Effect of time variation of glass dissolution rate on reactive transport modeling of chemical weathering

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Many laboratory dissolution experiments have shown that mineral dissolution rates decrease with time (e.g. [1]). How the time variation of dissolution rate affects the reactive transport modeling is an important topic. Laboratory dissolution experiment of rhyolitic glass for 277 days at 20°C [2] showed that far-from-equilibrium dissolution rate (r_0) was at first ~500-1000 times greater than the rate determined from a field-based study [3] but decreased according to a power function of time (Fig. 1). Drop of dissolution rate is inferred to have occurred in the field as well as in the lab. By incorporating the time variation of r_0 observed in the lab directly into a reactive transport analysis, how whole-rock average saturation index (Ω_{avg}) and dissolution rate (R_{avg}) in a rhyolite block (cube 0.33 m on a side) change with time was evaluated. The result (Fig. 1) showed that R_{avg} decreased with increasing elapsed weathering time and approached the field rate, which occurred during an early weathering stage (≤~100 years from the onset of the weathering). In addition, Ω_{avg} was high at the start of reaction but decreased with time and eventually became fairly low. Similar phenomenon may occur also for plagioclase, K-feldspar, and biotite, and the time variation of dissolution rate would significantly affect the modeling of various water-rock systems.

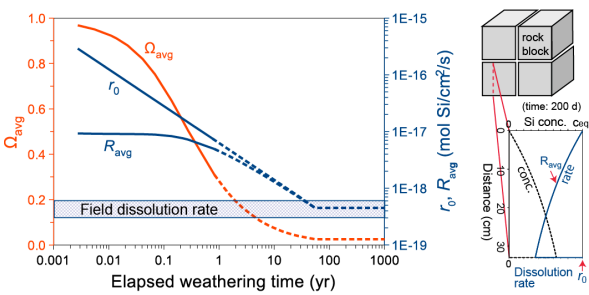

Figure 1: Time variations of r_0, R_{avg} and Ω_{avg}.

[1] White and Brantley (2003) *Chem. Geol.* **202**, 479-506. [2] Yokoyama (2013) *Geochim. Cosmochim. Acta.* **118**, 295-311. [3] Yokoyama and Banfield (2002) *Geochim. Cosmochim. Acta.* **66**, 2665-2681.