

High pressure garnet-bearing ultramafites and basites from the Main Uralian Fault: Comprehension of the Uralian mantle composition

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Three types of high pressure (HP) garnet-bearing rocks associated with the Iherzolite massifs have been distinguished in the Main Uralian Fault (MUF) zone (Southern Urals, Russia): 1) olivine-spinel-pyrope websterite ($Mg\# = 0.91-0.83$), 2) garnet clinopyroxenites ($Mg\# = 0.85-0.72$), 3) amphibole-pyroxene-ilmenite-garnet basites ($Mg\# = 0.91-0.65-0.45$). The comparison with HP rocks from the orogenic Iherzolite complexes gives some similarities only for garnet pyroxenites. But the most Uralian HP rocks have $CaO/Al_2O_3 > 1$. It is much higher than those in primary mantle and in rocks from ophiolites ($CaO/Al_2O_3 = 0.8-0.9$). It indicates these rocks could not be the source or protolith of the Uralian HP rocks. It is supposed, that mantle source must be enriched in clinopyroxene and probably had a wehrlite composition. Perhaps, the most magnesium-rich high-pressure ultramafites in the MUF are relicts of such Paleozoic metasomatized mantle. Some of the garnet-bearing rocks could be the melts crystallized at the deep level close to the boundary between garnet and spinel facies. The study is supported by RFBR grants 13-05-00597, 13-05-96031, and scientific programs 2-C-5-1004 and 12-5-008-NDR

Coupled dissolution and precipitation at mineral – fluid interfaces

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When a mineral reacts with an aqueous solution with which it is out of equilibrium the first step of any reaction sequence is the dissolution of the mineral surface. The dissolution of even a few monolayers of the parent surface may result in a fluid boundary layer that is supersaturated with respect to a more stable solid phase. Nucleation of this product phase on the parent surface will depend on nucleation kinetics and will be enhanced if there is a degree of epitaxy (i.e. structure matching) between the two solids. The nucleation of the product on the surface of the dissolving parent enhances the dissolution rate of the parent that in turn increases the growth rate of the product. Such an autocatalytic reaction leads to a feedback mechanism between dissolution and precipitation such that their rates become equal.

Continuation of the transformation (replacement) reaction depends on keeping open fluid transport pathways to the reaction interface between the parent and product solids. In other words porosity must be generated in the product phase. The generation of porosity depends on two factors: the relative molar volumes of the two solid phases, and even more importantly, the relative solubilities of the two phases in the fluid i.e. their relative stabilities under the relevant physico-chemical conditions.

These simple ideas, encompassed in the term “interface-coupled dissolution-precipitation” have very wide application to mineral-fluid reactions in the earth as well as in industrial processes. Central to the whole concept is the importance of the mineral-fluid interface. The fluid at this interface can become supersaturated while the “bulk fluid” away from the interface plays no direct role in the reaction except as a fluid reservoir, i.e. it can remain undersaturated with respect to the reaction products.

Examples of mineral-fluid reactions will be given, starting from direct in situ observations by Atomic Force Microscopy and their relevance to mechanisms of incongruent dissolution and “leaching”, to hydrothermal experiments of mineral replacement mechanisms and their relevance to mineral-fluid interaction in rocks.