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Quaternary climate variability as the main driver of the fluvial evolution of the Middle Tocantins River, eastern Amazonia

Jandessa Jesus[1], Fabiano Pupim[2], and André Sawakuchi[1]
[1]Institute of Geosciences, Universidade de São Paulo, São Paulo, Brazil (jandessa@usp.br)
[2]Department of Environmental Science, Universidade Federal de São Paulo, Diadema, Brazil

The Tocantins River is the easternmost fluvial system of the Amazon region, with a watershed draining both the Amazon rainforest and the Cerrado dry forest. This condition makes the Tocantins a natural laboratory to investigate the effects of past climate variability along with the rainforest-savanna ecosystems because its watershed drains both the Amazon rainforest and the Cerrado dry forest, and it is influenced by the Equatorial and central-northeast Brazil hydroclimates. Despite these unique physiographic and climatologic conditions, the Quaternary history of the Tocantins River is poorly known due to a lack of geochronological data about its sedimentary record. Here, we use optically stimulated luminescence (OSL) dating applied to quartz sand grains combined with geomorphological and sedimentological techniques to reconstruct the morphosedimentary evolution of the middle reach of the Tocantins River during the Late Quaternary. Three main geomorphological units were mapped: (i) fluvial plain, (ii) fluvial terraces, and (iii) paleo-alluvial fans. The OSL ages of 33 sediment samples retrieved from these geomorphological units range from 661 ± 42 years to 160 ± 16.3 ka, allowing to reconstruct of the depositional-erosion periods during the Mid-Late Pleistocene and Holocene. Our data indicate three stages of fluvial aggradation and two stages of incision. The older aggradational stage is represented by sediments from Upper Terrace (T1) and the paleo-alluvial fan deposited between 160 and 32 ka. Subsequently, a major incision event occurred at ~31 ka, which resulted in the abandonment of T1. The second phase of aggradation is recorded in the Lower Terrace (T2) and it also promotes reactivation of the paleo-alluvial fans from 31 to 6 ka. A new incision occurred from about 6 to 5 ka, allowing the abandonment of the T2 and reducing the local base level to its current position. The modern floodplain was built from 5 ka to the present, with sediment deposition due to lateral migration of the Tocantins River channel. The phases of aggradation and incision were correlated with regional paleoclimatic data, suggesting that precipitation changes related to the South American Summer Monsoon (SASM) as the main driver of the evolution of the Tocantins river in the last 160 ka. Disturbances in the supply of sediments and the flow of these rivers promote phases of depositional (drier periods) and incision (wetter periods). These depositional and incision phases of the Tocantins River appear to be synchronous with changes recorded by rivers from central and western Amazon, suggesting that the SASM is the main control of the Amazon fluvial systems. The continuous change in the Tocantins River dynamics has molded a high heterogeneity of habitats in the associated floodplains and terraces, which is a fundamental factor to support the diversity of fauna and flora in this transitional environment

between Amazon and Cerrado biomes.