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Sorption of water by biochar: Closer look at micropores

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Typically, biochar has been assumed to increase total water content of the soil system and thereby positively influence plant-soil moisture hydraulics. In this work, we focused on water's interaction with micro-pores (<2 nm) and its influence on water availability. In other words, the main question was if the driving force of water's behavior was the physics or chemistry of biochar pores. The temporal scale of liquid water entry into biochar's pore network is very complex, with observed bubbling occurring days, weeks, and even months after a piece of biochar is immersed under water at ambient conditions. Elevated temperature biochar typically has a positive heat of immersion measured calorimetrically, whereas the calculated BET energy of sorption from a water sorption isotherm typically decrease with production temperatures. To further complicate matters, different pieces of biochar interact differently with water even though the entire batch was created in the same reactor at the same time and after liquid water exposure the physical structure of biochar is irreversibly altered, sometimes negligible other times catastrophically. Nevertheless, based on the estimations of diffusion coefficients in biochar from drying curve analyses, pore surface moieties do reduce the effective diffusivity of water vapor in biochar. Contrary to the rule of thumb in soil physics, where higher gas filled porosity correlates with higher soil moisture holding capacities, our results indicate that biochar's water sorption rate and capacity is actually reduced at ambient conditions by an increase in microporous volume. Thereby, biochar's hydrophobic behavior is partly due to the entrapment of gas within the air-filled porosity which prevents liquid water's entry, even though these biochars possess elevated gas phase sorption capacities (e.g., BET N2/CO_2 surface areas).