Salt weathering in humidity-change environments: a laboratory experiment

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A laboratory weathering experiment simulating under changing humidity conditions were carried out using five types of rocks (porous tuff, porous sandstone, dense sandstone, and two porous mudstones) with three types of salts (sodium chloride, sodium sulfate, or magnesium sulfate). The rock specimens were subjected to humidity oscillations in a climatic cabinet where air humidity ranged from 20%RH to 98%RH during 6-hour periods 20˚C. Prior to the weathering experiment, the specimens were oven-dried, and the water supply was restricted only from air humidity during the experiment.
Humidity oscillation induced cycles of repeated of salt deliquescence-recrystallization and hydration-dehydration. Salts on rock surface deliquesced and hydrated in a high-humidity period, while they crystallized in a low-humidity period. The degrees of damage were correlated with moisture amounts absorbed to the rock specimens in the high-humidity period.
Sodium chloride which deliquesces at humidity of more than 80%RH caused the most intensive weathering. Porous sandstone with sodium chloride was completely broken down after 100 cycles of humidity changes. Dense sandstone and porous tuff showed flaking or swelling on their surfaces. Equotip surface hardness of dense sandstone with sodium chloride decreased with increasing number of humidity cycles. Sodium chloride can easily induce salt weathering by salt deliquesce and recrystallize in environment where air humidity fluctuates in a short time interval, such as the surfaces of rock cliff in coastal spray zones.
Magnesium sulfate induced a weight loss in porous sandstone, through flaking from the surface of porous tuff, and through swelling and cracking on the surface of dense sandstone. Sodium sulfate was not effective in the humidity-change experiment, although salt efflorescence was extensively produced. Slow hydration rate of sodium sulfate can cause the ineffectiveness of sodium sulfate. In addition, volumetric expansion with hydration of sodium sulfate may result in pore clogging, and hinder infiltration of moisture into the rock specimens. The restricted activity of sodium sulfate suggests that sodium sulfate rarely induces salt weathering by daily humidity fluctuation. Magnesium sulfate might influence rock decay more than sodium sulfate when air humidity fluctuates in a short period.

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