

Thin Water and Ice Films at Mineral Surfaces

Merve Yeşilbaş and Jean-François Boily

Umeå University, Chemistry Department, Umeå, Sweden (merve.yesilbas@chem.umu.se)

Mineral-water and ice interactions play important roles in atmospheric cloud formation. They also affect soil biogeochemistry as well as outer-space processes.

In this study, thin water and ice films formed on minerals of varied bulk and surface structure, shape, size and surface roughness were probed by Fourier Transform Infrared Spectroscopy (FTIR) and by Dynamic Vapor Adsorption (DVA). Measurements on several types of iron (oxyhydr)oxides, phyllosilicates, orthosilicates, tectosilicates as well as Arizona Test Dust (ATD) and Icelandic volcanic ash constrained our understanding of the molecular-level nature of mineral surface-water and ice interactions. DVA experiments showed that particle size is the key feature controlling water loadings at 25 °C. Under this condition, nano-sized particles stabilized the equivalence of no more than ~6 monolayers of water at the near saturation of water vapor while sub-micron sized particles stabilized several thousand layers. This result can be explained by the greater ability of larger sized particles at driving water condensation reactions. Cryogenic FTIR measurements at -10 and -50 °C revealed that most minerals acquired the thin ice films with similar hydrogen bonding environments as those formed at room temperature.^[1,2] These thin ice films have weaker hydrogen bond environments than hexagonal ice ($\nu_{OH} \approx 3130 \text{ cm}^{-1}$), a result seen by FTIR through predominant O-H stretching modes at $\nu_{OH} \approx 3408\text{-}3425 \text{ cm}^{-1}$. The water bending region ($\sim 1630 \text{ cm}^{-1}$) also reveals that most thin ice films are rather supercooled forms of water. Only the materials with greatest levels of heterogeneity, namely ATD and volcanic ash, stabilized solid forms of water reminiscent to hexagonal ice. This work thus constrains further our understanding of how interfacial ice is stabilized at mineral surfaces, and opens possibilities for future studies focused on atmospheric gas uptake on mineral- water and ice admixtures.

[1] Song, X. and Boily, J.-F. (2013), *Environ. Sci. Technol.* 47, 7171-7177.

[2] Song, X. and Boily, J.-F. (2013), *Chem. Phys. Lett.* 560, 1-9.