Multidisciplinary Scientific Program of Investigations of the Demerara Marginal Plateau: from the Initial Formation under the Influence of the CAMP Hotspot and Transform Tectonics to Present-day Sedimentary Processes

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ABSTRACT

An updated inventory of transform passive continental margins in the world was published by Mercier de Lépinay et al. in 2016. This inventory shows that these margins represent 30% of passive continental margins and a cumulative length of 16% of non-convergent margins. The inventory also highlights the fact that many submarine plateaus prolong transform continental margins, systematically at the junction of oceanic domains of different ages. Globally, we identified twenty of these marginal submarine plateaus (Falklands, Voring, Demerara, Tasman, etc). They systematically experience two phases of deformation: a first extensional phase and a second transform phase that allows the individualization of those submarine reliefs appearing on bathymetry as seaward continental-like salients. Understanding of the origin, nature and evolution of those marginal plateaus has many scientific and economic implications.

The Demerara marginal plateau located off French Guiana and Surinam belongs to this category of submarine provinces. The French part of this plateau has been the locus of a first academic investigation in 2003 during the GUYAPLAC cruise dedicated to support the French delineation of the limits of the continental shelf beyond 200 nautical miles. This cruise was the starting point of a scientific program dedicated to geological investigations of the Demerara plateau, sustained by different cruises and collaborations: (1) IGUANES (2013) completed the mapping of this plateau including off Surinam, allowed to better understand the segmentation of the Northern edge of the plateau, and to demonstrate the combined importance of contourite and mass-wasting processes in the recent sedimentary evolution of this domain (see poster session); (2) Collaboration with TOTAL (PhD thesis of Mercier de Lépinay) to better qualify the two main phases of structural evolution of the plateau, respectively during Jurassic times for its Western border and Cretaceous times for its Northern and Eastern borders; (3) DRADEM (2016) (see poster session) mapped the continental slope domain of the transform margin north of the Demerara plateau and was dedicated to the dredging of rocks outcropping on the continental slope, suspected to be Cretaceous in age and older; (4) MARGATS (2016) (see poster session) dedicated to the better understanding of the internal structure of the plateau and its different margins using multi-channel reflection and refraction seismic methods.

The combination of all those experiments allow us to paint an integrated portrait of the Demerara marginal plateau – that may be very useful in understanding the processes involved (1) in the individualization of such plateaus (volcanism, heritages, kinematics, …) (2) in their evolution (subsidence, mass-wasting processes, domains of deep-sea current acceleration).

The Mesozoic evolution of the Demerara plateau appears to have been strongly influenced by an hot spot related to Central Atlantic Magmatic Province (CAMP). Emplaced 200 Ma ago, the CAMP is genetically linked to the opening of the Central Atlantic ocean. Magmatism related to

the CAMP is widespread from Bolivia to France, especially in the Guyana craton, West Africa and along the East Coast of the United States. Seaward Dipping Reflectors (SDR) along the Central Atlantic margins can also be related to the CAMP. This magmatism is currently related to a mantle plume. However, continental traps are missing, and the trace of the expected hot spot related to the CAMP was still not clearly identified.

From industrial seismic lines, it has been recently proposed that the Demerara and Guinea plateaus are not remnants of thinned continental crust, but consists mainly in thick magmatic stacked SDRs. Data from the dredging cruise DRADEM and from the seismic cruise MARGATS confirm the magmatic nature of the basement of the Demarara plateau (see posters). Geochemical analysis of the few recovered samples unambigously point out a Ocean Island Basalt (OIB) signature, and U/Pb dating of magmatic zircons indicates cristallisation at 173.4±1.6 Ma.

Based on these new petrological and geophysical data, we propose a kinematic model where a single hot spot can both be the source of the CAMP and take into account the magmatic occurrences in the area of Demerara plateau and conjugated Guinea plateau since 200 Ma. This kinematic reconstruction has huge implications on the nature of the basement, and the evolution of both heat flow and vertical displacement (uplift and subsidence) during the Cretaceous history of the Demerara area.

However, because the identification of magnetic anomalies in the southern Central Atlantic is still crude, when not inaccurate, one can expect that this kinematic model can be significantly improved after a reappraisal of the magnetic anomalies, and a new definition of the oceanic isochrons in the area. The next steps of our multidisciplinary research program include (1) a better understanding of these kinematic conditions in this domain (based on new observations including magnetic data) (2) a better knowledge of the geology of the slope domain by in situ observations with either a ROV or a manned submersible, (3) a better knowledge of the sedimentary environments associated with the outer plateau (in-situ observations and current measurements).