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238U–234U–230Th Disequilibria in Paleosols from the Azores Archipelago: Implications for Reconstructing Past Weathering Rates

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The weathering of silicate rocks is widely recognized as one of the primary processes regulating atmospheric CO_2 concentrations over million-year timescales. Soils and paleosols—representing the residual products of prolonged interaction between surface waters and volcanic substrates—constitute valuable archives that provide key insights into the patterns and dynamics of cumulative chemical weathering over geological timescales. However, the use of paleosols to reconstruct temporal variations in weathering rates and their relationship to external forcing, particularly during Quaternary climatic fluctuations, remains relatively underexplored.

Recent studies conducted in the Central and Eastern Azores, based on geochemical variations along paleosol profiles and K–Ar and $^{40}Ar/^{39}Ar$ dating of volcanic units bracketing these paleosols [1,2,3], have identified periods of enhanced weathering and pulses of rapid soil formation occurring over timescales of a few thousand to a few tens of thousands of years.

Although the 238U–234U–230Th disequilibrium method has been widely applied to active soils and modern weathering profiles, it has rarely been used to investigate paleosols. Yet, this approach offers the potential to directly quantify weathering rates. It is particularly valuable in cases where the age difference between bracketing lava flows greatly exceeds the duration of soil formation, or where volcanic units are unsuitable for K–Ar dating. The method requires that, once buried by a lava flow, the paleosol behaves as a closed system with respect to U-series nuclides and that its geochemical signature is not significantly altered by thermal or chemical interaction with the overlying lava.

Here, we present new U–Th isotopic data from paleosols developed on lava flows younger than 200 ka in the Azores Archipelago, and discuss the potential of the 238U–234U–230Th disequilibrium approach to constrain paleosol formation rates.

[1] Hevia-Cruz, et al. (2024) Quat. Sci. Rev., 324, 108438.[2] Hevia-Cruz, et al. (2024) Paleoceanogr. Paleoclimatol., 39 (5), e2023PA004810. [3] Hevia-Cruz, et al. (2025) Geochim. Cosmochim. Acta, 401, 62–76.