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Nature of water molecular bridging of the soil organic matter

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Soil is a complex anisotropic and porous system consisting of both inorganic and organic parts, air and water, inhabited and successively transformed by soil biota. Processes of soil formation are influenced by several factors. Among the most important factors belong the inorganic and organic input materials, which are mixed and transformed during soil formation. As a result, specific interactions and interrelationships develop between soil compartments. Although, they are important for soil function and its stability, they are still not well understood. This work deals with water molecule bridges (WaMB), as one of those interactions, and their relation to organic matter functioning.

Differential scanning calorimetry (DSC) belongs to the family of methods of thermal analysis, i.e. it uses heat as a probe of the sample's nature. In soil science, the application of this common method is quite rare. In our previous works, DSC revealed a physical stabilization of organic matter segments in soils by development of WaMB. Results suggested the development of those bridges at ambient temperature accompanied with condensation of water into small nanodroplets. In another work, we found out that water, evaporating at the same temperature as WaMB transition occurs, correlates with the activity of soil microorganisms measured via CO_2respiration.

In this work, the enthalpy and kinetic parameters of water evaporation are studied in two kinds of soil: in clay-rich chernozem soils originating from Siberia and a histosol collected in Germany. We discuss the details of application of DSC, experimental arrangement and advantages and disadvantages of this approach. It is shown that enthalpy of evaporation can be used for understanding the nature of water binding in soils with well-developed aggregates. In contrast, the evaporation of water from histosol, without a typical soil texture, is more complicated because of diffusion processes. Further, the connection between enthalpy of evaporation and soil microbiological activity is discussed.