Rapid fluid-driven transformation of lower continental crust associated with thrust-induced shear heating

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Caledonian eclogite- and amphibolite-facies metamorphism of initially dry Proterozoic granulites in the Lindås Nappe of the Bergen Arcs, Western Norway, is driven by fluid infiltration along faults and shear zones. The granulites are also cut by numerous dykes and pegmatites that are spatially associated with metamorphosed host rocks. U-Pb geochronology was performed to constrain the age of fluid infiltration and metamorphism. The ages obtained demonstrate that eclogite- and amphibolite-facies metamorphism were synchronous within the uncertainties of our results and occurred within a maximum time interval of 5 Myr, with a mean age of ca. 426 Ma. Caledonian dykes and pegmatites are granitic rocks characterised by a high Na/K-ratio, low REE-abundance and positive anomalies of Eu, Ba, Pb, and Sr. The most REE-poor compositions show HREE-enrichment. Melt compositions are consistent with wet melting of plagioclase- and garnet-bearing source rocks. The most likely fluid source is dehydration of Paleozoic metapelites, located immediately below the Lindås part of the Jotun-Lindås microcontinent, during eastward thrusting over the extended margin of Baltica. Melt compositions and thermal modelling suggest that short-lived fluid-driven metamorphism of the Lindås Nappe granulites was related to shear heating at lithostatic pressures in the range 1.0-1.5 GPa. High-P (=2 GPa) metamorphism within the Nappe was related to weakening-induced pressure perturbations, not to deep burial. Our results emphasize that both prograde and retrograde metamorphism may proceed rapidly during regional metamorphism and that their time-scales may be coupled through local production and consumption of fluids.