



The two endmember types of serpentinization

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Serpentinization may act on peridotite between two extreme environments spanning from chemical weathering of peridotite at the Earth surface to hydration of peridotite in subduction zones close to the terminal breakdown of antigorite.

Surface serpentinization produces a distinct yellow weathering rind on peridotite when exposed to the atmosphere long enough. Rind minerals and thickness depends on the type of peridotite, atmospheric parameters and on the details of transport and kinetics of the chemical reactions as well as on reaction time.

The fundamental process “peridotite + rainwater = weathering rind + runoff water” describes the rind forming process. This hydration reaction produces mainly metastable chrysotile and depends on the water supply from the rock surface to the reaction front. The transport mechanism is grain boundary diffusion. At the reaction front, kinetics controls the progress of the weathering reactions. The competing kinetics-diffusion control determines the rate of rind growth. The alteration zone must be wetted after a dry period and the reaction resumed at the front. The wetting-drying cycles may contribute significantly to the hydraulic properties of the weathering rind. Reaction details of the rind forming process are saved in the subtle structures of the crusts.

Subduction zone serpentinization at the other extreme takes place close to the final thermal decomposition of antigorite. It hydrates peridotite of the subducting lithospheric mantle that has survived serpentinization at the sea floor and at shallower depth in the subduction system. The H₂O needed for the serpentinization process is provided by the decomposition of antigorite (and chlorite) at some short distance down slab. 700°C and 3 GPa are typical conditions for this “last chance” serpentinization, which also recrystallizes earlier formed (colder) serpentinites to antigorite-schists that may also contain metamorphic forsterite and diopside. Titanian clinohumite is a characteristic mineral occurring in subduction zone serpentinites.