Fluid-controlled eclogitization of pseudotachylyte-bearing shear zones, Flakstadøy, Norway

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Eclogite-facies shear zones occur surrounding pseudotachylyte veins and fractures in granulite-facies basement on Flakstadøy (Lofoten Islands, Norway). Omphacite and albite-diopside symplectite identified in the shear zones demonstrates shear zones formed at eclogite-facies conditions, estimated at 690-750°C and 1.3-1.5 GPa from garnet-omphacite pairs and the jadeite component of clinopyroxene. Eclogitization likely took place c. 460 Ma based on lower intercept from U-Pb SHRIMP dating. The brittle deformation accompanying pseudotachylyte formation opened fluid pathways that overcame kinetic barriers for metamorphism in metastable lower crustal rocks. The advection of fluids likely reduced rock strength, facilitating deformation, and localizing strain within the shear zones: A strong alignment of amphibole <001> parallel to the shear zone and pseudotachylyte fabric demonstrates fluid availability during shearing, and that hydrous phases grew during fluid-driven eclogitization. Hydration reactions producing amphibole and biotite in the shear zones consumed available fluid leaving the lower crust dry and preventing retrogression. The preservation of pseudotachylyte textures such as injection veins, aligned microlites, skeletal garnet, and fine-grained “chilled” margins; differences in mineral chemistries between the shear zone and host rock; and relict omphacite in shear zones show that metamorphism was a rapid process, that shearing was not reactivated during exhumation, and that retrogression was minimal. Pyroxene LPOs parallel to the shear zones correlate to deformation temperatures >500°C and quartz fabrics showing prism <a> ± rhomb <a> slip demonstrate deformation from >450-550°C up to 750°C at a high strain rate, and correspond to eclogite-facies metamorphic conditions. The eclogitized shear zones on Flakstadøy demonstrate that lower crustal rocks can remain metastable if they lack the “on-off switch” of an influx of fluids to drive metamorphism and deformation in the lower crust, potentially controlling large-scale orogenic processes.