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# Granulite-amphibolite transitions: quantifying the conditions of fluid infiltration and deformation in cratonic margins

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## Abstract

Cratonic crust preserves large, contiguous expanses of gneissic rock, in which granulite-facies mineral assemblages commonly dominate. The margins of cratons can experience repeated orogenic cycles, during which granulite-facies mineral assemblages are overprinted and deformed at lower-grade conditions. The retrograde transition from granulite to amphibolite facies is an important control on the strength of both ancient cratonic crust and younger, lower continental crust. However, this transition is strongly dependent on the ability of reactive fluids to permeate nominally impermeable granulite rocks at depth in the continental crust. The relative efficacy of dynamic fluid infiltration (e.g. within shear zones) and static fluid infiltration (e.g. grain boundary diffusion) with respect to granulite-amphibolite transitions is poorly understood. We aim to place constraints on the conditions, rates and length-scales of fluid flow through granulite rocks in order to elucidate the rheological behaviour of cratonic margins in contemporary and ancient orogenic settings.

In this study, we analysed a portion of the Superior craton crystalline basement in northern Quebec, Canada (Figure 1), which was metamorphosed at granulite-facies conditions in the Archaean and later retrogressed to amphibolite facies during the middle Palaeoproterozoic Trans-Hudson orogen. This retrogression occurred in association with the development of an overlying thrust belt, the dehydration of which is thought to be the fluid source for retrogression of the underlying basement. The basal décollement to the overlying thrust belt likely acted as a fluid conduit from which fluids percolated into the basement down a thermal and/or chemical gradient (St-Onge and Lucas, 1995).

Here, we use an integrated microanalysis and phase-equilibria modelling approach to reconstruct the pressure-temperature-fluid conditions of this variably retrogressed cratonic margin. Within the basement, granulite-facies assemblages (orthopyroxene-clinopyroxene) are preserved at distances greater than ~10 km structural distance below the basal décollement. Retrogression to hornblende-epidote-biotite amphibolite was pervasive at depths of up to 2-5 km below the basal décollement while patchy, lower-intensity retrogression to hornblende-garnet-clinopyroxene amphibolite is observed between ~5-10 km below the décollement. As thrust-related deformation is absent beyond 5 km below the basal décollement, it is apparent that static fluid flow via grain boundaries is an important mechanism in the patchy zones of low intensity retrogression. These observations suggest that different fluid infiltration mechanisms were in operation at different structural levels. Initial phase-equilibria modelling results using T-$M_{H_2O}$ (temperature-modal water) pseudosections highlight the sensitivity of mineral assemblage to water availability. Future work will apply this approach to quantify regional fluid budgets and allow us to explore questions such as whether the overlying dehydrating thrust belt was a viable or sufficient fluid source.

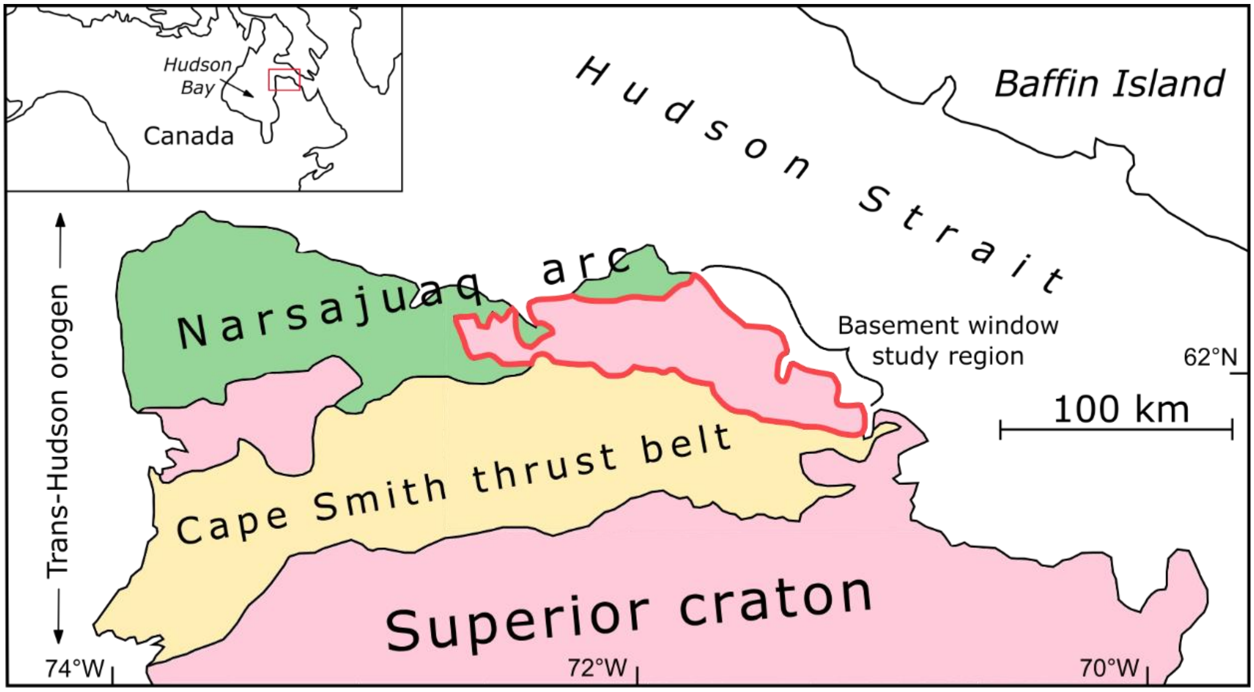


Figure 1: Overview map of the eastern Trans-Hudson orogen. The study region (red outline) contists of a tectonic half-window into the underthrust Superior craton basement below the Cape Smith thrust belt. See inset for location of main figure. Modified after St-Onge and Lucas (1995).

## References

St-Onge and Lucas, 1995. Large-scale fluid infiltration, metasomatism and re-equilibration of Archaean basement granulites during Palaeoproterozoic thrust belt construction, Ungava Orogen, Canada. J. Met. Geol., 13: 509-535.