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Mineral-fluid interaction and possible mechanisms of reaction-induced weakening

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In the absence of applied stress, minerals reequilibrate in the presence of a fluid phase by coupled dissolution and precipitation processes which can result in the pseudomorphic replacement of one phase by another. A critical aspect of the mechanism is the generation of micro- and nano-porosity in the product phase(s), allowing pervasive fluid infiltration and mass transport to the moving reaction interface. The coupling of dissolution and precipitation depends on which aspect of the dissolution-transport-precipitation process is rate controlling and it is known that this can be modifed by the fluid composition. On the other hand, it is also well-known that the solubility of a dissolving phase is increased by stress resulting in pressure solution and deformation by dissolution-precipitation creep. Understanding the feedback mechanisms during simultaneous mineral reaction and applied stress is a challenging problem. Our approach is to combine detailed petrological and textural observations on natural rocks, with experiments on analogue salt systems to try to relate reaction progress with evidence for enhanced deformation. Textural development and mineral replacement reactions in rocks around a shear zone in anorthositic gabbros in the Lindås Nappe, Bergen Arcs demonstrate the intimate relationships between reaction and deformation and the textural features which might provide clues to mechanisms of rock weakening. Compaction experiments on salt systems in which reequilibration occurs by a combination of pressure solution and pseudomorphic replacement also demonstrate that strain rate at a given stress is also very significantly increased during reaction. The observations suggest that dissolution-precipitation creep may be a widespread deformation mechanism whenever mineral reactions take place in the presence of fluid and applied stress.