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Ice and cryosalt formation signatures in clay aggregates

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Hydrohalite is a cryosalt mineral that forms in freezing solutions of NaCl. Its formation within aggregates of atmospheric mineral particles could play key roles in ice formation mechanisms, especially over marine environments. Clay aggregates are of especial as these layers aluminosilicate minerals that can aggregate and encapsulate water within nano- to microporous environments. [1,2]. In particular, montmorillonite, the second major clay component ($\sim$ 40%) in troposphere, plays very important roles in atmospheric cloud formation by triggering heterogeneous water condensation and ice nucleation reactions [3].

In this study, we aimed to develop a fundamental understanding of ice and hydrohalite formation at the surfaces and interfaces of aggregated montmorillonite particles exposed to 0.01-5 M NaCl. Experiments involved Fourier Transform Infrared (FTIR) spectroscopy of samples frozen from -10 to -100 $^{\circ}$C and Field-Emission Cryogenic Scanning Electron Microscopy (Cryo-FESEM) at -90 $^{\circ}$C.

FTIR revealed the formation of ice at low particle densities ($<<$ 10 g/L) with low salt content in aggregated particles of montmorillonite. Cryosalt formed however at higher densities ($>>$ 10 g/L) and only above -50 $^{\circ}$C. Results also showed that cryosalts only form in flexible gels of Na-montmorillonite but not of the more rigid Ca-montmorillonite. Cryo-FESEM revealed the microporous-sized environments of saline montmorillonite gels. Cryo-FESEM confirms that ice forms in rigid gels and distributed along the pores and in aggregated montmorillonite particles. Cryosalt minerals formed, in contrast, between and/or near clay aggregated walls [1].

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