

EGU2020-11978

<https://doi.org/10.5194/egusphere-egu2020-11978>

EGU General Assembly 2020

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When Did Vesicular Av Horizons Form in the Desert SW U.S.: Elucidating Between Soil Processes and Luminescence Ages

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Vesicular A (Av) horizons, and associated overlying desert (rock) pavement, are ubiquitous features across desert environments. Extensive research has demonstrated that the Av horizons develop from the incorporation of dust (eolian sediment) during soil development; however, two conflicting models have emerged regarding the age of the Av horizons. Published luminescence (OSL) ages from Av horizons suggest that Av horizons are Holocene, with reported ages commonly ≤ 5 ka. In addition, other studies have suggested Av horizons and desert pavements are Holocene in age because Late Pleistocene environmental conditions (primarily an increase in vegetation cover) largely destroyed desert pavements and Av horizons prior to the Holocene, especially for surfaces above 300-400 m elevation. In contrast, time-related trends in the morphology of Av horizons suggest that Av horizons and pavements must have existed prior to the Holocene.

Geochronology and soil morphology from two soil chronosequences formed on alluvial fans in the Mojave Desert (soils ~ 0.5 ka to ~ 100 ka, ~ 900 m above sea level) and in the Sonoran Desert (soils ~ 0.5 ka to ~ 250 ka; ~ 200 m above sea level) indicate that Av horizons existed prior to the Holocene and that the strength of Av development coincides with increasing age of the surface. In both chronosequences, Av horizon properties of eolian derived silt and clay, development of soil structure, horizon thickness, all systematically increase with surface age on soils with no evidence of past erosion or substantial soil mixing. Soil morphology and depth profile relations further support that soil profiles are intact with no evidence of erosion or mixing just prior to the Holocene. OSL dates of Av horizons are considerably younger than soil profiles dated with cosmogenic nuclides and OSL. Some examples include: Av: 5ka/soil: 10-12ka; Av: 1-3ka/soil: 16-21ka; Av: 2-6ka/soil: 50-60ka; Av: 1ka/soil: 210 ka. Mixing of the Av and episodic addition of Holocene dust cannot alone account for age inconsistencies. Recent research using OSL for thermochronology indicates that closure of electron traps occurs between 35° to 50° C. Measured hourly summer temperatures in Av horizons (Sonoran and Mojave Desert sites) commonly exceed 35° to 50° C May through September. We suggest that anomalously young ages for Av horizons may be due to high soil temperatures and degradation of the OSL system.

How to cite: McDonald, E., Sweeney, M., Hanson, P., and Sion, B.: When Did Vesicular Av

Horizons Form in the Desert SW U.S.: Elucidating Between Soil Processes and Luminescence Ages,
EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-11978,
<https://doi.org/10.5194/egusphere-egu2020-11978>, 2020