THE STORY OF THE CAIRNGORMS.

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WHETHER the boundaries of what are to be strictly regarded as "The Cairngorms" have been defined I do not know, but, on any view, the granite mass forms the main part of the group and its presence is the reason for the existence of the mountain mass.

The Cairngorms do not owe their present prominence either to a special and localised folding and upheaval or to a local accumulation of ejected volcanic material. They gradually emerged as mountains because they were composed of a rock resistant to denudation, surrounded by other rocks less resistant. The granite, out of which the outstanding summits and ridges have been carved, has withstood reduction better than the crystalline schists into which it was intruded and by which it is now surrounded. The Cairngorms, therefore, are, like all British mountains, *Relict Mountains* or *Mountains of Circumdenudation*.

The story of the Cairngorms is the story of the granite mass—of its intrusion, of its disinterment, of its sculpture by the hand of Nature into its present form. That story, except in its earliest and latest stages, is obscure; for much of the long intervening stages direct evidence is but slight, though supported by the definitely ascertained sequence of events in the history of similar regions.

A. Intrusion of the Granite.

Some four to five hundred million years ago all the mainland of Scotland except a coastal strip from Skye to Durness, much of the north and west of England, nearly all Wales, and a large part of Ireland were subjected to tangential pressure from north-west and south-east, and thrown into a series of more or less parallel ranges of folded mountainsknown collectively as the *Caledonian Mountains*—running approximately north-east and south-west.

All the ranges were not formed simultaneously. Folding proceeded during Ordovician and Silurian times, and by the beginning of the Devonian or Old Red Sandstone period the pressure to which the Caledonian orogeny was due had relaxed. It was then that the *Newer Granites*, to which class the Cairngorm granite belongs, were intruded in a molten condition deep down among the previously folded and metamorphosed (altered) rocks of the Caledonian ranges.

The Older Granites were intruded before or during the folding, and in the larger masses their component minerals show a banding or foliation, due to movement under pressure after or during consolidation: they are indicated on geological maps as "Foliated Granite," and clearly belong to the period of tangential pressure and orogenic or mountainbuilding movements. They may be seen in typical form on Cairnshee (Durris) and between Glen Clova and Glen Esk.

The Newer Granites, on the other hand, show no sign of mineral banding : they were not intruded under tangential pressure but after pressure had relaxed or been replaced by tension.

Cooling of an intrusive molten granitic magma under a thick and heavy cover is essential for slow crystallisation and the production of coarse-grained, wholly crystalline rock like the Cairngorm granite.

B. Uncovering of the Granite.

1. Early Stages.—The Cairngorm granite, then, seems to have been intruded by, and almost certainly somewhat before, the beginning of Old Red Sandstone times. Since then it has been stripped of its cover and has itself been denuded—to what depth one can only guess. It is, however, impossible to believe that all the hundreds of millions of years which have elapsed since its emplacement among the roots of the Caledonian Mountains should have been needed for an uninterrupted process of subaerial denudation to uncover it and carve it into its present form. Within these

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long æons there is evidence that there were (1) periods when subaerial denudation of one part of Scotland spread continental deposits over adjoining areas, and (2) periods when the region was depressed, partly or wholly, below sea-level and buried under thousands of feet of marine sediments.

2. Later Stages .- It is known with certainty that early in Tertiary times, millions of years ago, all Scotland was raised above sea-level: the watershed lay far to the west and drainage was directed eastward. Rivers rapidly sank their valleys into the land to a depth determined by the base-level (i.e., sea-level) of the time. At first valley deepening went on rapidly and the interstream ridges became more and more pronounced. But as time passed they too were cut into by the development on their flanks of streams tributary to the rivers on either side, and were everywhere attacked by other agents of denudation-chemical action of air and underground water, frost-rending, rain-wash and soil-creep. The main streams too developed gentler and gentler gradients as they cut down nearer to base-level, and began to swing from side to side of their valleys and to undercut, and aid in the destruction of, the interstream ridges.

In country built of rocks of *low* and *uniform* resistance the final result would be the reduction of the whole to a series of broad river valleys separated by low divides and the formation of—not a plain but—a *peneplain*. In Scotland, particularly in the Highlands, where rocks generally offered *high* and *varied* resistance to denudation, the peneplain was very imperfect, the more resistant rocks on certain watersheds standing up as *monadnocks* or relict mountains and ridges. These rose—some more than 1,000 feet—above the gently undulating surface of the peneplain carved on intervening and less resistant rocks.

Relative to sea-level, the land at the close of this period of imperfect peneplanation stood much lower than now. By and by elevation—greatest in the west—raised the peneplained areas to a height of 2,000 to 3,000 feet above the sea to form what has been called the *High Plateau*. The eastward slope imparted to the upheaved peneplain revived the whole drainage and streams at once began to cut down into the substance of the High Plateau. Valley deepening was followed in due course by valley widening, and the surface of the former peneplain is now approximately indicated by the level of the watersheds on the strongly dissected High Plateau.

The High Plateau is well displayed between the Highland sections of the North Esk and South Esk, and as far north as Glen Muick and westward to the sources of the Isla; it is very evident in Gaick Forest and Atholl Forest, in the Monadhliath and the basin of the Upper Findhorn. One interesting portion abuts against the north flank of the Cairngorms and, in fact, includes part of the granite area. The Caiplich and Avon drain a region where the summit levels on interstream ridges rise to $2,500\pm$ feet. To the south the Beinn a' Bhùird plateau and the Ben Avon ridge rise rapidly to heights of well over 3,500 feet.

The High Plateau, first defined and named by Drs Peach and Horne, is not to be confounded with "The Table-land of the Highlands " which is the subject of cap. vii in Sir Archibald Geikie's charming volume, "The Scenery of Scotland," now unfortunately out of print. Geikie says in this book : " Does it not seem to [the observer] that these mountain tops and ridges [of the Highlands] tend somehow to rise up to a general level, that in short there is not only on a great scale a marked similarity of contour about them but a still more definite uniformity of average height " (third edition, p. 147); and again: "The long flat surfaces of the Highland ridges mark, I believe, fragments of a former base-level of erosion " (ibid., p. 155). It is clear that Geikie considers that the summits of what are now usually called "monadnocks "mark the former level of a peneplain -his "base-level of erosion." He speaks elsewhere of the Cairngorm plateau and the flattish top of Lochnagar, most of which has been cut away during the growth of the great corrie, as parts of the peneplain. In distant view, particularly from the south, the Cairngorms show up as an undulating plateau; and no one who has walked across the flat tops of Braeriach, Ben Macdhui and Beinn a' Bhùird will deny . that a plateau feature is there clearly marked.

It seems likely that both the High Plateau and the Tableland of the Highlands are verities: the latter was formed as a peneplain which, after an uplift of 1,000 feet or more, was afterwards reduced to an imperfect peneplain at a lower level, the now dissected High Plateau. The much denuded remnants of the Table-land of the Highlands are indicated most often by isolated summits and ridges that rise nearer to 4,000 than 3,000 feet, but most plainly by flat-topped monadnocks like the Cairngorms.

That there should be remnants of a peneplain at a higher level than the High Plateau seems reasonable since in various parts of Scotland there are indications of the beginnings of peneplanation at lower levels than 2,000 feet. The Scottish area, it may be assumed, was elevated not all at once but by stages. Each stage was followed by a long interval of stillstand and peneplanation more or less perfect-the first of which there is any evidence, by that which produced the Table-land of the Highlands; the second, by that testified to by the High Plateau; the later, by platforms of erosion and incipient peneplanation at levels below 2,000 feet (the lower limit of the High Plateau). Peneplanation, it may be added, always begins at the coast, and, being due to widening of valleys and reduction of watersheds, extends slowly inland along the river valleys: it rarely reaches completion.

C. Sculpture of the Cairngorms.

1. **Preglacial Sculpture.**—The Cairngorms could not be said to exist till they had been set in relief as *hills* during the denudation that produced the peneplain now 2,000 to 3,000 feet above sea-level. On the uplift of that peneplain to form the High Plateau they were carried up with it and attained a height that justified the name of *mountains*.

Because of a long process of differential denudation coupled with an uplift of the whole country, the Cairngorms gradually emerged to form an isolated, flat-topped mountain mass which—as one would expect—acquired a radial drainage system of its own. Off its west end a number of streams discharge to the Feshie, but the eastward drainage off the narrower east end is not well marked. A glance, however, at any good map shows the numerous streams with courses approximately north or south, the main watershed running nearly east and west.

Now rivers not only deepen and widen their valleys by *vertical* and *lateral* erosion but also slowly—very slowly—lengthen them by *headward* erosion. In the Cairngorms they have pushed their way back and, with the aid of tributaries subsequently developed on their valley sides, have cut up and destroyed a great part of the original summit plateau.

A pair of streams working along the same line but in opposite directions may be called *opposing streams*. Their sources are pushed back towards each other till they eat into and lower the broad or narrow dividing ridge, across which they form a shallow depression or saddle and finally a deep notch. If headward erosion by one of the pair is more rapid, the watershed is not only lowered but displaced towards, and into, the valley of the less aggressive stream. In both these cases a pass is formed from one valley into the other : the usefulness of the pass as a route across the mountain mass depends on the amount by which the height of the watershed has been reduced.

In the Lairig Ghru the watershed has been greatly lowered by the activity of the two opposing streams, Allt na Lairig Ghru and Allt Druidh. There are two watersheds in the Lairig an Laoigh south of Bynack More; both have been cut down by opposing streams.

The present source of the Am Beanaidh is Lochan nan Cnapan, which lies well to the south of the springs of Allt Luineag and Allt Sgairnish, the two headstreams of the Eidart. From just below the south top of Braeriach (4,149 feet) a small stream flows for some distance south-west as if heading for the Eidart, makes an abrupt right-angle bend, and pours through Coire Dhondail to Loch Einich. It seems clear that the original watershed between northward and southward drainage ran from Sgor Gaoith to Einich Cairn: the Am Beanaidh pushed the watershed southward and

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invaded the territory of its rival. Their preglacial relationship is now much obscured by the enormous amount of glacial erosion at the head of Glen Einich.

Another example of the work of opposing streams is furnished by the Upper Quoich (which originally flowed down Glen Slugain) and Allt an t' Sluichd. Between their heads a marked dip or saddle has been worn in the watershed. Here again the preglacial features are obscured by the results of glacial erosion so prominent in the Garbh Coire and Slochd Mòr.

Denudation of the Summit Plateau.—At an early date in the history of the Cairngorms as an independent mass the summit plateau was severed into two parts, a western and an eastern, by the formation of the flat saddle of the Moine Bhealaidh. The flat extends south and east along the ridge bearing Craig Derry (2,900 feet) and Beinn Bhreac (3,051 feet). The severance probably occurred during the denudation that led to the evolution of the High Plateau: the flat corresponds in elevation with, was probably formed as part of, and here represents, that physiographical feature. Or may the flatness be partly due to erosion by ice from the west ? It lies directly opposite the mouth of Corrie Etchachan, and we know that ice from it traversed the Moine Bhealaidh.

The Western Plateau lies west of the Lairig an Laoigh, and thirty square miles is a moderate estimate of its area at an early date. It certainly included Cairn Toul, Braeriach, Ben Macdhui, Cairn Gorm, and Beinn Mheadhoin, together with the now outlying and denuded fragments seen in Sgòran Dubh and Sgòr Gaoith to the west and Beinn Bhrotain and Monadh Mor to the south-west. Later the plateau has been broken up in various ways. (a) As explained above, opposing streams have cut it in two along the line Glen Dee-Lairig Ghru. Glacial erosion on the watershed and along the valley lines has emphasised this line of division. (b) Ben Macdhui and Beinn Mheadhoin have been separated from Cairn Gorm by headward erosion of the Avon and its headstreams. (c) Both portions have been encroached upon along much of their margins by other

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streams, most of whose valleys now head in definite corries, large and small. (d) Sgòran Dubh and Sgòr Gaoith no doubt represent portions detached by the Am Beanaidh and Eidart; Beinn Bhrotain and Monadh Mòr have been isolated through the development of Glen Geusachan by fluviatile, later supplemented by glacial, erosion.

The *Eastern Plateau* consists of Beinn a' Bhùird, Cnap a' Chléirich, and Ben Avon. It too has been cut across in the saddle between the opposing streams, Quoich and Allt an t' Sluichd. The summit of Ben Avon has been reduced from a plateau to a ridge by stream attack along its flanks. Beinn a' Bhùird too has been gashed by streams working back from the Quoich, and the plateau has been greatly diminished by the formation and growth of the great eastern corries.

2. Glacial and Postglacial Sculpture.—At the close of preglacial times the drainage pattern of the Cairngorms was the same as it is to-day, but the valleys were very different. Trunk valleys like Glen Einich, Glen Geusachan, Glen Dee, and Glen Derry were shallower and narrower. Those whose streams were actively cutting into the plateau, as in the Garbh Choire and Corrie Etchachan, were deep, narrow glens, V-shaped in cross-section.

The summit plateaux were more extensive. Summits, ridges, and valley sides, long subjected to weathering in a mild preglacial climate, had acquired a thick mantle of deeply weathered rock. Here and there tors, consisting of the more resistant patches of granite, projected on plateau and ridge as on Exmoor and Dartmoor, which have escaped scouring by ice-sheets, and as they have in postglacial times been once more developed in the Cairngorms.

Weathering along the well-developed system of joints partially freed blocks from the parent rock, and removal by wind and rain of the finer products of weathering led to their appearance on the slopes as loose, rounded boulders resembling glacial erratics.

Lakes were not much in evidence—if at all. Washing by rain and deflation by wind carried much of the loose, granitic soil into the valleys to clog the watercourses and give rise to shallow pools, more often temporary than permanent.



ETCHACHAN AND CAIRNGORM

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(1) Glacial Sculpture.—One effect of glaciation was the early removal of the mantle of weathered rock: thereafter the ice worked on living rock. But even an outline of the work of ice in the sculpture of the Cairngorms would demand more space than can be given it now. A fairly complete account, "The Glaciation of the Cairngorms," was published in 1929 (*The Deeside Field*, Fourth Number, 1929).

To glaciation, however, are due all the features that to-day attract the mountaineer-properly so called-and the "high walker," and the following points may be specially noted :-(a) All the larger valleys have been widened and deepened into glacier troughs, U-shaped in cross-section and bounded by oversteepened rock walls. (b) The numerous lakes, from corrie tarns to long glen-lakes, are directly due to glaciation. (c) The heads of nearly all valleys that terminate on the edge of the plateaux, particularly those facing north and east, have been converted into corries. Very few corries, none of them typical rock-walled amphitheatres, open to south or west. Coire Sputan Dearg, facing south, though rockrimmed, is not a typical corrie, but rather a glacially widened valley head; Coire Garbhlach, opening to the west, is still less typical. (d) To the formation and gradual enlargement and encroachment of corries is to be attributed the loss by the plateaux of a large proportion of their preglacial extent. (e) Severe glacial erosion of the watersheds in the two easiest passes has greatly increased their value as cross-routes.

(2) Postglacial Sculpture.—This has been slight. A few effects may be noted :—(a) Scree formation, mainly due to frost action on steep rock faces. This tends to undo the oversteepening by ice. (b) Frost-rending on bare tops and ridges. Many of these are now completely covered by coarse frost-riven rock fragments. (c) Wind action, e.g., the formation of wind potholes on the tors of Ben Avon. The sand-blast that undercuts exposed rock and which the "high walker" faces with toil and pain in a strong wind must be a by no means negligible factor in the denudation of exposed spots.

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