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Petrogenesis of Sveconorwegian magmatism in southwest Norway; constraints from zircon U-Pb-Hf-O and whole-rock geochemistry

Nick M W Roberts (1,2), Trond Slagstad (3), Randall R Parrish (1), Michael J Norry (2), Mogens Marker (3), Matthew S A Horstwood (1), and Torkil Røhr (3)

(1) NERC Isotope Geosciences Laboratory, British Geological Survey, Nottingham, United Kingdom (nirob@bgs.ac.uk), (2) University of Leicester, Leicester, United Kingdom, (3) Geological Survey of Norway, Trondheim, Norway

The Sveconorwegian orogen is traditionally interpreted as a Himalayan-scale continental collision, and the eastward continuation of the Grenville Province of Laurentia; however, it has recently been proposed that it represents an accretionary orogen without full-scale continental collision (Slagstad et al., in press). We suggest that magmatism is one of the key constraints to differentiate between different types of orogens; thus, detailed investigation of the timing and petrogenesis of the magmatic record is a requirement for better understanding of the Sveconorwegian orogen as a whole. Here, we present new U-Pb geochronology, zircon Hf-O isotope, and whole-rock geochemical data to constrain the petrogenesis of the early –Sveconorwegian Sirdal Magmatic Belt (SMB).

The SMB is a batholithic-scale complex of intrusions that intrudes into most of the Rogaland-Hardangervidda Block in southwest Norway. Current age constraints put emplacement between ∼1050 to 1020 Ma. New ages from the Suldal region indicate that the onset of SMB magmatism can be put back to 1070 Ma, which is some 30-50 Myrs prior to high-grade metamorphism. Average initial εHf signatures range from ∼0 to 4; these overlap with later post-Sveconorwegian granites and with early-/pre-Sveconorwegian ferroan (A-type) granites. Average δ18O signatures range from ∼5.7 to 8.7, except for one anomalous granite at ∼11.6. The Hf-O signatures are compatible with a mixed mantle-crustal source. Crustal sources may include ∼1500 Ma Telemarkian or ∼1200 Ma juvenile crust. Hf-O bulk-mixing modelling using a 1500 Ma crustal source indicates >50 % mantle input.

Although much further mapping and geochronological work is required, granitic magmatism appears to have persisted throughout much of the ∼1100 to 900 Ma period that spans the Sveconorwegian orogen. This magmatism is consistently ferroan (i.e. dry); however, the SMB marks a clear transition to magnesian (i.e. wet) magmatism, with a return to ferroan magmatism at >990 Ma. We propose that this transition corresponds to subduction-driven dehydration-melting of the mantle, producing the SMB in a traditional continental volcanic arc environment. A large lower-crustal input is typical of continental arc batholiths (DeCelles et al., 2009). The interpretation of the SMB as a continental arc is key, but not exclusive, to an accretionary model for the Sveconorwegian orogen. The exact timing and setting of syn-/late-Sveconorwegian 990 to 940 Ma ferroan magmatism thus remains a critical link in the understanding of this orogen.

Slagstad et al. (in press) A Non-Collisional, Accretionary Sveconorwegian Orogen. Terra Nova, DOI:10.1111/ter.120012

DeCelles et al. (2009) Cyclicity in Cordilleran orogenic systems. Nature Geoscience 2, 251-257.