

**AAPG Annual Meeting
March 10-13, 2002
Houston, Texas**

Morphologic and Structural Characterization of the Rio Grande do Norte State Northern Coast, Northeast Brazil, Based on Remote Sensing Images

Tabosa, Werner F., PPGG/UFRN - ANP-PRH22, Natal, RN; Vital, Helenice, DG/PPGG/UFRN/ ANP-PRH22 - CNPq Researcher, Natal,RN; Amaro, Venerando E., DG/PPGG/UFRN/ANP-PRH22, Natal, RN.

The present work corresponds to a morphologic and structural features analysis based on Landsat7-ETM+ images in the area of São Bento do Norte. This area is inserted in the Potiguar Basin geological domain, in the context of the Carnaubais fault. This domain belongs to a larger complex in PETROBRAS oil exploration research, among the trend of Carnaubais, Alto de Macau and the submerged portion of the basin. The area of São Bento do Norte appears in this context as being a key area, for the understanding of the sedimentologic and structural modeling. The coast line in this area is submitted to the continuous action of the trade winds, with direction from E to NE, responsible for the mechanism of the coastal drift and the transport of the coastal sands. It is possible that part of the effects is influencing directly the geoenvironmental features on the pole of oil production. The RGB321 and RGB521 Landsat-ETM+ triplets was used to characterize the submerged portion. They stood out mainly structural elements and morphologic geometry of bed forms and sand waves with crests oriented mainly NE-SW parallel to beachrocks belts and the coastline. These bed forms may be a key processes of hydrodynamic conditions of the coastal area between São Bento do Norte and Macau. The formation and evolution of these features are probably associated to the Carnaubais fault system. Similar forms, as the Galinhos and Ponta do Tubarão spits, are present in areas of oil and gas exploration.

Introduction

The present work corresponds to an analysis of the structural and morphological features based on Landsat and SPOT digital images processing in São Bento do Norte area. The shelf morphology of the São Bento do Norte area is a representative one of the northeastern Brazil (Fig. 1). It is shallow with an average width of 18 km where reach the slope with a maximum depth of 40 m and than the depth increases abruptly to oceanic depths. This area is inserted in the Potiguar Basin geological domain, in the

Carnaubais fault system context, and in the limit east of the PETROBRAS oil exploration research area. The São Bento do Norte area play an important role in the structural and sedimentologic modeling understanding on this portion of Northeastern Brazilian coast. Here, the coast line is directly submitted to the continuous action of the E to NE direction trade winds. In such areas the winds act in two important ways: 1) increasing the coastal drift mechanism, responsible for the coastal sand transport; and 2) transporting the sands of the beach face to the coastal dunes formation (Vital *et al.*, 2000). Facing these elements it is possible that most of the effects originated in this area have a direct influence on geoenvironmental characteristics of the PETROBRAS oil and gas fields.

Methodology

The majority of satellites sensors in activity use electromagnetic spectrum ranges from the visible region (0.4 to 0.7 μm) to reflected and thermal infrared bands (0,7 to 14,7 μm) to terrestrial resources and coastal monitoring studies. This background information on remote sensing and spectral properties of surface material sets the methodology stage for applying the visual/digital interpretation of two satellite images from Landsat 5-TM (WRS 215/064, acquired on August 02/1998) and Landsat 7-ETM+ (WRS 215/064, acquired on June12/2000). The Landsat multispectral images interpretation is based on recognition of distinctive spectral characteristics of seawater, soils, vegetation and rocks outcrops. Enhanced images of these multispectral bands can be obtained combining three selected bands in a color system as RGB (red-green-blue additive system). The advantage is that human vision can easily delineate colors contrast. The visual evaluation of some possible triplets emphasized RGB321 (Fig. 2) and RGB521 (Fig. 3) color composites as the most useful to fulfill the landscape units thematic mapping coastal features characterization, and some regional indicators of the relationship between geomorphology and structural patterns in the area. Digital

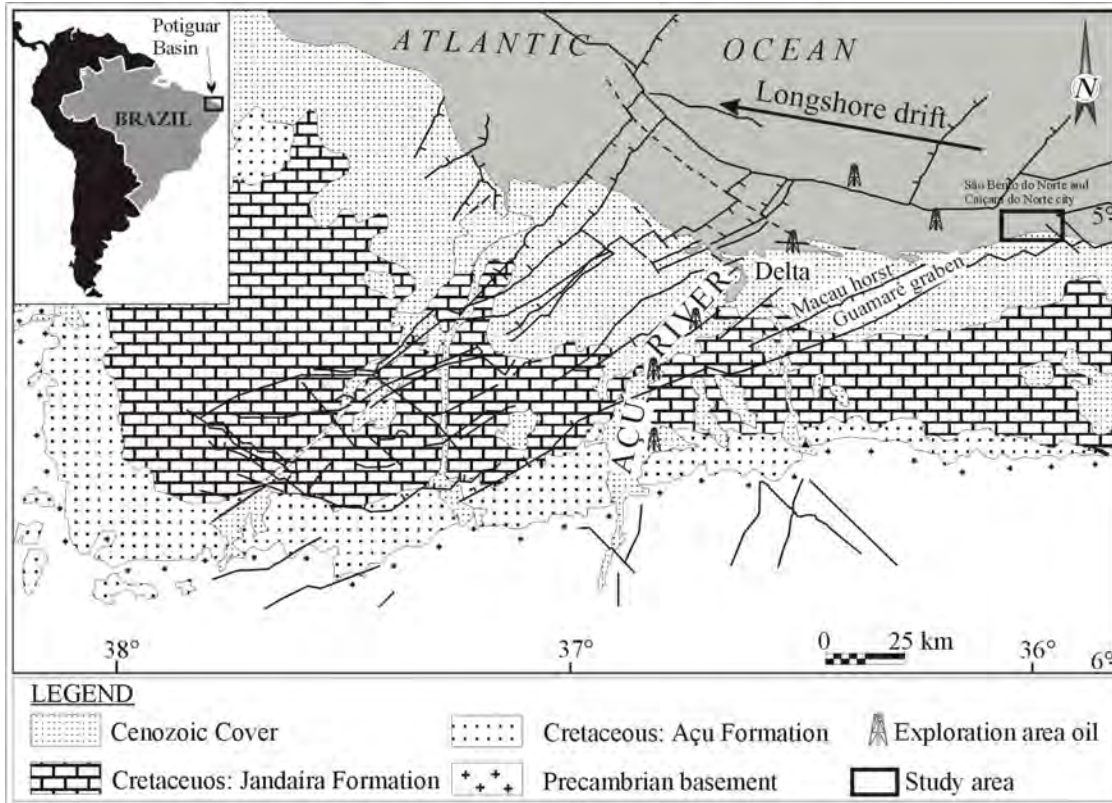


Figure 1 - Geographical location of the studied area.

image-processing included contrast enhancement methods applied in single bands to improve the contrast of the original brightness values for highlighting landscape units distinction. The best effect was obtained with uniform distribution stretch (histogram equalization) that redistributed pixels to the most range of brightness values. The exceptional Landsat color composites were the construction base of large scales thematic maps despite the spatial resolution of 30 m. The images and maps integration demonstrated that beyond features qualification it was possible to semi-quantify the most common aspects of environmental changes due to physical parameters (eg. tide, currents, wind) in the coastal area.

Results and Conclusions

The principal aim was to recognize all sorts of landscape units with their appropriate fitting to morphologic and structural patterns in the area. The digital comparison between both scenes allowed the identification of major changes in shoreline and coastline hydrodynamic features formation, also working as a guide for geodynamic evolution comprehension. Digital image processing techniques were applied to multispectral bands of both scenes to emphasize quality interpretation. On the resulting images, visual analysis pointed out the RGB321 and RGB521 color composites as the

best to solve the major problems. The RGB321 image (Fig. 2) assigned spectral reflectance of turbid water (sands/clays plumes) and sedimentation patterns which suggest longshore drift to the west. The RGB521 image (Fig. 3) enhanced seafloor features related to hydrodynamic conditions and/or structural patterns control. Taking into account the observed results in the RGB321 and RGB521 images, as well as field observations and sediment samples, a spatial configuration of the landscape units in the coastal area and sea bottom morphology was obtained. The presence of a great scale submerged bank stand out in the portion far east of the area (Vital *et al.*, 2001). This feature seems to be associated to the Carnaubais fault system (Tabosa *et al.*, 2001). It has important implications to the hydrodynamic processes of the whole coastal area along the PETROBRAS oil fields by the currents deflection and waves diffraction promoting depositional areas such as the Galinhos and Ponta do Tubarão spits and erosional ones such Caiçara do Norte.

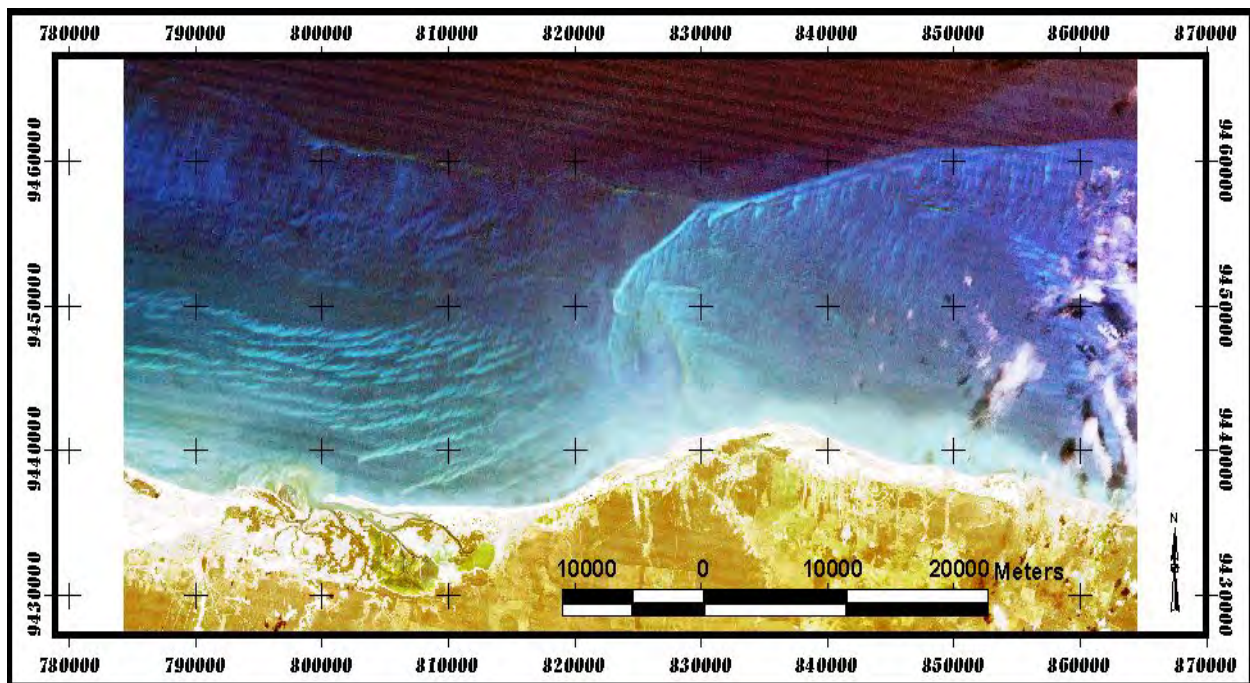


Figure 2 – RGB321 Landsat-ETM+ (WRS 215/064, acquired on June12, 2000, low tide 7:41Hrs/AM and Landsat tracking path around 10:00 Hrs/AM), image triplets showing sediment plumes and sedimentation patterns suggesting longshore drift to the west.

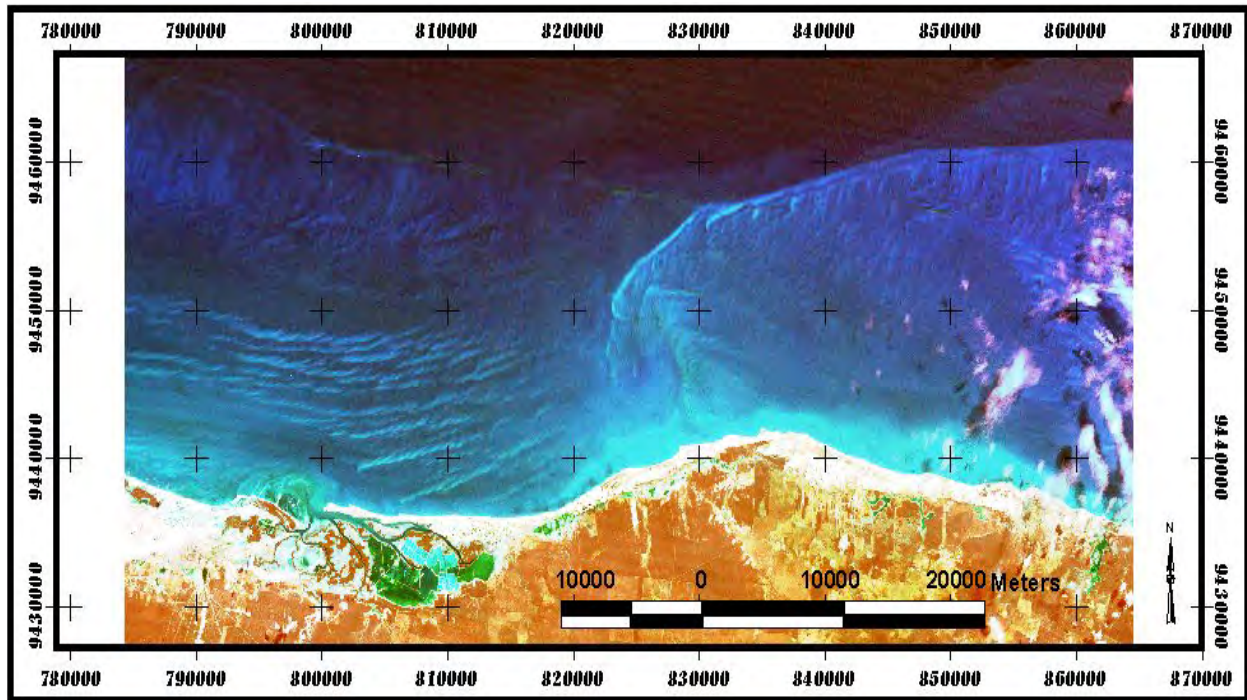


Figure 3 - The combination RGB521 Landsat-ETM+ (WRS 215/064, acquired on June 12, 2000, low tide 7:41 Hrs/AM and Landsat tracking path around 10:00 Hrs/AM), was used mainly to characterize seafloor features related to hydrodynamic and structural patterns control.

References:

TABOSA, W.F.; CALDAS, L.H.O; VITAL. H.; AMARO, V.E.; 2001. Remote Sensing of the Northeastern Brazilian Continental Margin (São Bento do Norte / Caiçara do Norte). The American Geophysical Union. Chapman Conference on the Formation of Sedimentary Strata on Continental Margins. Ponce, Puerto Rico. P.37

VITAL. H.; TABOSA, W.F.; STATTEGGER, K.; CALDAS, L.H.O; 2001. Tectonics and Bottom Morphology Control on Sediment Distribution in the Brazilian Northeastern Continental Margin: São Bento do Norte / Caiçara do Norte Area. The American Geophysical Union. Chapman Conference on the Formation of Sedimentary Strata on Continental Margins. Ponce, Puerto Rico. P.37

VITAL, H.; STATTEGGER, K.; TABOSA, W.F.; RIEDEL, K.; 2000. Why Does Erosion Occur on the Northeastern Coast of Brazil?: The Caiçara do Norte Beach Example. Submetido ao Journal of Coastal Research.

Acknowledgments

The authors thanks the Universidade Federal do Rio Grande do Norte / Programa de Pós-Graduação em Geodinâmica e Geofísica and the ANP/ PRH 22 by the mastership to the first author. This study is supported by the CNPq-CTPETRO grant number 468045/00-7 (Project MAMBMARE), PROBRAL 72/98 (CAPES-DAAD), e “Küstenentwicklung und heutige Küstendinamik in Rio Grande do Norte – NE Brazilian” (GTZ / DFG).

Keywords: remote sensing, coast line, geoenvironmental, morphology, Northeastern Brazil

Abbreviations used: DG – Departamento de Geologia, DFTE – Departamento de Física Teórica e Experimental, PPGG – Programa de Pos-Graduação em Geodinâmica e Geofísica, UFRN – Universidade Federal do Rio Grande do Norte, ANP – Agencia Nacional do Petróleo.