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Self-sustained eclogitisation of the deep crust

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At convergent boundaries, the densification of the lower crust modifies the buoyancy forces with strong implications for geodynamics. It is associated with a reaction of eclogitisation which was previously shown to be kinetically favoured by the presence of fluids and associated with deep-crustal and intermediate-depth earthquakes(1,2). However, the mechanism underlying the coupling between reaction and seismicity at depth is still poorly constrained. We collected new field data in the Bergen Arcs (Norway) and used numerical models to determine how the fluid pathways necessary for reaction to occur are formed and maintained. Eclogitization occurs in the vicinity of a pseudotachylite surrounded by a damage zone in which fluids circulated. It mainly occurs in patches around granulitic garnets. These garnets contain 3 times more water than garnets found far from the pseudotachylite. They are zoned with a higher water concentration in their centre. This zonation is modelled by considering hydrogen diffusion in garnet and hydration in the matrix surrounding the garnet. The diffusion profiles are only reproduced when considering closed system conditions. The measurement of high chlorine content in amphibole at the edges of the eclogitic patches confirms reaction in closed system with desiccation. We used a model coupling reaction, deformation and fluid flow to show that reaction occurs in several weeks, and leads to porosity generation and fluid pressure decrease by several hundreds of megapascals. The rock becomes mechanically unstable and can collapse by releasing seismic waves which form new pathways for subsequently arriving fluids.

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