

PRINCIPLES OF ESTIMATION OF RELATIVE STABILITY OF SILICATE AND OXIDE MINERALS IN COMMON ACIDIC WEATHERING ENVIRONMENTS

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There are many natural observations of relative resistivity of minerals to weathering. Classical is the series of S. Goldich (1938), which is the same as famous N. Bowen series of magmatic differentiation. A lot of experimental studies were made in order to determine rates of dissolution of minerals in aqueous solutions. These proved incongruent character of dissolution and formation of a leached layer on surface of minerals due to proton exchange. The shortcoming of experimental work is low ratio of altered (dissolved and leached) to unreacted bulk materials (micromoles per gram). In contrast, natural weathering profiles demonstrate that altered to high extent material dominates and often preserves textures of primary rocks. Evidently under mineral-water interaction conditions stability of solids depends on the strength of chemical bonding within their structures. It is measured by Madelung energy or atomization energy. The Madelung energy per oxygen atom seems to be reliable approximation to estimation of stability of minerals. Unfortunately there are many discrepancies. The degree of polymerization of (Al, SiO_4) tetrahedra in mafic silicates influences on their stability. However leucocrate branch of Goldich series (calcic-alcalic-potash feldspars) demonstrates strong dependence of minerals stability on their composition. Reasonable results can be achieved if account for chemical bonding and geometry of crystal structures and leading mechanism of alteration of silicate and oxide minerals in common weathering environment. The latter seems to be proton exchange that is selective removal of weak Lewis acids (K^+ , Na^+ , Ca^{2+} , Mg^{2+} , Fe^{2+}) from crystal structure. Leucoxenization of ilmenite provides good example of oxidative proton exchange that is not restricted by subsurface area but spread into bulk of mineral grains. The proton exchange possess positional and charge nonequivalency because proton does not occupy position of cation but is localized in vicinity to oxygen. On my opinion it is the main reason of disturbing and breaking down crystal structures. Consequently the procedure of estimation of relative stability of minerals must include, besides energetical and geometrical considerations, also evaluation of portion of weak Lewis acids and their mobility in crystal structure. The portion of mobile cations tends to decrease during oxidative proton exchange. Mobility of a cation depends on its size and compactness of the crystal structure.