

Fluvial Evolution of the Eastern Andean Piedmont:

Late Quaternary Sedimentary Records from the Caquetá and Guaviare Rivers, Colombia

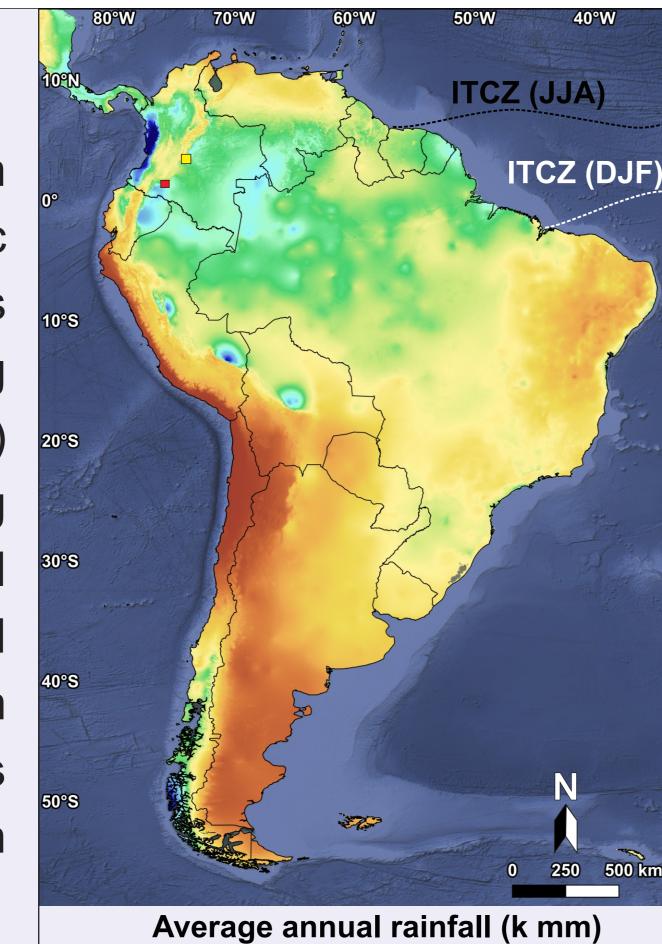


Morphometric indices

Caio Breda¹, Bodo Bookhagen², Mauricio Parra¹, André Sawakuchi¹, Carolina Cruz¹, Priscila Souza³, Gaspar Monsalve⁴, Agustin Cardona⁴, and Fabiano Pupim¹

INTRODUCTION

The Tropical Northern Andes (TNA) exhibit variations in uplift, erosion rates, and river incision due to active tectonic deformation. Over the past 250 ka, the Andean terrigenous contribution to the Amazon Basin shows a strong precessional signal, with the South American Monsoon (SAM) and the Intertropical Convergence Zone (ITCZ) controlling sediment transfer. This study uses geomorphic indices and mapping techniques combined with Optically Stimulated Luminescence (OSL) dating and erosion rates derived from Be and Al cosmogenic nuclides, to interpret river systems responses to environmental changes along the eastern flank of the Andes in Colombia.



CLIMATIC COMPONENT

We identified a **strong orbital signal**: between 150 and 60 kyr, insolation and eccentricity variations were significantly high, decreasing markedly after 60 kyr.

During MIS 5, a distributive fluvial system was active under conditions of greater imbalance. In this period significant aridity, along with increased temperatures and CO₂ levels, created favorable conditions for the expansion of Andean forests.

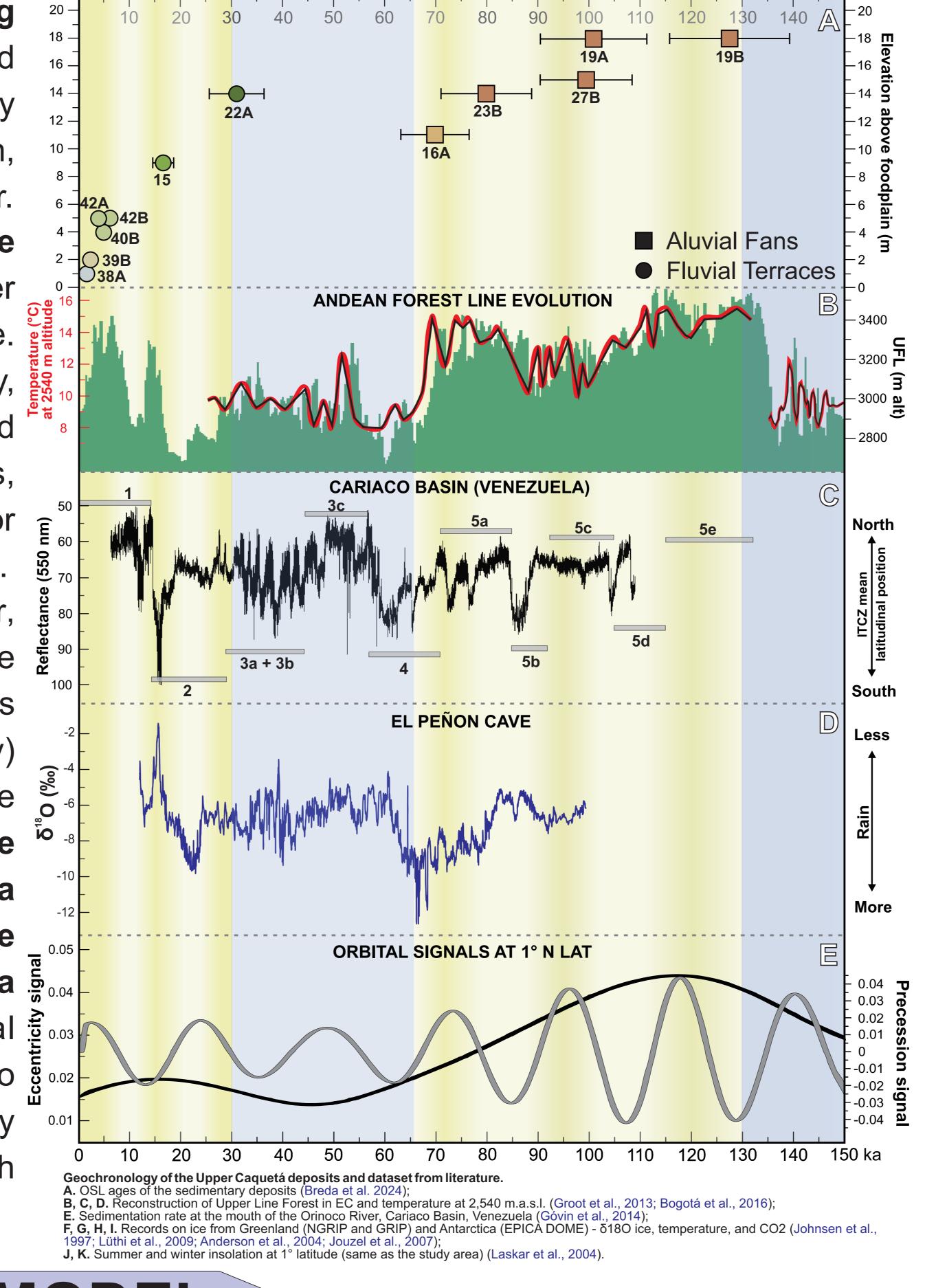
Between 60 and 30 kyr, abrupt millennial-scale climate and environmental oscillations (e.g., temperature and humidity) occurred, resulting in the retraction of Andean forests. The last 30 kyr were marked by a more balanced landscape. The fluvial pattern shifted to a braided system, and fluvial terraces, predominantly dated to the Holocene, reflect relatively more arid conditions and high CO2 concentrations.

Breda, C. et al., 2024. Variation in the ITCZ position

the tropical Andes (Colombia) during the late

Quaternary. Geomorphology, 462, 109333.

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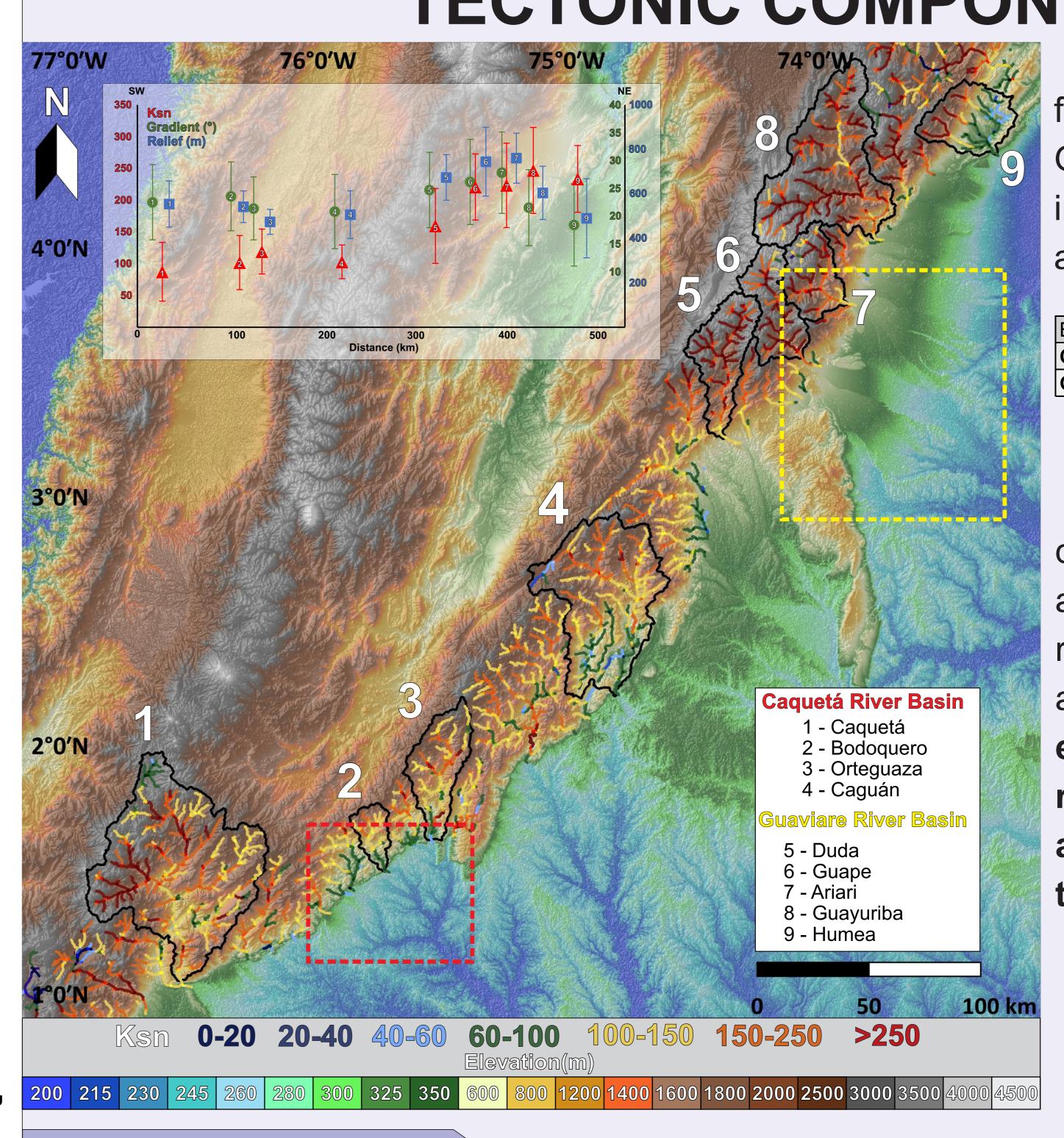


TECTONIC COMPONENT

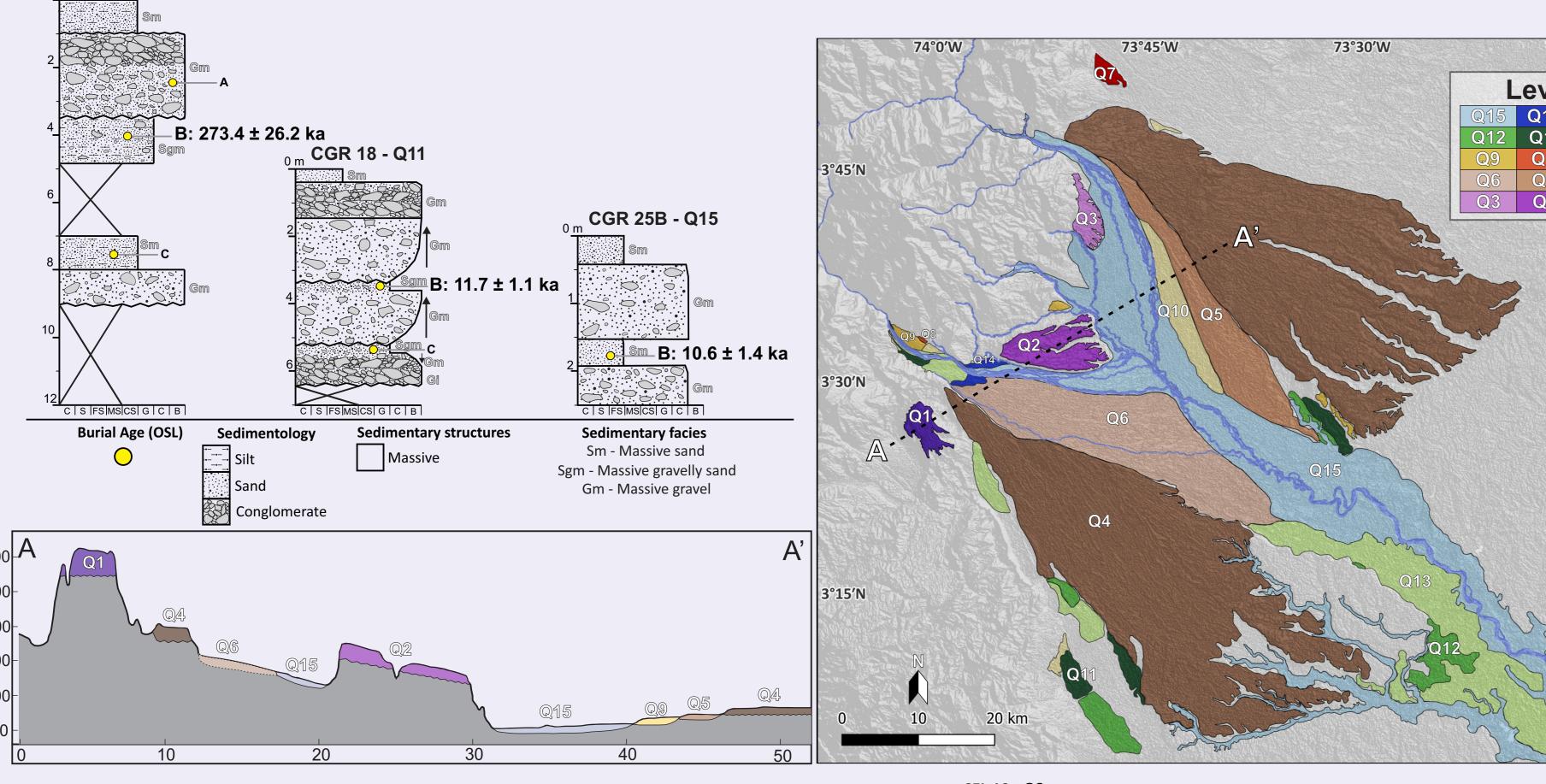
from the Caqueta and Guaviare basins show an increasing trend of tectonic activity from SW to NE.

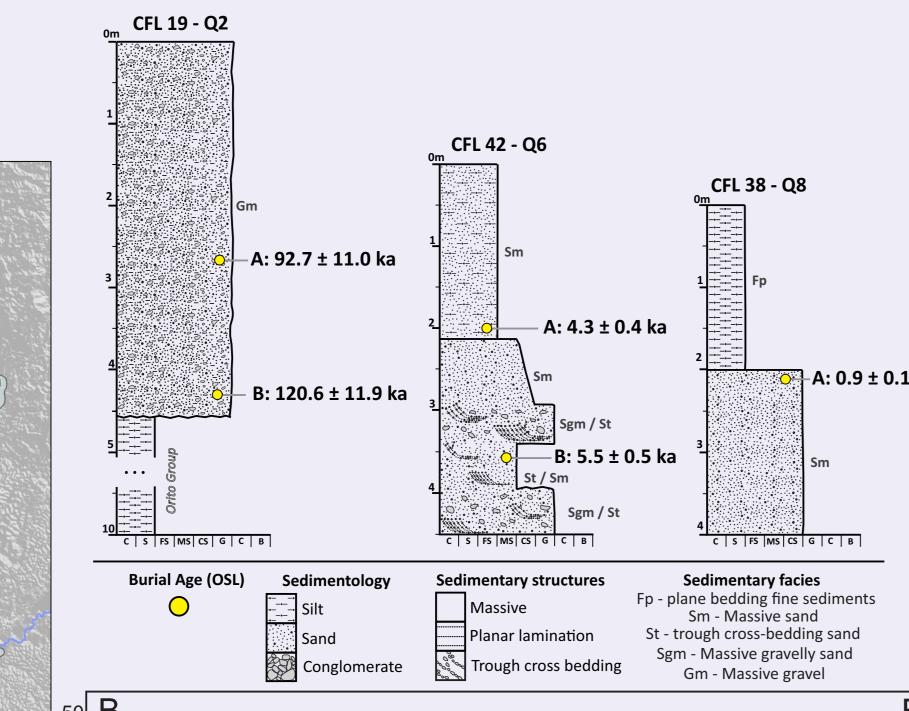
| BASIN | SLOPE (°) | RELIEF (m) | KSN | CAQUETA | 20-25 | 400-600 | 50-100 | GUAVIARE | 25-30° | 600-800 | 200-300

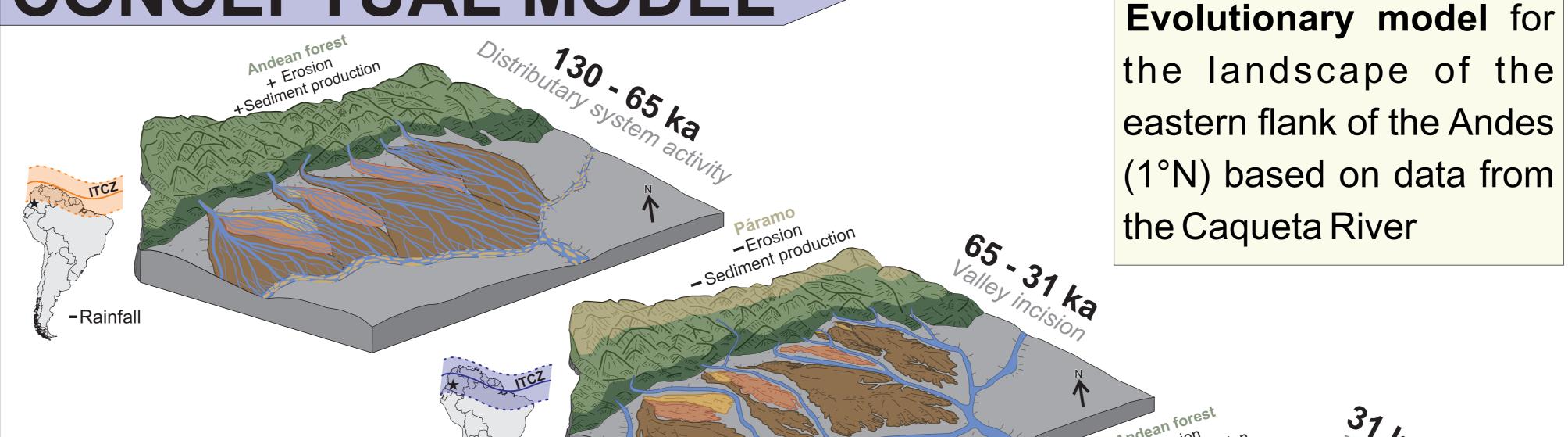
Thermochronological data, zircon (U/Th)/He ages, and cosmogenic erosion rates (Perez-Consuegra et. al., 2021, 2025) indicate that exhumation and erosion rates in the Guaviare Basin are 5 to 10 times higher than in the Caqueta Basin.



MAPPING







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KEY POINTS

- The greater number of geomorphological unit levels, higher Ksn values and older ages (up to 300 ka) suggest greater sedimentary production and capacity to accommodate sediments in the Guaviare River Basin (3-4.5°N).
- OSL ages suggest that fluvial dynamics (e.g. sedimentation and incision) are closely related to climatic factors, mainly driven by mean position of the ITCZ.
- From at least 300 ka until 60 ka the river systems of the were distributary. After a prominent period of incision (60–30 ka), the river systems became tributary.

NEXT STEPS

To improve the understanding of the paleoenvironmental evolution on the eastern flank of the Andes, a more robust framework of OSL and IRSL ages will be integrated with erosion and paleoerosion data obtained from cosmogenic nuclides (Be and Al), providing a detailed view of geological processes in the tropical northern Andes throughout the Quaternary.

