



The mechanism of interface-coupled dissolution and precipitation during apparent non-stoichiometric mineral dissolution

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Understanding the mechanism of multicomponent mineral and glass dissolution is important in a wide range of natural (such as weathering) and technological (such as glass corrosion) processes, as well as being crucial in defining rate laws for mineral reactions. Atomic force microscopy (AFM) has been used to make in situ nanoscale observations and measurements, which confirm the formation of a cation depleted layer at the mineral-solution interface during dissolution of multicomponent minerals such as wollastonite, CaSiO_3 and dolomite $\text{Ca,Mg}(\text{CO}_3)_2$ in water at acidic pH. Observations combined with compositional analysis of reaction fluids as well as mineral precipitates, give clear evidence that such a layer is formed in a two step process: 1. stoichiometric dissolution of the mineral surface and; 2. subsequent precipitation of a secondary phase from a supersaturated fluid boundary layer in contact with the mineral surface. Such a mechanism presents a new paradigm that differs from the concept of preferential leaching of cations, as postulated by most currently accepted dissolution models. Furthermore, this mechanism applies to any Earth situation where aqueous fluids are in contact with minerals and so will be the controlling mechanism in processes such as metamorphism, metasomatism and element sequestration, eg., CO_2 sequestration.