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# Effect of water saturation on weathering of a rock: an example of rhyolite

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Weathering of a rock proceeds by the interplay between reaction and transport. In unsaturated zone above a water table, air and water are present in rock pores and water saturation of a rock has a large variation. In the present study, the effects of the water saturation on chemical reaction rate and transport through rock pores were evaluated, taking the weathering of porous rhyolite from Kozushima, Japan, as an example.

Permeability test and through diffusion experiment were conducted using a rhyolite core which was completely saturated with water under vacuum, and a saturated hydraulic conductivity and a saturated effective diffusion coefficient of dissolved Si were determined. Similar experiments were conducted using a dried sample, and an unsaturated hydraulic conductivity and an unsaturated effective diffusion coefficient were determined. The unsaturated hydraulic conductivity was smaller than the saturated one by a factor of 0.08 and the unsaturated diffusion coefficient was smaller than the saturated one by a factor of 0.4. The changes of hydraulic conductivity and diffusion coefficient are inferred to be due to the changes in tortuosity, connectivity, size, and number of flow paths.

To compare the weathering rate of the rhyolite (dissolution rate of Si) under a saturated condition and that under an unsaturated condition, the weathering rates were computed by a reaction-transport equation using the values determined by the permeability test and diffusion test and a dissolution rate per unit reactive surface area determined separately. The weathering rate calculated for the saturated condition was 7E-18 mol Si $cm^{-2}$ $sec^{-1}$ and that for the unsaturated condition was 9E-19 mol Si $cm^{-2}$ $sec^{-1}$) (in the case of a rock size of 50 cm). As to the rhyolite in Kozushima, weathering rate in the field has been estimated to be about 6E-19 mol Si $cm^{-2}$ $sec^{-1}$, which was determined by comparing the chemical compositions of rhyolites having different duration of weathering. Comparison of the field rate and numerical results reveals that the calculated result under the unsaturated condition agrees well with the field rate. This indicates that evaluation of the effect of water saturation is important for precise prediction of weathering rate.