Burial, Uplift and Exhumation History of the Atlantic Margin of NE Brazil*

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Abstract

We have undertaken a regional study of landscape development and thermo-tectonic evolution of NE Brazil, which has implications for hydrocarbon prospectivity in the Early Cretaceous Recôncavo-Tucano rift and offshore basins. Our results – that are partly based on Apatite Fission-Track Analysis (AFTA) – reveal a long history of post-Devonian burial and exhumation across NE Brazil (Figure 1). Uplift movements just prior to and during rifting led to further regional denudation, to filling of rift basins and finally to formation of the Atlantic margin. The rifted margin was buried by a km-thick post-rift section, but exhumation began in the Late Cretaceous as a result of plate-scale forces. The Cretaceous cover probably extended over much of NE Brazil where it is still preserved over extensive areas. The Late Cretaceous exhumation event was followed by events in the Paleogene and Neogene.

The results of these events of uplift and exhumation are two regional peneplains that form steps in the landscape (Figure 2; see Bonow et al. 2009). The plateaux in the interior highlands are defined by the Higher Surface at c. 1 km above sea level. This surface formed by fluvial erosion after the Late Cretaceous event - and most likely after the Paleogene event – and thus formed as a Paleogene peneplain near sea level. This surface was reburied prior to the Neogene event, in the interior by continental deposits and along the Atlantic margin by marine and coastal deposits. Neogene uplift led to re-exposure of the Paleogene peneplain and to formation of the Lower Surface by incision along rivers, below the uplifted Higher Surface, that characterize the present landscape.

In the onshore rift basins, low thermal gradients mean that rocks at depths of 4 km or more lie within the oil window. Our results show no evidence of elevated heat flow during rifting; so hydrocarbon potential was not exhausted at an early stage in the basin history. Instead,

hydrocarbon generation ceased after maximum burial in the Late Cretaceous, but due to prolific source rocks and efficient traps, major hydrocarbon accumulations are present in the basins.

Our results show that the elevated landscapes along the Brazilian margin formed during the Neogene, c. 100 Myr after break-up (cf. Cobbold et al., 2001). Studies in West Greenland have demonstrated that similar landscapes formed during the late Neogene, c. 50 Myr after break-up (Bonow et al., 2006a, b; Japsen et al., 2006). Many passive continental margins around the world are characterized by such elevated plateaux and it thus seems possible, even likely, that they may also post-date rifting and continental separation by many Myr (Japsen et al., 2009).

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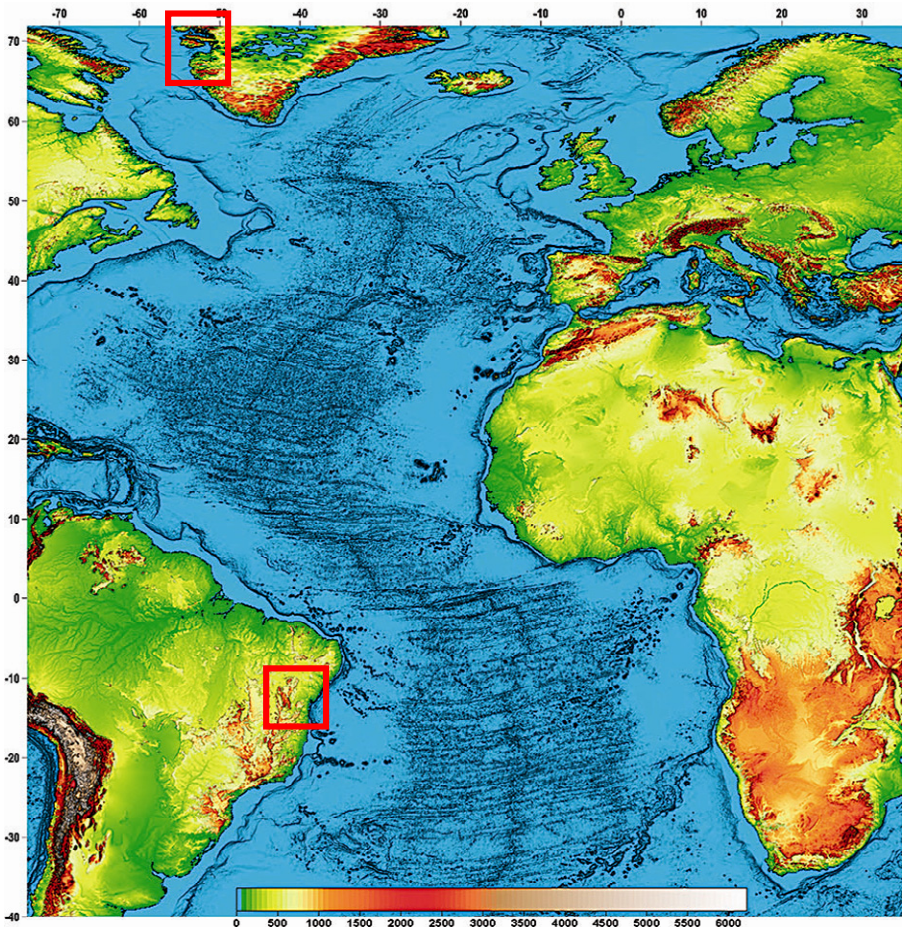

Figure 1. Topography of the Atlantic region with location of the study areas in Brazil and Greenland. Note that both elevated and low-lying, passive continental margins are found along the Atlantic Ocean. Thus, the present elevation of the margin cannot be a result of rifting and breakup, but must be caused by later processes. Studies of the West Greenland and Brazilian margin demonstrate that the present topography in these areas was formed tens of millions of years after breakup (Cobbold et al., 2001; Japsen et al., 2006, 2009; Bonow et al., 2009).

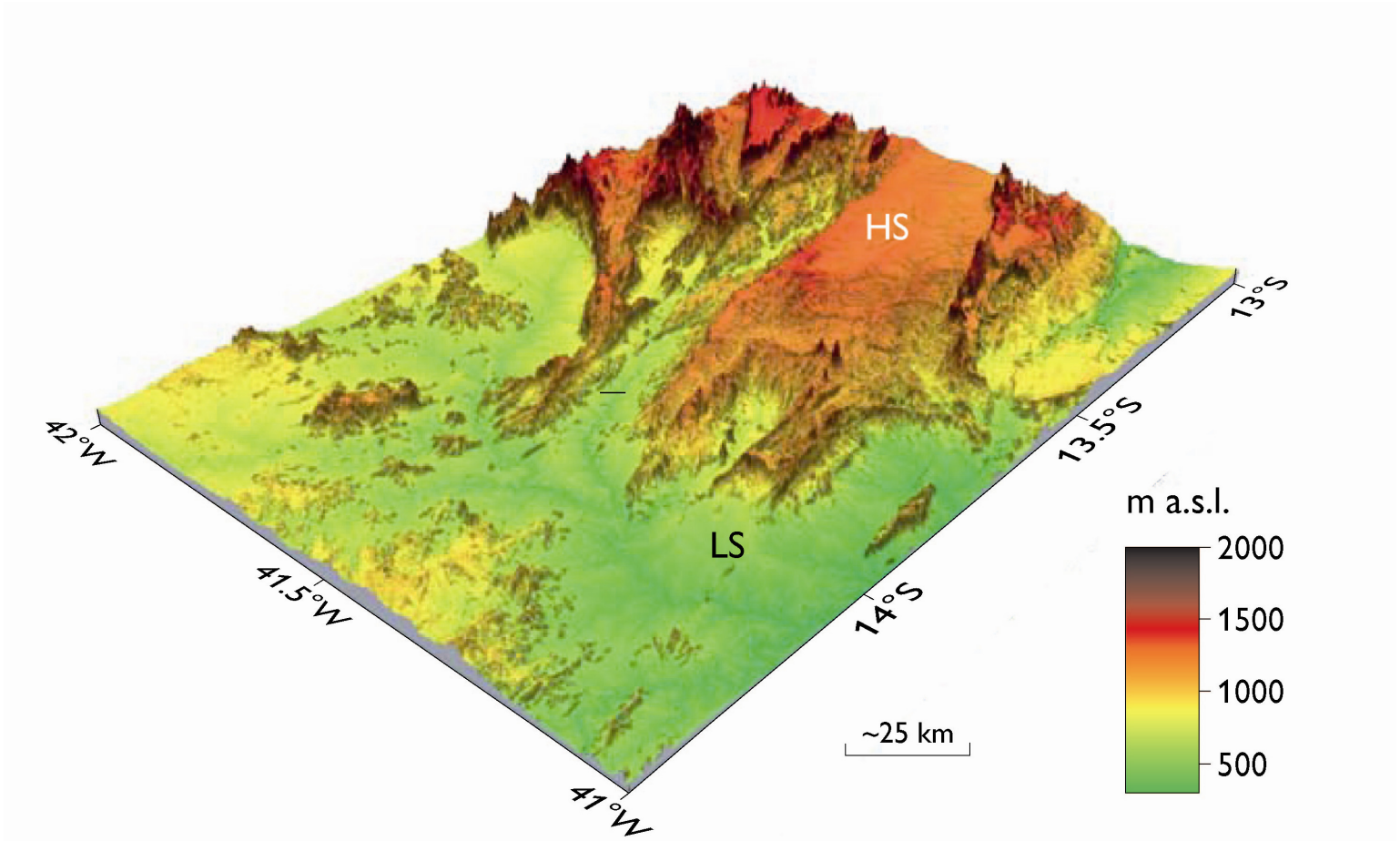

Figure 2. Digital terrain model with the Paleogene Higher Surface (HS) and the Neogene Lower Surface (LS) that are separated by escarpments in the Chapada Diamantina area, NE Brazil (location within red rectangle, Figure 1). The Higher Surface forms a coherent plateau at elevation of 1200–1400 m (reddish) with only minor valley incisions. This plateau is presently being dissected by rivers along the escarpment, eroding down to the Lower Surface, here at elevation of 500–400 m (greenish). Escarpments are also found above the Higher Surface; they may be representing steps towards older surfaces at higher elevations. Modified from Bonow et al. (2009).