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Water Mobility in the Interfacial Quasi-Liquid Layer of Ice/Clay Nanocomposites

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At ice/solid interfaces, a quasi-liquid premelting layer (qll) is formed at temperatures below the melting point of bulk water. This qll affects the properties of ice/clay nanocomposites found in ground ice and permafrost. One of the decisive parameters is the water mobility within the qll. Using quasi elastic neutron scattering, the translational diffusion constant of the qll was studied for model systems prepared from clay minerals with large surface to volume ratios. Measurements on a series of charged (vermiculite), hydrophilic (kaolin), and hydrophobic (talc) ice/clay nanocomposites unravel the influence of the solid surfaces. For all composites, the translational diffusion constants within the qll are strongly reduced compared to super cooled bulk water. Depending on their surface properties, significant differences were found for the studied clay minerals. This indicates that beside of confinement effect, intermolecular interactions between the water molecules and the solid surfaces play an important role for the water mobility in the qll.

Significance statement

Material properties of permafrost strongly depend on the molecular scale structure and dynamics of the qll at ice/solid interfaces. Here, we report a QENS study on ice/clay nanocomposites that serve as model systems for permafrost. The results have implications to understand contaminant migration in frozen soils.

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