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From coronitic to vein garnet growth: the importance of fluid-mineral interplays during granulitization

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Porosity, permeability and fluid content of deep continental crustal rocks play a fundamental role on crucial properties such as rock rheology and rock ability to concentrate mineral resources. Granulitic rocks correspond to high – temperature metamorphic rocks that constitute most of the lower crust. Granulites are classically considered as dry rocks, mostly because their equilibrium P-T conditions are above the dry solidus. However, numerous studies have evidenced the presence of low water activity and CO_2-rich fluids during granulitic reactions. A fundamental issue is to understand the potential role of such fluids during granulitization processes: are granulitization reactions fluid-assisted or can they occur in completely dry conditions? How do fluids influence granulitic mineral growth and associated element transfer?

To address these key questions, we studied a massif of Precambrian granulitic rocks from the Western Gneiss Region in Norway: the Flatraket massif. It corresponds to quartz-monzonites exhibiting the granulite facies assemblage garnet + plagioclase + K-feldspar + biotite +/- clinopyroxene +/- quartz. These rocks are considered as completely dry, due to both the coronitic texture of garnets, interpreted as solid-state diffusion, and the absence of younger Caledonian eclogitic retrogression. However, we observed garnet veins texturally associated to these coronas, suggesting fluid-driven mass transfer. Moreover, the similar garnet composition in both textures (EMPA analyses) suggests that veins and coronas formed coevally, at granulitic P-T conditions. We performed a detailed microstructural and petrological study (EMPA, SEM) of these rocks that allowed deciphering the complex sequence of granulitic reactions that finally gave rise to both garnet coronas and veins. We here present the results of the detailed microstructural study and propose a scenario that reconciles the a priori paradoxal coeval formation of garnet veins and coronas. The proposed scenario implies local and transient switch from fluid-under-saturated environment during corona growth to fluid-saturated conditions during garnet vein formation, due to local biotite breakdown. The switch in fluid regime implies changes in both mineral growth and element transfer mechanisms. This study highlights the importance of fluid-rock interplays during metamorphism even in globally “dry” rocks.