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Towards an integrated magmatic, structural and metamorphic model for the 1.1–0.9 Ga Sveconorwegian orogeny

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Orogeny involves magmatic, metamorphic, deformational and erosional processes that are caused by or lead to crustal thickening and the development of high topography. In general, these processes operate along the margins of continental plates, either as a result of subduction of oceanic crust (accretionary) or collision between two or more continental plates (collisional). Many of these processes are common to accretionary and collisional orogeny, and do not uniquely discriminate between the two. With only a fragmented geological record, unravelling the style of orogenesis in ancient orogens may, therefore, be far from straightforward. Adding to the complexity, modern continental margins, e.g., the southern Asian margin, display significant variation in orogenic style along strike, rendering along-strike comparisons and correlations unreliable.

The late Mesoproterozoic Sveconorwegian province in SW Baltica is traditionally interpreted as the eastward continuation of the Grenville province in Canada, resulting from collision with Amazonia and forming a central part in the assembly of the Rodinia supercontinent. We recently proposed that the Sveconorwegian segment of this orogen formed as a result of accretionary processes rather than collision. This hypothesis was based mainly on considerations of the Sveconorwegian magmatic evolution. Here, we show how the metamorphic/structural record supports (or at least may be integrated in) our model as well.

The key elements in our accretionary model are: 1) formation of the Sirdal Magmatic Belt (SMB) between 1070 and 1020 Ma, most likely representing a continental arc batholith. Coeval deformation and high-grade metamorphism farther east in the orogen could represent deformation in the retroarc. 2) cessation of SMB magmatism at 1020 Ma followed by UHT conditions at 1010–1005 Ma, with temperatures in excess of 1000°C at 7.5 kbar. Subduction of a spreading ridge at ca. 1020 Ma would result in an end to arc magmatism and juxtaposition of hot asthenosphere and lower crust. This is a plausible explanation for the UTH event, in contrast to simple crustal thickening and radiogenic self-heating that are generally considered unable to produce such PT conditions. 3) long-lived (990–920 Ma) ferroan magmatism, temporally associated with high-grade metamorphism and large-scale deformation, probably reflecting formation inboard of an alternating compressional/extensional continental margin.

We have no known record of events after ca. 920 Ma, but it is conceivable that the active margin persisted well into the Neoproterozoic, possibly indicated by metamorphic and magmatic activity recorded in Grenville/Sveconorwegian orogen-derived sedimentary rocks.