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Thermal structure of a major crustal shear zone, the basal thrust in the Scandinavian Caledonides

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In continental collision, most of the convergence between the two involved plates is accommodated on a major thrust system at crustal to lithospheric scale, which thermal state depends on critical parameters such as thrust rate, initial thermal properties of involved lithosphere units or local processes such as shear heating. In active orogens the deeper part of such thrust systems is only imaged by geophysics and their thermal state is inferred from modeling. The Norwegian Caledonides offer a rare exhumed thrust system : the Jotun Basal Thrust (JBT), that allows the direct determination of its thermal envelope through Raman Spectroscopy of Carbonaceous Material (RSCM). Data were collected in the Alum shales formation, an organic carbon-rich unit of Cambro-Ordovician age along which the basal decollement of the JBT accommodated a significant portion of the relative movement between the Caledonian nappe stack and Baltica during the Scandian collision and its later collapse. Maximum temperature mapping within this unit shows isotherms almost cylindrically grading from $\sim$320°C in the southeast to $\sim$500°C in the northwest in the trailing end of the nappe stack. Based on Bt+Chl+Grt+Phg equilibrium, we estimate that the trailing end reached 500°C at 1.2 ± 0.1 GPa pressure. 2D thermo-kinematic modeling constrained with these new natural data and timing considerations for the Scandian collision were used to understand the geodynamic significance of this maximum temperature envelope. By testing the influence of the geometry, velocity and extensional reactivation duration, our models indicate that (1) peak temperatures were diachronous along the JBT and were reached during extensional reactivation in its shallowest parts, (2) thrust rate and dip angle must have remained low for the JBT and (3) the Scandian Caledonides represent a relatively cold orogenic wedge compared to other mountain belts of the same size.