Nc-AFM studies of pristine mineral surfaces and their interaction with water

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The interaction of mineral surfaces with water regulates many important natural phenomena, including dissolution, CO_2 sequestration, corrosion, and ice nucleation. Yet, the atomic processes at the heart of the mineral-water interaction are still largely unknown due to the lack of experimental, atomically resolved studies [1]. Here, I will show our current efforts in answering open, fundamental questions on the mineral-water interaction.

Our tool of choice is non-contact atomic force microscopy (nc-AFM). We use it to characterize the surface atomic details of two model minerals – muscovite mica and feldspar microcline – cleaved under pristine (ultra-high vacuum, UHV) conditions. We follow the first stages of ice nucleation by dosing water vapor at 100 K and observe how the surfaces react upon exposure to ultra-clean liquid water [2]. Despite the apparent similarity of the discussed minerals (both are K-aluminosilicates with easy cleavage planes), marked differences appear in their surface atomic details and ice-nucleating behaviors. Mica is terminated by an array of K^+ ions with short-range order, see Figure 1 [3]. Differences at the local (atomic) level determine different water adsorption sites, causing heterogeneous ice nucleation. Instead, cleaved microcline offers a regular honeycomb lattice, which acts as a template for 2D ice growth.

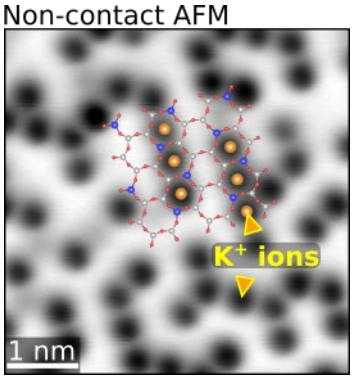

Figure 1: Constant-height, non-contact AFM image of UHV-cleaved muscovite mica.

[1] Coluzza *et al.*, Atmosphere 2017, 8(8), 138
[2] Balajka *et al.*, Rev. Sci. Instrum., 89 (2018)
[3] Franceschi *et al., submitted.*