The Geological record of environmental change

Glaciation: The Geology of Northern Scotland

Voice Over

Intricate and haunting scenery in the Scottish Highlands and islands draws both tourists and geologists. The landscapes result from both glacial action in the last million years, and from earlier geological processes of more than half a billion years ago, which formed the underlying rocks. The rocks are Precambrian and include hard crystalline varieties and others more prone to erosion. Repeatedly, advancing glaciers have sculpted the land and gauged out innumerable sea rocks and inlets. The last glacial maximum was 23,000 years ago but large glaciers still remained 12,000 years later. They flowed westwards and south-westwards, the ice exploiting and accentuating weaknesses in the crust, to carve out valleys and fjords, such as the Firth of Lorne. And then about 10,000 years ago, the glacial ice disappeared, leaving behind today's typography. Glaciation exposed sedimentary rocks of the Dalradian super-group which formed between 750 to 500 million years ago. They provide a record of environmental change as long as the Mesozoic and Cainozoic eras combined.
At the start of Dalradian deposition, the older continental crust of the Highlands hadn't yet linked to the rest of Britain. With Greenland and North America it formed Laurentia and lay far from its present position on the margin of Rodinia, or motherland in Russian, a super-continent which formed a billion years ago. When Rodinia broke into several drifting continents 750 million years ago, what was to become the Highlands straddled the Equator. The drifting continents took another 400 million years to reassemble as Pangaea during the early carboniferous period. Late Precambrian rocks between Scotland's giant crustal fractures, the Great Glen and the Highland Boundary Faults, consist of Dalradian sedimentary sequences laid down in basins as Rodinia rifted apart. Younger masses of granitic intrusions, shown here in grey, punctured them 400 million years ago. Four sedimentary sequences make up the Dalradian: the Lower Grampian Group; the Appin; the Argyll; and the youngest: Southern Highland Group. At this scale, Dalradian structural complexity is simplified. In the early days of serious fieldwork, oddities became apparent in the Dalradian. Some sediments, filled with boulders of many different types, seemed very like recent glacial deposits. Most of these possibly glacio-genic rocks occur close to the boundary that separates the Appin and Argyll Groups. These sediments, probably all the same age, are odd because they were deposited at tropical latitudes. The best tests in Western Europe for theories of late Precambrian Snowball Earth conditions are in coastal exposures of the Inner Hebrides. It's there that the recent Glaciation had its most traumatic effect shaping small, linear islands. One group, the isles of the sea or in Gaelic, the Gravellachs, provide the ideal opportunity to gather field evidence. These islands beautifully expose rocks that lie exactly at the boundary between the Appin and Argyll Groups of the Dalradian. Being uninhabited it's no surprise that most visitors to the Gravellachs are geologists who are interested in the way environmental conditions changed in the past. In a few parts the islands are densely vegetated; only a few deer and sheep graze there. But the results of the last glaciation which etched out the harder Dalradian strata as parallel whaleback ridges, and the softer ones as linear depressions, can still be seen clearly. The Gaelic name, Gravellachs, is very apt: it means 'rough little island'.