Geophysical Research Abstracts
Vol. 20, EGU2018-**PREVIEW**, 2018
EGU General Assembly 2018

The Mesoproterozoic Sveconorwegian orogeny: orogen scale interpretation of metamorphic and magmatic patterns supports an ultra-hot collision model

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The Sveconorwegian orogeny is a representative Grenvillian orogeny, involving multiphase reworking of the margin of Fennoscandia at the end of the Mesoproterozoic, between 1150 and 900 Ma. The asthenosphere was possibly c. 100°C hotter than today, having a major impact on tectonic style in the lithosphere. Two geodynamic models compete: a collision between Fennoscandia and another continent to contribute to Rodinia assembly, versus an accretionary (tectonic switch) model at the margin of Fennoscandia. Here we provide an analysis of the structural, metamorphic and magmatic record across the entire Sveconorwegian orogenic belt, through time, supporting the collision model. Convergence-related metamorphism is observed in narrow belts, with increasingly high pressure signature eastwards, towards the (cratonic) Fennoscandia foreland, with time. Peak P-T-t conditions of 1.15 GPa - 850 °C - 1145 Ma are recorded in the Bamble-Kongsberg Lithotectonic Units, 1.5 GPa - 740 °C - 1046 Ma in the Idefjorden Unit, and 1.8 GPa - 870 °C - 990 Ma in the Eastern Segment. Peak metamorphism is followed by isothermal decompression and partial melting. These events are attributed to the pull effect of delamination and foundering of the heavy continental lithospheric mantle in three steps towards the east. This delamination is paired with the formation of an orogenic plateau, growing with time from the centre of the orogen towards the east and west, and associated with protracted mantle upwelling, magmatism, crustal melting, low-pressure metamorphism and upper crustal extension. Orogenic plateau construction started with bimodal magmatism between 1280 and 1145 Ma, overlapping with demonstrably extensional intramontane basin sedimentation between c. 1210 and 1050 Ma, in the Telemarkia Lithotectonic Unit. In the east of the orogen, it was eventually limited by the mid crustal ramp (Mylonite Zone) overlying the Eastern Segment. In the westernmost exposed part of the orogen, the 1066–1020 Ma Sirdal-Feda high-K calc-alkaline magmatic suite is interpreted as voluminous crustal melting (with inherited volcanic arc signature), coeval with (mantle-derived) mafic underplating. This magmatism was followed by two ferroan plutonic suites, the hydrous hornblende-biotite granite (HBG) suite between 990 and 925 Ma and the anhydrous anorthosite-mangerite-charnockite (AMC) suite between 935 and 915 Ma. Anorthosite plutons contain xenocrystic 1040 Ma-old high-alumina orthopyroxene megacrysts, and therefore are interpreted as product of remelting (at 1.3 GPa) of 1040 Ma mafic underplates. The crust was affected by prolonged granulite-facies metamorphism peaking twice in ultra-high temperature conditions, at 0.6 GPa - 920 °C - 1029–1006 Ma and 0.4 GPa - 920 °C - 930 Ma, overlapping in time with magmatism. The extreme temperature in the crust implies that the asthenosphere was located directly under the crust between 1030 and 925 Ma, under the orogenic plateau. The consistent shallow pressure of c. 0.4 GPa for emplacement of (exposed) plutons and granulite-facies metamorphism between 1066 and 925 Ma implies little differential exhumation at the end of orogeny. A wide orogenic plateau speaks up for a collision orogeny. Isotopically, the Oaxaquia margin of Amazonia is possibly conjugate to the Sveconorwegian margin of Fennoscandia during collision.