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Replacement processes in crystalline rocks

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A substantial question in metamorphism is what is the mechanism that dominates the conversion of one mineral assemblage to another in response to a change in the ambient physical and/or chemical conditions. Petrological, microstructural, and isotopic data indicate that aqueous fluids must be involved even in the reequilibration of large-scale systems. Fluid-mineral reactions take place by dissolution - precipitation processes, but converting one solid rock to another requires pervasive, either dominantly advective or diffusive fluid-mediated transport through the entire rock. The generation of reaction-induced porosity and the spatial and temporal coupling of dissolution and precipitation can account for fluid and element transport through rocks and the replacement of one mineral assemblage by another.
To determine the mechanism of metamorphic reactions we refer to examples of interfaces and reaction textures which contain both the “before” (precursor) and “after” mineral assemblages - case studies where the process of conversion is frozen in. We will illustrate some aspects of the role of fluids in metamorphic reactions and discuss how reactive fluids can pervasively infiltrate a rock. The examples we will use are focussed on crystalline rocks and include reactions from the lower continental crust, the subducting oceanic crust, and the continental upper crust to show that except at very high-temperature conditions, essentially the same mechanisms are responsible for converting rocks to thermodynamically more stable mineral assemblages for given Pressure-Temperature-fluid composition (P-T-X) conditions.