

# Evidence for tectonic reactivations in the Marajó Island (northern Brazil) during the Quaternary: integrating remote sensing and sedimentological data

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**Abstract.** This work aims to provide data for contributing to the reconstruction of the Quaternary tectono-sedimentary history of one of the largest fluvial Island in the world, the Marajó Island at the mouth of Amazon River. The study was based on the integration of remote sensing and geological fieldwork. The results show that the complex interaction of NW-SE, NE-SW, NNW/N/NNE-SSE/S/SSW, E-W/ENE-WSW/ESE-WNW lineaments culminated with the detachment of the Marajó Island from mainland.

**Key-words:** SRTM, Landsat, Tectonics, geological history, Marajó Island, Quaternary

## 1. Introduction

Fault reactivations have imposed a strong control on the orientation of the lowland Amazon rivers, as well as of their tributaries (RADAM 1974, Bemerguy 1981). However, detailed mapping of the structural lineaments in this area is incomplete. This work aims to present evidences of seismic activity in the eastern Marajó Island (**Figure 1**) during the Quaternary, taking into account integration of geomorphological data derived from spatial analysis and sedimentological data obtained from outcrops and cores. This type of approach might contribute to better understand the origin and evolution of one of the largest fluvial island in the world. In addition, it will bring elements to help reconstructing the intriguing network of paleochannels that typify its morphology, and which represents one of the best records of Quaternary events in northern Brazil.

## 2. Methodology

The structural lineaments (**Figure 1**) were traced with basis on Landsat 5-TM (Ref. 224-060 and 225-061, INPE) and Landsat 7-ETM (Ref. 223-060 and 223-061, GLCF) images, collected in August/2001, as well as SRTM-90 m topographic data distributed by the USGS. The latter were visualized accordingly using customized shade schemes and palettes to efficiently highlight the morphologic features. Image interpretation of elevation data was made possible by the use of the software Global Mapper (Global

Mapper Software LLC). The spatial data were combined with drainage maps available from SIPAM/SIVAM.

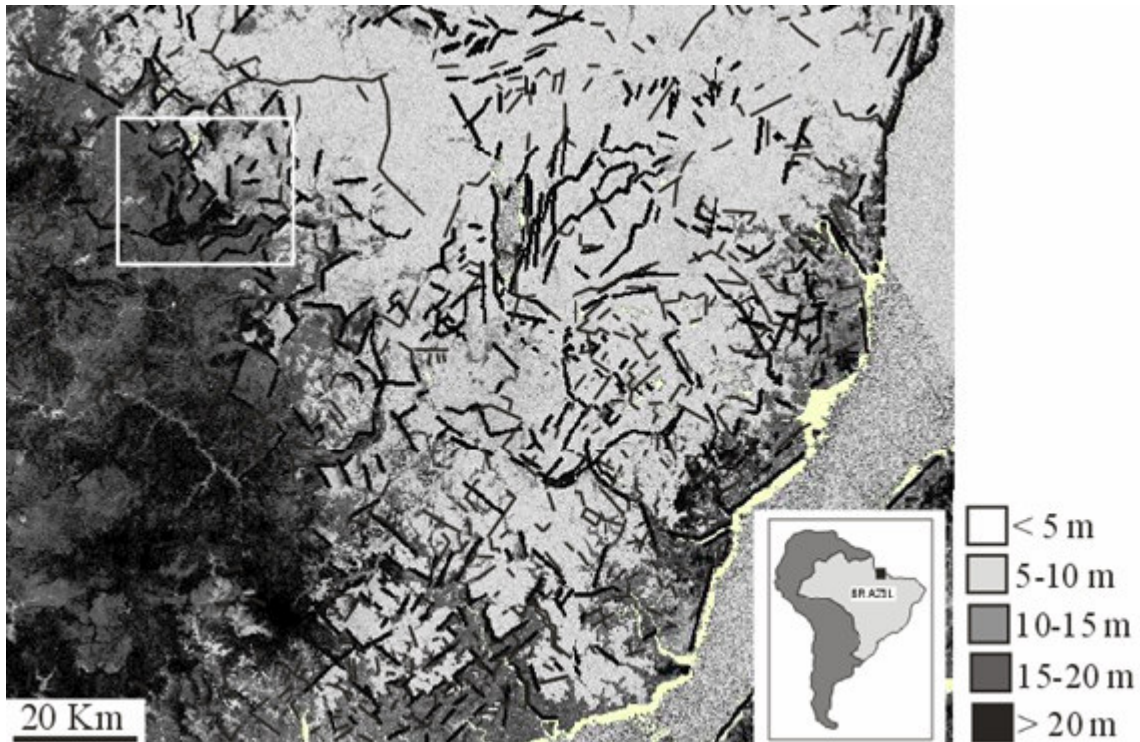


Figure 1: SRTM topographic data from the eastern Marajó Island, with the corresponding tectonic lineaments mapped from the integrated analysis of modern and paleodrainage systems. Inside box locates figure 2.

The fieldwork consisted of sedimentological data based on descriptions of few outcrops along ephemeral river banks and farm dams, which were combined with data obtained from cores collected on a continuous basis using a RKS percussion drilling system, model COBRA mk1, and a LONGYAR 40 drilling system, respectively. The subsurface data available for this study included ten drills averaging 18 m of depth, and one drill that reached 120 m of depth. The cores ranged from 4.5 to 6.0 cm of diameter.

### 3. Results

The integrated study presented herein helped to propose that, despite the location in a passive continental margin, the Marajó Island was characterized by great tectonic and sedimentary dynamism throughout the Quaternary. Four main groups of tectonic lineaments, orientated to the NNW/N/NNE-SSE/S/SSW, NW-SE, NE-SW and E-W/ENE-WSW/ESE-WNW, were recognized. Physical relationships among these features provide elements for discussing the succession of events. This procedure led to the recognition of an important tectonic phase producing NNW/N/NNE-SSE/S/SSW lineaments that predate all the other tectonic phases. Subsequent events resulted in more widespread deformation in the NW-SE, and then NE-SW directions, with the first having

caused a slight depression of the eastern side of Marajó Island (**Figure 2**). E-W/ENE-WSW/ESE-WNW lineaments might have developed in different phases, both predating and post-dating the other tectonic events (**Figure 3**).

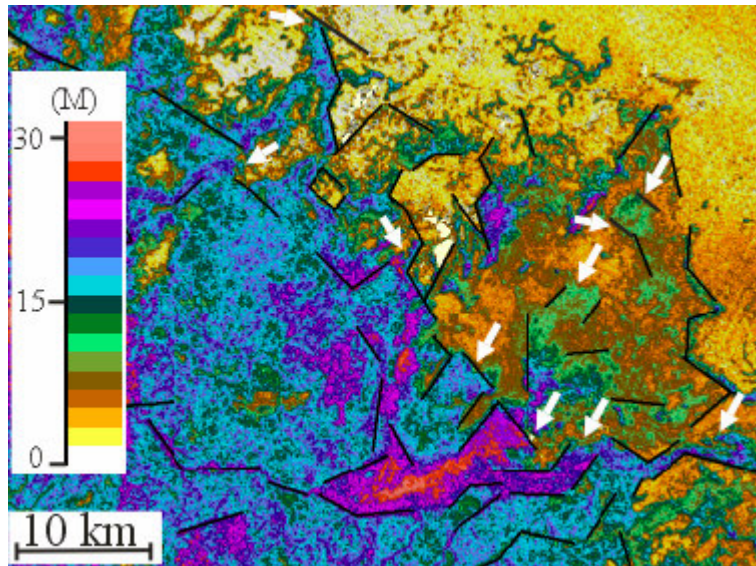


Figure 2: NW-SE tectonic lineaments (black lines) define two physiographic compartments in the Marajó Island, with the lowest SRTM topographic values (mostly yellow to brown) been recorded to the east. Note that these lineaments sharply disrupted (white arrows) many of the paleochannel, some of them displaying E-W/ENE-WSW/ESE-WNW straight segments.

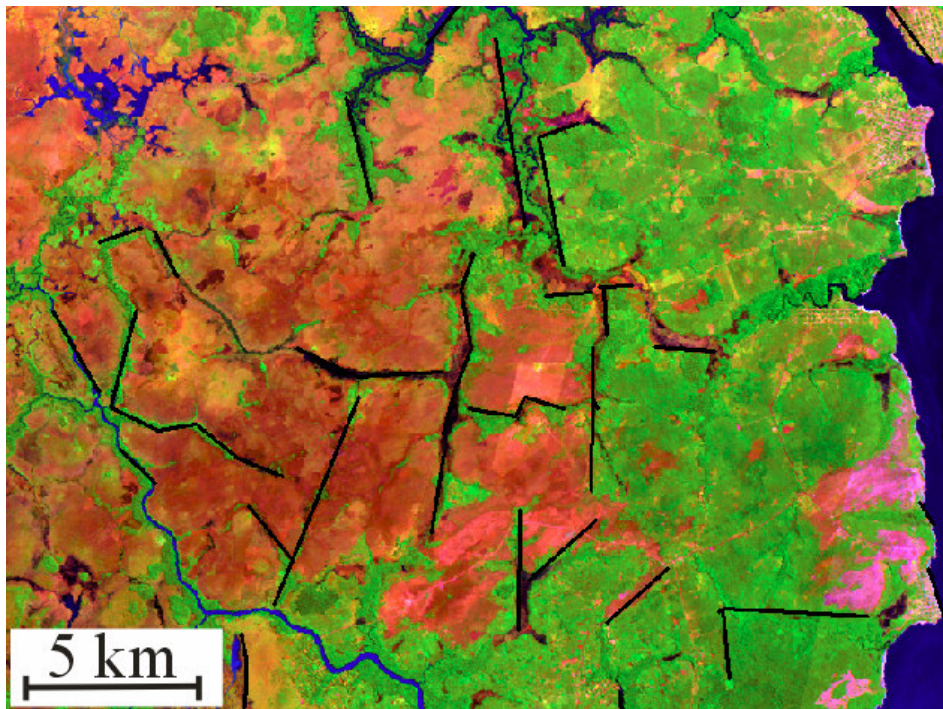




Figure 3: E-W/ENE-WSW/ESE-WNW lineaments that disrupt NNW/SSE lineaments, and are in turn disrupted by NNE-SSW lineaments, eastern side of the Marajó Island. (Landsat image, RGB 543).

#### 4. Conclusions

Many previous publications have proposed that the Quaternary history of the Marajó Island was strongly controlled by tectonics, which is in accordance with major tectonic events proposed for the Brazilian Amazon region during the Cenozoic (e.g., Costa and Hasui 1997; Costa *et al.* 1993, 1995, 2002; Bemerguy *et al.* 2002). The remote sensing information presented herein, combined with sedimentological studies, represent an effort to provide data supporting that these tectonic events were contemporaneous to sedimentation, having a great control on the evolution of the depositional systems. Tectonics would have favored the development of subsiding areas, and created sites to accommodate new sediments. As the study area remained tectonically unstable during sedimentation, thick horizons of deposits strongly marked by abundant soft sediment deformation structures were formed. A complex network of tectonic lineaments controlled and/or modified the course of channels in both the modern and the paleodrainage systems. This tectono-sedimentary evolution took place in different phases, as recorded by the four successive trends of lineaments recognized in the study area. Main tectonic episodes seem to have been related to reactivations of NW-SE and NE-SW orientated fault zones, with the first been responsible for a slight depression of the eastern half of the Marajó Island with the consequent renewal of sedimentation during the Holocene. Interaction of lineaments having these orientations produced many subsiding areas that still act as depositional locus during seasonal floodings. The complex interaction of NW-SE, NE-SW, NNW/N/NNE-SSE/S/SSW, E-W/ENE-WSW/ESE-WNW lineaments culminated with the detachment of the Marajó Island from mainland. Although dating of individual events is not available, radiocarbon dating reveals that this tectono-sedimentary history took place even during the last 40,000 yr. B.P.

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