

Reaction-induced embrittlement of the lower continental crust

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Field observations and geophysical data reveal a causal link between brittle seismic failure and eclogitization of the lower continental crust. We present results from experimental deformation of plagioclase-rich samples at eclogite-facies conditions and quantify the link between rock rheology and the kinetics of the eclogitization reactions. The deformation was ductile both in the absence of reaction and when the progress of eclogitization was fast compared to the imposed strain rate. However, when the reaction rate was relatively slow, the breakdown of plagioclase into nanocrystalline reaction products induced a weakening that triggered seismic failure. Fluid-induced plagioclase breakdown under eclogite-facies conditions is an exothermic reaction accompanied by a negative change in solid volume. This is similar to other mineral transformations that are known to trigger transformational faulting. We demonstrate that mineral reactions lead to brittle deformation in situations where reaction rates are slow compared to the deformation rate. This reaction-induced instability may provide a generic mechanism for embrittlement at depths beyond the normal seismogenic zone.

Keywords: lower crust, Eclogitisation, Granulite