Modeling and experiments on dissolution of minerals under the presence of air in pores: difference in silicates and carbonates

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Minerals inside rocks and soils react with water infiltrating into pores. Even if air is present in the pores, the surface of the mineral is generally wet with water film and dissolution progresses[1]. The thickness of water film is often much thinner than one micrometer, and the efficiency of the flushing of elements dissolved from the mineral in the water film is lower than the case that the pores are filled with bulk water. To evaluate how the dissolution behavior under the presence of air depends on the type of mineral, we conducted flow-through dissolution experiments using a core of Berea sandstone, which consists of quartz, feldspar, and Ca-Mg-carbonates, etc. The experiments were conducted both under the water-saturated (pores were filled with water) condition and the unsaturated condition. Comparison of the results of the two conditions showed that the dissolution of carbonate was significantly retarded under the presence of air, whereas the dissolution of silicates was relatively little affected by air. A numerical model of the dissolution of minerals covered with water film (Fig. 1) suggests that the different dissolution behavior is due to the difference in the closeness to equilibrium concentration in water film, which stems from the differing dissolution rate constants of minerals.

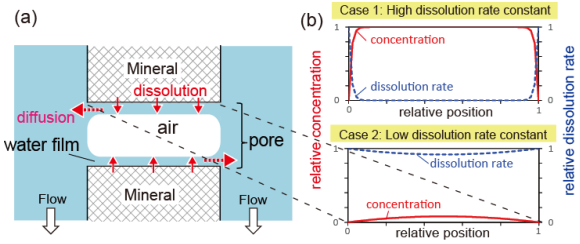

Fig. 1: (a) A schematic of the dissolution of mineral wetted with water film. (b) Profiles of concentration and dissolution rate in the water film calculated for the cases that the rate constant of the mineral is high (case 1) and low (case 2).

[1] Nishiyama and Yokoyama (2013) *Geochim. Cosmochim. Acta.* **122**, 153–169.