



Gel-mediated dissolution and reprecipitation - A novel mineral reaction mechanism

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Rates of mineral reactions are controlled by two major factors: surface kinetics and element transport. Dissolution and precipitation of minerals in the presence of a hydrous fluid is assumed to occur predominantly by hydrolysis of the outermost charged monolayers of the reacting crystal and subsequent incorporation of atoms from ionic solutions into favorable sites at the product surface. Element transport during mineral reactions is commonly thought to occur via ionic solutions with the mineral solubility in the coexisting fluid being a rate limiting factor. Here we show in high-pressure/low temperature rocks that an alkali-Al-Si-rich amorphous material forms directly by depolymerization of the crystal lattice. Depolymerization starts along grain or phase boundaries, dislocation cores in the crystal lattice or lattice defects in general that serve as element exchange pathways and are also sites of porosity formation. High hydrogen concentrations in such dislocation cores within nominally anhydrous pyroxene has been confirmed by Nano-SIMS measurements and indicates hydrolysis and recrystallization within mineral grains. Element transfer in the alkali-Al-Si-rich amorphous material is thermodynamically decoupled from ionic solutions and therefore enables significantly higher element transport rates than previously thought. The resulting amorphous material occupies large volumes in an interconnected porosity network which has been documented in 3D imaging. Precipitation of product minerals occurs directly by repolymerization of the amorphous material at the product surface. This new dissolution-reprecipitation mechanism has major implications for the role of mineral reactions during geophysical and geochemical processes in the dynamic Earth.