Impact of Carbohydrate Structure on Hydrated Smectite Nanopore Dynamics

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Carbohydrates represent a prevalent class of organic compounds in soil matrices. Prior studies [1-3] have implicated the role of carbohydrates in soil mineral aggregation and soil water retention. Our recent research [1, 2] has shown that the adsorption of two common carbohydrates (glucose and cellobiose) to the prototypical smectite clay, montmorillonite (MONT), resulted in increased nanopore size and restructured water dynamics. Here we seek to unravel the interaction mechanisms and water retention dynamics in MONT nanopores populated with different carbohydrate types. We investigate four carbohydrates of different structural complexity: the monomer glucose, the dimer cellobiose, the linear polymer amylose, and the highly-branched polymer amylopectin. We use isotope-ratio mass spectrometry to obtain clay samples with carbon equivalent carbohydrate content. We identify adsorption sites using nuclear magnetic resonance measurements (^{29}Si and ^{27}Al). We investigate hydration dynamics using a combination of moisture-dependent X-ray diffraction (XRD) and thermogravimetric analysis with in-line mass spectrometry. This research will provide new insights into how organic molecules influence mineral structural and hydration properties.

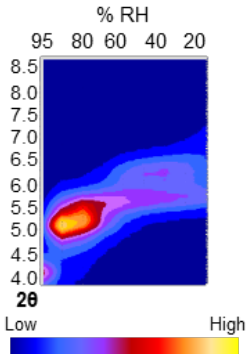

Figure 1. XRD profile intensity mapped across relative humidity (RH) for cellobiose-populated MONT [1].

[1] Kelch *et al*. (2019) *J. Phys. Chem. C* **123** (47), 28816–28827. [2] Aristilde *et al.* (2017) *Adv. Water Resour.* **106**, 24-38. [3] Carminati *et al.* (2010) *Plant Soil* **332**, 163-176.