Chapter 23 Economic geology

The district is one of the most rugged in Scotland, and consists for the most part of mountain and high moorland. The higher ground is mostly deer forest but also provides rough grazing for sheep; cattle are grazed on the lower slopes and in the valleys. There is no concentration of arable land, but many of the discontinuous patches of raised beach have been brought under cultivation. After the removal of the old Caledonian Forest, which originally extended over much of the district, timber was nowhere grown on a commercial scale for many years. Since 1920, however, planting of coniferous trees has been proceeding, mainly on the eastern side of Loch Linnhe, where for instance the Forestry Commission has considerable plantations in the Glen Nevis, Onich and Duror areas.

Owing to its western situation and mountainous topography, the area receives an abundant rainfall. Water supplies for houses and for the centres of population are almost entirely derived from surface sources such as springs, streams and small reservoirs. The exploitation of the water power resources of the district has led, during the present century, to the development of an important mineral industry, the manufacture of aluminium, first at Kinlochleven (1909) and then at Fort William (1929). The raw materials are imported, but the availability of a very considerable head of water for the generation of electricity is, as discussed in chapter 1, related to the late geological history of the area. The Blackwater Reservoir [NN 250 605], for instance, which supplies the Kinlochleven factory, lies at a height of about 1000 ft above O.D., in a remnant of one of the eastward-draining consequent valleys (Figure 1) which were incised in relation to a sea considerably further away than Loch Leven and Loch Linnhe are today. Adjustment accompanied development of subsequent valleys guided by structural features — in this case the Loch Leven shatter-belt — and resulted in the segmentation of the older drainage system and the beheading of its streams. The remnants of the consequent valleys are thus in some cases left "hanging" in relation to the subsequent valleys as later modified by glaciation; and it is this characteristic, combined with the high rainfall, that has made possible the development of hydro-electric power in the district. The water power resources have not yet been fully tapped, and a project is now under consideration to divert by tunnel the waters of upper Glen Nevis in order to produce power on the shores of Loch Leven (Rep. N. Scot. Hydro-Elect. Bd. for 1954).

Various mineral industries have developed from time to time in the district, largely as a result of the proximity of the raw materials to the coast and of the availability of cheap transport by sea. Slate, granite, kentallenite, quartzite, limestone, dolomite and phyllite have all been quarried, the slate on a large scale, the other rocks to a lesser extent. Peat has long provided a local source of fuel. Road metal of reasonably good quality is readily obtainable in most parts, and the materials used have included granite, porphyrite, andesite, quartzite, etc., as well as gravel from raised beach and morainic deposits.

Slate

The Ballachulish Slates were until fairly recently quarried on a large scale for the manufacture of roofing slates. Work was begun at Ballachulish about 1697, and during the 18th and 19th centuries the excellent quality of the slate and the large quantities that were produced placed Ballachulish in the forefront of the Scottish slate industry. Between 1837 and 1869 the annual output increased from 3 million slates to 15 million, and the quarries in the latter year gave employment to 400 men. In 1937 production was 4½ million slates, about 200 men being then employed. After a decline in the industry during the second world war an attempt was made to resuscitate it in the immediate post-war period. The revival was however short-lived and the quarries are no longer in operation.

The workable slates of the district all belong to the Ballachulish Slate group, the extensive outcrops of which belong to the cores of the Appin and Ballachulish recumbent synclines. In the Ballachulish Core the principal slate outcrop is that which extends for about 6 miles south-south-westwards from its western outcrop on the two shores of Loch Leven, at Callert and Ballachulish ((Figure 8) and (Plate 3), pp. 50, 55). Only the northern part of this belt is of economic interest and it is here that the industry found its greatest development. The slate has been worked in five quarries of varying size, all south of Loch Leven. The largest is the Main (Ballachulish) Quarry at East Laroch [NN 080 580], roughly 400 yd long and 280 yd wide. It has been worked into the hillside along a number of galleries; and the height of the quarry face is some 300 ft above floor-level, from which extensive sinkings reach an additional depth of about 115 ft. Five seams of especially good quality are known in this quarry and from these the bulk of commercial slate was derived. The method of working is briefly described in the 1916 edition of this memoir (pp. 230–1). Reserves of good quality slate-rock in the Ballachulish area are very great, and there is ample scope both for the extension of existing workings and for new development.

The slates which constitute a large part of the Appin Core north of Loch Leven extend north-eastwards in a wide belt for over 7 miles, from North Ballachulish [NN 052 603] almost to Glen Nevis. There are immense resources of slate-rock in this belt, but apart from a number of trial pits and a fairly large quarry at North Ballachulish [NN 052 603] there has been no attempt to exploit them. In the North Ballachulish [NN 052 603] Quarry pyrites has been altered to pyrrhotite by the Ballachulish "Granite" across the loch, and this weathers freely to give holes (p. 38). Much of the slate outcrop is difficult of access, and the most promising area for future development appears to be in the vicinity of the existing quarry, which is adjacent to both main road and sea-loch; but it would have to be far enough inland to escape the effect of the "granite". Another possibility is in Gleann Righ [NN 060 630], about 1½ miles to the north-east.

The slate-rock is fine-grained, and dark grey or bluish grey — generally called black; the cleavage faces, though even, often show a well-marked "grain" or lineation. Pyrites is abundant, usually in scattered cubes one sixteenth to one quarter of an inch across. The presence of pyrites does not however adversely affect the lasting qualities of the slate (except at North Ballachulish [NN 052 603]), for this mineral has proved to be very stable even in a town atmosphere; nor does it interfere with the regular cleavage of the slate as the crystals usually break across when the slate is split, leaving a flat surface. The rock splits along a true slaty cleavage which is determined by a parallel orientation of the minute mineral constituents. The bedding is obscure in the best of the slates, but may be indicated by parallel banding where the normal slate contains limy or siliceous intercalations; it may coincide with the cleavage, but frequently is greatly folded and puckered, with the cleavage running parallel to the axial planes of the minor folds. Where the cleavage is even, the slate-rock splits easily. In some areas, however, *e.g.* the strip of Ballachulish Slates east of Ballachulish, at the entrance to Glen Coe, the cleavage is so badly puckered that the slate is unworkable.

As much of the slate-rock is unsuitable for the production of roofing slates, the latter have constituted only a small proportion of the rock actually quarried, and large quantities of waste slate have accumulated. While this material has been employed locally for building and other purposes no systematic attempt has been made to put it to more profitable use. Elsewhere, powdered slate has found application in many industrial fields (Jones 1921). It has been used, for instance, in the manufacture of bricks and tiles, in the glass and pottery industries, as a filler in the manufacture of coarse rubber wares, and as a base for paints and distempers. The Ballachulish Slate is of suitable composition for cement manufacture (Robertson, Simpson, and Anderson 1949, p. 16), and the utilisation of crushed waste for this purpose would be facilitated by the availability of limestone in the district. When heated to a temperature high enough to cause surface fusion, some slates expand considerably, giving a product which can be used as a lightweight concrete aggregate (Lea 1956, p. 501); it is possible that slate waste from the Ballachulish quarries might be suitable for this purpose.

Further References. — Bremner 1869, pp. 429–32. Carmichael 1837, pp. 400–2. M 'Gregor 1845, pp. 247–51. Richey and Anderson 1944, pp. 2–13, 32–4. (References expanded p. 289).

2025: See also

Scottish slates image gallery

East Laroch [NN 080 580], Ballachulish slate belt, Scotland

Loch Leven, north side quarries, Ballachulish slate belt, Scotland

West Laroch [NN 080 580] slate quarries, Ballachulish slate belt, Scotland

Granite

Ballachulish

The only "granite", that is, granite or quartz-diorite in the geological sense, which has been worked in the district for other than local use is the Ballachulish "Granite". This has the advantage of a sea frontage some 21 miles long between Ballachulish Ferry [NN 053 598] and Kentallen [NN 008 573] (5 of (Figure 18), p. 129). In the bluff behind the narrow raised-beach platform a number of quarries have been opened in the quartz-diorite which forms the outer member of the complex. The rock in this area is grey and of an even, medium texture, but the presence of numerous dark inclusions of baked schist detracts from its appearance. It was at one time largely used as a building stone in Oban [NM 860 300] and elsewhere in Argyllshire, but all the quarries have now been abandoned owing to the capricious nature of the jointing. The jointing and inclusions do not, however, affect the quality of the rock as roadstone or as material for concrete aggregate, for which working might be resumed.

The pink granite which forms the central part of the complex is in general free of inclusions, but is nowhere easily accessible, since its outcrop lies for the most part above the 1500-ft contour. A narrow band of "white granite", also free of inclusions, occurs in a small outcrop of quartzite about 1¾ miles north-east of Kentallen. In a small trial quarry this "granite" was found to be too irregularly jointed for the extraction of sizeable blocks; it might however be used for setts or roadstone.

Mullach nan Coirean

The northern extremity of the Mullach nan Coirean Granite (2 of (Figure 18)) is exposed in Glen Nevis, between five and six miles from Fort William, from which it is accessible by road. The rock is a pink, rather coarse granite and is moderately widely jointed. It has been quarried from time to time, for example, for a bank in Fort William and more recently for a new bridge over the Nevis.

Ben Nevis. — The various members of the Ben Nevis Complex (1 of (Figure 18)) outcrop for the most part in rugged and relatively inaccessible ground. The porphyritic Subzone 4 of the Outer "Granite" and the coarse, grey non-porphyritic quartz-diorite (Subzone 3), which is the main component of the marginal intrusions on the west side of the complex, are, however, reasonably accessible on the east side of Glen Nevis ((Figure 31), p. 178). As both rocks are fairly widely jointed and are free from inclusions and aplite veins they might repay working in this area. The porphyritic Outer Granite is a handsome rock, not unlike Shap Granite, and might find a use as an ornamental stone. Ben Nevis "granite" was used in concrete aggregates for the Lochaber Water Power Scheme.

Other granites

The Moor of Rannoch and Etive "granite" complexes (7, 8 of (Figure 18)) extend into Sheet 53, but because of their position are not likely to be of economic interest in this area. The Fault-Intrusion of Glen Coe (6 of (Figure 18)) has been quarried on a small scale at Clachaig. The granites which outcrop along the west coast of Loch Linnhe (3, 4 of (Figure 18)) are for the most part crushed and brecciated as a result of movement along the Great Glen Fault and are therefore of no economic value, except, possibly, for road metal.

Reference. — Anderson and Macgregor 1939, pp. 44–53.

Kentallenite

Kentallenite, locally known as "black granite", was at one time quarried at the type locality of Kentallen [NN 008 573]. A handsome dark rock with large, lustrous biotites, it takes a good polish and was formerly in demand as a monumental and ornamental stone. The quarry was abandoned when the construction of the branch railway to Ballachulish prevented further extension into the hill behind; but new quarries could easily be started or the abandoned quarry deepened.

The Kentallen and other outcrops of dark igneous rocks (appinite, augite-diorite, cortlandtite, kentallenite, monzonite) are shown in (Figure 32), p. 186. With the exception of the Kentallen stone none of them has been exploited.

Quartzite

Appin Quartzite

South of Loch Leven the Appin Quartzite outcrops in a broad belt between Kentallen and Appin. It was formerly quarried on the hillside above Lagnaha [NN 004 563], south of Kentallen, for export to the English pottery district, where it was used in the form of setts to pave the grinding tubs and as runners driven forward over the floor of the tubs by revolving vanes. It is felspathic, and is said to maintain a rough surface suitable for grinding purposes better when slightly weathered than when it is quarried at some depth. From its connection with the pottery industry the quartzite came to be known locally as "china-stone". The Lagnaha [NN 004 563] rock has also been used for grinding with pottery clay, as refractory cylinder linings and as a constituent of scouring soap.

North of Loch Leven, the quartzite forms an extensive outcrop in the Onich area [NN 025 614]. Although the Appin Quartzite invariably contains a certain amount of felspar, it is locally a fairly pure silica-rock. In a cutting along the main road about a mile east of Onich Pier some 300 ft of intensely white quartzite are exposed; a rough estimate places its silica content at about 95 per cent. The reserves are very great and the locality is well placed for road or sea transport.

Binnein Quartzite

The Binnein Quartzite, BQ of (Figure 15), p. 99, is the only quartzite in the district which is sufficiently free from felspar and other impurities to merit consideration as a possible source of high-grade silica-rock for the manufacture of refractories, etc. It outcrops on both sides of Loch Leven at Caolasnacon [NN 138 607], and in the Kinlochleven area [NN 190 620] where it forms a belt about 2½ miles in width interrupted by an irregular outcrop of Binnein Schist. It frequently has a rusty appearance owing to the presence, both in the rock itself and as a coating along joint planes, of iron oxide. In its purest form, however, it is a glittering white, fine to medium-grained rock with very even texture; felspar is not noticeable in the hand-specimen, but a few tiny muscovite flakes are sometimes apparent. On analysis, bulk samples from a number of localities both north and south of Loch Leven showed a silica content ranging from 97.80 to 99.10 per cent. The reserves of Binnein Quartzite are immense and the rock could easily be quarried within convenient reach of road or sea transport.

Imperial Chemical Industries Ltd. has kindly informed us that quartzite in lump form, obtained from the Caolasnacon outcrop south of Loch Leven [NN 138 607], has recently been used, on account of its high purity, to fill an absorption tower in a sulphuric acid plant in Glasgow.

References. — Anderson 1945a, pp. 7–10 analyses, pp. 21–5. Hinxman 1920, pp. 149–50, 163–4.

Limestone, dolomite, and marble

Limestone and dolomite

The district as a whole is comparatively rich in limestones, but much of the material shown on the one-inch map as limestone is no more than slightly calcareous schist of no economic value. Moreover, in the vicinity of the various "granites" the impure limestones are altered to calcsilicate-hornfelses. East of Loch Linnhe there are two, probably three, distinct limestone groups, Ballachulish, Appin and Shuna [NM 920 490], all three quarried for local purposes. The Ballachulish Limestone provides fairly extensive outcrops of high-grade non-dolomitic limestone (as for instance at Creag Aoil [NN 180 776] Quarry) in the area north-east of Fort William, beyond the northern limit of Sheet 53; it is, however, of limited economic importance in the present district, as bands of reasonably pure material are uncommon and are of restricted extent.

The Appin Limestone, formerly quarried at Onich and Duror for agricultural purposes, is dolomitic in character. Both in regard to its magnesia content and its purity it shows a wide range of variation, but locally it approaches the composition of a true dolomite (Analyses, p. 244). A highly dolomitic band extends southwestwards from Acharra House [NM 988 544], Duror, to Portnacroish [NM 926 474] (Appin railway station). The best quality of dolomite so far found within the

Appin Limestone outcrop occurs in this band in the Duror area. Its silica content, however, varies considerably, and sometimes reaches a high proportion; the rock therefore cannot be considered either for refractory purposes or for magnesium production. The reserves are probably considerable and the area is within easy reach of road and rail transport. In recent years dolomite from the Duror area has been utilised by The Cape Asbestos Co., Ltd., Rocksil Works, Stirling, for the manufacture of rock-wool, a material which finds increasing application in thermal and sound insulation. The company concerned has kindly supplied the following details of its use. The dolomite, after preliminary crushing at the quarry, which has an annual output of several thousand tons, is conveyed to Stirling, where it is powdered, mixed with a certain proportion of fireclay, and briquetted. The briquetted material is melted at approximately 1500°C and the molten matter extruded into fine filaments which are collected on a conveyor belt to make a fleecy mass of fine, interlacing fibres of rock-glass. This material is marketed for loose-fill insulation and, in conjunction with various bonding agents, also forms the basis of a wide range of insulating products, including slabs and quilts of various types, many of which can be cut and shaped as required.

Part of the Appin Limestone outcrop in the Ballachulish area consists of dolomite of fairly high quality. At one locality in Gleann an Fhiodh [NN 080 560] (p. 60), the rock is very friable and falls readily into a fine powder which has excellent abrasive and polishing qualities.

Marble

At the "Marble Quarry", close to the last-mentioned locality, another band of the Appin Limestone is of the "tiger-rock" variety, cream and pale pink in colour, with dark grey stripes. An attempt was made to exploit this rock as an ornamental stone, but in spite of its handsome appearance it did not find a market. The sparkling white appearance of much of the Duror outcrop of Appin Limestone makes it highly suitable for terrazzo chippings, ornamental stone dressings, etc., where a light-reflecting surface is desired; the rock might also be of value as an ornamental stone, particularly where it contains streaks of green serpentine.

Several bands of white crystalline marble occur in association with rocks of the Glen Scaddle igneous complex of chapter 9. There is no record of their having been worked and they are probably not sufficiently accessible to be of economic interest.

Brucite-marble, a material which has been successfully used in America as a substitute for magnesite in the manufacture of basic refractory linings, is developed where the dolomitic Appin Limestone comes in contact with the Ballachulish "Granite". The most easily accessible locality is near Kentallen, but the material there is of rather inferior quality.

References. — Anderson 1945b, pp. 3–5, 13–4; analyses, pp. 16–20. Anon. 1954, pp. 16–7. Guppy and Phemister 1949. Hinxman 1920, pp. 224–5. Kennedy 1940, pp. 7–10. Muir and others 1956; analyses, pp. 20, 80. Robertson and others 1949, pp. 16–8, 21, 36, 49–52, 56, 112. Wilson and Phemister 1946, p. 7.

Phyllite (for building)

On the north side of Loch Leven, east of North Ballachulish [NN 052 603], the Leven Schists were at one time quarried fairly extensively for building stone. The cleavage here is even and unpuckered, and the rock can be readily worked in large slabs.

Mineral veins, etc.

Barytes

A vein of barytes, stated in the 1916 edition of this memoir (p. 234) to be 4 ft thick, occurs in a steep gully leading to the Allt a' Gharbh Choire Bhig, a tributary of the Amhainn Coir ' an Iubhair [NM 920 623]. The locality is about 1400 yd E. 10°S. of the summit of Garbh Bheinn (Ardgour) [NM 905 622]. Further examination of the occurrence, by K. C. Dunham in 1946, shows that the barytes, 1 ft in average thickness, occurs on the hanging wall side of a mineralised crush-breccia associated with a north-west basic dyke which has been traced for many miles (p. 263). The breccia, about 3 ft thick, consists of fragments of dyke and country rock in a matrix of chalcedonic silica, white carbonate, and, locally, quartz; it contains a very little barytes. The well mineralised zone extends for about 80 yd in an east-south-easterly direction from the point where the dyke gives off three branches (two of which are indicated on the one-inch map). Evidence of strong chalcedony-carbonate mineralisation with a little barytes was also found further to the east-south-east along the course of the dyke.

Galena

Galena occurs in a small calcite vein in limestone near Invercreran [NN 014 471] [NN 014 471], Glen Creran. An early attempt to work it proved unsuccessful (Wilson 1921, p. 92). A small amount of galena is associated with the barytes of the Ardgour occurrence described above.

Haematite

A haematite vein has been mapped between 1400 and 1500 yd E. 17° N. of Glen Ure [NN 070 475] House. There is no record of its thickness, but it may have been worked at one time, since charcoal, probably the relic of a local bloomery, was found nearby.

Pyrites

The Ballachulish Slates might possibly be of economic interest as a source of pyrites, particularly if the large quantities of slate debris from the quarries were to be utilised, for instance, in cement maufacture. The mineral forms conspicuous cubes, usually from one sixteenth to a quarter of an inch across, but occasionally up to an inch or more. The quantity of pyrites in the waste heaps must be considerable, and a useful tonnage might be obtained by concentration after crushing the slate debris.

Sand and gravel

Spreads of alluvial and fluvio-glacial sand and gravel flank many of the streams and rivers, and there are frequently considerable areas of raised beach deposits at river mouths (*e.g.* Invercoe [NN 098 593] and Inverscaddle [NN 025 680]), and in bays (*e.g.* at Onich [NN 025 614] and North Ballachulish [NN 052 603]). On both sides of the Corran Narrows [NN 0183 6342], but particularly on the west, there are wide expanses of fluvio-glacial sand and gravel which form a terrace at about 75 ft above sea-level. Locally the morainic drift of the district consists of rudely bedded sand and gravel. None of these deposits appears to have been worked for more than intermittent local use.

Peat

Although large spreads are uncommon, peat is widely distributed throughout the area and for long has provided a local source of fuel. The most important moss, which has been extensively worked, is situated on the gravel terrace at

Clovulin [NN 000 630], south-west of the Corran Narrows [NN 0183 6342]. T. R. M. L.

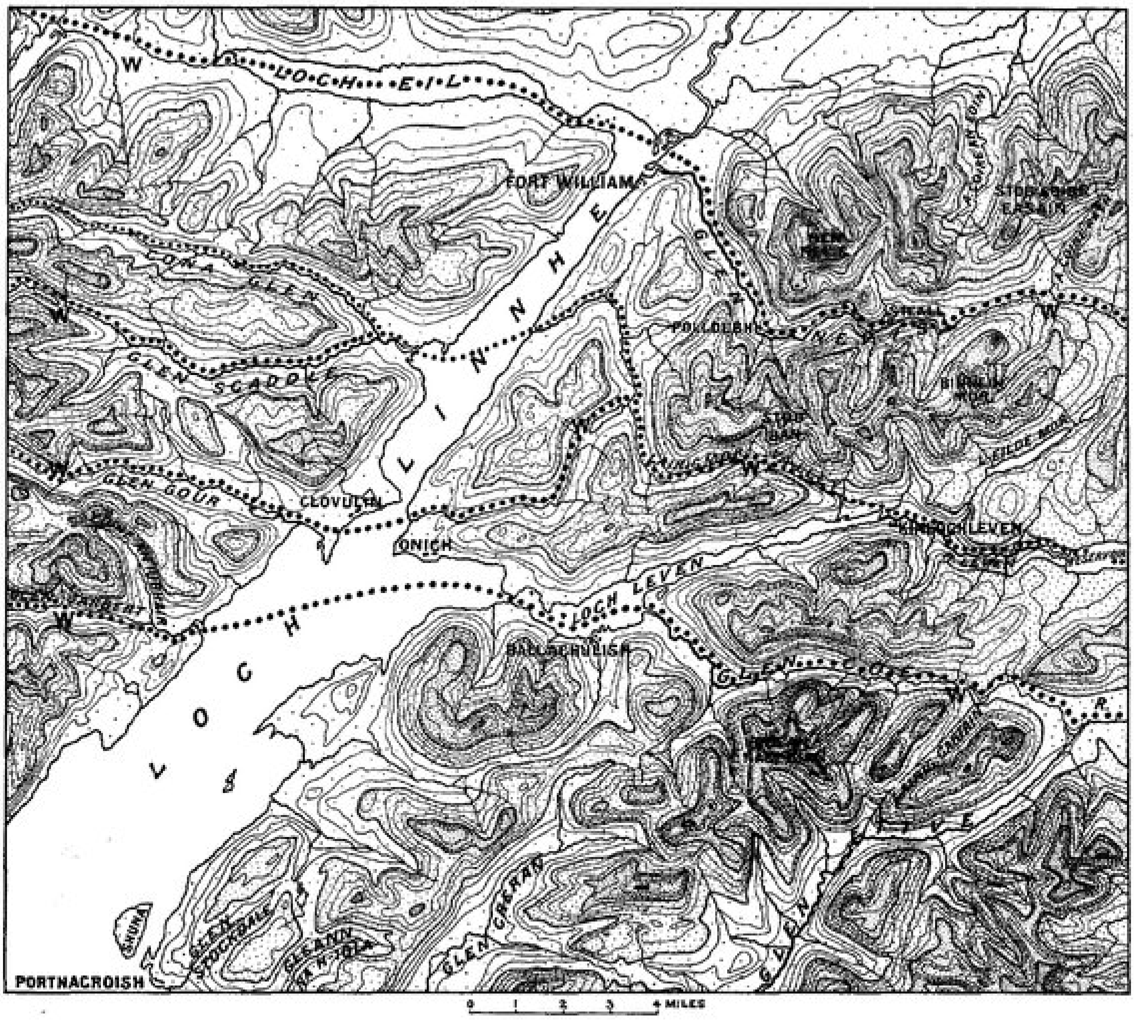


Fig. 1. Map of inferred original Tertiary drainage system (shown in heavy dots)

Shatter-belts guide Loch Linnhe, Loch Leven and Lairig Gartain.
Contour-interval 250 ft, with change of ornament every thousand feet.
W, Secondary Watersheds. R, west end of Rannoch Moor

(Figure 1) Map of inferred original Tertiary drainage system (shown in heavy dots) Shatter-belts guide Loch Linnhe, Loch Leven and Lairig Gartain [NN 200 544]. Contour-interval 250 ft, with change of ornament every thousand feet. W, Secondary Watersheds. R, west end of Rannoch Moor.

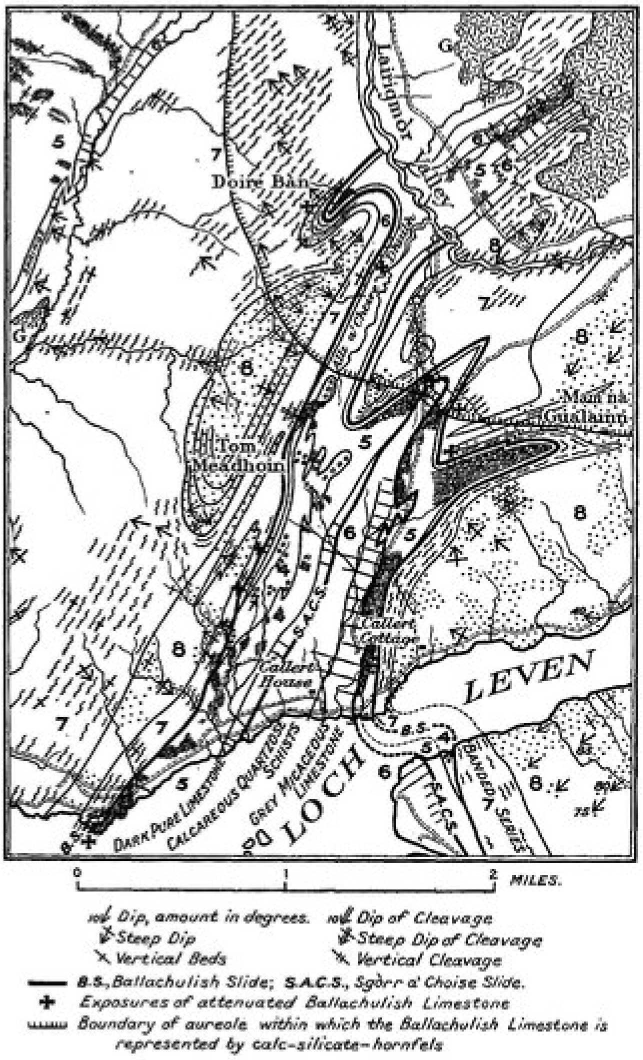
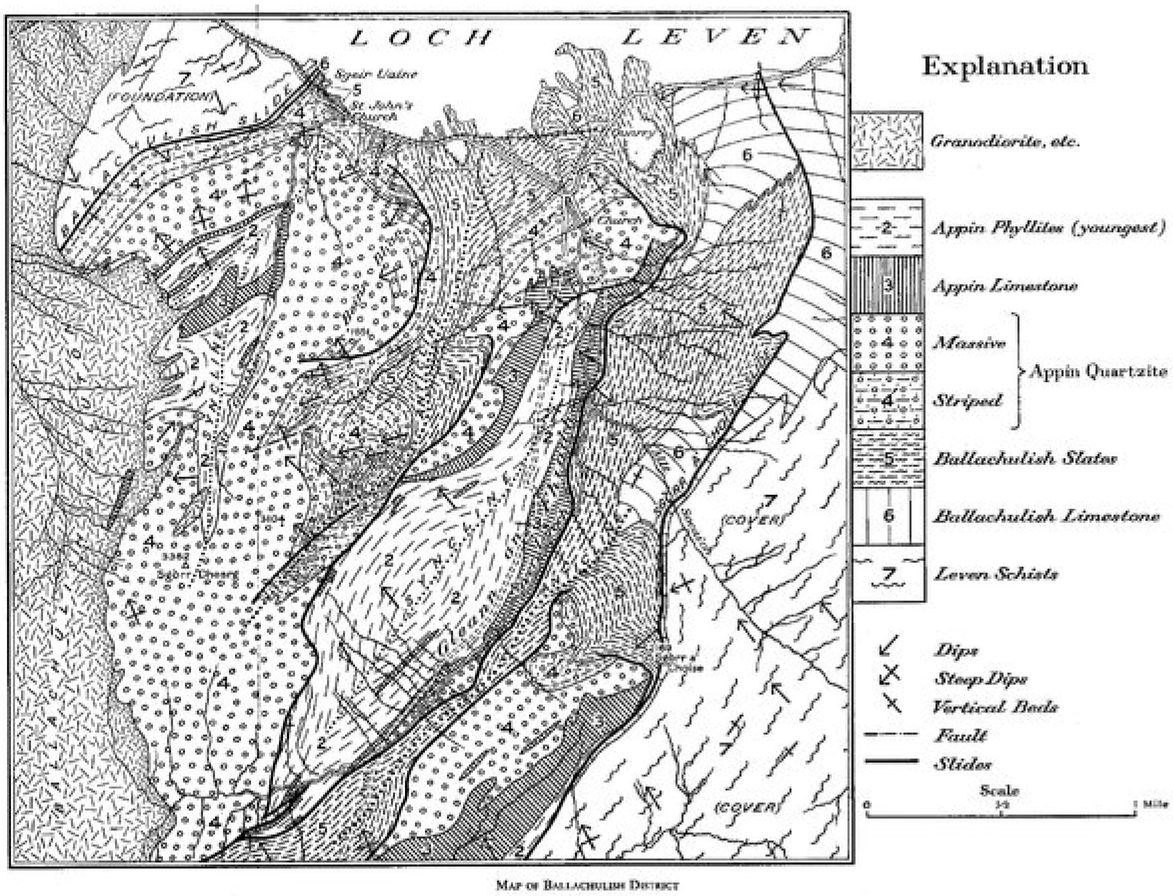


FIG. 8. Map showing outcrops in Callert district

4, Appin Quartzite (youngest) ; 5, Ballachulish Slates ; 6, Ballachulish Limestone ; 7, Leven Schists ; 8, Glen Coe Quartzite ; G, Granite

(Figure 8) Map showing outcrops in Callert district 4, Appin Quartzite (youngest); 5, Ballachulish Slates; 6, Ballachulish Limestone; 7, Leven Schists; 8, Glen Coe Quartzite; G, Granite.



(Plate 3) Map of Ballachulish District.

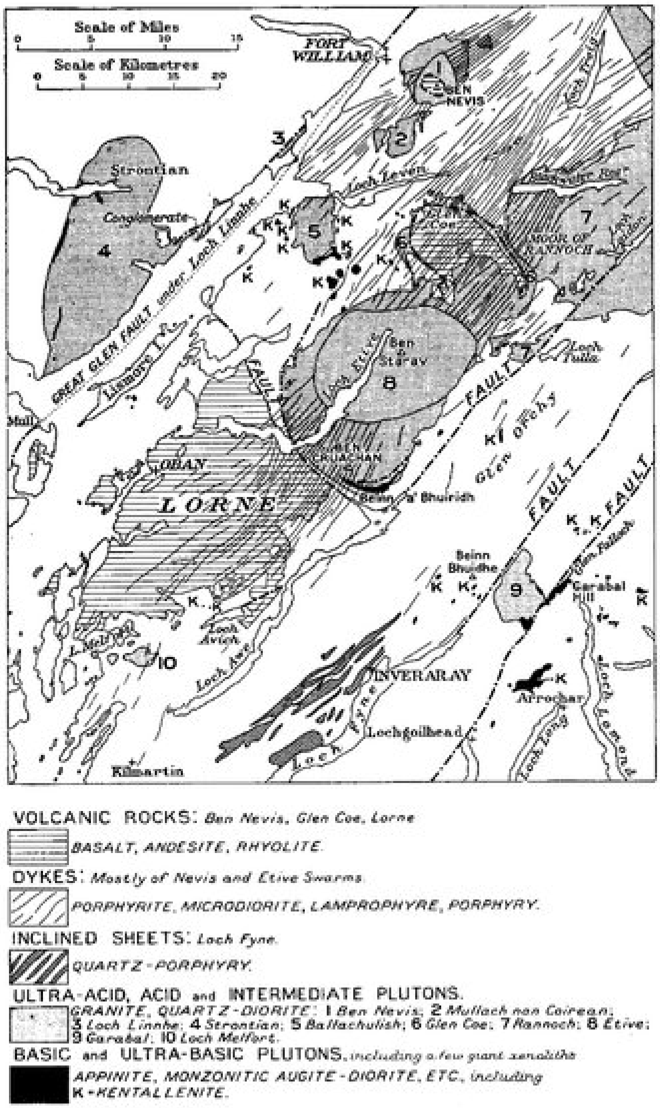


FIG. 18. Map of igneous rocks of South-West Highlands referred to Lower Old Red Sandstone Period

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

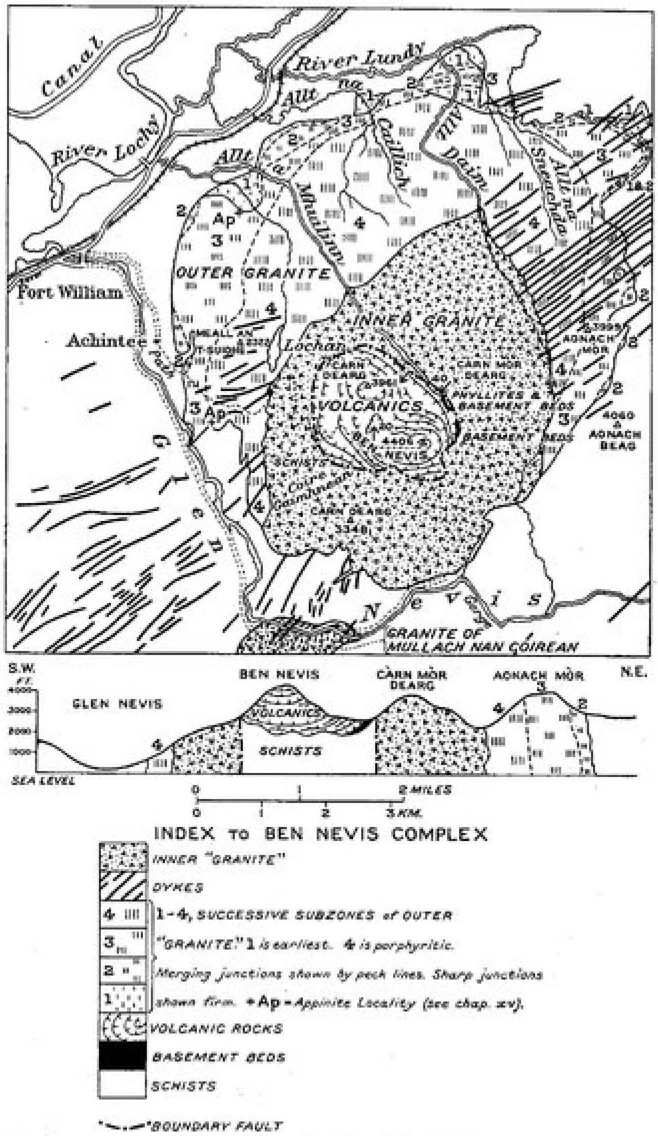


FIG. 31. Map and section of Ben Nevis

(Figure 31) Map and section of Ben Nevis.

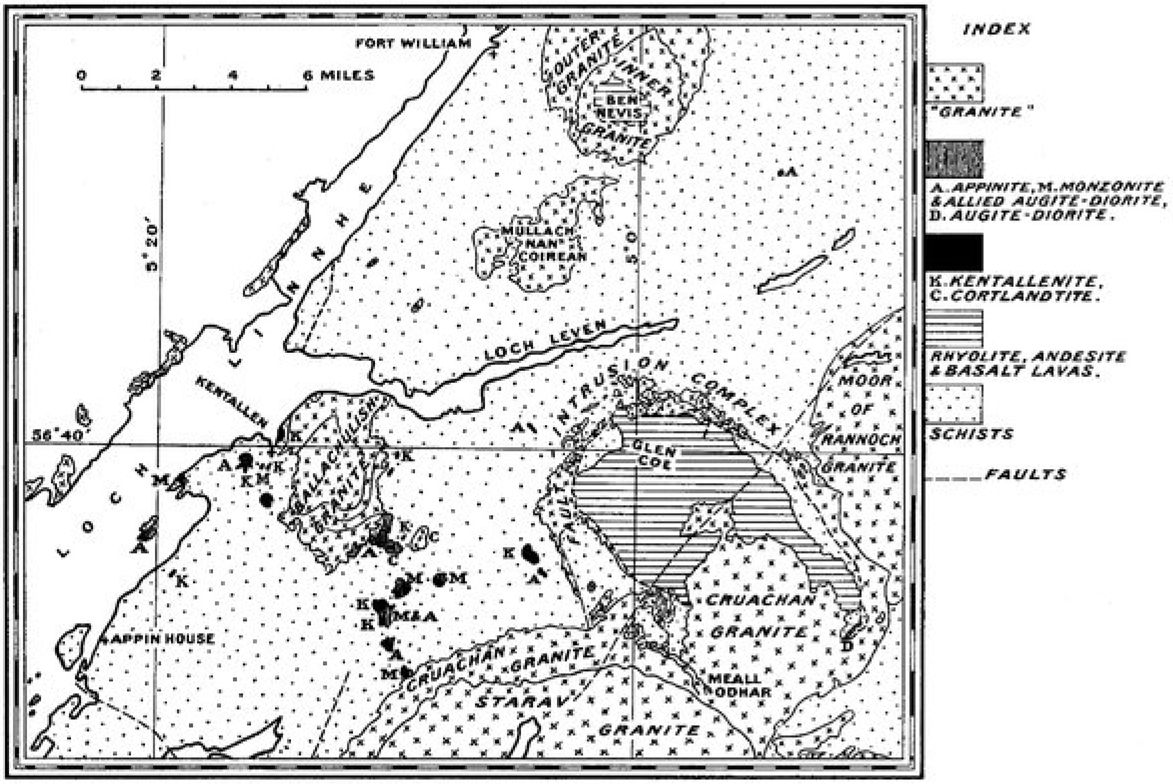


FIG. 32. Map of plutonic and volcanic rocks of Sheet 53 referred to the Lower Old Red Sandstone Period

(Figure 32) Map of plutonic and volcanic rocks of Sheet 53 referred to the Lower Old Red Sandstone Period.

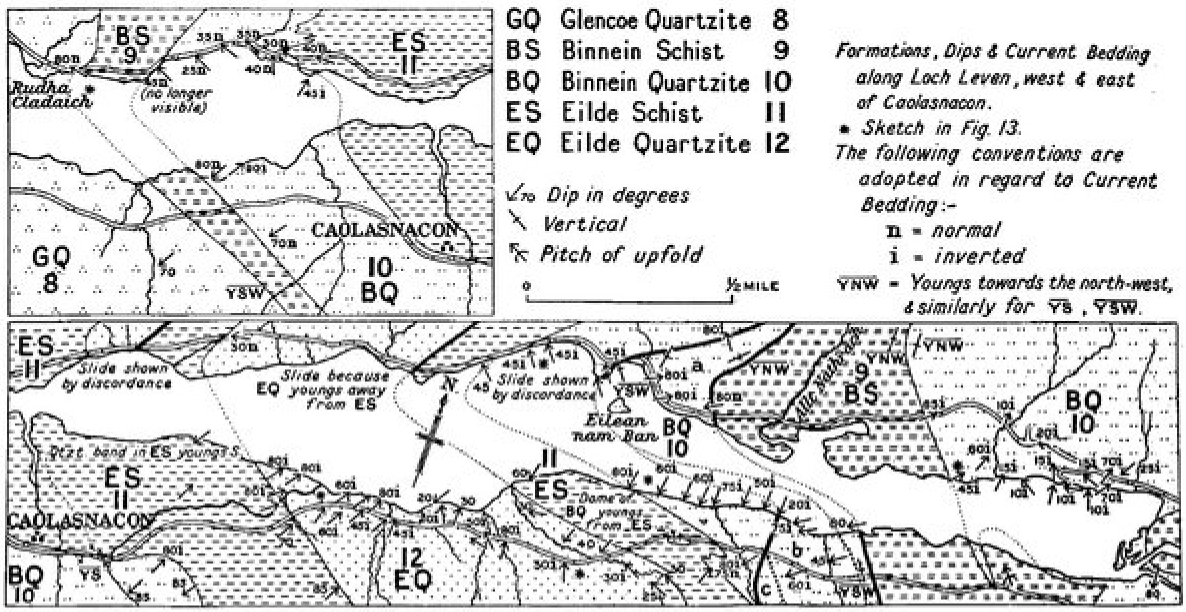


FIG. 15 (West above, east below). Formations, dip and current-bedding west and east of Caolasnacon

(Figure 15) (West above, east below). Formations, dip and current-bedding west and east of Caolasnacon.