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Mineralogy Affects Water Vapor Adsorption and Water Content in Experiments Simulating Atacama Soil Conditions

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Water limitation is one of the primary constraints on living systems in hyperarid regions and microbes must be highly adapted to survive and grow in these extremely dry environments. Field results from the Atacama Desert reveal evidence for daily water vapor adsorption cycles in hyperarid soils, which could provide a habitable environment for xeri-tolerant microbes. Water vapor adsorption (WVA) is a physiochemical process where water adsorbs to soil particles at night when temperatures are lower, and desorbs during the day when temperatures are higher. Soil WVA is often parameterized as a function of surface area, temperature, and grain size. However, soils are complex mixtures of rocks and minerals at a range of particle sizes; the effects of mineralogy on water vapor adsorption are not well understood. Here, we describe the results of experiments to quantify the effects of relative humidity, temperature, mineralogy, and grain size on water vapor adsorption. We examined six minerals (olivine, anorthite, quartz, serpentine, kaolinite, and calcite), each at two grain sizes (sand: <2 mm & ≥180 µm, and silt/clay: <180 µm). Minerals were incubated at 35ºC and 11% RH until they attained a steady state mass. We found that secondary minerals (serpentine and kaolinite) and evaporite minerals (calcite) adsorbed 1 to 1.5 mg water per gram dry weight of soil (mg water gdw^{-1}) and primary minerals (olivine, anorthite, and quartz) absorbed <0.8 mg water gdw^{-1} (Fig. 1). The effect persisted across all grain sizes. These results suggest grain size alone is insufficient to explain differences in WVA for different soils. Further work is needed to determine the magnitude of the daily WVA cycle for different minerals and assess the micro-scale habitability of soil environments provided by water vapor adsorption.