# The reactive surface area of fractured rocks and implications on the estimation of weathering rates

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## Reactive surface area of a network of fractures

The reactive surface area of a network of fractures can be estimated from:

$$A_r^f = 2R \times \sqrt{\frac{\rho g n}{12 \mu K}} \qquad (1)$$

where $R$ is the recharge to a spring, $g$ is the acceleration of gravity, $\rho$ and $\mu$ are the specific weight and dynamic viscosity of water, and $n$ and $K$ are the effective porosity and hydraulic conductivity of the fractured medium. This area is about three orders of magnitude smaller than the surface area of the mineral grains in a certain volume of rock:

$$A_r^b = M \times S = \frac{R}{n} \times S \qquad (2)$$

where $M$ is the mass of grains involved in weathering and $S$ is the specific (e.g. BET) surface area. The important consequence of this is that, when flow takes place preferably through the network of fractures (e.g. perennial springs), a normalization of the weathering rates by Equation 2 (usual approach) will be in error by a factor of ~1000.

## Weathering rates

Using a mole-balance model [1], we related the chemical composition of springs with the weathering of plagioclase and biotite in the granites and schists of the Sordo river basin (North of Portugal). Using a standard hydrograph separation method, a regular finite differences method and data from the literature, we estimated $R$, $n$, $K$, and $S$ for the same area. For plagioclase, the average log rates normalized by Equation 2 (given by -15.6±0.3) are in agreement with average field log rates obtained by other authors, whereas those normalized by Equation 1 (given by -12.9±0.3) are one order of magnitude smaller than average laboratory log rates. If, as we believe, the latter values are the ones to consider, then the huge differences commonly reported in the literature between laboratory dissolution and field weathering rates may sometimes be artefacts of normalization, not a reality. Similar conclusions could be taken from biotite weathering rates.

## Reference

[1] Pacheco F.A.L, and Van der Weijden C.H. (1996). Water Resour. Res, **32**, 3553-3570.