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Eclogite-facies metamorphic reactions under stress and faulting in granulites from the Bergen Arcs, Norway: an experimental investigation

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Field observations from the Bergen Arcs, Norway, demonstrate a network of pseudotachylites quenched under eclogite-facies conditions in mafic granulites. In these nominally anhydrous high-pressure high-temperature (HP/HT) rocks the formation of pseudotachylites, believed to represent fossilized earthquakes, cannot be explained by processes akin to dehydration embrittlement. On the contrary, the transition to eclogite is expected to involve hydration of the initial rock.
To experimentally investigate the underlying mechanisms leading to brittle failure in HP/HT rocks, we performed deformation experiments on natural granulite samples from the Bergen Arcs. The experiments were conducted under eclogite-facies conditions (2-3 GPa, 990-1220 K) to trigger the breakdown of plagioclase - the main constituent of granulite. For these experiments, both a D-DIA and a Griggs apparatus were used. The D-DIA press is mounted on a synchrotron beamline, enabling us to monitor strain, stress, and phase changes in-situ while contemporaneously recording acoustic emissions. The Griggs experiments were performed on a new device installed at ENS Paris, in which only stress-strain were recorded, and post-mortem microstructures investigated. The initial material consisted of a fine grain size granulite powder ($< 38\ \mu$m) composed of mainly plagioclase and minor amount of pyroxene. Hydrous phases are phlogopite and epidote group minerals that make up less than 1 vol. % of the total bulk rock powder plus the adhesion water on grain surfaces.
Mechanical data together with XRD observations and the record of acoustic emissions demonstrate a correlation between stress drops, the growth of plagioclase breakdown products and the onset of acoustic emissions during deformation of our specimen within the eclogitic field. Microstructural analysis show remarkable similarities with that of the natural ecoligitic pseudotachylites of the Bergen arcs. The plagioclase decomposition products form narrow conjugated shear bands, along which dissected and displaced crystals are found in the samples. The lack of microstructural evidence for macroscopic brittle failure in our microstructures could be due to plastic overprinting of early brittle structures. Nevertheless, our preliminary experimental results show a strong correlation between strain localization, dynamic fracture propagation (rapid enough to produce AEs) and the eclogitization of granulite.