Isothermal compression of an eclogite from the Western Gneiss Region (Norway): a multi-method study

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The Western Gneiss Region in Norway is constituted by a crustal nappe stack that comprises some of the best-preserved exhumed ultra-high pressure (UHP) terranes on Earth. The UHP rocks result from the subduction of the western edge of the Baltica craton beneath Laurentia during the Caledonian orogeny. Mafic eclogites form lenses within granitoid orthogneisses and show the best record of the pressure and temperature evolution. Their exhumation from the UHP conditions has been largely studied, but the prograde evolution has been rarely quantified in the eclogites although it constitutes an important constraint on the tectonic history of this area. This study focused on an unaltered eclogite sample from Vågsøy in the Nordfjord region. This sample was investigated using a large panel of methods including phase-equilibria modelling, trace-element analyses of garnet, trace- and major-element thermo-barometry and quartz-in-garnet barometry by Raman spectrometry. The eclogite comprises omphacite, garnet, white mica, epidote and amphibole and accessory rutile, quartz, zircon, carbonates and kyanite. Garnet shows a grossular-rich core with inclusions of quartz, epidote, white mica and amphibole, while grossular-poor rims are enriched in pyrope and middle rare-earth elements and include omphacite and rutile. Inclusions in garnet core point to crystallization conditions in the amphibolite facies at 550–600 °C and 11–15 kbar, while chemical zoning in garnet suggests growth during isothermal compression up to the peak pressure of 28 kbar at 600 °C, followed by near-isobaric heating to 640–680 °C. Isothermal decompression to 8–13 kbar is recorded in fine-grained clinopyroxene-amphibole-plagioclase symplectites. The absence of a temperature increase during compression seems incompatible with the classic view of crystallization along a geothermal gradient in a subduction zone and may question the tectonic significance of eclogite-facies metamorphism. Two main tectonic scenarios are discussed to explain such an isothermal compression: (1) either the mafic rocks were originally at deep level within the lower crust and were then buried along the isothermal part of the subducting slab, or (2) the mafic rocks recorded significant tectonic overpressure at constant depth and temperature conditions during the collisional stage of the orogeny. A multi-chronometer geochronological study is currently performed, using Sm/Nd and Lu/Hf on garnet and U/Pb on zircon and rutile, and expected to bring additional, discriminant constraints on this *P*–*T* evolution.