



Caledonian igneous (CAL-IGN)

Block Description

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For Igneous and Mineralogy GCR block descriptions and GCR site lists,
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Introduction

The GCR sites selected for this GCR Block represent a major episode of intrusive and extrusive igneous activity in Britain that occurred as a result of the 'Caledonian Orogeny', lasting from about 500 million years ago (Ma) to around 360 Ma (see **Caledonian Structures of the Lake District (CAL-STR-LD); Caledonian Structures of the Southern Uplands (CAL-STR-SU); Caledonian Structures of Wales (CAL-STR-WL)**), which was a period of mountain building and continental collision that began in the Ordovician Period (which lasted from 495 to 440 Ma) and continued through Silurian (440–417 Ma) and Devonian (417–354 Ma) time.

There is at present no agreed definition of the term 'Caledonian', but is taken here to include all of the convergent tectonic and magmatic events arising from the closure of the 'proto-Atlantic' Iapetus Ocean in which many of the rocks of Late Proterozoic and early Palaeozoic age had been deposited. It therefore encompasses subduction beneath the continental margins; the accretion or obduction of oceanic crust and island-arc material onto these margins; and ultimate collision of the continents, uplift and development of extensional molasse basins. Within this broad orogenic framework many separate 'events' are identified, such as the 'Grampian Event' and the 'Acadian Event'. By this definition, most Caledonian igneous rocks of Britain range in age from about 500 Ma (earliest Ordovician) to around 390 Ma (end Early Devonian), with related activity continuing to around 360 Ma (end Late Devonian) in Orkney and Shetland.

For details of stratigraphy related to the Caledonian Orogeny see **GCR Blocks for Ordovician, Silurian and Devonian Stratigraphy: Arenig - Llanvirn (ARE-LLV); Arenig - Tremadoc (ARE-TRE); Caradoc-Ashgill (CAR-ASH); Llandeilo (LDO); Llandovery (LDY); Ludlow (LUD); Marine Devonian (MAR-DEV); Non-Marine Devonian (NMAR-DEV)**).

Tectonic setting and evolution

The Iapetus Ocean was created in Late Proterozoic time by the rifting and pulling apart of a large supercontinent known as 'Rodinia'. The opening started sometime around 650 million years (Ma) ago and, by the beginning of Ordovician time, at 510 Ma, the ocean was at its widest development of possibly up to 5000 km across. On one side of the ocean lay the supercontinent of Laurentia, which is represented today largely by the Precambrian basement rocks of North America, Greenland, the north of Ireland and the Scottish Highlands. On the opposite side lay the supercontinent of Gondwana, consisting of the basements of South America, Africa, India, Australia, East Antarctica and Western Europe (including south Ireland, England and Wales). A separate continent, Baltica (the basement of Scandinavia and Russia), was separated from Gondwana by an arm of the Iapetus Ocean, known as the 'Tornquist Sea'. The wide separation is supported by palaeontological data which shows distinctly different faunal assemblages in the Lower Palaeozoic rocks of each continent and by palaeomagnetic interpretations.

The continental plates of Laurentia, Gondwana and Baltica started to converge during the early part of the Ordovician Period, initiating new tectonic and magmatic processes which marked the start of the Caledonian Orogeny. The Iapetus oceanic crust was consumed in subduction zones beneath oceanic island arcs and beneath the continental margins.

Magma was being created by the melting of mantle and oceanic crustal material within and above the subduction zones and by melting within the thickened continental crust.

The exact sequence and timing of events as the three plates converged is the subject of much debate, in which the distribution, nature and timing of the igneous activity are crucial evidence.

The tectonic history of the Caledonian Orogeny in Britain can be divided into the following time intervals, linking together coeval magmatic events in the various terranes across the whole orogenic belt.

- Early Ordovician –Tremadoc and Arenig
- Mid-Ordovician –Llanvirn and Llandeilo
- Late Ordovician –Caradoc and Ashgill
- Early and mid-Silurian –Llandovery and Wenlock
- Late Silurian and Early Devonian –Ludlow to Emsian
- Mid- and Late Devonian –Eifelian to Famennian

GCR site selection

Within this GCR Block, sites fall into natural 'networks', which are based upon petrological or tectonic affinities, age and geographical distribution. The ten networks are:

- Ordovician Volcanic Rocks and Ophiolites of Scotland
- Ordovician intrusions of the NE Grampian Highlands of Scotland
- Ordovician Igneous rocks of the Lake District
- Ordovician Igneous rocks of Central England
- Ordovician Igneous rocks of Wales
- Silurian and Devonian Plutonic rocks: alkaline intrusions of the NW highlands of Scotland
- Silurian and Devonian Plutonic rocks: granitic intrusions of Scotland
- Silurian and Devonian Plutonic rocks: northern England
- Silurian and Devonian volcanic rocks: Scotland
- Silurian and Devonian volcanic rocks: Wales

Sites that are important for unravelling the geological history of these major igneous events will also be important for demonstrating general processes of igneous rock petrology, magma evolution and emplacement, and volcanology (e.g. Cauldron Subsidence theory at Glencoe) irrespective of their role in building up a picture of the sequence of events of geological history of the UK.

Weighting of site selection has focussed on identifying those sites where the contribution of Caledonian igneous rocks of Great Britain to igneous petrology and the understanding of igneous processes and have played a major role in the initiation, testing and evolution of many theories of igneous processes.