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Meteoric ^{10}Be analysis from a soil chronosequence in the Mojave Desert, USA reveals the long-term stability of Av horizons and potential avenues for future research

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Quantification of geomorphic processes governing development and long-term stability of vesicular A (Av) horizons in deserts is critical to understanding desert soil genesis and evaluating stability of desert surfaces. Previous attempts to date Av horizons have yielded Holocene ages that are discordant with underlying soil ages, leading some investigators to interpret Av horizons as recently formed features. In contrast, systematic increases in the expression of Av horizon development have been identified from studies that examine trends in soil morphology on Quaternary timescales. This study uses meteoric ^{10}Be ($^{10}Be_{met}$) as a radiometric tracer in the soil to (1) test the hypothesis that Av horizons are long-lived features in low-relief desert landscapes, and (2) enable improvement of dating techniques applicable to desert soils.

Meteoric ^{10}Be concentrations were examined for selected soils within a chronosequence from the Mojave Desert, Southern California, USA. The pedons selected for analysis are from an alluvial fan sequence composed of mixed plutonic parent materials sourced from the adjacent Providence Mountains. Samples for $^{10}Be_{met}$ analysis were collected from Av and underlying B horizons of three pedons of varying soil age and from an active alluvial channel to evaluate relationships between $^{10}Be_{met}$ concentrations and soil exposure time. Additionally, two separate peds from the Av horizon of a single pedon were subsampled to evaluate the relative concentrations in four zones within individual Av peds, including the surface, bottom, sides, and interior.

Meteoric ^{10}Be concentrations from Av horizons range from 6.95x10^6 at/g (active channel) to 1.09x10^9 at/g (oldest) and exhibit a systematic increase in $^{10}Be_{met}$ concentration with increasing soil age. Similarly, samples obtained from underlying B horizons in Holocene to Pleistocene soils have $^{10}Be_{met}$ concentrations of 1.34x10^8 at/g (youngest) to 9.40x10^8 at/g (oldest). The subsampled Av pedons show apparent physical fractionation of $^{10}Be_{met}$, primarily towards ped interiors, which contain 1.01x10^9 to 1.09x10^9 at/g $^{10}Be_{met}$. The remainder of the ped exhibits a comparative reduction in $^{10}Bet_{met}$ concentrations by 12-38%. This trend is similar to carbonate and clay-particle trends that also tend to fractionation in Av ped interiors, indicating a greater proportion of moisture content in these zones relative to exterior ped surfaces.

Our preliminary observations strongly support the hypothesis that Av horizons are persistent and stable features in the landscape, contrary to prior studies that attempt to explain universally young Av ages using arguments that favor Av destruction and reformation in response to climate dynamics during and after the Pleistocene-Holocene transition. Our results have several major implications. First, Av horizons strongly influence the flux of water into the soil profile, thereby governing hydrologic, biologic, and pedogenic processes at and below the soil surface. This study will enable detailed investigation of the rates associated with primary moisture and sediment movement in desert soils. Second, our methodologies provide a technique that can be further developed to directly date Av soil horizons independent from the underlying sediment. Finally, our findings have the potential to inform the hydro-pedologic connectivity between Av horizons and underlying soil materials to enable a better understanding of soil genesis in arid environments.