Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18333

Mineral Composition Affects Water Vapor Adsorptionin Unsaturated Soils

DONALD M GLASER[1] AND HILAIRY HARTNETT[2]

[1]NASA Goddard Institute for Space Studies
[2]Arizona State University
Presenting Author: dmglaser@asu.edu

Water vapor adsorption (WVA) is an important mechanism for water input to unsaturated soils; particularly in hyperarid environments where WVA is a source of soil moisture equal to or greater than the input from rain. Current models of adsorbed water content rely on surface area (or clay content), as well as temperature and relative humidity (or matric potential). However, we show that adsorbed water content is also sensitive to the mineral composition of the adsorbant (i.e., soil particle). We developed an empirical model based on a series of 160 water vapor adsorption experiments using pure minerals (i.e., olivine, anorthite, quartz, serpentine, or calcite) each at two surface areas (low and high), across a range of four temperatures (10 – 35°C) and four relative humidity values (11 – 75%RH). In general, we show that olivine and anorthite adsorb much less water (normalized to surface area) compared to quartz, serpentine, and calcite. There are, however, environmental conditions where olivine or anorthite have a higher adsorbed water content, highlighting the complexity of the role of mineralogy in WVA. The results of our work provide evidence that minerals have different equilibrium adsorbed water content when all other variables (i.e., temperature, relative humidity, and surface area) are fixed. We show that the adsorbed water content of complex natural soils can be modeled as a linear combination (by mass) of the adsorbed water content of the five described minerals. Our model estimates agree with measured adsorbed water contents to within a factor of five, and are often much better. This work suggests soil mineral composition plays an as-yet-undescribed role in the soil water content of arid and hyperarid soils and sets the stage for future estimates of WVA in planetary environments based solely on remotely sensed observables (i.e., temperature, relative humidity, grain size, and mineral composition).