

Tectonic history and mineralisation in the North Atlantic Craton: A view from Scotland

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The Lewisian Gneiss Complex of North-west Scotland represents a c. 250 km x 150 km fragment of the North Atlantic Craton, comprising tonalite-trondhjemite-granodiorite (TTG) gneisses that were formed in the Archaean and successively reworked during the Palaeoproterozoic. This talk will review new work on the event history of the Lewisian, and its relationship to the wider North Atlantic Craton.

A significant programme of zircon dating over the last two decades showed that the protoliths of the Lewisian Gneiss Complex TTG gneisses were formed in the Archaean (c. 3100-2800 Ma) and that different protolith ages occur in different terranes within the Lewisian Gneiss Complex (Kinny et al., 2005). Similar relationships have been recognised in the Archaean gneisses of Greenland. However, most Lewisian gneisses are characterised by a 'smear' of zircon ages along concordia between c. 3000 and 2500 Ma, and it is difficult to disentangle protolith and metamorphic ages. Mafic to ultramafic rocks, and some supracrustals, are locally associated with the TTG gneisses; their ages are uncertain, but they may represent the remnants of Archaean greenstone belts.

Some relatively undeformed granitoids found within parts of the Lewisian Gneiss Complex give preliminary U-Pb zircon ages of c. 2800-2700 Ma. These granitoids may be related to the similarly-aged Skjoldungen alkaline province in East Greenland. The tectonics of the Lewisian at this time are uncertain. Field evidence clearly demonstrates that some parts of the Lewisian Gneiss Complex have undergone a granulite-facies metamorphic event, associated with extensive partial melting, known as the Badcallian. The age of this event remains controversial, but is generally considered as either c. 2800-2700 Ma (Corfu et al., 1994) or c. 2500 Ma (Kinny et al., 2005). In the North Atlantic craton in Greenland, orogenic events have been recorded between c. 2860 and 2600 Ma, and were typically associated with gold mineralisation (Kolb et al., 2013).

Most workers in the area are agreed that a subsequent period of metamorphism and deformation, known as the Inverian, took place around c. 2480 Ma. This was followed by continental extension and the emplacement of mafic dyke swarms across the North Atlantic craton, including the Scourie Dyke Swarm in the Lewisian Gneiss Complex. The magma source included components from the sub-continental lithospheric mantle that had been enriched by Archaean subduction-derived fluids.

The next major activity in the Lewisian Gneiss Complex occurred around 1900 Ma, as continental arcs developed along the margins of the North Atlantic Craton. In the Lewisian, these arcs are represented by sedimentary and volcanic rocks of the Loch Maree Group and South Harris Complex, as well as granitic intrusions into these and other major terrane boundaries. Stratiform sulphide deposits associated with the Loch Maree Group have been explored for Cu, Zn and Au. Subsequent deformation (the Laxfordian event) was associated with crustal thickening and partial melting, and emplacement of pegmatites between c. 1790 and 1660 Ma. These include some rare-metal pegmatites, with a compositional range between two end-members: a LREE-enriched end-member, and a Li-Ta-enriched end-member.

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