Tracing paleosols in a UAV-based photogrammetry model of the alluvial stratigraphy in the Bighorn Basin, Wyoming

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Abstract:

Strikingly-developed paleosols have been extensively reported in the alluvial floodplain stratigraphy of the Willwood Formation, Bighorn Basin, Wyoming. They result from strong pedogenesis on the floodplain fines during the long, channel-stability overbank phases. Stratigraphic alternations between the overbank phase and the avulsion phase featuring weak pedogenesis on heterolithic sandy avulsion-belt deposits, are demonstrated to be driven by orbital climate forcing based on 1D cyclostratigraphic analysis. Given that the floodplain aggradation cycles can be influenced by both allogenic forcing and autogenic processes, it is crucial to reveal its lateral persistency and variability so as to disentangle the interaction between allogenic and autogenic factors over spatial and temporal scales. We here trace paleosoil beds laterally in a 3D, fully-georeferenced UAV-based photogrammetry-model that covers an area of ~10 km^2 and straddles a stratigraphy of ~300 m. This model is integrated with detailed sedimentary logs produced in trenched sections to document the lateral persistency and variability of paleosol-bounded floodplain aggradation cycles. There are a total of 44 cycles with an average thickness of 6.8 m. We comprehensively analyse seven successive cycles that show an average thickness range from 3.7 to 9.7 m and a standard deviation of 1.0 to 2.5 m. Variogram analysis reveals that the thickness of a cycle at one locality is related to that at another locality over a maximum distance of 1.1-1.6 km roughly in the paleoflow direction and 0.2-0.7 km perpendicular to the paleoflow direction. We suggest that this is related to morphodynamic features of the fluvial system that are more continuous in the paleoflow direction. Compensational stacking of vertically adjacent cycles seems to occur within the duration of three successive cycles and full compensation is achieved after more than five cycles are deposited. Relationships between paleosols and associated channel-belt deposits are to be analysed in order to reveal the corresponding sedimentary environment and possible paleoclimate.