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Surface Chemistry of Environmentally Important Minerals

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Motion of surface ions is integral in the dissolution and growth dynamics of carbonate minerals. The present study investigates the density and the mobility of surface ions and the structure of the adsorbed water layer with changes in relative humidity (RH). The time evolution of the polarization force, which is induced by an electrically biased tip of an atomic force microscope, shows that the density and the mobility of surface ions increase with rising humidity, a finding which is consistent with increasing surface hydration. A marked change in the observations above 55% RH indicates a transition from a water layer formed by heteroepitaxial two-dimensional growth at low RH to one formed by multilayer three-dimensional growth at high RH. A comparison of the results of several rhombohedral carbonates (viz. CaCO_3 , FeCO_3 , ZnCO_3 , MgCO_3 , and MnCO_3) shows that a long relaxation time of the polarization force at high RH is predictive of a rapid dissolution rate. This finding is rationalized by long lifetimes in terrace positions and hence greater opportunities for detachment of the ion to aqueous solution (i.e., dissolution). Our findings on the density and the mobility of surface ions help to better constrain mechanistic models of hydration, ion exchange, and dissolution/growth.

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