

Chris Thomas and Martin Gillespie explain how the granite beneath the Cairngorms influenced the local landscape

Renowned for their dramatic and distinctive landscape, the Cairngorm Mountains lie at the heart of the Scottish Grampian Highlands. The mountains and the surrounding area are amongst the most heavily used upland regions of the United Kingdom, supporting in various ways a significant part of the central Grampian Highlands economy. Forming the core of the recently designated Cairngorms National Park, the mountains host one of Europe's finest groups of landscape features; some of these predate the ice ages, some were formed during the ice ages, and their development continues today. They presently support a sub-arctic fauna and flora. The landscape, climate and wildlife combine to produce a mountain environment unique in the UK. The landscape features contain a wealth of information about past environmental change and how the landscape evolved through arid, tropical and arctic periods to today's temperate climate. The Cairngorms are recognised internationally for their Earth heritage value, and are included on the UK's 'Tentative List' of World Heritage sites, submitted to UNESCO. Developing and implementing policy in the Cairngorms is politically sensitive, as shown by the recent furore over developing the Cairngorm Mountain Funicular Railway and the protracted and often heated debate over the National Park's status, extent and planning framework.

Over the past three years, the British Geological Survey has studied the links between geology and landscape in the Cairngorms in a project co-funded by Scottish Natural Heritage. Though its primary aim is scientific, the project was driven by a requirement for Cairngorm Earth heritage information for non-specialist users. These include: land managers such as the new National Park Authority, to enable them to adopt sustainable land use and conservation measures; recreational visitors looking for informative maps and guides; and secondary schools and universities needing teaching resources – the Cairngorm Mountains are included as a case example in the Scottish curriculum, and form an important study area for degree-level Quaternary science and glaciology.

The Cairngorm massif forms a broad dome some 30km by 20km, rising from 300-500m above sea level at its margins, to a deeply dissected central plateau at around 1000m. The massif includes the largest area of land over 900m high, and four of the five highest mountains, in the UK. Its typical landscape features include high and extensive rolling plateaux, deeply incised troughs with steep sides and flat bottoms, spectacular corries, and large tors. Before this project, the relationship between the landscape features and the geology of the Cairngorms was poorly understood.

The massif is underlain almost entirely by the Cairngorm Granite, which, about 425 million years ago, was injected as molten magma into overlying metamorphosed and deformed sedimentary rocks. Remote sensing analysis and field surveys of the Cairngorm Granite has generated new datasets and thematic maps of the granite body. We have integrated these in a geographic information system (GIS). The data illustrate the orientation of veins and fractures and the distribution of rocks with different textures. They also illustrate the distribution and

orientation of veins and zones of granite that have reacted with chemicals in fluids moving through the veins. These data have substantially improved our understanding of the geological 'architecture' and history of the Cairngorm Granite. Combined with a review of the distribution and character of Cairngorm landforms, these advances provide insights into the links between geology and landscape in the massif.

Chemically, the granite is relatively uniform. Geological mapping has highlighted areas of granite with distinctive textures. However, these bear little relationship to any Cairngorm landscape features, indicating that contrasts in granite texture had little influence on the development of the landscape.

The Cairngorm massif developed because the granite weathered and eroded more slowly than the surrounding metamorphic rocks. The overall size, shape and elevation of the massif are controlled almost entirely by the size and shape of the granite body. As the granite body cooled and solidified in the crust, it was altered locally by hot fluids moving through fracture zones with approximately north-east/south-west orientations. Once exposed about 380 million years ago in the Devonian Period, the altered granite weathered and eroded more quickly than the unaltered granite, leading to the development of valleys with dominantly northerly or southerly trends.

Ultimately, through the erosive power of water and ice, these valleys have become the great features that dominate the Cairngorms landscape today. The massif appears to have been an 'upland' feature since it was exposed. Weathering and erosion were probably particularly severe during the Palaeogene and early Neogene periods (65 to about 20 million years ago), when the climate was much warmer and more humid than today.

During the glacial stages of the Quaternary Period in the last two million years, it seems that ice over the high plateaux was more or less stationary, leaving the plateaux largely unchanged. In contrast, ice moving off the edges of the plateaux scoured the floors and walls of many valleys, changing their shape and creating troughs such as Lairig Ghru. Ice accumulated on high west and north facing slopes and scoured out deep, bowl-shaped corries. The Cairngorm plateaux are well known for their tors. These are isolated rocky towers, formed in relatively unfractured rock that is less susceptible to weathering and erosion than adjacent more fractured rock, and are a classical feature of granite landscapes. They are particularly common and spectacular in the central and eastern areas of the Cairngorm mountains, some exceeding 15m in height.

There is an important growing cultural awareness of the value of landscapes, the need to manage and understand them sensitively, and the importance of understanding geology as the foundation of all landscapes.

Martin Gillespie and Chris Thomas are geologists at the British Geological Survey, Murchison House, West Mains Road, Edinburgh EH9 3LA, tel: 0131 667 1000, emails: cwt@bgs.ac.uk, mrg@bgs.ac.uk

Chris Jordan/BGS



Typical Cairngorms mountain scenery: looking north north-east from Beinn Macduibh towards Cairn Gorm on the left, Glen Avon, centre, and Bynack More, centre right. The boulder-strewn terrain in the foreground is typical of the upland plateaux.

A typical large Cairngorm Granite tor on Bynack More. Note the person for scale.

Understanding the **Cairngorms**