Free energy dependence of Albite dissolution kinetics

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Quantification and understanding of silicate mineral weathering have important implications for many environmental problems. Yet, except the recent study of Gruber et al., [1], rate laws for silicate minerals dissolution, which are based on experiments conducted under ambient conditions (close-to-equilibrium, low temperature and acidic-neutral pH), are lacking. The dissolution rates of silicate minerals are very slow under ambient conditions and the change of the ion concentration is lower than the uncertainty associated with measurement. As a result, the uncertainties attributed to the derived dissolution rates are very large causing the rates to be insignificant. In order to overcome these analytical difficulties, dissolution experiments are usually conducted under far-from-equilibrium, elevated temperature and very high or low pH conditions.

Here we present new experimental results of single point batch experiments (SPBE) of albite dissolution in a spiked solution. The novel method that use Si isotopes [2] enables detecting rates that otherwise can't be detected using conventional methods under ambient conditions. Albite dissolution rates were determined under neutral-acidic pH, temperatures of 3.6, 25 and 50 °C, and a wide range of under saturation conditions (ΔG_r). The activation energy (E_a) of albite dissolution was found to be identical within uncertainty to E_a derived from the elevated temperature experiments in previous studies. The dependency of the dissolution rate on deviation from equilibrium ($f(\Delta G_r)$) was in agreement with the prediction of the proposed rate law of Gruber et al., [1] which is based on the stepwave model. However, the value of ΔG_{crit} was found to be significantly different, suggesting an effect of extrinsic properties of the experimental environmental conditions.

[1] Gruber, C., et al., *Resolving the gap between laboratory and field rates of dissolution*. Geochimica et Cosmochimica Acta, 2014. **147**: p. 90-106. [2] Gruber, C., et al., *A new approach for measuring dissolution rates of silicate minerals by using silicon isotopes*. Geochimica et Cosmochimica Acta, 2013. **104**: p. 261-280.