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Zircon Lu–Hf isotopes in high-alumina orthopyroxene megacrysts from the Neoproterozoic Rogaland Anorthosite Province, SW Norway: A window into the Sveconorwegian lower crust

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The Rogaland Anorthosite Province consists of three massif-type anorthosite bodies and an associated layered Bjerkreim–Sokndal intrusion. The rocks were emplaced between ca. 950 and 920 Ma, following the Sveconorwegian orogeny at ca. 1000 Ma. The anorthosites are commonly thought to have formed by melting of the lower continental crust. They lack zircon or other dateable minerals, so geochronological constraints come from zircon crystals found within opx megacrysts in the rocks. The opx megacrysts contain ca. 7.7 wt.% $Al2O_3$, and are therefore high-alumina opx megacrysts (HAOM). Pressure estimates range from ca. 11 to 13 kbar which implies that the HAOM crystallised in the lower crust and that their zircon cargo has probably been shielded from interaction with the middle and upper crust. If the assumption of a lower-crustal source is correct, the zircons may be viewed as probing the Hf isotopic composition of the lower crust in SW Norway. Zircons were separated from HAOM in the Egersund–Ogna anorthosite and yield a U-Pb age of 948±3 Ma, supporting Andersen and Griffin's (2004) suggestion of onset of magmatism prior to the commonly accepted ca. 930 Ma age for these rocks. Lu–Hf isotopic analyses of the zircons yield a εHf948 Ma value of +3.8 $\pm$ 3 (2σ), which is interpreted to represent the composition of the lower crust in SW Norway.

Three crustal components (or, more correctly, their lower-crustal counterparts) were considered as potential source rocks for the anorthosite magma that formed the Egersund–Ogna body: i) ca.1500 Ma Telemarkian magmatic rocks that cover large tracts of S Norway; ii) ca.1260 Ma magmatic rocks that are geographically widespread in south and central Scandinavia, but volumetrically minor; iii) 1050 to 1020 Ma magmatic rocks in the 30–40 km-wide and nearly 200 km-long Sirdal Magmatic Belt in SW Norway. The isotopic data show that 1500 Ma crust cannot be a major component of the lower-crustal source, whereas both 1260 Ma and 1050–1020 Ma crust are possible candidates. Considering the large volumes of 1050–1020 Ma rocks recently identified in SW Norway, a lower-crustal source of this age is likely. This means that Sveconorwegian-age crustal growth in SW Norway was significant, and that the Sveconorwegian orogeny did not merely rework older crust.

Andersen, T. and Griffin, W. L., 2004, Lithos, 73, 271-288.