Mafic intrusions in SW Sweden

petrogenesis, geochronology and crustal context.

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ABSTRACT

Mafic intrusions in south-western Sweden were analysed for radiogenic isotopes, major- and trace elements to enhance the understanding of their importance in crust formation processes. The emphasis has been on petrogenesis, intrusion ages and relationships with surrounding crustal rocks. By working on well-preserved mafic rocks, important results on their origin and comparison with modern equivalents were achieved.

The Olstorp and Kedum bodies were derived from hydrous mafic to ultramafic magmas that formed in subduction zones. They fractionated to form cumulates rich in olivine, pyroxene and hornblende which was stabilised due to the high water fugacity in the magmas. This suppressed plagioclase crystallisation until more evolved liquids formed. Anorthite rich plagioclase crystallised to form hornblende gabbros. The crystallisation sequence, mineral and whole rock chemistry is typical for subduction derived mafic cumulates. Both the ultramafic and the gabbro cumulates resemble those forming in modern arc systems. By comparison with modern arc cumulates, it is suggested that these cumulates formed by the same processes as those acting in present-day arcs. This strongly supports a uniformitarian model for mafic arc cumulates back to the mid Proterozoic. Initial Nd, Sr, and Os isotope ratios for Olstorp and Kedum support their derivation from a source that was enriched relative to depleted mantle. The cause of this enrichment was contributions from subducting lithosphere and sediments.

The intrusions caused melting of the country rock and the formation of back-veins. The intrusions were thus dated by ion-probing zircon that grew in back-veins. This is a powerful tool which eliminates uncertainties due to metamorphic reworking. Zircon in igneous environments is very resistant to Pb-loss even at magmatic temperatures. Therefore unaffected xenocrystic zircon provides age information about the country rock that was intruded. REE, Th, U, P, and cathodoluminescent imaging on dated zircon spots provide important constraints for discriminating between igneous and metamorphic zircon.

For bodies like Kedum which occurs as a tectonic lens, back veins were not found, so more traditional dating methods were needed. An 1.88 Ga Re-Os isochron dates the Kedum magmatism and the age corresponds to that of Sm-Nd depleted mantle model ages for granitoid rocks in SW Sweden.

The discovery of ~1780, ~1980, and ~3430 Ma detrital zircon in the Stora Le-Marstrand Formation (SLM) shows that diverse and old crustal components contributed to its sediments. The Stora Le – Marstrand Formataion contains small amounts of basaltic material and the high amount of sediments with Nd components, an island-arc origin for SLM is difficult to accept, and an Andean setting is proposed.

Sveconorwegian (Grenvillian) metamorphism in the Median Segment was characterised by reworking of ~1600 Ma igneous zircon at 1012 ±45 Ma. Following this event, 928 ±8 Ma migmatites formed by partial melting of the Stora Lundby palaeosome at ≥4 kbar. Regional deformation had ceased by 1040 Ma in the Western Segment but at least local isoclinal folding of the migmatite veins occurred after that.

Keywords: mafic-ultramafic, Proterozoic, Baltic Shield, crust formation, Sm-Nd, Rb-S, U-Pb, Re-Os, subduction zone, magmatism, igneous, cumulate.