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Deciphering the link between eclogitization of granulite and deep crustal earthquakes

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Eclogitization increases the density of crustal rocks to values close to mantle values, which has strong implications for geodynamics at convergent margins. This reaction is kinetically favoured by the presence of fluids but the processes generating fluid pathways in the deep crust are still unclear. Here, we studied the incipient stage of eclogitization in the lower crustal granulite from the Bergen Arcs area, western Norway. The sample studied is cut by a finely recrystallized pseudotachylite formed by frictional melting during seismic slip. In the wall rock of the pseudotachylite, omphacite, eclogitic garnets, and kyanite occur at the rim of the granulitic garnets. These eclogitic patches are spatially connected by a network of small fractures crossing a highly fragmented matrix of plagioclases surrounded by zoisite needles. X-ray microtomography reveals that some granulitic garnets are fractured parallel to the pseudotachylite. The water content measured with infrared spectroscopy in these fractured garnets is 178 $\pm$32 ppm H_2O whereas it is 52 $\pm$ 22 ppm H_2O in the granulitic garnets away from the pseudotachylite with the same composition in major elements. These results suggest that fracturing associated with deep earthquakes generates the fluid pathways necessary for eclogitization to start. The use of a numerical model coupling reaction, fluid flow and poroviscoelastic deformation reveals that the negative volume change during eclogitization will maintain these evolving fluid pathways through time until the entire rock is completely eclogitized.