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Early reaction of plagioclase : an underrated alteration step during burial of the continental crust

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Mutual links between metamorphic reactions and rheological properties of rocks under pressure, temperature and deviatoric stress are a major source of discrepancy of thermo-mechanical models when it comes to predict strain localization for instance. The interactions between metamorphism and strain are also considered as a possible cause for unexpected mechanical instabilities, e.g. mechanical failure, in lithological units buried deep in convergent plate boundaries.

The partially transformed granulite facies anorthosites on the Holsnøy Island, Bergen Arcs, Norwegian Caledonides, constitute one of the few archetypical exposure of crustal rocks deforming and reacting at the same time in the eclogite facies conditions. In these rocks, eclogite-facies paragenesis develops with devitrification patterns in « brittle » pseudotachylyte, and in their damage walls, along a pervasive network of « ductile » shear zones, as well as « statically » along digitations following the preserved granulite facies foliation, with no apparent relation to strain.

The present study, that follows recent advances in the understanding of relationships between crystallization of pyroxene and local scale pressure field, or modeling of the interaction between the eclogitization reactions sequence and strain localization, focuses on the first steps of incipient plagioclase destabilization along eclogite facies « fingers ».

Granulite facies plagioclase, close to 40 % anorthite in composition, is subject to reactions both in the NASH and CASH subsystems, with contrasted stoechiometries and kinetics. Petrological observations evidence that the lowermost pressure reaction in the CASH system (an + H2O = zo + ky + qz), occurs unbalanced, with high kinetics and reaction volume change and therefore initiates strain within plagioclase grains, that react by twinning and subgrains individualization. This early stage of intra-grain transformation induces an effective grain size reduction, and favors fluid percolation, therefore promoting the eclogitization progression. The reaction occurring inside of plagioclase grains also affects their grain boundaries where kyanite and transient reactions products, such as potential melts, accumulate also altering the overall aggregate properties.

We claim that this early, fast and pervasive reaction is a significative, yet underrated, step of mechanical alteration of the burying continental rocks.