Chemical Weathering Rates of Feldspars: A Stepwise Approach from Laboratory to Field Estimates

BASTIEN WILD[1,*], DAMIEN DAVAL[1],
GWENAËL IMFELD[1], GIUSEPPE D. SALDI[2]
AND KEVIN G. KNAUSS[2]

[1]Laboratory of Hydrology and Geochemistry of Strasbourg (LHyGeS), University of Strasbourg/EOST, UMR 7517 CNRS, 1rue Blessig, 67084 Strasbourg cedex, France
*correspondence: bastien.wild@unistra.fr
[2]ESD, LBNL, 1 Cyclotron Road, Berkeley CA 94720, USA

Chemical weathering of silicate minerals directly impacts geochemical cycles and fundamental processes, such as pedogenesis or global atmospheric CO_2 drawdown. A long-standing problem in water-rock kinetics is to relate laboratory-defined mineral dissolution rates with those observed in the field, since they differ by several orders of magnitude. This field/lab discrepancy may arise from both intrinsic (i.e., related to the microstructural evolution of mineral surfaces) and extrinsic (i.e., related to the composition of the reacting fluids) factors. To date, the exact nature and the relative contributions of intrinsic and extrinsic factors remain poorly understood.

Here we present a stepwise approach to elucidate the respective impact of both intrinsic and extrinsic factors on feldspar weathering rates. The dissolution anisotropy was measured using vertical scanning interferometry (VSI) coupled with atomic force microscopy (AFM) to follow-up modifications of surface microstructures in order to evaluate how intrinsic factors influence long-term labradorite reactivity. In a first step, polished labradorite single-crystals are reacted using acidic synthetic solutions at 80°C and 30°C. In a second step, a similar protocol is followed using filtered-sterile environmental fluids collected from the Strengbach river (Aubure, France) to better understand the role of dissolved solutes (e.g. colloids and dissolved organic matter) on labradorite reactivity. In a third step, environmental fluids and associated microbial communities are reacted to investigate the effect of both biotic and abiotic extrinsic factors on mineral reactivity.

Our preliminary results show that labradorite dissolution rates obtained under moderate pH conditions (pH = 3) correspond to those calculated based on the literature data. In contrast, dissolution rates obtained at pH = 1.5 are about 1 order of magnitude larger than those estimated from literature, concomitantly with a dramatic increase of surface roughness. These preliminary results illustrate the potential of an integrated approach to unravel the contribution of intrinsic and extrinsic factors in controlling mineral reactivity.