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Metamorphic densification of subducted granitoid rocks in the Sunnfjord area, Norwegian Caledonides: Petrogenesis, preservation and implications for Scandian collision dynamics

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Geodynamic models for continental collision require information on rock density and rheology as they evolve during the subduction-eduction cycle. The Western Gneiss Complex (WGC) in the Scandinavian Caledonides represents continental lithosphere that underwent transient subduction during the Scandian collision. Preservation of eclogite facies mineral parageneses in the predominant granitoid gneisses is rare due to amphibolite-facies overprinting and partial melting. However, rocks in the Dalsfjord area of the southern WGC underwent a lower-T, HP eclogite facies metamorphism and lie outside the realm of migmatisation in the higher-T, UHP domains further north. Grey bt+pl+qz+ep±grt±Ca-amp orthogneisses enclose areas of green, omphacite-bearing granitoid gneiss. These evolved from a dry, charnockitic precursor to omp+grt+czo+ky+qz+rt±pg±phe. They are L>S tectonites with a strong omphacite-aggregate shape fabric. Peak P-T was ~650^{o}C at 2.3GPa. Density of the omphacite gneiss under these conditions was calculated at ~3.2 g.cm^{-3} based upon the estimated mineral mode and pseudosection analysis. This would have been neutrally or slightly positively buoyant relative to anhydrous lithospheric mantle but negatively buoyant relative to a serpentinised mantle wedge. If this applied through a large enough rock volume it could have aided subduction or at least retarded buoyant uprise of the WGC during the early stages of the collision cycle.

The HP assemblage of the grey gneisses would have been rich in phengite and poor in omphacite; phengite would have spontaneously decomposed on decompression, while the more anhydrous assemblage in the less potassic and more calcic, green gneiss required addition of an aqueous fluid to fully decompose to an amphibolite facies paragenesis. Hence the grey gneiss remained reactive and its HP paragenesis was lost, but the reactivity of the omphacite gneiss was constrained by the availability of water so the HP paragenesis was partially preserved.

The evolution of density and rheology during the subduction cycle depended on an initial ingress of water followed by its differential consumption and release by different bulk compositions. The tectonite fabric indicates that transformation from dry charnockite resulted in a major change in rheology. However, the localised survival of pristine protoliths shows that the transformation was inefficient. Given its key role in crustal densification, a priority for future research will be to establish likely sources for large fluxes of aqueous fluids in the deepest levels of the orogen.