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Structure and evolution of the Demerara Plateau, offshore French Guiana: Rifting, tectonic inversion and post-rift tilting at transform–divergent margins intersection

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ABSTRACT

We present the structure and evolution of the eastern part of the Demerara plateau, offshore French Guiana, from the analysis of geophysical data collected during GUYAPLAC cruise. This area is located at the intersection of a transform segment and a divergent segment of a continental margin related to the Early Cretaceous opening of the Equatorial Atlantic. The main structures are NNE–SSW to NNW–SSE trending normal faults on the eastern edge of the plateau, and WNW–ESE to NW–SE trending acoustic basement ridges on its northern edge. When replaced in their Albian position, these structures appear to be parallel to the coeval oceanic accretion axis and transform faults, respectively. The most striking structures are related to a post-rift but syn-transform tectonic inversion, producing E–W to WNW–ESE trending folds, sealed by a regional unconformity. This shortening cannot be related to ridge push, but is probably related to a plate kinematic change 105 My ago, that modified the deformation in the vicinity of the transform fault. Late post-rift evolution also includes a significant Tertiary oceanward tilt of the edge of the Demerara plateau. The driving mechanism of this late tilt is unclear, but may be related to a lithospheric flexure resulting from the loading of the abyssal plain by the Orinoco and Amazon deep-sea fans.

1. Introduction

Formation and evolution of passive continental margins can be explained at regional scale by simple models of lithospheric thinning (McKenzie, 1978; Wernicke, 1985). However, these models do not encompass the numerous segments where the strike of the continental margin is not perpendicular to the plate divergence, as in oblique rifting, transfer zones, or along transform faults. Moreover, the post-rift evolution of numerous passive continental margins is not characterized only by a decreasing subsidence, but often show tectonic inversions (e.g. the Norwegian margin, Vagnes et al., 1998; US West Coast, Withjack et al., 1995; Angola, Hudec and Jackson, 2002).

We present in this paper a new data set of seismic reflection lines on the eastern part of the Demerara Plateau, offshore French Guiana (Fig. 1). The data were collected during GUYAPLAC cruise, performed in 2003 in the framework of the French program EXTRAPLAC to argue on the extension of the Exclusive Economic Zone. The main aims of this study are to discuss the role of obliquity in margin structure and evolution, and to describe the structures associated with the tectonic inversion experienced by this margin.

2. Geodynamic setting

The Demerara Plateau represents a bathymetric extension of the continental shelf offshore Guiana. Water depth increases progressively from South to North, with a steep slope at the northern transition with the abyssal plain, 180 miles (340 km) from the coast line, and a more gentle slope towards NE (Fig. 1).

The Demerara Plateau and its conjugated margin, the Guinean Plateau, are located at the intersection between two domains of the Atlantic Ocean (Fig. 2):

– The Central Atlantic Ocean, that opens since Jurassic times (Klitgord and Schouten, 1986). A very short (only few million years) but widespread magmatic event occurred 200 My ago, and created what has been referred as the Central Atlantic Magmatic Province (CAMP) (Marzoli et al., 1999). This magmatic event came before the oceanic accretion that started during Early Jurassic times in the northern part of the Central Atlantic (Sinemurian; Sahabi et al., 2004), and Middle Jurassic times in its southern part (Bathonian; Klitgord and Schouten, 1986). The Guinean

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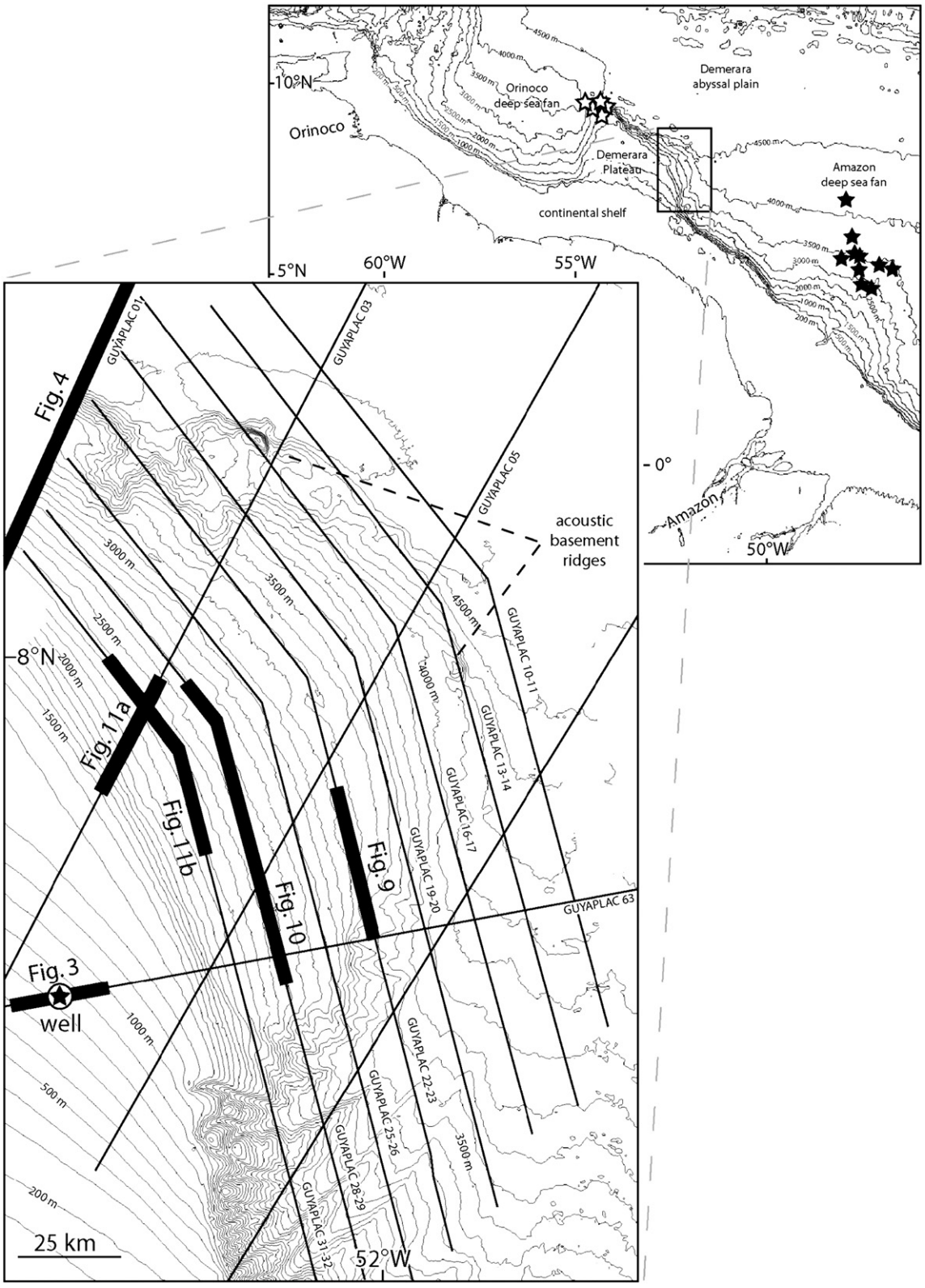

Fig. 1. Location of GUYAPLAC seismic lines in the eastern Demerara plateau. Bathymetry from GUYAPLAC cruise and SHOM data (equidistance 100 m). The upper box locates the Demerara plateau and the Orinoco and Amazon deep sea fans on the northern margin of South America. Stars indicate wells: open stars are sites from Leg ODP 207 (Shipboard Scientific Party, 2004), black stars are Leg ODP 155 sites (Flood et al., 1995), the circled black star locates industrial well G2 described by Gouyet (1988).

and Demerara Plateau were located East of the southernmost termination of the Central Atlantic Ocean, where the divergent plate boundary connected through a transform fault with another spreading axis located to the West in the Caribbean area. South and Southeast of this southern termination, there are only limited indications of Jurassic subsidence and continental sedimentation (Basile et al., 2005).

– The Equatorial Atlantic Ocean opened East of the Demerara Plateau during Early Cretaceous times (Fig. 2). This oceanic domain is characterized by the Chain, Romanche and Saint Paul transform