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Age of depositional and weathering events in Central Amazonia

Lucy Gomes Sant'Anna [a, b, *], Emílio Alberto do Amaral Soares [c], Claudio Riccomini [b, d], Sonia Hatsue Tatumi [e], Marcio Yee [e]

[a] School of Arts, Sciences and Humanities, University of São Paulo, Av. Arlindo Bettio 1000, CEP 03828-000, São Paulo, SP, Brazil
[b] Institute of Energy and Environment, University of São Paulo, Av. Prof. Luciano Gualberto 1289, CEP 05508-010, São Paulo, SP, Brazil
[c] Institute of Exact Sciences, Department of Geosciences, Federal University of Amazonas, Av. Gen. Rodrigo Octávio Jordão Ramos, 6200, CEP 69077-000, Manaus, AM, Brazil
[d] Institute of Geosciences, University of São Paulo, Rua do Lago 562, CEP 05508-080, São Paulo, SP, Brazil
[e] Federal University of São Paulo, Campus Baixada Santista, Avenida Saldanha da Gama 89, Ponta da Praia, CEP 11030-400, São Paulo, SP, Brazil

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ABSTRACT

In the last three decades, several studies have been devoted to understanding the role of Late Pleistocene–Holocene climate changes in the Amazonia lowlands environment. However, most of these studies used data obtained from sedimentary deposits (lakes, swamps, and colluvium) located away from the central plain or on the edges of the Amazonia region.

This article integrates optically stimulated luminescence and accelerated mass spectrometry ^{14}C ages with sedimentological and geomorphological data obtained during this study or compiled from the literature for fluvial and lacustrine deposits of the central alluvial plain of the Solimões-Amazon River.

The age data allow us to present a chronological framework for the Late Pleistocene–Holocene deposits and conclude that (i) the dryness of the LGM in central Amazonia lowlands is recorded by the formation of fluvial terraces and their weathering to pedogenic hematite between 25.3 ka and 17.7 ka; (ii) floodplain deposition was contemporaneous with terrace weathering and occurred in a context of decreased water volume in fluvial channels, lowering of river base level and sea level, and isostatic rebound of the continent; and (iii) lateral and mid-channel fluvial bars in the Solimões-Amazon River have a minimum age of 11.5 ± 1.5 ka, and their deposition responded to increased precipitation at the beginning of the Holocene.

1. Introduction

Investigations of the climate of the Amazonia region during the Quaternary have primarily focused on the Late Pleistocene–Holocene boundary, when relevant worldwide changes occurred in the last glacial-interglacial cycle. These studies have mainly used data from lakes, swamps, and colluvium located far from the central plain (Fig. 1). Research on the central plain has been focused on Holocene floodplain lakes in the lower course of the Solimões-Amazon River (e.g. Moreira et al., 2014). Because few studies have incorporated data from fluvial deposits of the main rivers of the Amazonia lowlands, there is a lack of chronological data from fluvial deposits that assist in the correlation between fluvial dynamics in the lowlands of Central Amazonia and climate change during the LGM, as has already been highlighted by several authors (Heine, 2000; Turcq et al., 2002; Vimeux et al., 2009; Irion and Kalliola, 2010; Baker and Fritz, 2015).

Several Quaternary depositional units have been identified in the alluvial plain and channel of the Solimões-Amazon River in Central Amazonia (Irion et al., 1995; Mertes et al., 1996; Latrubesse and Franzinelli, 2002; Rossetti et al., 2005; Irion et al., 2011; Rozo et al., 2012). However, the set of ages available for these units has led the authors to establish an almost exclusively Holocene sedimentary history. Recently, Soares et al. (2010) and Gonçalves et al. (2016) dated Pleistocene to Holocene sediments deposited by or under the influence of the Solimões-Amazon River in Central Amazonia, but the authors focused their approach on morphostratigraphic units and fluvial terraces and did not correlate them with previous important sedimentological studies (e.g., Latrubesse and Franzinelli, 2002). Thus, the information is still disjointed, with no clear relationship between geomorphological, sedimentological,

* Corresponding author. School of Arts, Sciences and Humanities, University of São Paulo, Av. Arlindo Bettio 1000, CEP 03828-000, São Paulo, SP, Brazil.
E-mail address: lsantann@usp.br (L.G. Sant'Anna).

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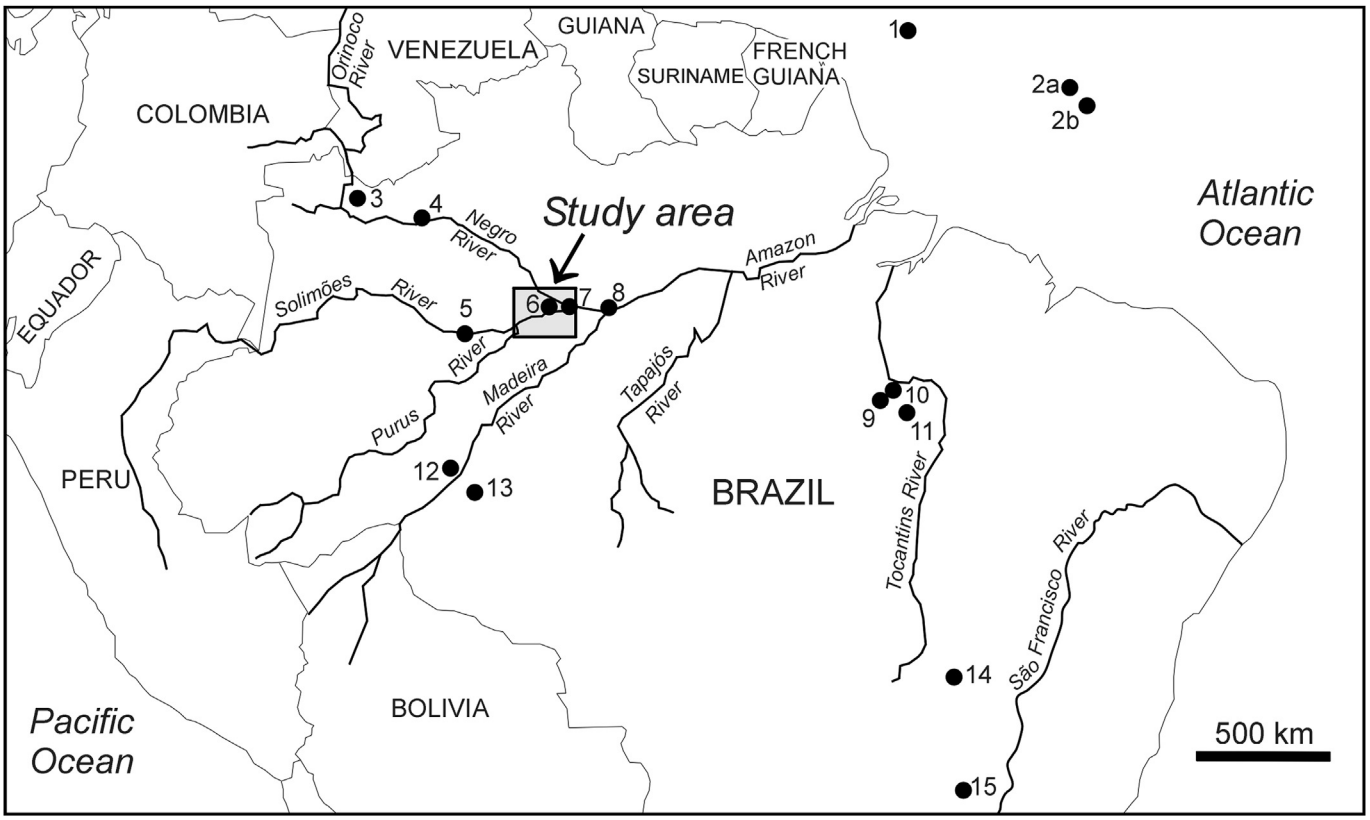

Fig. 1. Location of the study area and sites mentioned in the text (locations given according to original references). 1. Amazon fan, ODP site 942 (Maslin et al., 2011). 2. Ceará Rise, ODP sites 925 (2a) and 926 (2b) (Harris and Mix, 1999). 3. Pata Lake (Colinvaux et al., 1996a; Santos et al., 2001; Barbosa et al., 2004; Cordeiro et al., 2011; D'Apolito et al., 2013). 4. Dune system (Carneiro Filho et al., 2002). 5. Coari Lake (Horbe et al., 2011). 6. Calado Lake (Behling et al., 2001). 7. Profile 1 (Franzinelli, 2011). 8. Site NSK-50 (Ferreira, 2013). 9. Carajás (Sifeddine et al., 2001). 10. Carajás (Absy et al., 1991). 11. Carajás (Hermanowski et al., 2012a, b). 12. Interfluve of Madeira and Purus Rivers (Bertani et al., 2015). 13. Katira Creek (Van der Hammen and Absy, 1994). 14. Águas Emendadas (Ledru et al., 1998). 15. Salitre (Ledru et al., 1998).

and chronological data, which has prevented a clear understanding of paleoclimate records in the Quaternary plain.

In this paper, we present new optically stimulated luminescence (OSL) and accelerated mass spectrometry (AMS) ^{14}C ages for surface and subsurface samples of several alluvial plain and channel deposits of the Solimões-Amazon River in its stretch between the confluences with Purus (west) and Negro (east) Rivers. We have integrated the new ages with previously published data (dating and sedimentology of samples whose locations are reported) in order to construct the most complete chronological framework currently possible for the Quaternary fluvial sediments in Central Amazonia. Instead of using a geomorphological approach that highlights the river terraces, we focus on the fluvial sedimentary deposits and their evolution. The focus on depositional units is justified by the existence of clear interactions between current depositional processes and floodplains already formed on the banks of the Solimões-Amazon River, such as the current lacustrine deltas in lakes located on the floodplain (e.g., Mertes et al., 1996). In addition, it is likely that the Pleistocene–Holocene fluvial terraces defined by Gonçalves et al. (2016) include deposits from different sedimentary environments not yet fully identified due to the extensive vegetation cover and difficult access.

Based on the collated chronological framework and sedimentological data, we discuss the (i) relationship among fluvial dynamics, generation of river terraces, and weathering; (ii) age interval for floodplain deposition and formation of ria lakes in Central Amazonia; (iii) correlation with other regional data; and (iv) possible climatic and sea-level influences on fluvial dynamics during the last glacial maximum (LGM).

2. Distribution of depositional units

Fig. 2 shows the distribution of depositional units of the Solimões-Amazon River in the area between its confluence with the Purus and Negro Rivers, as well as the alluvial deposits of the Negro River in its lower stretch. This figure incorporates depositional units previously described by other authors and own geologic data from fieldwork focused on facies analyses. Previously published OSL and radiocarbon ages for these deposits (for which geographical coordinates of dated samples are available) are integrated into our description of the units.

2.1. Solimões-Amazon River

Based on geomorphological and sedimentological properties, the deposits of the Solimões-Amazon River were grouped in an alluvial plain, occurring in both margins of the river and where two main depositional units have been identified, and in an alluvial channel, which houses the several units identified in the current river channel.

The substrate of the Quaternary depositional units is formed by the Upper Cretaceous Alter do Chão Formation (Caputo et al., 1972) and the Miocene Novo Remanso Formation (Dino et al., 2012; Soares et al., 2015).

2.1.1. Alluvial plain

Fluvial and lacustrine depositional units have been identified in the alluvial plain at both margins of the Solimões-Amazon River.

The oldest fluvial depositional unit in the alluvial plain currently