第四紀晚期基岩和氣候對板內熱帶河流侵蝕與堆積行為的影響:以巴西東南部鐵特河為例

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摘要

河流系統的演化與不同時空的構造和氣候有關。儘管有許多影響控制河流動力學的研究，但缺乏對板內熱帶地區的研究。本篇將應用地貌學、沉積學和光激釋光(OSL)定年法去調查氣候和構造對第四紀晚期鐵特河上游及中游演化的影響，尤其會著重討論加積河階的形成。鐵特河是巴西東南部重要的河流之一，河流由結晶岩成的陡坡流至低地勢的板內沉積岩，且位於新生代構造和熱帶季風氣候盛行的地區。本篇在鐵特河上游河谷處僅發現一個河階，在中游距離河道上 2 到 105 m 公尺間辨識出七個河階序列。這些河階上的沉積物很薄（<10 m），是由砂和礫石所組成。其中鐵特河中上游的河階是屬於侵蝕性河階，而中下游則是堆積性河階。流域地形內的岩性變化和構造特徵主控著對河階的分佈。其中 Serra de Paranapiacaba 是一個急折區(knickzone)，阻礙了基準面的平衡及河流向上游切割，所以限制鐵特河上游區河階的形成及保存。而中游七階河階的形成是受控於低抗侵蝕性的基質、高河流功率和增加河道侵蝕效率的粗顆粒床載。因此，板內構造對河流形貌的影響僅受先前構造事件中出露地表的基盤控制。不同河階的沉積物經 OSL 定年的結果指出，自 18ka 以來鐵特河中部經歷 5 個加積時期，分別為:17.7 ± 1.7 ka； 9.8 ± 1.0 至 8.6 ± 0.8 ka； 7.1 ± 0.7 至 5.8 ± 0.5 ka； 4.2 ± 0.4 至 3.1 ± 0.3 ka；和 0.6 ± 0.06 ka。本篇結果表明，過去 18 ka 以來南美季風的變化導致巴西東南部河谷植被覆蓋和排水量的改變。加積期會與乾燥的環境和稀疏的植被條件有關。相反地，河谷下切則會發生在更潮濕且有利於植被恢復的環境條件下發生。因此，氣候引起的排水量變化是主要控制晚第四紀地貌演化的因素。

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The role of bedrock and climate for the Late Quaternary erosive-depositional behavior of an intraplate tropical river: The Tietê River case, southeastern Brazil

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ABSTRACT

The evolution of fluvial systems has been related to tectonics and climate controls across various spatiotemporal scales. Despite the growing efforts to investigate the effects of those controls 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) techniques to investigate the effects of climate and tectonic factors on the evolution of the Upper and Middle Tietê River during the late Quaternary, especially concerning alluvial aggradation and terraces formation. The Tietê River is one of the most important rivers of southeast Brazil, flowing from crystalline steep to sedimentary low-relief intraplate terrains, in an area with evidence of Cenozoic tectonics and under tropical monsoon climate. We recognized one fluvial terrace level in the Upper Tietê valley and a sequence of seven terraces, from 2 to 105 m above the channel level, in the Middle Tietê. These terraces are formed by thin deposits (<10 m), composed of sandy and gravelly sediments. The terraces of the Upper Tietê and the high and intermediate terrace levels of the Middle Tietê River are strath, while the low terraces of the middle reach are cut-and-fill. Lithological shifts and structural features of the watershed terrain play a strong control in the occurrence and distribution of these terrace levels. The Serra de Paranapiacaba, a regional knickzone, hinders the lowering of the base level and the river incision to upstream, limiting the formation and preservation of terraces in high topographic levels in the Upper Tietê. The formation of seven terrace levels in the Middle Tietê River was controlled by the combination of low erosion resistance of the lithological substrate and high stream power and coarse bedload that increased the erosion efficiency of the channels. Thus, the influence of intraplate tectonics on the fluvial landscape is restricted to passive controls by exhumated basement structures from older tectonic events. OSL dating of sedimentary deposits in different terrace levels indicate five periods of aggradation in the Middle Tietê valley since 18 ka: 17.7 ± 1.7 ka; 9.8 ± 1.0 to 8.6 ± 0.8 ka; 7.1 ± 0.7 to 5.8 ± 0.5 ka; 4.2 ± 0.4 to 3.1 ± 0.3 ka; and 0.6 ± 0.06 ka. The results indicate that changes in the activity of the South American Monsoon System induced changes in vegetation cover and water discharge in the river valleys of southeastern Brazil over the past 18 ka. The aggradation periods are correlated with drier environmental conditions and sparser vegetation. In contrast, valley incision occurred under transitions to wetter environmental conditions and was potencialized by vegetation recovery. Therefore, climate-induced changes in the water discharge were the main allogenic control on the late Quaternary landscape evolution.