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Are the mineralogy and rheology of the lower continental crust and upper mantle fluid controlled?

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Field relationships from the root zones of the Caledonian mountain chain exposed in the Bergen Arcs, Western Norway show that Precambrian granulite facies rocks ($P \leq$ 10 kbar, 800 ^{o}C) with compositions ranging from anorthosites to gabbro remained "metastable" and only reacted to Caledonian eclogite facies (P = 15-20 kbar, T = 650 $\pm$ 50 ^{o}C) and amphibolite facies assemblages along fluid channels and shear zones. The "dry" unreacted granulites were transected by pseudotachylytes (seismic induced frictional melts) while the reacted equivalent deformed by ductile flow. The eclogite formation led to a disruption of the granulite facies banding with formation of breccias where angular blocks of granulites are surrounded by eclogite facies shear zones. This fluid mediated metamorphism resulted in a change from brittle to ductile deformation mechanism of the deep crustal lithologies.

The granulite facies complex contains layers and boudins of ultramafites, including spinel lherzolite and garnet pyroxenite. The Precambrian spinel-lherzolite was partially reacted to garnet lherzolite during fluid infiltration. Like the anorthosite, the "metastable" spinel lherzolite was transacted by pseudotachylytes veins with a garnet lherzolite mineralogy indicating seismic faulting of lherzolites at pressure of 15 kbar. Disrupted garnet pyroxenite layers in eclogite facies shear zones change shape from angular blocks (when dry and unreacted) to elongated lens shaped bodies when hydrated and reacted. This suggests that the ultramafic rocks undergo the same fluid mediated rheology change as seen in the feldspar dominated rocks. Although the role of the fluid in the weakening process, by causing reactions (reaction enhanced weakening), by wetting the minerals or by heating by hot fluids, is not agreed upon, the field

data suggest that the fluid exert control both on the originally feldspatic lithologies and on the ultramafic lithologies taken as analog of the upper mantle.

It is suggested that a seismically active lower crust and upper mantle is mainly dry and undergoes hydration and metamorphic reactions. Upon hydration and metamorphism it will become aseismic.