Chapter 10 Rocks of Lower Old Red Sandstone age

Introduction

Rocks which accumulated at the surface during, in all probability, Lower Old Red Sandstone times are preserved in the Glen Coe district and also, less extensively, at Ben Nevis. They are represented in both places mainly by lavas and agglomerates, with stratified rocks forming a very small proportion of the whole succession.

Plant-remains, including indeterminate stems and *Pachytheca fasciculata* Kidston and Lang, have been found in basal sediments at Glen Coe; but they have proved difficult to date precisely (p. 145). Still, there are such close similarities between the lavas of Glen Coe and Ben Nevis and those of Lorne, only 15 miles to the south-west (Figure 18), that it seems safe to regard the three suites as broadly contemporaneous; and the sediments associated with the Lorne volcanic series have yielded fishes, a eurypterid and millipedes which are assigned by experts to the Lower Old Red Sandstone formation (for summary of the evidence with full references, see Bailey 1925, p.31).

The volcanic and sedimentary rocks rest with a violent discordance upon an old land surface sculptured in the Highland Schists, and now partially brought to light again by denudation. The deformation to which they have been subjected is mainly due to faulting. Folding, though sometimes sufficiently intense to proL duce inversion, is a local phenomenon, a phase of the faulting, not part of an extended system of crustal buckling; and there is no trace of cleavage.

The sedimentary rocks, consisting of red, grey and black shales, compact grits and conglomerates, are greatly indurated, whilst the volcanic rocks show various changes, due to weathering and the percolation of underground waters. Both too have suffered from contact-alteration in the vicinity of a northward extension of the Cruachan Pluton.

Amongst the volcanic rocks hornblende- and biotite-andesites are the only types of lava met with on Ben Nevis; whilst in Glen Coe basalt, pyroxene-andesite, hornblende-andesite and rhyolite, together with transitional varieties, are all represented.

The internal structure of the volcanic pile in Glen Coe (Figure 21) leads us to believe that this district was supplied from more than one source, situated in the immediate vicinity, though it is impossible now to point to the site of the volcanic vents. It is probable, however, that the lavas and sediments of Glen Coe may originally have been confluent with those of Lorne, on the one hand, and of Ben Nevis, on the other. A small crag of conglomerate made up of well-rounded boulders of quartzite occurs on the hilltop north of Gleann Seileach [NN 048 631], near Onich. It is probably *in situ* and of Lower Old Red Sandstone age, and, if these assumptions are correct, its position about equidistant from Glen Coe and Ben Nevis serves as a connecting link between the two. Fragments of similar conglomerate have also been found just beyond the eastern border of the map involved in a landslip at the southern foot of Stob Choire Claurigh [NN 262 738] (Sheet 54, Geol.) at the head of Allt Coire Rath [NN 250 713].

In this connection it should be noted that the Old Red Sandstone rocks of Glen Coe (Figure 19) and Ben Nevis (Figure 31) owe their preservation in large measure to faulting, by which they were let down relatively some thousands of feet. It will be shown that the subsidence of the Glen Coe fault-block was accompanied by the uprise of igneous magma, which consolidated about the down-thrown mass. Subsequent denudation has revealed the consolidated magma as an almost continuous ring of "fault-intrusion" surrounding a "cauldron-subsidence". At Ben Nevis there was probably a similar uprise of fault-intrusion, but erosion has cut down to a lower level, and reveals instead what we take to be magma (now "granite") retained in the reservoir into which cauldron-subsidence carried down a portion of the roof.

Chapter 11, which follows, deals with the volcanic and sedimentary rocks of Glen Coe from the point of view of their local variations and their relations to the floor of crystalline schists upon which they accumulated. Chapter 12 also concerns Glen Coe, but concentrates attention upon the cauldron-subsidence and the associated fault-intrusions (6, (Figure 18)). Chapter xiii treats of the great "granitic" complex of Etive (8, (Figure 18)), of which the Glen Coe Fault-Intrusions may be regarded as early northern offshoots. Chapter 14 describes the lavas, sediments and plutonic rocks of Ben Nevis (1,

(Figure 18)). Chapter 15 follows with an account of several plutonic masses which are with considerable confidence ascribed to the same general period as those of Glen Coe, Glen Etive and Ben Nevis. Chapter 16 treats of minor intrusions of probable Lower Old Red Sandstone age. These include some relatively early, widely distributed sheets of lamprophyre; but the great majority are N.E. dykes definitely associated with either the Etive or the Ben Nevis plutonic foci. Petrological details are throughout reserved for chapters xvii and xviii. In reading the chapters dealing with field-relations it is well to bear in mind that "granite" is used in an extremely broad sense to include both granite and quartz-diorite.

The evidence that all the intrusions mentioned above are not of later date than the lower Old Red Sandstone period rests upon the fact that similar dykes and plutonic masses, in the East Highlands, are always earlier than the widespread Orcadian or Middle Old Red Sandstone of that district.

If next we seek a lower limit for the age of these intrusions, we note that some of them are certainly younger than the lavas of Glen Coe and Ben Nevis, which we have seen above may safely be placed in the long period of the Lower Old Red Sandstone. Thus:

1. The Fault-Intrusion of Glen Coe, the "Granite" Complex of Etive, and the accompanying swarm of dykes can be demonstrated to be later than the lavas of Glen Coe.
2. The Inner "Granite" of Ben Nevis and a few individuals of the dyke-swarm of that mountain are equally clearly later than the lavas of Ben Nevis.

To proceed. The age-relation of the Outer "Granite" and of most of the dykes of Ben Nevis to the lavas cannot be settled by examination of contacts; but the analogy of the Outer "Granite" of Ben Nevis to the Outer or Cruachan "Granite" of the Etive Complex, and of the dyke-swarm of Ben Nevis to the dyke-swarm of Etive (Figure 18), leaves no real doubt as to the Lower Old Red Sandstone age of the entire Ben Nevis Complex and its attendant dykes.

For the rest of the "granites", again no direct field evidence is available; but we rely upon the close petrographical affinity, which seems to link them with the intrusions of Etive, Glen Coe and Ben Nevis into a single great suite. There is, however, one main cause for hesitation in pressing this conclusion: in Lorne and also in Glen Coe, "granite" boulders of types similar to those of proved Lower Old Red Sandstone age, are locally abundant in the basement conglomerates of the great volcanic series. Some geologists, notably G. Barrow, attach considerable weight to these "granite" boulders, regarding them as evidence in favour of a period of "granitic" intrusion much earlier than that of Lower Old Red Sandstone times. To the writers, however, this argument does not seem very strong, since, in Skye, Mull, and Arran, Tertiary granophyres and gabbros are abundantly represented in Tertiary agglomerates. The answer, already anticipated by A. Harker, was supplied in Mull where certain explosive vents show early Tertiary granophyre and gabbro in contact with later Tertiary agglomerate. Now, in Lorne and Glen Coe, to return to the district under consideration, no natural base of the Lower Old Red Sandstone is known, and the conglomerates which contain the "granite" boulders, often contain also an overwhelming proportion of volcanic rocks, which, like the "granites", are of types common in the Old Red Sandstone suite. It seems reasonable then to suppose that such basement conglomerates may have formed at a comparatively late stage in the vulcanicity of the district, when "granites", of the same general age as the lavas, had already become available, as a source for boulders, through the agency of explosion or even of erosion. A likely source for some of the boulders is the Moor of Rannoch Pluton (7, (Figure 18)), which Grabham has shown to be older than the Fault-Intrusion of Glen Coe. H. K., H. B. M., E. B. B.

While it may be taken as almost certain that the major "granite" plutons of Sheet 53 belong to a single great suite which flourished in Lower Old Red Sandstone times, it remains quite possible that this suite, even in the West Highlands, had its beginning in the late Silurian. In the east, near the Highland Border towards Stonehaven, there are similar "granite" plutons which appear to have yielded many boulders to neighbouring Downtonian conglomerates. Accordingly the "granites" concerned, both in the west and in the east, are often called "Newer" or "Caledonian" to avoid more specific dating.

Chapter 15 furnishes notes on the field relations of certain small basic and ultrabasic plutons, including such characteristic types as appinite, monzonitic augite-diorite and kentallenite. These are shown black in (Figure 18) where

their grouping about the Ballachulish and Garabal Hill [NN 305 175] Plutons (5, 9, (Figure 18)) may be taken to indicate a common origin. Boulders resembling much decomposed kentallenite have been noted by Maufe in a Glen Coe conglomerate (p. 144); so that in this matter the basic and ultrabasic rocks are on a par with their intermediate and acid associates. For further suggestions concerning age we must go to the island of Colonsay, 40 miles south-west of Sheet 53. Here and here alone outside (Figure 18) do we find an additional example of the associated basic and ultrabasic types listed above; and here, in Colonsay, we find that some at least were intruded during an interval between two episodes of Caledonian movement, both strong enough to cleave Lower Torridonian sediments that serve as country-rock. The earlier of these two movements was the more powerful, and was accompanied locally by a metamorphism that developed minute biotites and hornblendes in some of the sediments (Wright 1908; Wright and Bailey 1911, p.36).

The remoteness of the Colonsay outcrops may possibly be due to displacement along the Great Glen Fault (chapter 21). If so, the fault passes south-east of Colonsay, not north-west as shown in (Figure 40). This is an alternative which the present writer favours on quite other grounds. E. B. B.

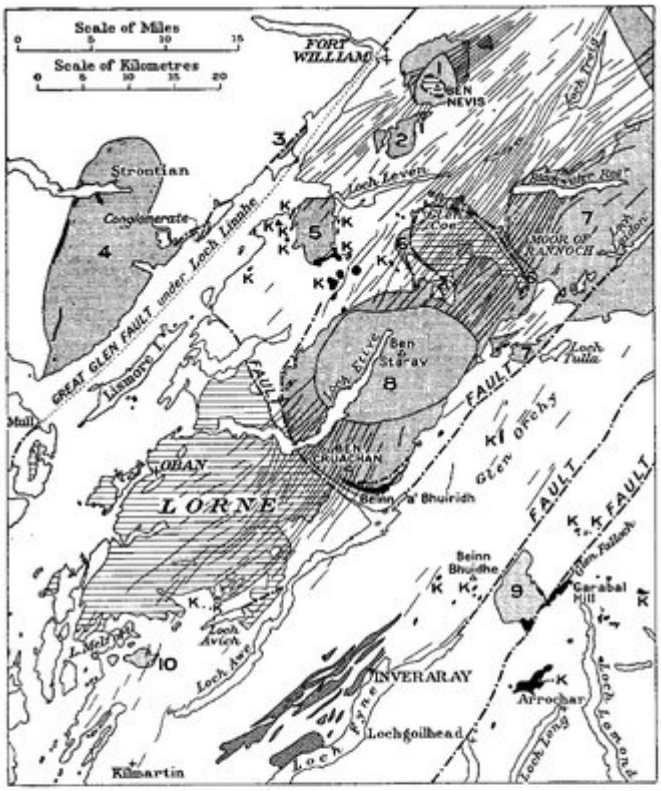

FIG. 18. Map of igneous rocks of South-West Highlands referred to Lower Old Red Sandstone Period

(Figure 18) Map of igneous rocks of South-West Highlands referred to Lower Old Red Sandstone Period.

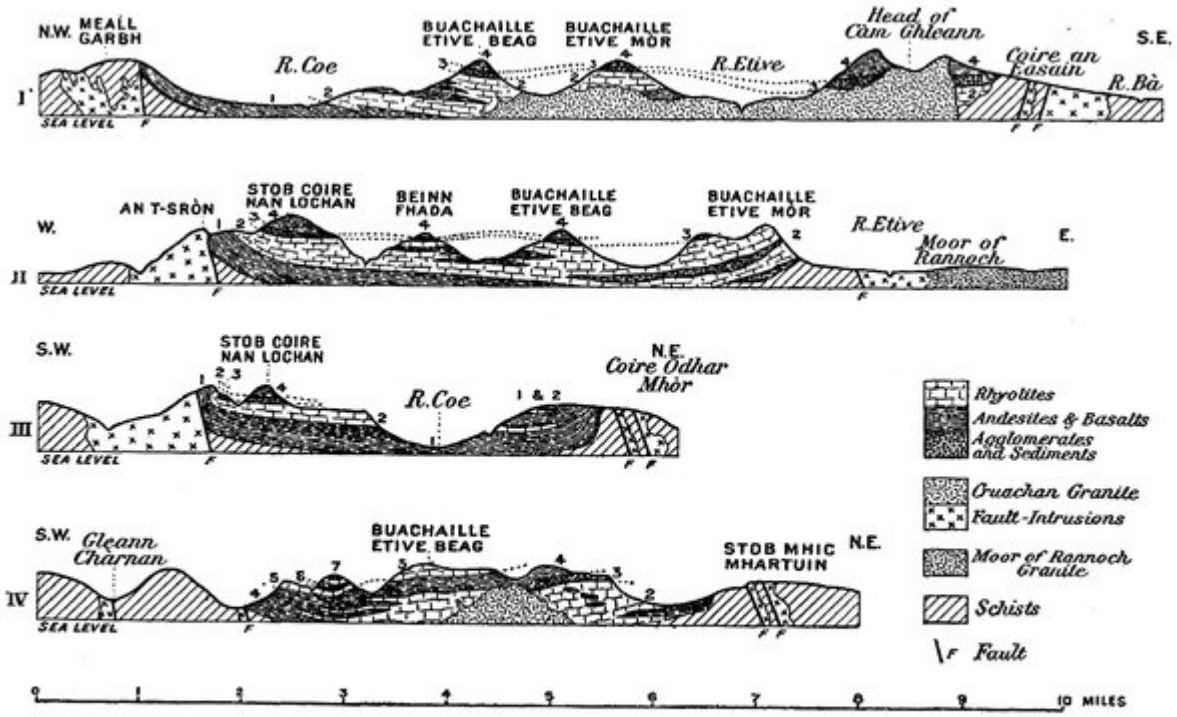

FIG. 21. Sections across the Cauldron-Subsidence of Glen Coe
The numbers 1-7 refer to groups discussed in the text

(At Coire an Easain the boundary-faults incline outwards to S. E., not inwards as shown above)

(Figure 21) Sections across the Cauldron-Subsidence of Glen Coe The numbers l-7 refer to groups discussed in the text (At Coire an Easain the boundary-faults incline outwards to S. E., not inwards as shown above).

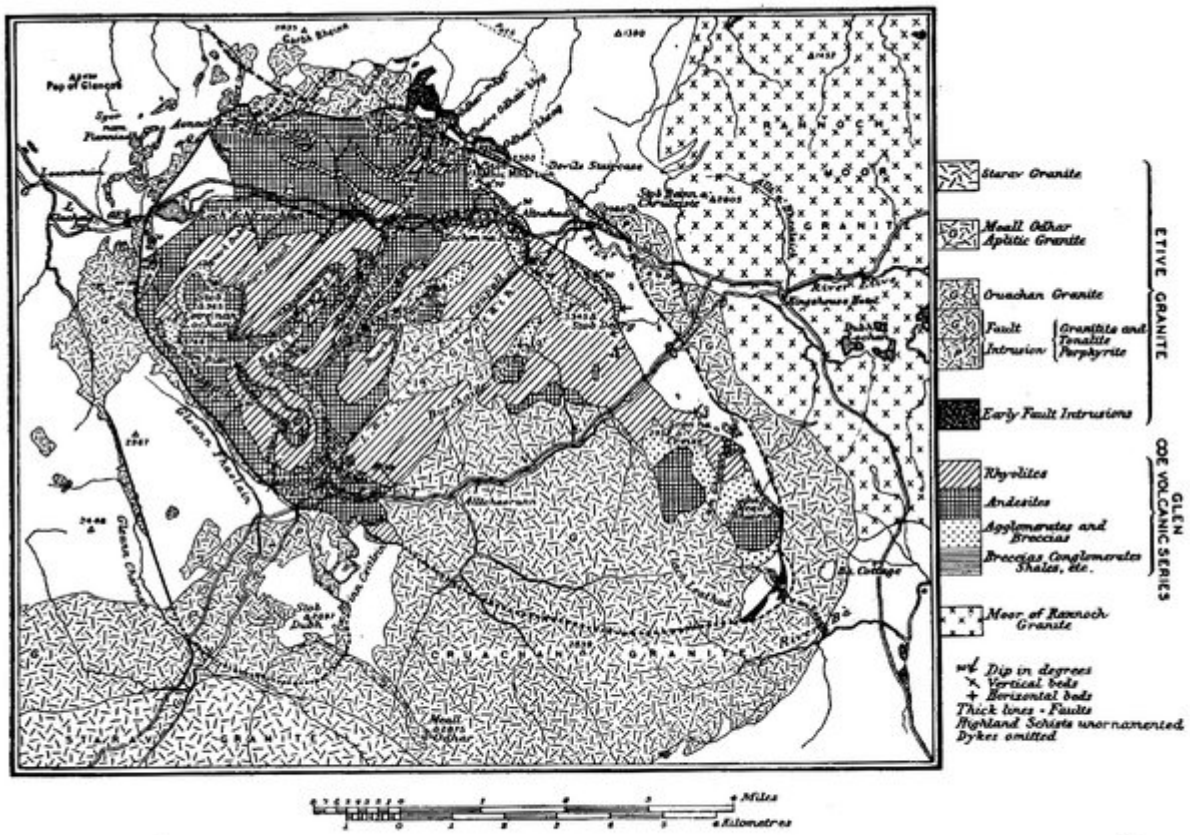

FIG. 19. Map of the Cauldron-Subsidence of Glen Coe and associated igneous phenomena
For new road see Fig. 22

(Figure 19) Map of the Couldron-Subsidence of Glen Coe and associated igneous phoenomena. For new road see (Figure 22).

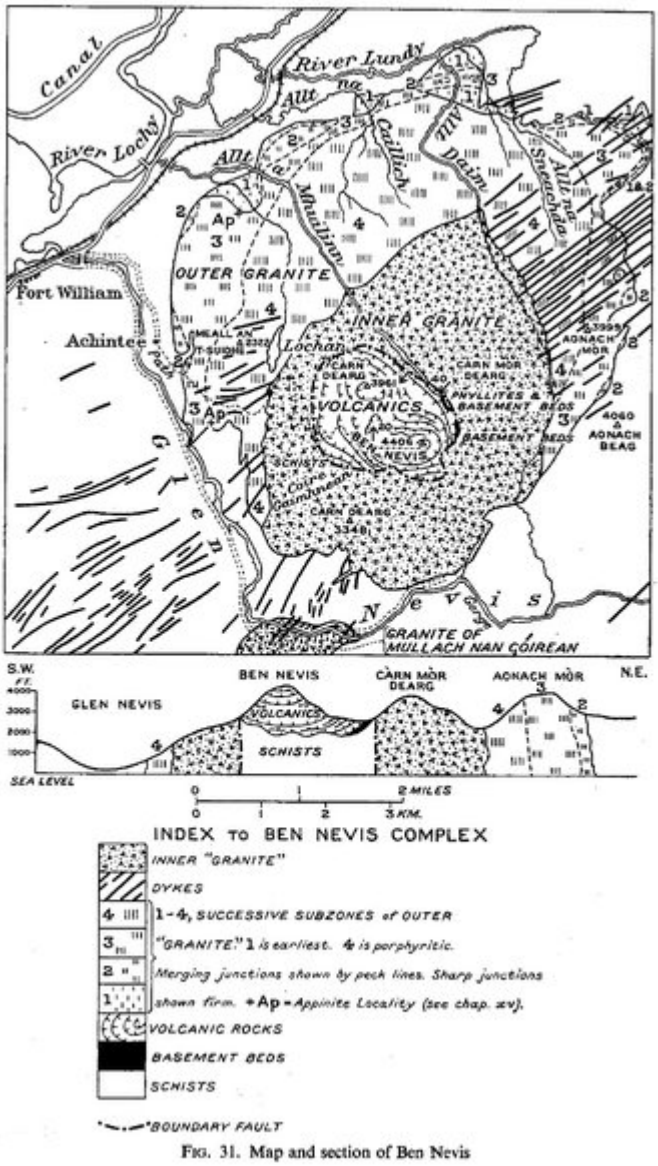

FIG. 31. Map and section of Ben Nevis

(Figure 31) Map and section of Ben Nevis.

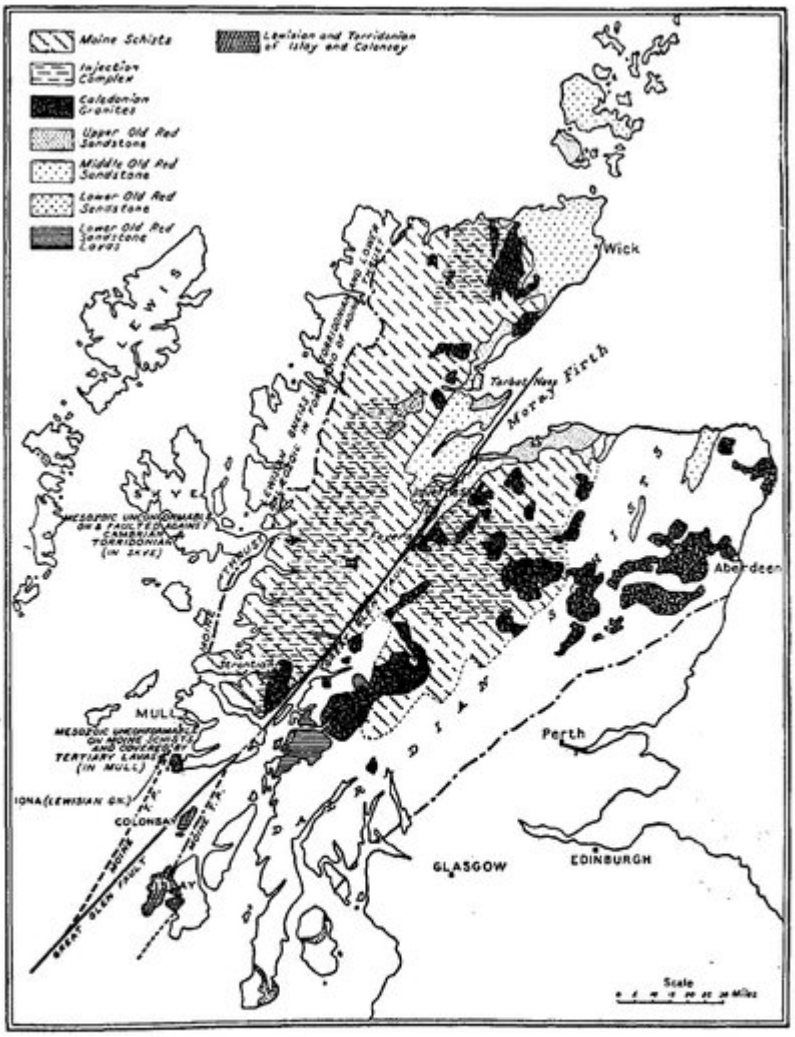

FIG. 40. Geological map of the Scottish Highlands to show the present position of the Moine injection complexes, the Strontian and Foyers granites, and the Moine Thrust-plane, after W. Q. Kennedy

(Reproduced, by permission, from *Quart. Journ. Geol. Soc.*, vol. cii, pt.i, 1946, fig. 2)

(Figure 40) Geological map of the Scottish Highlands to show the present position of the Moine injection complexes, the Strontian and Foyers granites, and the Moine Thrust-plane, after W. Q. Kennedy (Reproduced, by permission, from Quart. Joum. Geol. Sot., vol. cii, pt.i, 1946, fig. 2).