An Iapetus origin for a layered eclogite complex in the northern Western Gneiss Region, Scandinavian Caledonides

Charlotte Möller[1], Yue Cai[2,3], Hannes Brueckner[3], Kristoffer Szilas[4], Martin Whitehouse[5]

[1]Department of Geology, Lund University, Sölvegatan 12, SE-223 62 Lund, Sweden;
[2]State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology and Center for Excellence in Life and Paleoenvironment, Chinese Academy of Sciences, Nanjing 210008, China
[3]Lamont–Doherty Earth Observatory of Columbia University, Palisades, New York 10964, USA;
[4]University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen, Denmark;
[5]Swedish Museum of Natural History, Box 50007, SE-104 05 Stockholm, Sweden.

The Western Gneiss Region (WGR) of the Scandinavian Caledonides is one of the world's largest high- and ultrahigh-pressure [(U)HP] terranes and serves as a template for deep tectonic burial and subduction of continental basement. The (U)HP metamorphism was the consequence of the protracted Scandian continental collision at 430-400 Ma and related subduction of the Baltica margin beneath Laurentia. Two different origins are known for the eclogite-facies rocks in the WGR. Precambrian gabbroic intrusions were eclogitised *in-situ* and record the P–T–t history of Baltica during continental subduction. By contrast, ultramafic bodies, some containing garnet peridotite, garnet pyroxenite, and eclogite, represent fragments of the subcontinental mantle beneath Laurentia that were tectonically incorporated into the Baltican basement.

We present evidence for a third type of eclogite in the WGR: an eclogitised fragment of oceanic crust from the Iapetus. This third type is represented by the Kråkfjord eclogite complex, a km^2-sized body with an interior consisting of layered kyanite eclogite (meta-troctolite), and subordinate layers and lenses of garnet peridotite, garnet websterite, and layers and pods of leucotonalite. This interior is capped by Fe-Ti rich eclogite, locally containing pockets of migmatitic aluminous gneiss. The elemental abundances and Nd, Sr isotopic compositions of the Fe-Ti rich eclogites have a Mid-Ocean Ridge Basalt (MORB) signature. In contrast, the interior kyanite eclogites, peridotites and pyroxenites have chemistries typical of the gabbroic lower oceanic crust of slow-spreading ridges. The different rock compositions appear related by fractional crystallisation, with the interior rocks having a cumulate origin. Collectively, the geochemistry suggests that this mafic–ultramafic complex represents an eclogitised piece of oceanic lithosphere.

This scenario is supported by zircon geochronology. U–Pb SIMS dating of igneous zircon cores from a leucotonalite pod in the interior of the Kråkfjord complex yield Ordovician igneous ages of 500–440 Ma, with the ~480 Ma age interpreted as a 'the best' isotopically undisturbed age. This age matches those of Iapetus ophiolite and oceanic arc sequences elsewhere in the Scandinavian Caledonides. Leucotonalitic dykes are absent in the host Precambrian orthogneisses, supporting the interpretation that the Kråkfjord complex was tectonically emplaced into the Precambrian basement after ~480 Ma.

Metamorphic zircon from Fe-Ti rich eclogite in the carapace of the Kråkfjord complex dates eclogite-facies metamorphism at 420 ±2 Ma, synchronous with the Scandian continental collision. Zircon from leucosome within amphibolitised Fe-Ti rich eclogite dates subsequent hydration and partial melting at 411 ±2 Ma.

The U–Pb ages of metamorphic zircon in the aluminous migmatitic gneiss in the carapace range between 440 and 400 Ma. Ages of detrital igneous zircon cores from the same rock fall between 2.0 and 0.44 Ga, clustering at ~1.5 Ga (Gothian),

1.2–0.9 Ga (Sveconorwegian), and 0.6–0.45 Ga (Iapetan), which suggest derivation from Baltican crust and the Iapetus Ocean. The youngest Ediacaran–Ordovician age population indicates that the aluminous sediments were deposited shortly before the Scandian continental collision.

Collectively, our data show that Iapetus oceanic rocks, which elsewhere were obducted into high tectonostratigraphic positions, were also subducted and tectonically emplaced into the Precambrian basement of Baltica.