EGU 2021

Session GM5.1 – 'Fluvial systems: Dynamics and interactions across scales'

# Change of channel pattern and construction of fluvial terraces driven by SAMS since the LGM in southeastern South America: records from Tietê River, Brazil

Caio Breda[1]; Fabiano do Nascimento Pupim[1,2]

**1** Instituto de Geociências, Universidade de São Paulo, USP; **2** Departamento de Ciências Ambientais, Universidade Federal de São Paulo, UNIFESP

## Introduction

The last 30 ka is a period marked by abrupt environmental changes on Earth. Despite the efforts to investigate the effects of past environmental changes in the fluvial dynamics, there is a lack of studies in intraplate tropical regions. Here, we applied geomorphological, sedimentological, and optically stimulated luminescence dating (OSL) technics to investigate the effects of environmental factors (e.g., climate and tectonics) on the evolution of the Tietê River during the Late Quaternary.

## Study Setting

The headwaters of the Tietê River are in the escarpments of Serra do Mar and flows to the west for about 1100 km until it discharged into the Paraná River (**Fig 1**). To better understand of the propagation of the response to environmental forces and control factors in the river dynamics, this study analyzed sedimentary deposits in two sites over 500 km of the system.

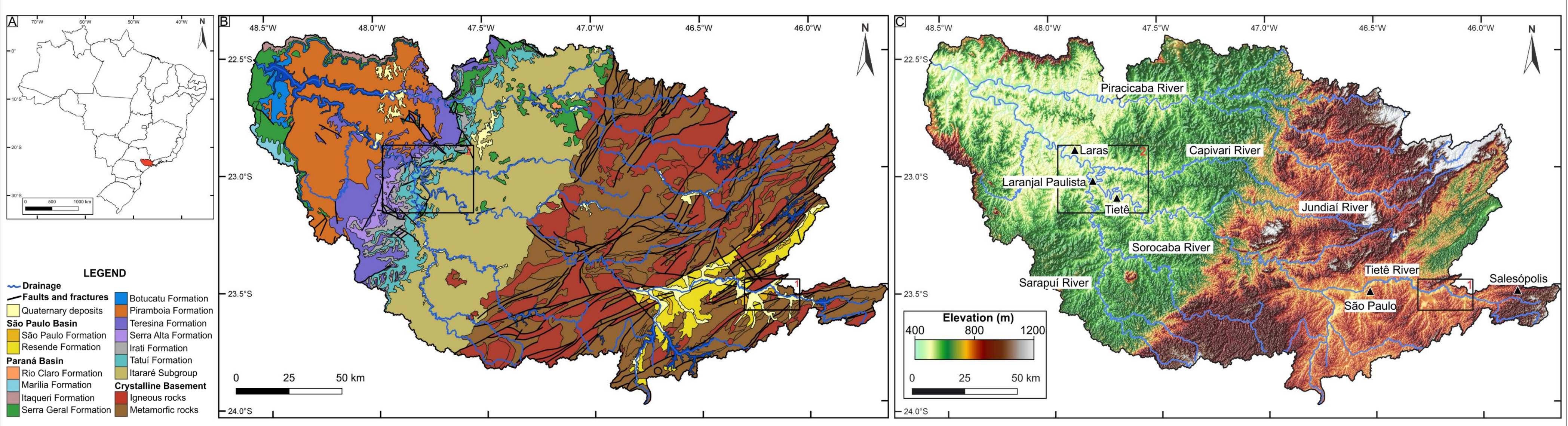

**Figure 1.** The topography and geological settings of the Upper and Middle Tietê River basins. (A) Location of drainage basins in Brazil; (B) simplified regional map showing major geological units and tectonic structures; (C) Digital Elevation Model (DEM) with the main tributaries; In B and C, polygons 1 and 2 delimit the study areas in the Upper and Middle course of the Tietê River, respectively.

The hydrological regime of the Tietê River basin is controlled by the seasonality of rainfall due to the activity of the South America Monsoon System (SAMS), which provides convective rains during the southern hemisphere summer and dry conditions during the winter. During the last $10^2$ ka, oscillations in the Earth's orbital cycles significantly affecting SAMS rainfall over southeastern Brazil and induced significant shifts in the paleovegetation of this region. These changes directly impacting the dynamics and functioning of river systems throughout over the late Quaternary.

## Occurence and distribuition of fluvial deposits

Fluvial terraces were mapped along 500 km around the Tietê River valley (**Fig. 2**), we identified a sequence of seven well-preserved terrace levels in the middle reach and one level in the upper reach (**Figs. 3 and 4**).

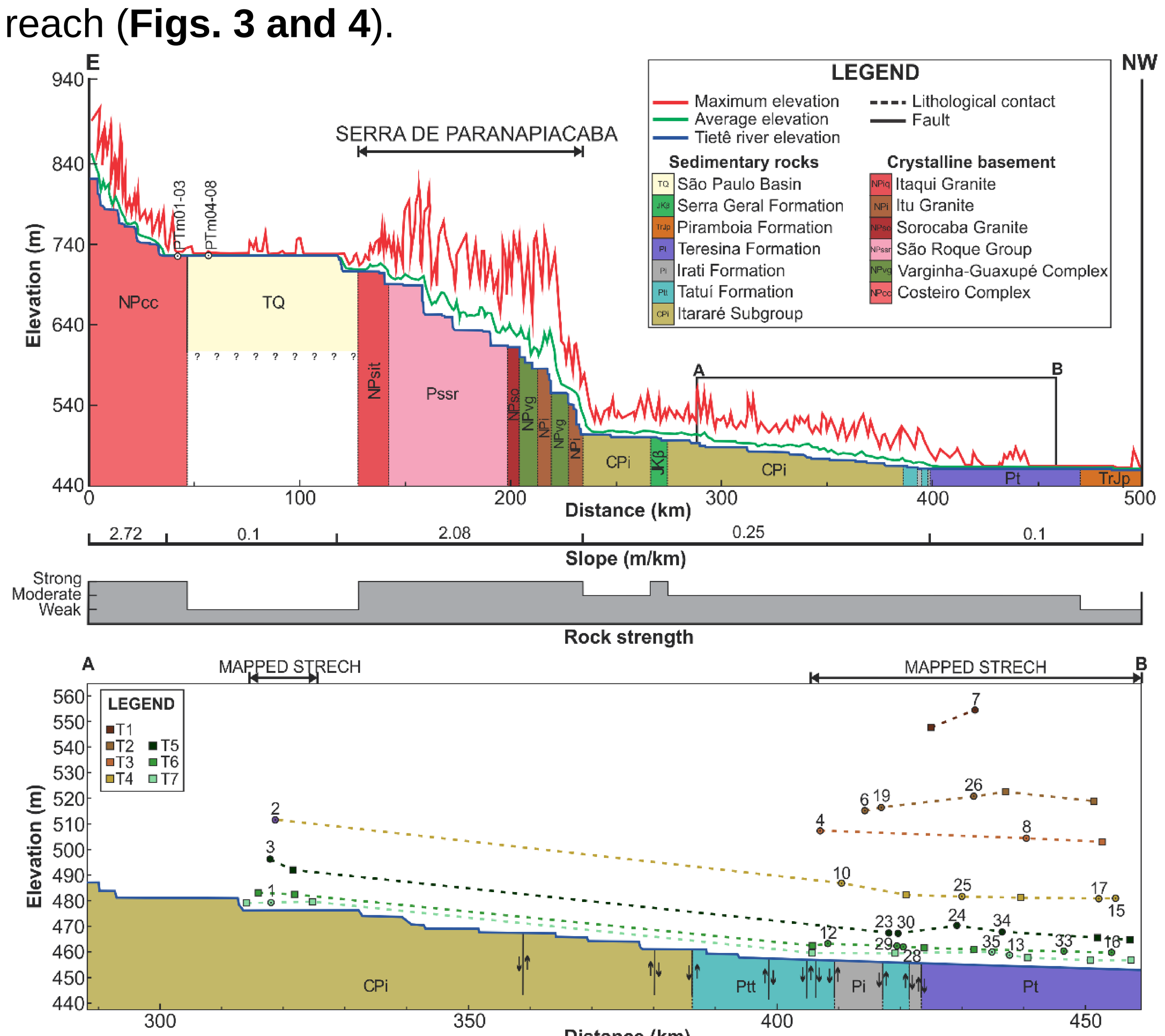

**Figure 2.** Longitudinal profile of the upper and middle course of the Tietê River; Maximum elevation (red) and medium elevation (green) were determined from an 800m band from the Tietê channel (minimum elevation in blue). Regional geology data from Perrota et al. (2005), with qualitative attributes about the resistance of the different lithologies, considering only the rock type rheology, without consideration of structural discontinuities. Profile A-B presents the stretch of the mapped areas in the Middle Tietê. In detail, the longitudinal paleoprofiles of the different levels of river terraces.

The integrated analysis of the longitudinal profile, morphological and geological aspects, suggests that this disparity in the number of terrace levels is due to a strong litho-structural control that supports a regional knickzone between the upper and middle reach of the river (Serra de Paranapiacaba). The stronger rocks (igneous and metamorphic) of the Serra de Paranapiacaba limit the base level lowering and the river incision to upstream, which inhibits the development of several terrace levels in the upper reach of the river. The high topographic gradient and incorporation of blocks of strong rocks as bedload have intensified the erosion power of the Tietê channel from the Serra de Paranapiacaba to downstream, promoting vertical incision over the weak basement (fractured sandstones and siltstones) and the preservation of seven terrace levels.

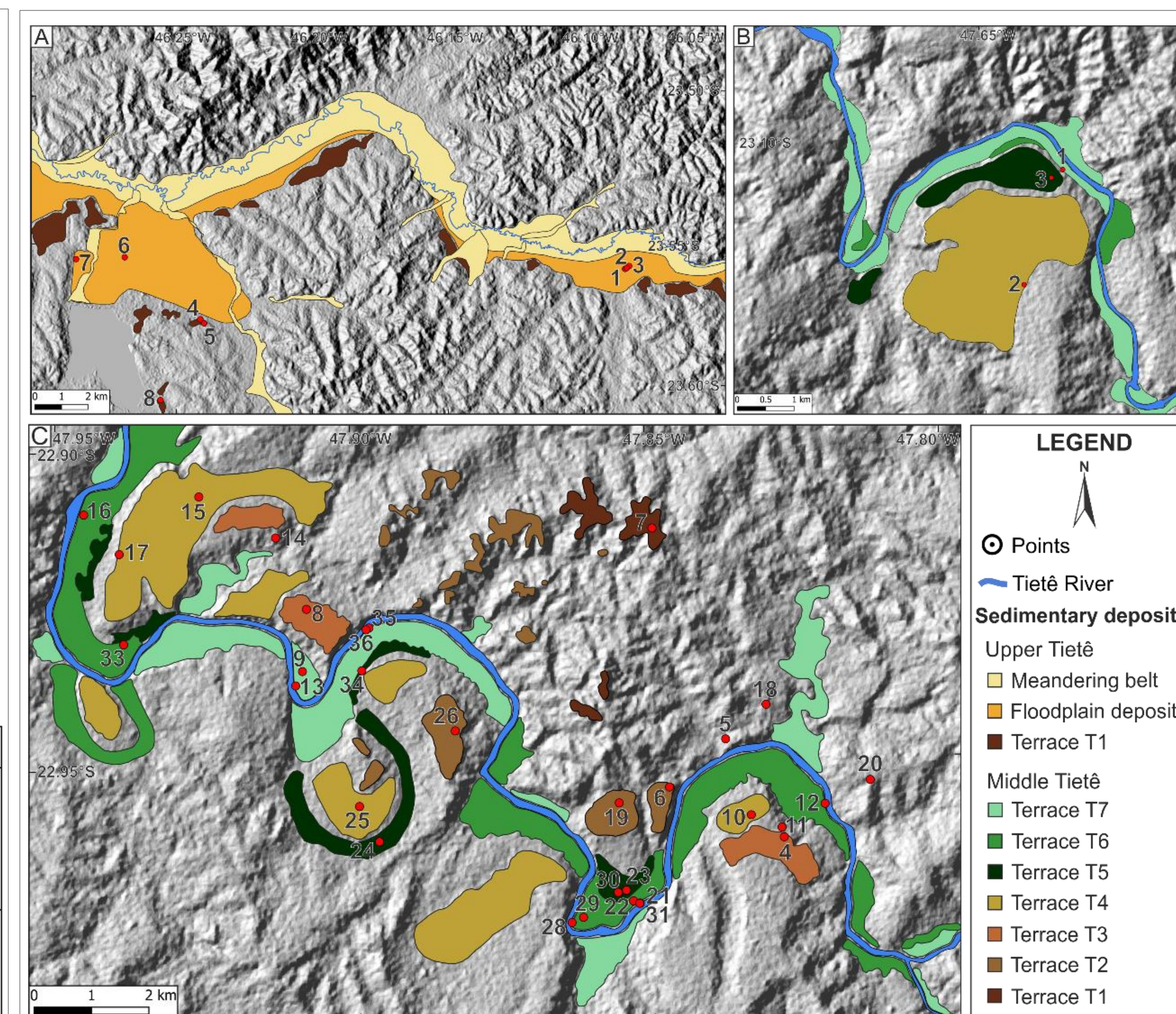

**Figure 3.** Geomorphological maps in the Tietê watershed. (A) Area located in the Upper Tietê. A level of river terrace and sandy-conglomeratic deposits in the floodplain and silty-clay in the meandering belts. All samples receive the acronym PTm. (B) and (C) are the areas mapped in the Middle Tietê and Sorocaba basin, 320 km and 450 km away from the source, respectively.

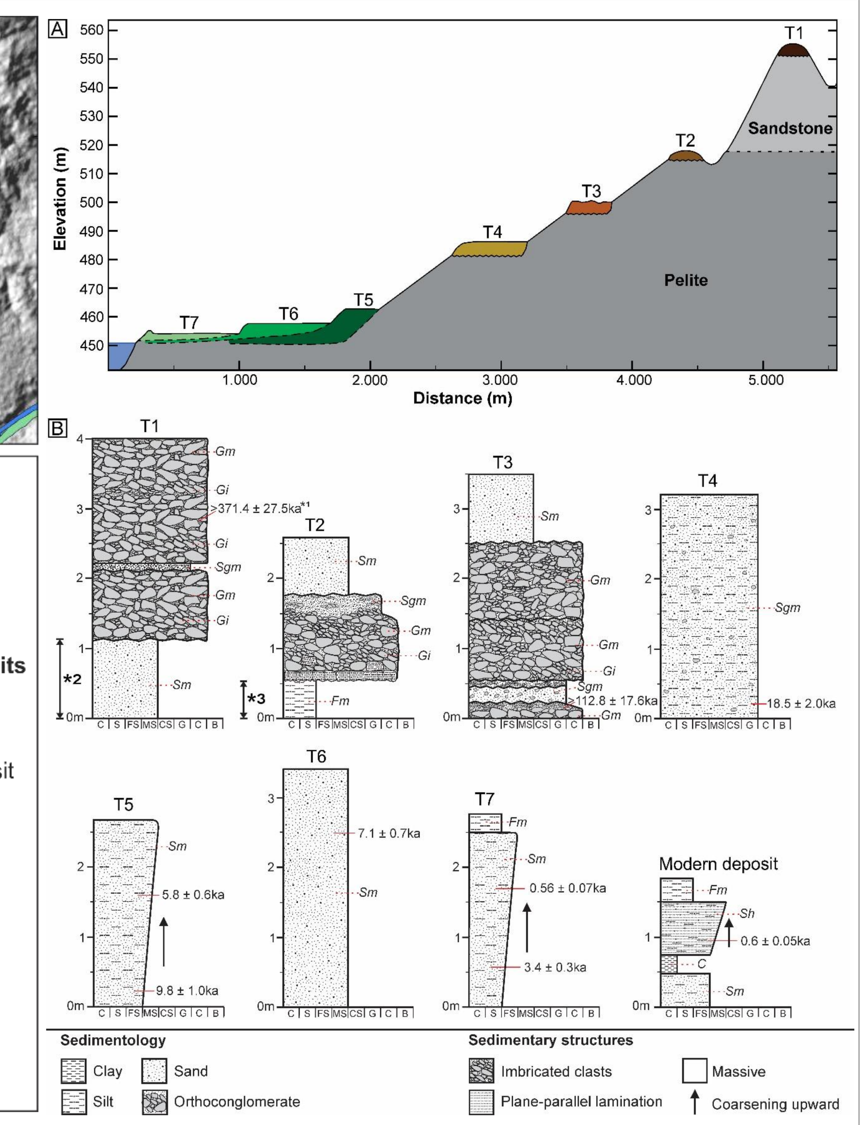

**Figure 4.** Schematic topographic section of the terrace levels and sedimentary deposits from the Middle Tietê River. (A) Topographic distribution of the terrace levels. (B) Sedimentary facies columns of deposits.

Sedimentological analysis and OSL ages of the deposits preserved in terraces in the Middle Tietê River (**Fig. 5**) demonstrate river response to regional Quaternary climate variations. The occurrence of strath terraces levels with conglomeratic and sandy deposits (T1 to T4) indicates a channel with high stream power and competence to transport sediments, suggesting a braided channel operating under drier conditions until the LGM. The lack of sedimentary deposits preserved between ~18 and ~11 ka indicates that the last deglacial was a period with high climatic instability with the predominance of erosion processes. The low-level cut-and-fill terraces (T5 to T7) formed by fine sandy deposits record that establishing the current meander channel began in the Early Holocene, associated with the relative expansion of forest vegetation and low sediment supply.

The OSL ages of the four lowest terrace levels (T4 to T7) (**Fig. 5**) have revealed 5 periods of sediment aggradation since 20ka (LGM) associated with short periods of rainfall decrease and vegetation retraction. The channel incision and terrace abandonment have occurred under relatively wetter conditions, associated with abnormal precipitation events (e.g., Heinrich stadial 1, Younger Dryas, and "8.2ka"). Our research has demonstrated that lithological and structural factors play a key role in the occurrence and distribution of fluvial terraces in a river that flows over intraplate terrains in southeastern South America. However, the correlation between terrace developments and paleoenvironmental conditions indicates that the SAMS is the main factor in the evolution of these fluvial systems during the Late Quaternary.

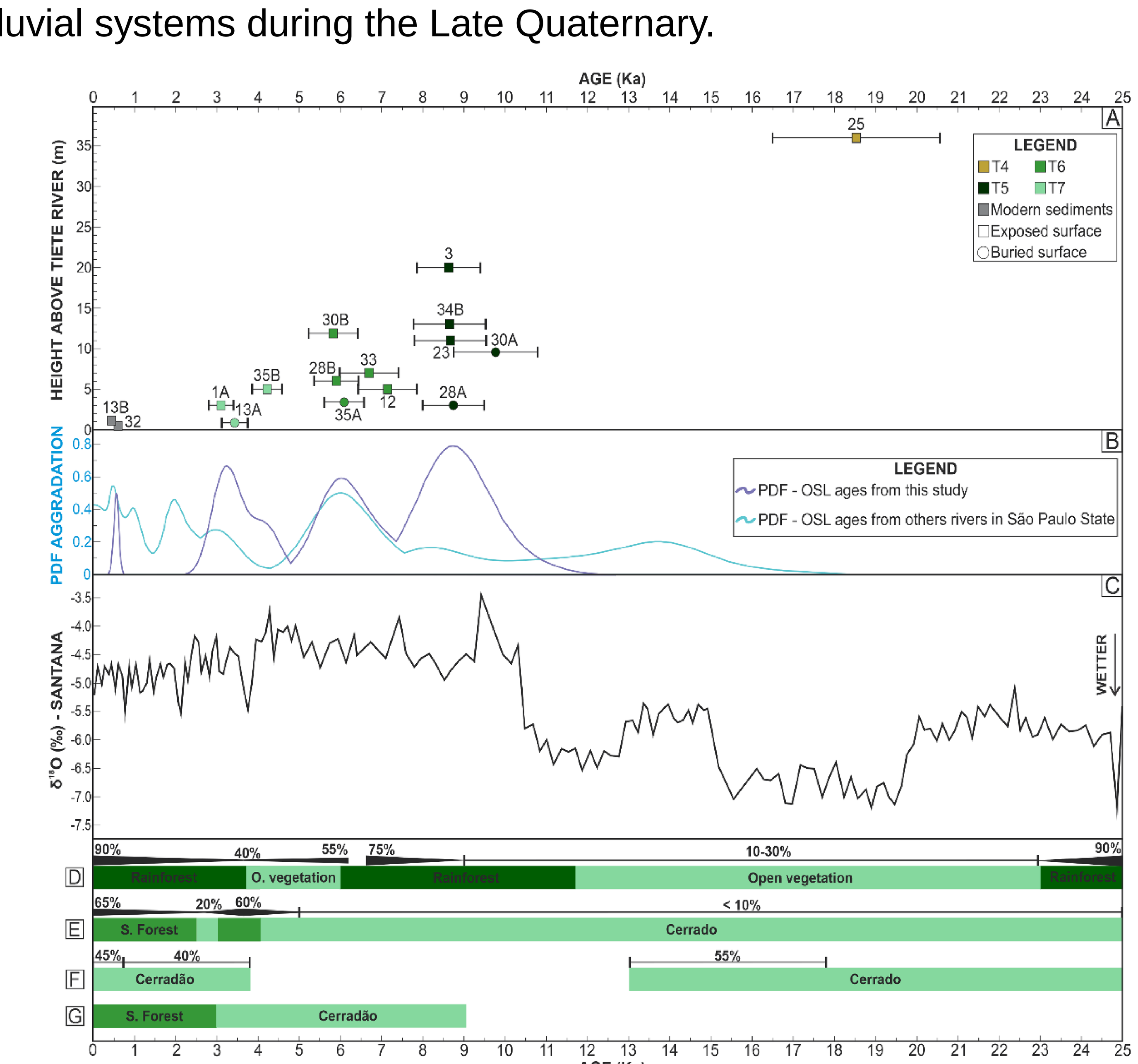

**Figure 5.** Geochronology of the Tietê River deposits and comparison with data from southeastern Brazil literature. (A) OSL ages of the samples from Middle Tietê. (B) Probability density function (PFD) for this study and other terraces in state of São Paulo (Dias and Perez Filho, 2015; Pinheiro and Queiroz Neto, 2015; Storani, 2015; Storani and Perez Filho, 2015; Valezio and Perez Filho, 2015; Ladeira and Celarino, 2017; Souza and Perez Filho, 2018; Lupinacci and Souza, 2019) normalized by the total sampled. (C) δ18O data from the Santana Cave (Cruz et al., 2006). Palynological data from (D) Ledru et al. (2009); (E) Bissa and Toledo (2015); (F) Áviles et al. (2019) and (G) Scheel-Ybert et al. (2003). All percentages refer to the content of arboreal pollen.

### Acknowledgements

The authors would like to thank the Laboratory of Gamma Spectometry and Luminescense of the University of São Paulo (LEGaL, USP), Brazil. FNP are funded by CNPq (grant #304727/2017-2)