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# The first angstrom-scale view of weathering

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Lower Antelope Canyon in Arizona was carved out of the surrounding sandstone by both mechanical weathering and chemical weathering. Credit: Moondigger, CC BY-SA 2.5

Sedimentary rocks and water are both abundant on Earth's surface, and over long stretches of time, their interactions turn mountains into sediment. Researchers have long known that water weathers sedimentary rocks both physically, by facilitating abrasion and migration of rocks, and chemically, through dissolution and recrystallization. But these interactions never have been viewed before in situ at the angstrom scale.

In a new study, Barsotti et al. use environmental transmission electron microscopy to capture dynamic images of water vapor and droplets interacting with samples of dolostone, limestone, and sandstone. Using a custom fluid injection system, the team exposed the samples to distilled water and monitored the effects of the water on pore sizes over the course of 3 hours. Physical weathering was readily observable in the experiments with water vapor, and the chemical processes of dissolution and recrystallization were more pronounced in experiments with liquid phase water.

The researchers were able to observe a layer of adsorbed water that had formed on micropore walls of all three rock types. They found that as water vapor was added, the pore size contracted by as much as 62.5%. After 2 hours, when water had been removed, the pore sizes increased. Overall, with respect to the initial size, the final pore size of the dolostone decreased by 33.9%, whereas the size increased by 3.4% and 17.3% in the limestone and sandstone, respectively. The team suggests that these changes in pore size were due to adsorption-induced strain. The liquid phase experiments revealed that dissolution rates were highest in limestone, followed by dolostone and sandstone.

The study supports previous work suggesting that dissolution and recrystallization can alter the size and shape of the pores in sedimentary rocks. It also provides the first direct evidence from an in situ experiment that adsorption-induced strain is a source of weathering. Ultimately, these changes to pore geometry could lead to changes in rock properties such as permeability that influence water flow, erosion, and elemental cycling on broader scales.

**More information:** Elizabeth Barsotti et al. In Situ Investigation of Fluid-Rock Interactions at Ångstrom Resolution, *Journal of Geophysical Research: Solid Earth* (2021). DOI: 10.1029/2020JB021043

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