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Deep section of a Neoproterozoic fossil magma rich rifted margin exposed

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Structures of rifted continental margins are the finite result of active processes when continents rift apart. During the convergent stages of Wilson cycle, remnants of rifted margins may be incorporated into orogens, especially the magma-poor end-member. The magma-rich margins, however, are commonly lost in subduction due to low buoyancy. The understanding of magma-rich margins is therefore mostly based on drill holes and geophysical observations. In this contribution, we explore the temporal evolution and the ambient conditions of a magma-rich rifted margin preserved within the Scandinavian Caledonides. The Scandinavian Dyke Complex was emplaced in a sedimentary basin during the opening of the Iapetus Ocean 615 to 590 million years ago. The dyke complex now constitutes 70-90% of the area and is locally well-preserved despite the complex Caledonian history. Five field seasons in northern Sweden and Norway provide new observations from regional to microscopic scale about the structural geometry, relative timing, and development of the margin. Jadeite in clinopyroxene geothermobarometry, titanium in biotite geothermometry and garnet isopleth modeling show that the ambient pressure and temperature conditions were similar for the entire dyke complex at 0.25 to 0.45 GPa, with contact metamorphic temperatures up to c. 700°C. Using a photomosaic of a large and well-exposed cliff face we used layers in the metasediments as markers to restore the host-rock back to the pre-dike configuration, allowing us to quantify the average strain accommodated by the dyke swarm. It accommodated for >100% extension and for 27% crustal thickening. From this we infer that the magma influx rate was higher than the tectonic stretching rate, implying that magma was emplaced in a forceful manner, which is also supported by field observations. In the northern part of the study area, high precision dating of magmatic zircon shows that significant partial melting of the sedimentary host-rock, at relatively shallow levels, occurred at 613 ± 1 Ma. This shows that the crust was molten already 6 Ma before the dyke swarm was emplaced at 606 ± 2 Ma. We propose that the locally pervasive partial melting occurred due to high geothermal gradient and introduction of mafic melts in the lower crust. These processes caused a rapid shallowing of the brittle-ductile transition, which thereby significantly reduced the strength of the crust.