The Effects of Aminium and Ammonium Cations on the Ice Nucleation Activity of K-feldspar

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Abstract

Mineral dust is one of the most abundant types of ice nucleating particles in the atmosphere. During atmospheric transport, mineral dust particles can become coated with inorganic and organic solutes, which can impact their ice nucleation activity. Aminium cations formed from amines are one type of organic solute that can coat mineral dust particles in the atmosphere, but their effects on the ice nucleation activity of mineral dust have not been studied. We investigated the effects of primary, secondary, and tertiary aminium cations with methyl and ethyl groups, as well as ammonium cations, on the ice nucleation activity of K-feldspar, an important type of mineral dust, in the immersion freezing mode at low cation concentrations (0.2 to 20 mM) using a droplet-freezing apparatus. Ammonium cations substantially increased the ice nucleation activity of K-feldspar, consistent with previous studies. In contrast, primary aminium cations significantly reduced K-feldspar ice nucleation activity, and secondary and tertiary aminium cations had no significant effect (the effect was less than the uncertainty of our measurements). Our combined results are consistent with the following mechanisms: ammonium cations undergo ion exchange with K-feldspar, providing exposed N-H groups for hydrogen bonding with ice; primary aminium cations undergo ion exchange with K-feldspar, exposing a hydrophobic tail that is not effective at nucleating ice; secondary and tertiary aminium cations do not undergo ion exchange with K-feldspar due to steric effects caused by the multiple hydrophobic groups on the cation.

Early Career Scientist

NO, I am not an early career scientist.

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