Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23794

Topographic controls on alkaline soil development in East Africa Rift Valley Critical Zones

GARY E STINCHCOMB[1], SARA SHEDROFF[2] AND CATHERINE BECK[3]

[1]University of Memphis
[2]University of Massachusetts
[3]Hamilton College

Presenting Author: gstnchcm@memphis.edu

Sue Brantley's work has been instrumental in elucidating our understanding of soil's vital role within the Critical Zone (CZ). Through her contributions, she has not only deepened our understanding of present-day processes but also participated in early Earth studies and influenced researchers exploring the fossilized remnants of Deep-Time CZs, paleosols. This study continues the Deep-Time CZ work and explores the weathering features of paleosols from the early Miocene of eastern Africa, a region associated with some of the earliest hominoid fossils. We used morphological, mass-balance geochemical, microscopic, and mineralogical techniques to reconstruct the weathering features of three nearly complete early Miocene paleosols (P5, P9, P11) that were situated along either lake-margin (P11) or alluvial-plain (P5, P9) landscapes more than 17 Ma (Figure). Morphological and microscopic data show distinct changes in weathering that appear linked to paleo-topographic position. Field and microscopic data reveal more pedogenic $CaCO_3$ nodules in the lake-margin paleosol, whereas the alluvial-plain paleosols have fewer nodules. These data suggest that lake-margin paleosols may have been more alkaline. Our sodium (Na) mass-balance geochemistry is consistent with this change in alkaline soil development. When normalized by fossil soil thickness, our mass balance data show that total Na loss of the lake-margin paleosol is -0.08 g m^{-1}. However, total Na loss is 1.8x greater in the alluvial-plain paleosols, -0.14 g m^{-1}. Our paleo-rainfall reconstructions for these same fossil soils indicate a semi-arid climate and similar within error, suggesting that mean annual rainfall was not a factor driving this change in Na loss and $CaCO_3$ accumulation. It is more likely that topography drove these changes, where the relatively higher elevation alluvial plain was a recharge zone with lower pH and was more prone to Na loss while gaining minimal $CaCO_3$. In contrast, the relatively lower elevation lake-margin was a more alkaline discharge zone with minimal Na loss and more gains in $CaCO_3$. This topographic control on alkaline soil development in the early Miocene resembles natural saline seeps documented in the Pleistocene and modern eastern Africa rift valley. These features may have been persistent, long-term controls on semi-arid CZs in fault-bounded systems.