



Can the dissolution rates of individual minerals be used to describe whole rock dissolution?

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There have been an exhaustive number of laboratory studies determining the dissolution rates of individual minerals, but few have focused on the dissolution rates of minerals in multi-mineralic rocks. As a result, geochemical modeling of the temporal evolution of water-rock interaction is generally based on the assumption that the dissolution rate of minerals within a rock is equal to that measured in the laboratory on individual minerals. To verify this hypothesis, we have determined experimentally the dissolution rates of a well characterized metabasalt rock (Apollaro et al., 2011; Bloise et al., 2012) from the Mt. Reventino area (Southern Italy) at 25°C in mixed flow reactors. From these experiments and rock modal analysis we have deduced the dissolution rates of the minerals present in the rock (actinolite, albite, chlorite, epidote, and phengite).

The major observation of this effort include: (i) only small differences in the dissolution rates of the individual minerals were observed; these rates are close to the whole-rock dissolution rate and (ii) the dissolution rates of albite and chlorite are in close agreement with laboratory rates obtained from individual mineral dissolution experiments, whereas those of actinolite, phengite, and epidote are not consistent with those reported in literature by 1-2 orders of magnitude. These results demonstrate that the dissolution rate of a given mineral in a multi-phase rock can be affected by the presence of the other minerals. Rock dissolution kinetics are likely constrained by the dissolution rates of the more abundant, lesser reactive mineral or minerals in the rock. These unreactive minerals can prevent the dissolution of the more rapidly dissolving mineral grains by keeping them out of contact with the aqueous phase. This implies that the overall weathering rate of rocks cannot be modelled from the measured dissolution rates of its individual minerals. If confirmed through further studies, this conclusion may have important implications in geochemical modeling, as well as for characterizing element release from rocks in nature systems.

References:

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