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LOWERMOST AMAZON RIVER: AN OVERVIEW

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Sedimentological, geochemical and high-resolution seismic studies conducted on the lowermost Amazon River during 1989-1996 by the author allow the characterization of strata preserved in this unknown portion of the Amazon.

Vital (1996) and Vital et al.(1998) subdivide the lowermost Amazon into five areas based on the riverbed morphology observed by high-resolution bathymetric, shallow seismic reflection and side-scan sonar analysis: Xingu Mouth (XM), Amazon North Branch (ANB), Amazon South Branch (ASB), Estreitos (EST) and Jari Mouth (JM). These techniques were utilized with success and they made possible to discover a variety of reflectors delineating areas either of sediment transport or of deposition on an older river bottom.

According to channel morphology and acoustic patterns, the lowermost Amazon can be divided into areas of low energy conditions and areas of high energy conditions with intense sediment transport in form of sandwaves. Zones of erosion can frequently be observed along steep channel margins. Changes in acoustic impedance and the presence of reflectors are caused by changes in grain size and the corresponding effects on porosity, as well as by the effects of consolidation on porosity, identifiable both in profile and as a tonal contrast on side-scan record resulting from the changing bottom slope and textural character of the sediment.

In the Xingu Mouth and the Jari Mouth, deposition of fine grained sediments predominates, while intense sediment transport with temporary deposition of sand prevails in other areas. The Amazon North

Branch is characterized by more than one scour and Amazon South Branch by a main scour on the NW side; both ANB and ASB have wide and steep channel walls. In the Estreitos area the channels are narrow, long, and deeply incised into older fine-grained sediments (fine silt to clay) which allow a greater penetration of seismic signals.

In high energy areas, the lowermost Amazon is covered by a sandy layer (very fine to fine sand, which varies locally to medium-coarse sand) in the channel and silt close to the margin. Generally asymmetrical sandwaves are observed in the upper part of the lower delta plain whereas symmetrical sandwaves prevail in its lower part, indicating sediment transport by downstream directed bottom currents as well as by tidal effects. Sediment transport studies for the Amazon River have demonstrated that the sediment is stored in its bed during stages of rising water, and released during high and falling water (Meade et al., 1985). This fits well with our observations of the seasonal variability of the riverbed, which shows a remarkable net erosion from rising to low discharge. In addition, the widespread occurrence of high-energy conditions on the Amazon delta plain may be caused by the uplift of the Gurupa structural arch leading to increased surface slopes with a relatively straight main channel locked in position (Mertes et al., 1996).

Below the surface layer, a minimum of 3 units was indicated by seismic records and could be related to sea level fluctuations and changes in the river discharge. Reflectors are more common downstream, mainly in ASB and EST. This might be related to relatively weak currents in these areas, which allow more strata to be preserved. Dating from the different units would also be important in order to define the chronology of sediment storage in the area.

Where deposition occurs (on the flanks of the river channel and at the mouths of tributaries entering the Amazon), we can observe acoustically transparent sediments - consisting of soft silt or muddy silt - overlying strong subbottom reflectors, which might be related to older deposits. This reflects inundation and incision caused by Quaternary rising and falling of the sea-level.

Moreover, the detection of fault scarps interpreted as results of neotectonic activities shows that neotectonic activities can be important locally and should not be ignored as a possible reason for modern river instability. Neotectonic features in this area are strongly related to the geometry of the basement structures.

Suspended sediment concentration measurements show that net deposition occurs on the delta plain (between Obidos and the Xingu River), while downstream suspended sediment transport remains approximately constant, and the surficial sedimentation through lateral sediment input keeps this region in a dynamic equilibrium.

In the Amazon the "corridor of sand" is predominantly very fine sand, that can vary laterally to fine and only rarely to medium-coarse sand. Generally, grain size tends to decrease from the scour, where the coarsest size is found, to the channel margin, where fine particles are deposited as water velocity decreases and the flow stagnates, although there is no significant change in texture downstream. In the Estreitos, the corridor of sands changes from very fine sand at its extremities (close to the Amazon and the Para Rivers) to fine and medium sand in the central part. Differences in texture from silty sediments bordering the sands are also observed: while in the Amazon they are mostly coarse silt, in the Estreitos they are essentially fine silt

Sediments collected from the lowermost Amazon River contain illite, kaolinite and montmorillonite as their dominant clay minerals, Hornblende-epidote-pyroxene together with various portions of stable minerals, mainly zircon, form the heavy mineral suite. Both, clay and heavy mineral assemblages are used as provenance indicators (Vital, Stattegger & Garbe-Schönberg, 1999).

Illite, chlorite and montmorillonite reflect mountainous sources under physical weathering conditions, kaolinite reflects soil composition under humid tropical conditions, where chemical weathering predominates. Clayey sediments carried in suspension are derived from the mountainous Andean regions, and from weathered Precambrian shield areas within the Amazon Basin.

Due to the location of this area in an intensive chemical weathering environment chemical weathering processes strongly modify the original sediment composition and can be recognized apart from the provenance processes by the geochemical signature. Sediments from the lowermost Amazon River are characterized by an enrichment of quartz and a depletion of chemically unstable grains in the sands, indicating a highly recycled nature and or extreme chemical weathering. The muds, on the other hand, contain high concentrations of major cations reflecting a diverse mineralogy (micas, clay minerals, feldspar).

Two morphogenetic phases have been described in the Amazon Plain (Iriondo, 1982) based on radar maps: (1) a low-to-middle Holocene phase, characterized by development of bar-and-meander plains, flood deposits and estuarine deposits; and (2) a present phase, with extensive bar-and-meander plains. The morphogenetic factors in both phases are controlled by the hydrological regime (discharge decrease during the middle Holocene period) and neotectonic movements. This agrees with the hypothesis to associate these changes to climatic disturbances caused by El Niño / El Niño-like phenomena. El Niño-like conditions are past average climate situations that generate the same perturbations as the strong El Niño events observed during the last decade. They are likely to correspond to the long-duration low phase of the Southern Oscillation.

In the upper delta plain of the Amazon we have evidence of high sedimentation rates (0.6 cm/year) for the last 800 years, whereas the overconsolitated river substrate is between 9000 and 13000 years old (Vital & Stattegger, 1999). Partly different variations in erosion and accumulation of the sediment on the shoreline as well as on the shelf during the Holocene are related to the distribution of fluid mud released from the Amazon and therefore dependent on the oceanic conditions that control fluid-mud distribution (Nittrouer & Kuehl, 1995).

Although relative sea-level curves for the last 7000 years have been constructed for several sections of the Brazilian coast no one is available for the north Brazilian sector. While the sea-level history of the Surinam margin suggests stable sea-level conditions there since the last 6000 years, the central part of the Brazilian coast was in prograding submersion until about 5.100 years BP, and, disregarding two rapid oscillations, in slight regression and uplift since then.

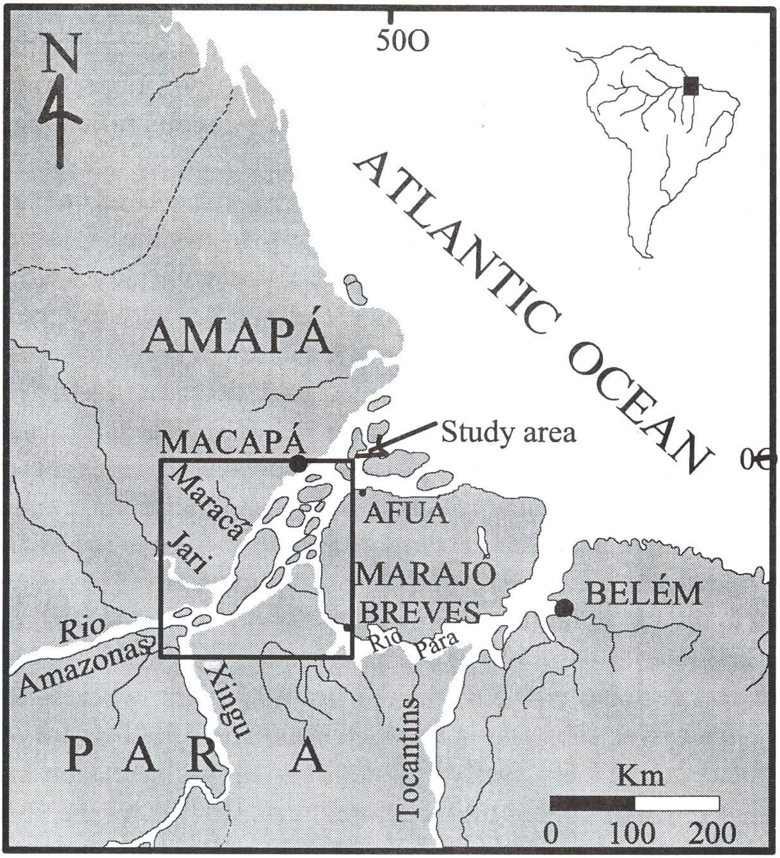

Figure 1: Location of the study area

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