed at different scales. The seismic analysis of the dataset shows that the distal plateau evolves through three evolutionary stages: (1) a “pre-contourite phase” from late Albian to early Miocene with depocenters highly influenced by the structure of the Northern transform-derived border of the plateau. Major unconformities record the Cretaceous/Tertiary re-suspension event, and the Paleocene/Eocene Thermal Maximum (PETM); (2) a transition period from middle Miocene to early Pliocene during which a major unconformity possibly records major changes in oceanic circulation and during which major gravitational events affected sediments down to Paleocene strata; and (3), a “contourite phase” during which strong bottom-currents shape the distal Demerara plateau. In particular, the
NADW (North Atlantic Deep Water) follows an older slope failure headscarp that is regularly and locally eroded during the Plio-Pleistocene. A contourite Depositional System made of a longitudinal moat and a drift has been mapped. Some pockmarks develop within this drift that is expressed at the scale of recent sedimentation on Chirp data. The analysis of current meter data recorded in the study area in a 8 month time period shows that the NADW is flowing parallel to the bathymetric contours at speeds reaching 32 cm/s. Core data allowed confirming the importance of contourite and mass-wasting processes in the recent (last 120-250 kyr) sedimentary evolution of this domain. Sedimentary sequences are clearly impacted by the variations of the NADW intensity and associated winnowing effect during glacial/interglacial cycles. In addition, in this area, periods of intense winnowing are marked by glauconitic neoformation. We suggest that the presence and degree of maturity of glaucony might be used as an effective proxy to study current variations depending on climatic oscillation. The next step of our program will be to better assess the sediment source – probably exclusively transported from the North by the NADW as illustrated by preliminary results.

References Cited


The Demerara marginal plateau: a case study of a distal marginal plateau dominated by contouritic processes and gravity instability


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1. Defining marginal plateaus and presentation of the Demerara plateau

The GUYAPLAC (2003), IGUANES (2013), MARGATS (2016) and DRADEM (2016) cruises allowed mapping the distal Demerara plateau with multibeam bathymetric data and acquiring high and very high resolution seismic data, including chirp data. 20 piston cores were also collected during the IGUANES cruise that allowed to ground-truth and characterize deep sediments. This dataset has been analyzed at different scales. The plateau is crossed by different water masses: The AHNW in the world, we identified twenty of those contourital plains. It is potentially fed by sediments from the Amazon, Orinoco, Maroni and Oyapock Rivers.

2. Available Dataset and hydrodynamic conditions

The bathymetric data (Figure 7) allows to identify different outstanding features: 1) a more than 250 km long linear slope failure headscarp that follows the edge of the plateau, 2) several elongated deformation (Figures 7 and 8), 3) hundreds of linear sedimentary ridges that develop parallel to the NADW. At the scale of Chirp and high resolution seismic data, sediment distributions are longitudinal evidencing the presence of a Contourite Depositional System (Figure 8). Some pockmarks develop within this drift that is expressed at the scale of recent sedimentation on Chirp data (Figures 8). The analysis of current meter data recorded in the study area in a 6 month time period shows that the NADW is flowing parallel to the bathymetric contours at speeds reaching 32 cm/s. Core data allowed confirming the importance of contourite and mass-wasting processes in the recent (last 120-250 kyr) sedimentary evolution of this domain. Sedimentary sequences are clearly impacted by the bathymetric contours at an 8 month time period shows that the NADW is flowing parallel to the bathymetric contours at speeds reaching 32 cm/s. Core data allowed confirming the importance of contourite and mass-wasting processes in the recent (last 120-250 kyr) sedimentary evolution of this domain. Sedimentary sequences are clearly impacted by the bathymetric contours at speeds reaching 32 cm/s. Core data allowed confirming the importance of contourite and mass-wasting processes in the recent (last 120-250 kyr) sedimentary evolution of this domain. Sedimentary sequences are clearly impacted by the bathymetric contours at speeds reaching 32 cm/s. Core data allowed confirming the importance of contourite and mass-wasting processes in the recent (last 120-250 kyr) sedimentary evolution of this domain.

Several questions remain:
- How do the comet tails develop? Above all, do they develop on top of a sedimentary high made of stacked transparent MTDs?
- How do contourite ridges develop parallel to the NADW direction?
- How do those comet tails develop above high winnowing periods?
- How do sediment ridges develop parallel to the NADW direction?
- How do those comet tails develop above high winnowing periods?
- How do sediment ridges develop parallel to the NADW direction?
- How do those comet tails develop above high winnowing periods?

And in the future? Nautile and AUV dives in 2019?

Elements of A contourite Depositional System

Interplay with slope instability and Fluid ascents


Figure 3: Location of the Demerara marginal Plateau, off French Guiana and Surinam belongs to this category of submarine plateaus. It is potentially fed by sediments from the Amazon, Orinoco, Maroni and Oyapock Rivers.


Figure 5: Bathymetric section (Mackelies, section A20) illustrating the distribution of water masses on the Demerara plateau. Schematic located on Figure 4.

Figure 6: Map of the Atlantic illustrating the general circulation of the main deep-water masses (based on Breda, 2011). NADW: North Atlantic Deep Water; AHNW: Antarctic Bottom Water.

Figure 7: IGUANES bathymetry chart showing the distal Demerara plateau and hundreds of elongated depressions on the seafloor (Loncke et al., 2016).

Figure 8: bathymetric details (a, b, c, d, e, f) showing the comet tails that develop on the seafloor as a result of interactions between the North Atlantic Deep Water current and subtropical highs (WTS-Maldives authigenic carbonates) (Loncke et al., 2016, Tallobre et al., 2016).

Figure 9: Bathymetric details (a, b, c, d, e) showing the comet tails that develop on the seafloor as a result of interactions between the North Atlantic Deep Water current and subtropical highs (WTS-Maldives authigenic carbonates) (Loncke et al., 2016, Tallobre et al., 2016).

Figure 10: Correlation between core tops and the generation of comet tails (Loncke et al., 2016).