The relationship between reactive surface area of rock and water saturation: Importance of water film

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Knowledge of reactive surface area of a rock is essential for quantitatively modeling water-rock interactions including chemical weathering and the fate of solutes. Because the rock pores in the subsurface are usually filled with both water and air, the extent to which mineral surfaces can react under such water-unsaturated condition needs to be evaluated. Here, we investigated the relationship between reactive surface area and water saturation by flow-through dissolution experiments using saturated and unsaturated rocks.

The experiments were conducted using the cores of Fontainebleau sandstone (porosity: 6%, quartz ~100%) and Kozushima rhyolite (porosity: 18%, glass 87%, plagioclase 9%, quartz 4%). The obtained bulk dissolution rate of the sandstone under unsaturated condition (= $r \times A_{unsat}$, where r is the dissolution rate constant and A_{unsat} is the reactive surface area under unsaturated condition) was almost equal to that under saturated condition (= $r \times A_{sat}$, where A_{sat} is the reactive surface area under saturated condition) (Fig. 1), demonstrating that the presence of air does not affect the reactive surface area [1]. This result shows that the surfaces of the pores filled with air are wholly wetted with water film and the water film induces dissolution and the transport of dissolved elements. Similar phenomenon was also observed for the rhyolite [2]. Our findings show that water film plays an important role on water-rock interaction under unsaturated condition (Fig. 2).

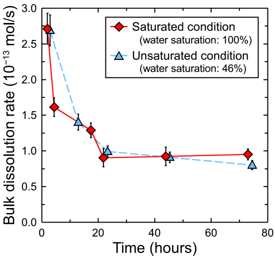

Figure 1. Dissolution rates of the sandstone under saturated and unsaturated conditions.

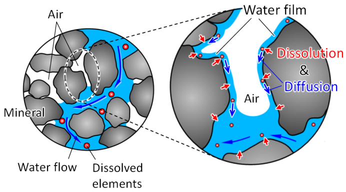

Figure 2. Schematic of how water-rock interaction proceeds under an unsaturated condition.

[1] Nishiyama & Yokoyama (2013), *Geochim. Cosmochim. Acta* **122**, 153–169. [2] Yokoyama & Nishiyama (2013), *Proc. Earth Planet. Sci.* **7**, 916–919.