Geophysical Research Abstracts
Vol. 21, EGU2019-18959-1, 2019
EGU General Assembly 2019

Ice nucleation properties of artificial microcline feldspar

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Alkali feldspars have been found to be the most efficient ice nucleating components of airborne mineral dust particles. Despite recent efforts to explain this experimental phenomena, the molecular mechanism of ice nucleation on feldspar is far from being understood. Recently, the surface topography and crystalline structure have been recognized as the two major factors defining the ice nucleation activity of K-feldspar. However, complex morphology and strong variability of chemical composition of K-feldspar hinder the quantification of individual factors contributing to its ice nucleating properties. One of the major unanswered questions is how the spatial distribution of Na-rich and K-rich regions of alkali feldspar is related to its IN efficiency and what is the mechanism behind this relationship.

In this contribution, we report the results of a droplet freezing experiment conducted on the thin sections of feldspar artificially modified with respect to its chemical composition. The almost pure K-reach monocline feldspar (adularia orthoclase) has been modified by exchanging up to 30% of its framework potassium with sodium under temperature and pressure similar to the natural magmatic environment. Modified in this way, the artificial feldspar bacame very similar to the natural microcline, which has been claimed to be the most IN active of all alkali feldspars. We demonstrate that the gradual change of crystalline structure and appearance of Na/K exsolution lamellae is correlated with the increase of median freezing temperature of water droplets deposited on the surface of the thin section. Finally, using the data of electron scanning microscopy and X-Ray spectroscopic microanalysis, we discuss the possible mechanisms responsible for the observed behavior.