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Gradation of Soil Hydraulic Properties from Canopy to Interspace on a Mojave Desert Soil Chronosequence

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Desert piedmonts are a mosaic of interspersed vegetation and open soil or interspaces. The distribution of perennial plants in arid regions is ultimately tied to available soil water. Alluvial fan complexes, commonly found in the arid southwest USA, evolve as a series of geomorphic surfaces of varying age and soil development. However, the evolution of soils depends on the proximity to plant canopies. For example, bioturbation and the accumulation of organic matter under plant canopies result in a mound-like formation around plant canopies. Interspace soils, on the other hand, evolve from coarse-textured debris flow deposits into smooth, desert pavements underlain by a highly structured vesicular Av horizon resulting from the accumulation of eolian dust. Infiltration capacity in interspace soils is reduced as a function of geologic age and soil development. Differences in both soil structure and texture in undercanopy and interspace microsites can be significant, thus affecting infiltration, plant available water, root distributions and the partitioning of evapotranspiration into plant transpiration and soil evaporation. In this study, we sought to answer the question: does the spatial structure in soil hydraulic properties from canopy to interspace also depend on the soil surface age? To answer this question, transects of hydraulic properties were measured radiating away from creasotebush (*L. tridentate*) shrubs into interspaces along a geomorphic chronosequence in the Providence Mountains located in the Mojave Desert, USA. Three soils along this intensively studied chronosequence were studied including a young (Qf6, ∼0.5 kya), an intermediate (Qf5, ∼4 kya) and an old (Qf3, ∼75 kya) geomorphic surface. The extent of heterogeneity in soil physical and hydraulic properties (texture, bulk density, hydraulic conductivity functions K(h)) was measured across microsites by sampling and analyzing soils for physical properties, and by using multiple, mini-disk tension infiltrometers (MDTI) spaced at 50-cm increments in linear arrays across a distance of 300 cm. Significant gradients of soil physical and hydraulic properties were observed from canopy to interspace microsites at 1.2 times the mean mound diameter. Significant (P <0.001) decreases in bulk density and significant (P <0.001) increases in organic matter were observed under shrub canopies. A consistent trend of decreasing Gardner's alpha with increasing radial distance from shrubs was also measured. However, K(h) functions under plants canopies remained relatively constant, while functions in interspace microsites depended on geologic surface age. In other words, hydraulic conductivity at the undercanopy microsites remained relatively constant at a value of $\sim$10 cm hr^{-1}. Interspace conductivities ranged from $>$100 cm hr^{-1} on the younger Qf6, to $<$1 cm hr^{-1} on the older Qf3. Our results show that the simple conceptual model, where undercanopy conductivities are always significantly higher than interspace conductivities, is not necessarily the case for all alluvial surfaces.