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# Sedimentary evidence of soil organic matter input to the Curuai Amazonian floodplain

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ABSTRACT

A multi-proxy study has been performed on a sediment core from the Curuai floodplain, Central Amazonia. The combination of elemental, isotopic and molecular analysis of a 110 cm core (a record of ca. the last 100 yr) allowed reconstruction of the hydrological conditions of organic matter (OM) deposition. Two units could be delineated. The first (UI) was composed of three sub-units: UIa (0–15 cm), composed of highly degraded organic particles originating from the surrounding soil and indicative of restricted transport; UIb (15–48 cm), during which the region was permanently flooded and the material stored came from soil runoff, mainly from alluvial forest; and UIc (48–88 cm) composed of material from Amazon River suspended sediment, itself originating from OM degradation in forest soil. In UII (88–111 cm), the OM originated mainly from the forest soil and other plant remains in the floodplain. The data reveal that, during the four distinct depositional periods, the sedimentary OM alternated between land derived soil and alluvial vegetation due to changes in hydrodynamics.



## 1. Introduction

Rivers ecosystems store, degrade and transport biogeochemical material of continental origin towards the sea. The majority of carbon does not reach the ocean. It is either transformed to $CO_2$ and released to the atmosphere or stored within the floodplain as sedimentary organic carbon (OC) after erosion and transport from distant sites (Aufdenkampe et al., 2011). This lateral export of C from terrestrial ecosystems has been increasingly considered a mechanism for closing the terrestrial net ecosystem C balance. It is important to understand C flow in systems like the Amazon River because the net C balance for tropical land ecosystems remains one of the greatest uncertainties in the estimation of net C fluxes (Tian et al., 2000). The latest estimate doubled the global land area known to be seasonally permanently flooded ($20 \times 10^6$ km$^2$; Aufdenkampe et al., 2011 and references therein). The Amazon River drains a huge amount of organic matter (OM) that originates from the tropical forest in its basin. In fact, a large part of the OC exported to the Amazon mainstream originates from floodplains (or 'várzeas'; Moreira-Turcq et al., 2013). Floodplains act both as OM producers and as storage systems (Moreira-Turcq et al., 2004). In these floodplains the sediments are composed of material from the Amazon drainage basin (both terrestrial and aquatic), autochthonous material produced in the floodplain (phytoplankton) and material from the immediate surroundings (marginal input). The floodplains along the Amazon River have been studied to improve understanding of the Amazonian C cycle in the central Amazonia floodplains and to determine how OM is stored in the sediment. Lignin can be used to improve characterization of the sedimented OM. It is highly abundant and resistant to microbial degradation and is therefore considered to be an important component of the C cycle, particularly for C storage (Thevenot et al., 2010 and references therein). Due to its exclusively vascular plant origin, its abundance in the parent material and its resistance, this macromolecule has been used to infer the quantitative input and lateral transport of land plant C. However, only a few studies have examined its transport and sedimentation in the Amazon basin and floodplains (Hedges et al., 1986; Farella et al., 2001; Zocatelli et al., 2011).

The primary goals of the present work were to characterize the OM (source, origin and preservation) and study its sedimentation, using several organic proxies, in a 1 m core from the Curuai floodplain. It was estimated that the core represents 100 yr of non-uniform sedimentation (Moreira-Turcq et al., 2004).

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## 2. Material and methods

### 2.1. Study area and core sampling

The Curuai floodplain lies between 1°50′S–02°15′S and 55°00′W–56°05′W on the southern margin of the Amazon River, 850 km from the mouth of the estuary (Fig. 1). It represents ca. 13% of the total flooded area of the Amazon River between Manaus and Óbidos (Maurice-Bourgoin et al., 2007) and is periodically or permanently connected to the main stream. The maximum floodable area, delineated by the boundary between "terra firme" forest (southwards, Fig. 1) and the Amazon, is 2430 km$^2$, which corresponds to a water level in Curuai of ca. 11.5 m. Terra firme forest is never flooded and is covered mainly by evergreen forest. During the low water season, the floodplain landscape consists mainly of grassland, low vegetation and alluvial forest. During periods of flooding, the alluvial forest can be fully covered, reaching the tree canopy and loosening the belt of aquatic grass along the lake margin (Richey et al., 2002). The yearly storage stage of the floodplain starts between November and January and lasts until May–June. The draining phase starts in July and lasts until November; the largest exported volume occurs from August until October (Bonnet et al., 2008).

### 2.2. Core description

TA11 core was collected from the northern part of the Curuai floodplain in Lake Santa Ninha (2°3′11.86″S; 55°29′7.73″O, Fig. 1) using a 1.5 m PVC tube (10 cm diameter) during the low water period. In the laboratory, the core was opened, described and sub-sampled every 1 cm or 0.5 cm, respecting the lithological units. Before slicing, an X-ray image (Table 1) of the core revealed sequential changes in sedimentation, and it was highly laminated except at the surface. TA11 comprised two units: the basal unit (UII, 111–88 cm) and the upper unit (UI), composed of three subunits. Sedimentation rate was calculated using $^{210}$Pb chronology (Moreira-Turcq et al., 2004) except for UII because the unsupported $^{210}$Pb concentration was near detection limit, precluding calculation of sedimentation rate. According to the chronology, the base of UI corresponds to an age of ca. 1900 AD.

### 2.3. Bulk analysis

Total OC (TOC) content (%), N (%) and C/N (g/g) were reported by Moreira-Turcq et al. (2004). Stable isotopic compositions ($\delta^{13}$C and $\delta^{15}$N) were obtained using a Europe Hydra 20/20 mass spectrometer (Waterloo University, Canada and University of California, Davis, USA) with samples that had been decarbonated with 1.0 M HCl. The standard deviation was 0.06‰ and 0.13‰ for $\delta^{13}$C (Vienna Peedee Belemnite, VPDB) and $\delta^{15}$N [15N–$(NH_4)_2SO_4$, Sigma 29,928-6], respectively. Mass spectrometer precision was ± 5%.

Rock–Eval pyrolysis was carried out on 100 mg powdered dry sediment with a "Turbo" Rock–Eval 6 pyrolyzer. The standard was n° 160.000 (Vinci Technologies) and device precision was ± 3%. Details of the methodology of the temperature program have been described by Zocatelli et al. (2012a). Briefly, the program was: 2 min at 200 °C, raised to 650 °C at 30 °C min$^{-1}$. The oxidation phase (an air stream) began with an isothermal stage at 400 °C, then increased to 650 °C (30 °C min$^{-1}$) and was held for 5 min at this temperature. Rock–Eval parameters were: (i) hydrogen index (HI, mg HC g$^{-1}$ TOC) and (ii) the oxygen index (OI, mg $O_2$ g$^{-1}$ TOC).

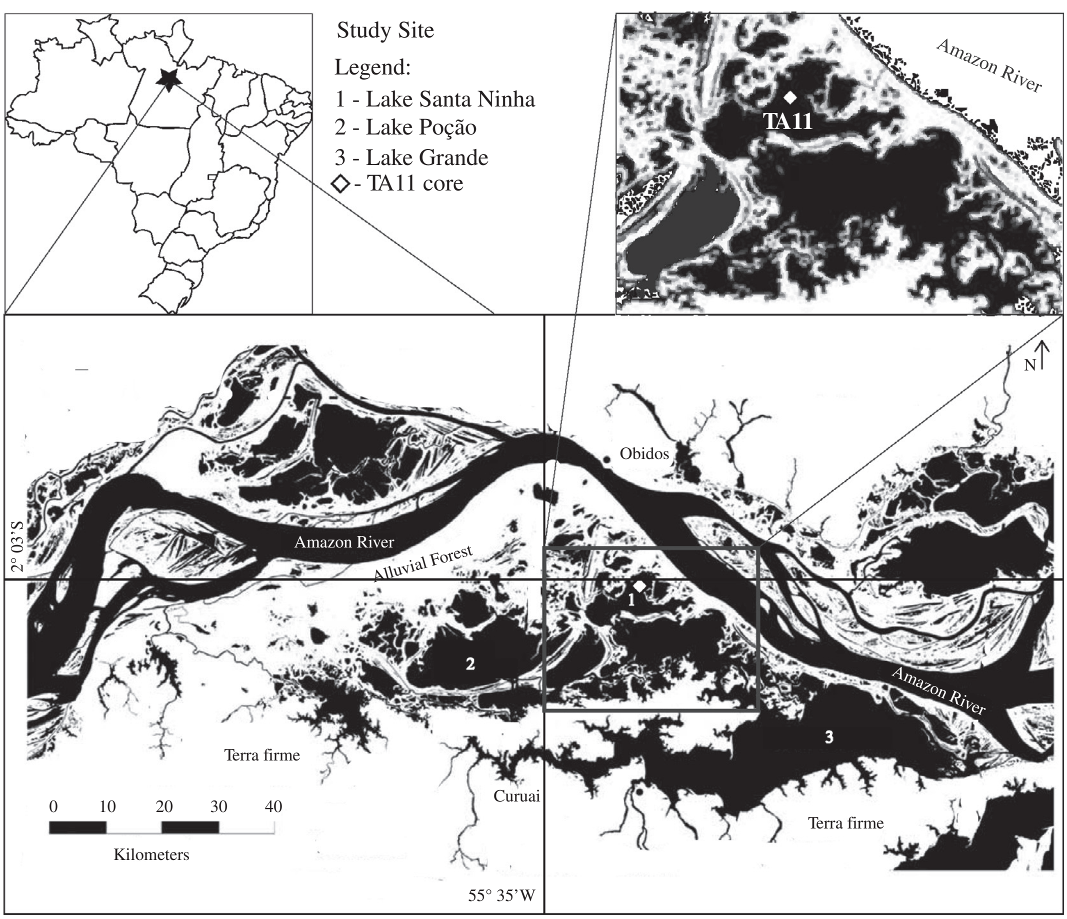


**Fig. 1.** Location of Curuai floodplain and TA11 core (white diamond). Numbers represent interconnected lakes: Lake Santa Ninha (1); Lake Poção (2) and Lake Grande (3).