# Introduction to the Northern Highlands of Scotland

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Johnstone, G S and Mykura, W. 1989. British regional geology: Northern Highlands of Scotland. Fourth edition. Keyworth, Nottingham: British Geological Survey.
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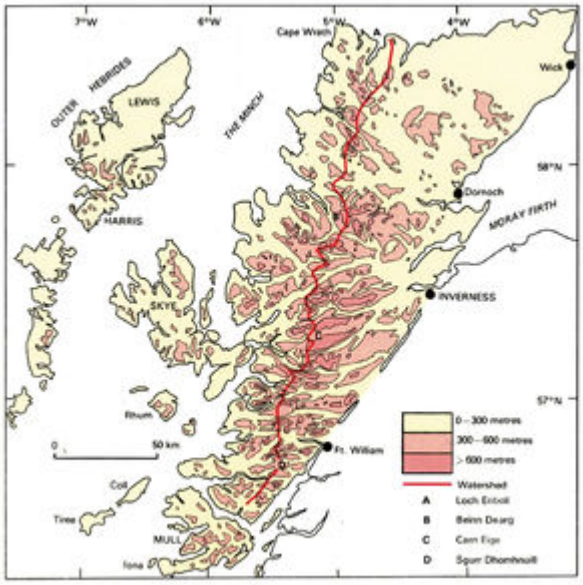
## Contents



## Introduction

The accordant summit levels of the dissected plateau of the southern portion of the Northern Highlands. P883255.




Physiography of the Northern Highlands..

P915458.

Loch Hourn is a fjord-like western sea loch, here seen from Druim Fada. P883256.

Typical Lewisian scenery is to be seen on North Uist in the Outer Hebrides. P001011.

## Boundaries of the area

The area dealt with in this book comprises the mainland of Scotland north of the Great Glen, including the Hebridean Islands. Much of the Inner Hebrides, however, consists largely of Tertiary igneous rocks and Mesozoic sediments which are also found in the peninsulas of Ardnamurchan and Morvern. As these areas are described in *British Regional Geology. The Tertiary Volcanic Districts,* only the pre-Mesozoic and post-Tertiary aspects of their geology are dealt with here. The Northern Isles (Orkney and Shetland) are the subject of a separate issue in the series.

No one geographical name adequately covers all the area described in this book. Opinion is divided about calling the mainland part the North-West Highlands, the Northern Highlands, or even, by the insertion of an arbitrary line between Dingwall and Kyle of Lochalsh, about dividing it into the Northern Highlands to the north and the Western Highlands to the south. Authorities could be quoted for each possibility. As none of the names includes either the eastern coastal lowlands or the Western Isles, all must be considered unsatisfactory as titles. The name ‘Northern Highlands’ has been retained for this book in order to maintain continuity with the previous edition.

An outline map of the region, and of the areas described in the other books in the British Regional Geology series, appears on the back cover.

## Physical features

Any observer standing on a high mountain within the Northern Highlands, as elsewhere in the Scottish hills, must be impressed by the general uniformity of levels of the summits which surround

him. In the distance, with the interference of ridge and valley, individual mountains become lost and the skyline gives the impression of a general plateau-like surface above which occasional notable eminences can be seen (P883255). The Highlands, therefore, give the appearance of having been carved out of a generally flat elevated surface — in other words, they appear to represent a dissected peneplain. That this view is too simple has long been appreciated, as many workers in the region have noted groupings of features at various levels which indicate the existence of intermediate erosion surfaces. For instance, George (1966) records three such surfaces in the western part of the mainland and in the Hebrides. These lie at 975 m, 730 m and 440 m above sea level. For other parts of the area, Godard (1965) suggests that five erosion surfaces are present.

To some workers these platforms, from which the local mountains have been carved and to which their summit levels correspond, represent subaerial erosion levels related to periods of stillstand during the upwarping of an original planar surface; to others (notably George, 1966), they suggest platforms of marine erosion. However, whatever the hypothesis favoured, it is now generally accepted that the surfaces were formed after the cessation of the volcanic activity of the Tertiary igneous period (i.e. during the Miocene–Pliocene) because intrusions of that age (which must have consolidated under considerable cover) are now exposed and are transected by erosion surfaces even at high present-day levels.

It will be seen from P915458 that the mountain area of the Northern Highlands is developed on either side of a north-south axis from near Loch Eriboll, through Beinn Dearg and Carn Eighe to Sgurr Dhomhnuill. Along this axis the general level of the summits descends only gradually north and south from Carn Eighe which, at 1183 m, is the highest mountain of the region. Eastwards from the axial line summit levels diminish gently to the north and east coasts; westwards from it, levels are well maintained until near the western seaboard, where the mountains descend steeply to sea level.

This variation in the distribution of elevated land does suggest that, no matter what has been the agent of planation, the late-Tertiary uplift was greatest in the area of the present-day high ground. The present watershed is not far from the axis of the mountain area; straight-running easterly-flowing rivers follow a long course to the sea on the east side of the watershed, and short westerly-flowing torrents descend rapidly to sea level down embayments in the mountain wall to the west. This distribution of drainage has given rise to the suggestion that the rivers reflect an original consequent pattern on either side of the axis of uplift and further, that this pattern was initiated on a surface of undeformed sedimentary rock which formerly covered the Highlands, but has since been completely eroded away from the varied and folded schists which are at present exposed It is possible that only such ‘antecedent’ drainage development could account for the lack of adjustment of the major streams to the complex geology. The various hypotheses concerning this theory all contain some difficulties. The most recent, which takes into account those of previous authorities, is by Sissons (1967). He supports the suggestion that the drainage was initiated on a sedimentary cover of Chalk and other Mesozoic rocks which started to rise above sea level prior to the commencement of Tertiary volcanic activity. The drainage pattern would have been well established at the outbreak of volcanicity, and broadly maintained throughout Tertiary times to the present day. On this hypothesis, the stepped benches of the Highland surface would have been formed during the main late-Tertiary uplift, but are essentially features of subaerial erosion related to successively lower relative sea levels. Consequent drainage directions, instituted on either side of the original cover-rock divide, would be maintained more or less by extension of the rivers seawards during each successive emergence The reader is referred to Sissons’ work for a discussion of these theories, and for an extensive bibliography on the subject.

The theories which propose an original divide on cover-rock explain the presence of the major through-valleys which lie across the present watershed of the Northern Highlands by postulating a

fortuitous near-coalescene of east-flowing and west-flowing streams. The fact that several have notable straight courses has given rise to the suggestion that the original watershed lay further to the west than at present and that the more active westerly streams have cut back to capture the headwaters of the east-flowing ones, thus causing an eastward migration of the watershed in pre-existing valleys. It may be, however, that some of the valleys are aligned along geological features such as major faults, groups of dykes, or close-set groups of joints of the pervasive east-west set which characterises much of the Northern Highlands. Any of these lines of weakness could cause selective erosion by both east- and west-flowing streams along a common line.

Whatever the origin of the early drainage pattern, the difference in the physiography of the land west and east of the present watershed is most marked. To the east, the original consequent drainage is exemplified by the Strath of Kildonan, the Loch Shin hollow, Strath Oykell, Strath Conon, and the eastwest valleys of the southern Ross and Inverness districts. Subsequent drainage towards the north-east and south-west was developed along the strike of the less resistant rocks, and along north-easterly crush-lines. The most important valleys of this latter system lie along the lines of the Great Glen Fault and the Helmsdale Fault (which skirts the eastern coast of Sutherland). Here erosion was aided by the presence of the relatively weakly resistant sediments of Old Red Sandstone and Mesozoic age, and the broad shallow arms of the sea, (or firths) of Dornoch, Cromarty and Moray represent submerged continuations of these valleys. In the south-east, drainage along the more rapidly deepened Great Glen hollow captured the easterly-flowing rivers of Ardgour which formerly may have reached the North Sea after a long journey across the Grampian Highlands (see Bailey, 1960, fig.1). Capture by subsequent streams is exemplified also in the interior of the region by the rivers Naver and Glas. Valley profiles of the major valleys are on the average gentle; the River Garry, for instance, takes 41 km to fall the 230 m from source to near sea level at Loch Ness (prior to subsequent stream erosion in the Great Glen, it probably took 80–100 km to reach the sea). Most valleys have a well developed, smoothly glaciated cross section with post-glacial stream incision confined to relatively localised ‘knick-points’. The great lochs which lie in the valley bottoms within the mountain belt are commonly the result of overdeepening by glacial action, possibly, as has already been indicated, along the line of strongly jointed rocks, dykes or, in some cases, shatter-belts.

To the west of the watershed, on the other hand, the streams run swiftly, commonly in gorges incised in the bottom of valleys which, though well-glaciated, are steep-sided and narrow. Sea level (or near to it) is reached at the head of long, narrow, freshwater lochs or fiord-like sea inlets several kilometres from the open waters of the Minch or Sea of the Hebrides. The Carnoch River, companion stream to the Garry (see above) in the same through-valley, descends the 230 m from the watershed to sea level at Loch Nevis in only 8 km. It is clear, therefore that the westerly-flowing streams have cut well back from the mountain wall on the west and have been more active than their easterly equivalents; this is possibly because of the steeper inclination of the original ‘consequent’ streams, as discussed earlier. Sissons makes the interesting suggestion that the western mountain wall is an exhumed pre-Mesozoic feature. If this is the case then the rapid back-cutting of the western streams could initially be attributed to the relative ease with which cover rocks were stripped. A geologist working in the western part of the Northern Highlands might be forgiven if he attributed the activity of the streams to the fact that, in remote times as at present, the rainfall was the controlling factor. The diminution in precipitation eastwards from the watershed is very marked.

The westward-flowing streams on the mainland thus reach or approach base-level well within the mountain belt. The freshwater lochs or sea inlets, along which their further course to open water lies, clearly occupy valleys overdeepened by glacial action (P883256). For instance, Loch Morar (the surface of which stood at about 10 m above OD prior to hydroelectric modification) has a maximum depth of 310 m, and has only a narrow gravel-crowned rock bar at its present outlet (although the

former outlet in the drift-filled Mointeach Mhor channel may have been deeper). The narrow fiord-like sea lochs commonly possess a threshold or sill somewhere along their length separating a steepwalled upper reach from a more open sea reach, with the depth in the upper section much greater than that in the seaward continuation.

Although these lochs were inundated after the withdrawal of the ice, later emergence of the land is indicated by the presence around them of late- or post-glacial raised beaches. Loch Shiel, now totally land-locked, must at one time have been a ‘fiord’; traces of the post-glacial raised beach remain all round its perimeter and shell sand, possibly marine, has been recorded from one locality. George (1966) extends the area involved in late-Tertiary regional erosion surfaces to include the Long Island (as the Outer Hebrides are sometimes collectively named). This area, composed almost entirely of ancient gneissose rocks, is dominantly low-lying and of low relief, but with isolated hills or massifs rising fairly abruptly from the general level. That there has been considerable late- or post-Tertiary erosion of the area there can be no doubt, as Tertiary dykes are truncated by the present land surface. It may be, however, that much of the present topography follows an exhumed erosion surface of Lewisian gneiss originally overlain by younger, softer sediments. In its general form it resembles the gneiss pediment below the mountain wall along the western seaboard of the Scottish mainland. On the Long Island, as on the mainland, the intricate pattern of sea inlets clearly indicates a submerged topography. Unlike the mainland there has been no emergence since glacial times; in fact, it is likely that slight submergence has been continuous since that time.

## Scenery

The scenery of the Northern Highlands is related to the geology to a marked degree. In the Outer Hebrides and on the low platform which fringes the mainland coast of western Sutherland, ancient hard gneiss (the Precambrian Lewisian Gneiss) gives rise to a rocky, lochan-dotted terrain (P001011). Along the north-west seaboard of the mainland the Torridonian Sandstone forms the mountain wall which has been eroded into steep-sided, often isolated, mountains rising abruptly from the gneiss basement. Further east, along a line from Kyle of Lochalsh to Loch Glencoul the sandstone mountains are capped by glistening white Cambrian quartzite and flanked to the east from place to place with lush grassy areas which mark Cambro–Ordovician limestone outcrops. Further north the tops of some peaks are made of the quartzite resting directly on gneiss. The south-western seaboard, west of the watershed, is made up of wild and remarkably rugged mountains which derive their character from the intensely varied schistose rocks from which they are made. In the more easterly part of the Northern Highlands, however, the stratigraphy is less diverse and the mountains of central Sutherland, Ross and Inverness[1], though in places higher than those further west, are less rugged, reflecting the simpler geology. The featureless landscape of Caithness is related to its foundation of limy flagstone and sandstone. Though lacking scenic interest inland it has wild sea-cliffs and stacks on the north and east coasts. The Tertiary igneous areas of the west are either horizontally terraced or ruggedly mountainous depending on whether they are underlain by bedded lavas or intrusive complexes of basic and acid plutonic rock.

Much of the fertile land round Dingwall and Tain owes its presence to spreads of superficial deposits mantling soft sandstone. The prominent hills and knolls in this area mark the outcrops of resistant beds of conglomerate.

## Selected bibliography

# Footnote

1. ↑ Most of the published work in the Northern Highlands uses the former ‘Shire’ nomenclature for area description. The new major ‘Region’ divisions are too large for this purpose and the subdivisions of District, which mostly use the old ‘Shire’ names, cover slightly different areas. Little confusion should arise, however, and ‘Shire’ terminology is used here.



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