

Compositional and textural equilibration of minerals in contact with aqueous crustal fluids

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Chemical reequilibration of a crystalline solid in an aqueous fluid often results in the replacement of one crystal by another [1] while retaining the external form and crystallographic details of the parent. Understanding the mechanism of such a pseudomorphic replacement is important for the study of natural processes such as diagenesis, metasomatism, weathering and metamorphism of minerals, as well as in the assessment of aqueous degradation of ceramic materials used in the chemical industry or for nuclear waste storage [2]. Previously proposed mechanisms include solid-state interdiffusion of chemical species [3], ion-exchange, leaching or dissolution-reprecipitation constrained by stress. We present *in situ* observations of the evolution of both the solid and fluid phase compositions at an interface during replacement reactions, using simple salt systems, as well as natural materials, under ambient conditions free from imposed stress. Mineral replacement can occur if solubility differences between parent mineral and new product phase allow for more of the dissolving phase to remain in solution, i.e., a volume deficit reaction. If the dissolving mineral causes the fluid to become supersaturated with respect to any other phase, a new solid phase may precipitate. This initial step at a crystal surface is the start of a pseudomorphic replacement that may continue through a crystal at a moving interface until a new equilibrium is reached. The interfacial control inevitably leads to the requirement of porosity in the product and the resulting mineral features, such as reaction rims, retention of the morphology of the parent and a porosity which may be transient, suggest a general coupled dissolution-reprecipitation mechanism for reequilibration in solid-fluid interactions [4,5]. These results elucidate a possible mechanism of ion-exchange, which can control crustal fluid compositions.

References

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