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## Chapter 35 Structure of Assynt, from Loch Glencoul to Knockan and the Cromalt Hills

By B. N. Peach and J. Horne. The district described in this chapter is contained in Sheets 101, 102, 107, and 108 of the Geological Survey Map of Scotland, on the scale of 1 inch to a mile (1:63 360).

In the mountainous region of Assynt extending from Glencoul to Knockan and the Cromalt Hills, where the belt of complication is from six to eight miles broad, the following tectonic features are so fully presented as to invest this district with special interest and importance:

1. In the northern part of the area three major lines of disruption — the Glencoul, the Ben More, and the Moine thrusts — follow each other in definite order from west to east. The first and most westerly brings forward the Lewisian gneiss, covered unconformably by Cambrian strata; the second, a slice of Lewisian rocks and Torridon Sandstone with the double unconformability of the Cambrian quartzites; and the third, the Eastern or Moine schists.
2. In the central and southern parts of the district each of the two lower thrusts is in turn overlapped by the one to the east till the Eastern schists rest directly on undisturbed Cambrian strata. This striking feature distinguishes the ground in Assynt from the rest of the belt of complication in the North-West Highlands.
3. The Ben More thrust-plane has been folded, and the important outliers of the materials which surmount it, showing the double unconformability, are met with from two to five miles west of its main outcrop.
4. The various sills of post-Cambrian igneous rocks are found occupying their respective horizons in the displaced masses above the Glencoul and Ben More thrust-planes, thereby proving the wide distribution of these intrusions before the movements.

Immediately to the south of Loch Glencoul the tectonic arrangement of the strata is precisely the same as that on the north side of the loch, described in the last chapter. The undisturbed Cambrian rocks from the basal quartzites to the fucoïd-beds, dipping to the E.S.E. at 12°, are there overlain by the piled-up members of the Middle Series, which, repeated by reversed faults, are truncated by the Glencoul thrust. This important displacement brings forward the southern continuation of the moved gneiss with its basic dykes north of Loch Beag, the thickness of the mass varying from 1500 to 1600 feet. The imbricate arrangement of the fucoïd-beds and serpulite-grit beneath that line of disruption and the bare plane itself are well seen along the course of a footpath which traverses the slope on the south side of the loch.

Southwards beyond Loch na Gainmhigh the north-west slope of Glas Bheinn exposes the thrust gneiss covered unconformably by the basal quartzites and pipe-rock in their natural order, the whole displaced mass resting on the Glencoul thrust-plane. Not far to the south of this point the relations of the strata become much more complicated, as shown in the accompanying section, across the northern part of Assynt.

On the southern slope of Quinag the unconformability between the quartzites and the Torridon sandstones (Bb) is clearly seen (Figure 31), the former dipping towards the E.S.E. at angles varying from 4° to 8°, while the inclination of the latter is in the same general direction at from 15° to 20°. Both zones of the Cambrian arenaceous series (Ca, Cb) are followed in normal sequence by the fucoïd-beds and serpulite-grit (Cc, Cd); but close to the high road leading to Kyl esku the undisturbed strata are cut off by a major thrust-plane or "sole" (T), along which the fucoïd-beds, serpulite-grit, and basal dolomite have been driven, being repeated by numerous reversed faults (t). This imbricate structure is merely a repetition of that above described on the north side of Loch Glencoul and at Heilim in Loch Eireboll. As an instance of the rapid reduplication of the beds, it may be mentioned that thirteen outcrops of the serpulite-grit appear here within a third of a mile. Near Achumore, another major thrust ushers in the basal dolomites with the igneous sills (F) lying at gentle angles and resting on the thrust strata just described. These are followed by the members of the two lowest groups (I., II.), both sub-divisions being repeated by various reversed faults, and folded in gentle arches and troughs, till the Calcareous series is over-ridden by the materials above the Glencoul thrust-plane. Owing to the covering of morainic drift, the outcrop of this line of disruption east of Achumore is concealed, but its position is approximately at the base of the steep

slope that runs southward from Glas Bheinn.

Above this thrust-plane and along the south-west declivity of the mountain, the various sub-zones of the pipe-rock (Cb), with the porphyrite sills (F), appear in inverted order, succeeded by the basal quartzites resting unconformably on the Archman rocks with the basic dykes, which there preserve their north-west trend. The inversion of the Cambrian strata, so conspicuously displayed on this slope of Glas Bheinn, is an example of the usual folding over and buckling under of the strata in front of the displaced masses of gneiss. In this line of section a small thrust drives the Lewisian rocks on to the basal quartzites, but both to the north and south of this locality the inverted base line of the Cambrian sequence can be traced. On the east side of the Lewisian inlier both divisions of the arenaceous series (Ca, Cb) follow in natural sequence together with their intrusive sheets.

Between Glas Bheinn and Beinn Uidhe a thrust, intermediate between the Glencoul and Ben More disruptions, intervenes and repeats both the basal quartzites and the pipe-rock, which, on the lofty plateau of Beinn Uidhe, are arranged in a gentle synclinal fold. Sheet 107 of the map shows that the sills of igneous material (F), which there occur near the top of the lower division of the quartzites, have been traced round this great flexure. Along the north-east slopes of Glas Bheinn and Beinn Uidhe the basal beds of the arenaceous series (Ca) rest unconformably on the gneiss save where small local thrusts intervene. Eastwards on the high plateau beyond Beinn Uidhe the Lewisian rocks again rise from underneath the thin veneer of quartzites, which have there been thrown into numerous small folds and repeated by reversed faults.

Descending the ridge towards Cailleach an Sniomh — a hill west of Gorm Loch Mor — we cross the outcrop of the Ben More thrust-plane, which there gives rise to a well-marked hollow. (Figure 31) This disruption has brought westwards the Lewisian rocks with both divisions of the arenaceous series on to the basal quartzite. Three characteristic intrusive sheets appear in this area, one at the base of the false-bedded Cambrian grits, a second higher up in the same sub-division, and a third in the lowest sub-zone of the pipe-rock. South of Gorm Loch Mar the evidence is much obscured by an extensive covering of moraines, but north of that lake the fucoïd-beds, serpulite-grit, and basal dolomite are repeated mainly by folding, and a similar arrangement of the strata is observable near the Fionn Allt. At the latter locality a lenticle of mylonised Torridon arkose (B) underlies the Moine thrust-plane (T'), above which the great series of Eastern schists supervenes.

At its western limit the section (Figure 32) shows the mode of occurrence of the intrusive sheets of albite-porphyrine (F), which are such a prominent feature in the Torridon sandstones (B) and Cambrian quartzites (Ca) on Beinn Gharbh. Allusion has already been made to the double unconformability on the north slope of that hill, where the basal quartzite, overlapping the Torridon Sandstone, comes to rest directly on the Lewisian gneiss. Next follow in order the sub-divisions of the pipe-rock (Cb), dipping E.S.E. at an angle of about 15°. The highest sub-zone pierced by the intrusive sill is that of the "trumpet" pipes. From the eastern side of the alluvium at the head of Loch Assynt rise the piled-up fucoïd-beds, serpulite-grit, and basal dolomite charged with *Salterella*. Two basic sills are here interposed, one between the serpulite-grit and the bottom of the Calcareous series, and the other in the Ghrudaïdh group (I.) These are followed by the Eilean Dubh dolomites and limestones (II.) resting on different members of the lowest division of the Calcareous series and repeated by reversed faults. That the dolomites and limestones in this portion of the plateau are not arranged in an inverted synclinal fold can be demonstrated in a conclusive manner, for within a distance of half a mile from Loch Assynt the piled-up limestones are truncated by another major thrust, which has brought up the fucoïd-beds, serpulite-grit, and basal dolomites, and has pushed them above the Eilean Dubh beds. This displacement can be traced northwards to the Chalda Burn and southwards across the Traligill to the limestone east of Stronechrubie.

About half a mile north-east from Inchnadamff Hotel the position of the Gleneoul thrust-plane is defined by a well-marked feature which skirts the escarpment of quartzites on the west slope of Cnoc an Droighinn. These strata have here been driven on to the dolomites of the Ghrudaïdh group. Though complicated by the recurrence of minor thrusts and the presence of numerous sills of igneous material, both divisions of the quartzites on that hill may be described generally as forming an inverted anticline and syncline on a core of gneiss. The fucoïd beds, the highest members of the series represented in the trough, are cut off on the east side by a reversed fault. Two intrusive sheets of porphyrite (F) here occur near the top of the lower division of the quartzites (Ca), and one of iegirme-felsite near the base of the lowest sub-zone of the pipe-rock. Another example of the latter type appears in a higher sub-zone in Allt Poll na Droighinn.

East of Cnoc an Droighinn a thrust occurs, which is the southern continuation of that west of Beinn Uidhe, and, like it, brings forward a mass of Lewisian gneiss (A) with basic dykes exposed on the north-west slope of Beinn an Fhurain. The basal quartzites (Ca) resting unconformably on the Lewisian floor can be traced round this inlier, though frequently in an inverted position. Eastwards the crest of the mountain is mainly composed of pipe-rock (Cb), overlain by fucoid-beds (Cc) and serpulite-grit (Cd), repeated by minor thrusts, and accompanied by intrusive sheets which resemble the types on Cnoc an Droighinn and occupy similar horizons.

The position of the outcrop of the Ben More thrust, which is the second great line of displacement in the Assynt region, lies on the east side of the peaty hollow between Beinn an Fhurain and Na Tuadhan, but the outcrop itself is there obscured by quartzite debris. Though not visible in this line of section, it is laid bare in the Beallach or pass between Na Tuadhan and Coinne-mheall, about a quarter of a mile south of the top of the former mountain.

The stupendous folds of Cambrian strata on Na Tuadhan, in advance of the great displaced mass of Lewisian gneiss of Ben More, are among the most impressive geological features in Assynt. (Plate 34)<ref>(Plate 34) forms the frontispiece of this volume.</ref> This mountain, which rises to a height of 2824 feet, with a cliff about 1100 feet high on its eastern face, partly bounds the great corrie on the north-west side of Ben More. Above the thrust-plane both divisions of the Cambrian quartzites (Ca, Cb) are arranged in a great inverted arch and trough, which are readily recognised from the surrounding peaks. The unconformable boundary line between the basal quartzites and the Lewisian gneiss can be followed round the base of the great crag on the east side of the mountain, and northwards for more than a mile to Corrie Mhaidh Beag, with a porphyrite sill along the junction. Outliers of this intrusive sheet, sometimes capped with basal quartzite, are found resting on the gneiss on the floor of Corrie Mhaidh, indicating the former continuation of that series southwards towards the slope of Ben More. It is noteworthy that a common cleavage foliation affects the outlying portions of the porphyrite and the Lewisian gneiss beneath, the planes being more or less parallel with the plane of the Ben More thrust. Two additional sills appear in the basal quartzites, and one in the third sub-zone of the pipe-rock.

But the most striking structural feature here is the sharply-inverted syncline which runs down the south-east side of the mountain for more than a thousand feet, and involves all the subdivisions of the Cambrian strata from the fucoid-beds (Cc) down to the thin pebbly grit at the base, together with the intrusive sheets (F) and the underlying floor of gneiss. The synclinal fold is followed by an arch, which is truncated by a normal fault with a downthrow towards the north-east.

The line of section in (Figure 32) now traverses Ben More, Assynt, where the structure becomes comparatively simple. On the declivity facing Corrie Mhaidh the basal quartzite (Ca) with the intrusive sheets (F) forms a thin veneer on the great mass of Lewisian gneiss and basic dykes, to which attention will be immediately directed. Though the quartzites here are not deformed, the porphyrite sill at the base of the arenaceous series is highly sheared.

On the far eastern slope of Ben More, towards the head waters of the River Cassley near Sron Lom, the Lewisian rocks are covered unconformably by the basal quartzite (Ca), followed by all the sub-zones of the pipe-rock (Cb), the fucoid-beds (Cc), the serpulite-grit (Cd), and the basal dolomites of the Glirtidaidh group (Ce), traversed by a few reversed faults. Here the various sills in the arenaceous series occupy their proper respective horizons. As the rocks are followed eastwards their deformation becomes more pronounced in the intrusive sheets, the quartzites, and the fucoid-beds. Still further east a narrow wedge of sheared Torridon Sandstone (B in (Figure 32)) has been driven on to these displaced strata, but it is soon truncated by the Moine thrust which brings in the Eastern schists.

The geological structure of the southern part of Ben More and of Coinnemheall — its western peak — is much more complicated. Between the latter mountain and Breabag a narrow pass, termed the Beallach, separates the head waters of the Oykeil River from the sources of the Traligill. On the northern slope of this defile the outcrop of the Ben More thrust is clearly seen in dip section, and the relations of the thrust masses may be studied in detail in the crags which stretch eastwards to the corrie surrounding Dubh Loch Mor. The structure of this complex ground is explained in (Figure 33) and (Figure 34).

At the bottom of the western slope (Figure 33) the basal quartzites are seen to have been driven on to the Cambrian dolomites by the Glencoul thrust. As the burn-section on this declivity is followed up to the 2500-foot contour line, the strata exposed are found to consist almost wholly of these quartzites (Ca) with their sills (F). They are repeated by

inverted folds and minor thrusts (t) in such a way as to indicate that these must form only a comparatively thin veneer over the concealed Lewisian rocks. About the 2500-foot level the basal quartzites are followed in order by the various sub-divisions of the pipe-rock (Cb) with their sills, until these rocks are abruptly truncated by the Ben More thrust-plane (T). At the place where the line of section in (Figure 33) is drawn the effect of this great disruption has been to drive the basal quartzites over the highest zone of the pipe-rock (Cb) and fucoid-beds (Cc). When the false-bedded grits (Ca) are traced along the crest of the mountain they are found to overlies unconformably both the Torridon Sandstone (B) and the Lewisian gneiss (A). On the summit the basal quartzites are succeeded by the lowest sub-division of the pipe-rock (Cb). In descending the north-eastern slope of Coinne-mheall the observer crosses the unconformable junction of the basal quartzites with the Torridon Sandstones, and likewise the boundary between the latter and the Lewisian rocks. (Figure 34)

Owing to the high inclination of the Ben More thrust-plane its outcrop here descends from the crest of the mountain to the Beallach. As a result of the friction along the unyielding "sole" of the thrust, causing the upper layers to move more rapidly than the lower, the Torridon Sandstones have been folded over the western face of the disrupted gneiss, as shown in (Figure 34). By means of the local conglomerate at the base the line of junction with the old Lewisian platform is easily traced, and the proof of inversion is thus placed beyond doubt. The basal conglomerate and the overlying grits, sandstones, and shales can be followed continuously from the Beallach, round the south-eastern spur of Coinne-mheall to the southern shoulder of Ben More, where they are unconformably overlain by a cake of the basal quartzites. (Plate 35) The area occupied here by the Torridon Sandstone is about half a square mile, about half of which is buried under the basal quartzites. The general inclination of these grits and sandstones is towards the W.N.W. at an average angle of 20°; the greatest thickness is about 1500 feet.

From his descriptions it is evident that Nicol recognised these green grits and sandstones as the true western red sandstone (Torridon) brought up in the centre of the so-called "upper quartz-rock". Hence he inferred that the syncline to the west is complete in all the formations from the upper limestone to the lowest gneiss. <ref>*Quart. Jour. Geol. Soc.*, vol. xvii., pp. 96–99; also Fig. 8, p. 96</ref> He further stated that granitic gneiss and mica slate with intrusive igneous rocks form the nucleus of the mountain, throwing off the quartzite all around, as from a great centre of elevation.

In the Beallach of Coinne-mheall the dip of the Ben More thrust-plane becomes almost flat, and hence the outcrop can be followed for two miles and a half down the River Oyke. Along the line of outcrop the Torridon Sandstones with their basal conglomerate (the "button stone") reappear on the east side of the valley, dipping underneath the Lewisian gneiss in inverted order. There can be no doubt, however, that this strip of Torridon strata is merely a continuation of the mass on Coinne-mheall and Ben More, as shown in section (Figure 35), the intervening portion having been removed by denudation.

In his account of the geological structure of the Assynt district, Dr. Callaway noted the superposition of the Torridon grits on the Hebridean gneiss on Coinne-mheall and Ben More, and the inversion of these sediments beneath the same mass of gneiss on the east side of the Oyke valley (Figure 35). He inferred that these appearances seem inexplicable except on the supposition of an overthrow of the gneiss and grit upon the dolomite. <ref>*Op. cit.*, vol. xxxix., p. 382; also Fig. 6., p. 383.</ref>

The outcrop of the great Ben More thrust-plane can be followed southwards from the Oyke valley, round the western slope of Sgonnan Mor, by Strathsheaskich, thence to Allt an Loin Dhuibh, and round Cnoc na Glas Choille to the base of the Cromalt Hills (in one-inch Sheet 101), where it is overlapped by the Moine thrust-plane. It is worthy of note also that the Glencoul thrust is not traceable further south than a point near the Beallach between Coinne-mheall and Breabag, being there overlapped by the Ben More disruption.

The broad plateau of the Calcareous series at Inchnadamff lies almost wholly within the area affected by the post-Cambrian movements. In the Stronechrubie cliff the fucoid-beds, serpulite-grit, the Ghrudaidh dolomites, and part of the Eilean Dubh group follow each other in natural order, with a prominent igneous sill on the horizon of Sub-zone 7, in the Ghrudaidh sub-division. The upper part of the cliff shows a well-marked thrust-plane or "sole", upon which, and tilted at an angle to it, the calcareous beds of the Eilean Dubh group rest. (See (Plate 36)) This disruption, along which a sheet of crushed igneous rock appears at intervals, is traceable northwards to a point on the Traligill River, about 300 yards

east of Inchnadamff Hotel. Again, on the slope south of the Traligill Burn at Glenbain, about six major thrusts are seen in dip-section, the beds between these planes being piled up by minor reversed faults.

East of Stronechrubie the calcareous rocks, representing the Ghrudaidh, Eilean Dubh, and Sail Mhor groups, are arranged generally in a great synclinal fold, the strata, with their accompanying sills, being piled up by numerous major and minor thrusts. One of the finest examples of a bare thrust-plane in the limestone plateau may be seen in the Traligill River, about a mile up stream from the Inchnadamff Hotel, where the Ghrudaidh dolomites (Group I.) have been driven over the Eilean Dubh beds (Group II., see (Plate 37)) It frequently happens that the water descends and flows along these divisional planes beneath the surface, reappearing at lower levels. Occasionally outliers of the fucoïd-beds and serpulite grit are found capping the Eilean Dubh dolomites and limestones in the north-west part of the plateau, separated from each other by major thrusts. But subsequent to these various displacements whereby the strata were driven together, the area along the north-eastern and eastern margins of the limestone-plateau was elevated in the form of a great dome. Hence at intervals various sections may be observed which show the natural passage from the pipe-rock to the fucoïd-beds, serpulite-grit, and basal dolomites, the strata dipping towards the west. This feature is illustrated on the slopes of Breabag; likewise beyond the Traligill near Glenbain, where the members of the Middle Series rise from underneath the thrust dolomites and are underlain by the pipe-rock and basal quartzites, which there form a normal arch — the continuation of the anticlinal structures on Breabag (Sheet 107)

South of Inchnadamff various outliers of the materials that overlie the Ben More thrust-plane have been left by denudation on the displaced masses. The most important of these occur on Cnoc an Leathaid Bhuidhe west of Loch Awe, on the moor south of Loch Urigill, and on the limestone-plateau south-east of Stronechrubie. The two isolated examples, north and south of Allt nan Uamh, are of special interest, as they show the original folding of the Ben More thrust-plane and its overlap of the Glencoul thrust-plane. (Sheet 101)

On the slopes of Canisp (Figure 36) the double unconformability of the quartzites (Ca, Cb) on the Torridon Sandstone (Bb) and on the Lewisian rocks (A) is exposed, the strata being intersected by several normal faults (ff). East of the Loanan indications may be observed of the piling-up of the Middle Series and basal dolomite by reversed faults, which are truncated by a major thrust that has brought westwards the two lowest groups of dolomite and limestone. On the line of section the basal quartzites appear in inverted order above the Ben More thrust-plane (T), but on the north-west face of Beinn an Fhuarain the pipe-rock rises from below these false-bedded grits, the beds being inclined to E.S.E. at rather high angles. Near the hill-top the unconformable junction of the basal quartzites on the Torridon sandstones is exposed, and when followed southwards the false-bedded quartzites pass transgressively across the Torridon Sandstone till they rest directly on the gneiss (A). Only a small exposure of the gneiss is there met with, but it contains one of the basic dykes. (Sheet 101)

The outcrop of the thrust-plane forms a well-marked feature round this inlier, and is seen in dip-section on the north-east shoulder of the ridge, near the caves of Allt nan Uamh, where the Torridon Sandstone rests directly on the Eilean Dubh limestone. The Allt nan Uamh, by carving a deep channel through the underlying calcareous rocks, has isolated the outlier on Beinn an Fhuarain, which is over a mile in length, from the smaller mass on Beinn nan Cnaimhseag on the north side of the stream. (Sheet 101) Along the north margin of the latter outlier the bare thrust-plane of Eilean Dubh dolomite is well displayed. It is inclined to the west at 15°.

In the hollow between Beinn an Fhuarain and Breabag the members of the Middle Series reappear, followed by the quartzites with a westerly dip. On Creag Liath the beds of the lower division (Ca) are exposed on the crest of an arch, and the successive zones of pipe-rock and intercalated sills (F) can be traced in normal order round the fold. The broad dome of Breabag consists of a compound anticline, chiefly composed of thrust zones of the pipe-rock (Cb) and fucoïd-beds (Cc). At one place the *Salterella* grit (Cd) is found on the high plateau. A striking feature of the mountain is the repetition by folds and reversed faults of two intrusive sheets (FF), one in Zone III. of the pipe-rock and the other in Zone V. of that division or in the fucoïd beds. In the pass between Breabag and Sgonnan Mor the highest zone of the pipe-rock is followed by the fucoïd-beds, serpulite-grit, and, at one place, by the basal dolomite, with intrusive sills of hornblendic rocks in both members of the Middle Series (Cc, Cd), these higher sub-divisions being abruptly cut off by the Ben More thrust.

The evidence as to tectonic arrangement furnished by the materials overlying this great plane of disruption on Sgonnan Mor is merely a counterpart, on a smaller scale, of that supplied by Ben More, Assynt. Here a considerable mass of Lewisian gneiss (A) appears with its basic dykes, and with the Torridon Sandstone (Ba) inverted beneath it; the double unconformability of the basal quartzites is displayed, and some of the characteristic intrusive sheets are to be seen on their respective horizons. On the line of section in (Figure 36) an inverted synclinal fold of Torridon Sandstone (Ba) may be observed on the western face of displaced gneiss. This fold is continuous with that on the south-west slope to be referred to in the sequel. (See (Figure 37)) The position of the thrust-plane is here clearly defined, as the rocks are bare of drift and their distinctive lithological characters make them readily distinguishable from each other. Close to the disruption the Lewisian rocks are sheared, but eastwards the pyroxene-gneiss and hornblende-biotite-gneiss are not much deformed. They are traversed by dykes of epidiorite and in one case by a dyke of peridotite with their normal north-west trend. A short distance to the east of the hill-top the lower division of the quartzite (Ca) rests unconformably on the gneiss with an intervening sill of porphyrite (F), and when traced southwards these strata are seen resting upon the Torridon Sandstone on the south-western declivity. The false-bedded quartzites are succeeded by the pipe-rock, which is then cut off by a thrust that has carried westwards a mass of syenite similar to that at Cnoc na Sroine. (Chapter 29) Covering an area of about three square miles, this eruptive rock is bounded along its western margin by a thrust-plane, and passes transgressively across the Lewisian rocks, both divisions of the quartzites, the fucoid beds, and serpulite-grit. On its eastern side near Kinlochailsh it is intrusive in the lower zones of the Calcareous series, which are there converted into marble ( $\lambda$ ), and further north it traverses the fucoid-beds. East of the marble at Kinlochailsh a narrow band of sheared granitoid rock (G) appears below the Moine thrust-plane (T'), which evidently belongs to the same series of intrusions. This great displacement, as in sections already described, here ushers in the enormous series of the Eastern schists (M).

The relations of the eastern continuation of the plutonic mass of Cnoc na Sroine east of Luban Croma to the materials overlying the Ben More thrust-plane are shown in (Figure 37). The valley of the Ledbeg River above the Loyne displays this extensive Igneous intrusion on its south side and the Cambrian quartzites of the Breabag ridge on the north. Where the rocks are not concealed by peat and drift the fucoid-beds, serpulite-grit, and marble rise from underneath the mass of syenite and borolanite (FBo) — as, for example, at Luban Croma, situated about a mile and a half N.N.E. from Aultnacallagach Inn. At that place the members of the Middle Series follow the pipe-rock zones round the anticlinal structures of Breabag. Beyond the syenite east of Luban Croma, sills of borolanite, as already indicated, appear in association with the marble in the small streams draining the south-west slope of Sgonnan Mor towards the Ledbeg River. In one of these streams the sheared granitoid rock (borolanite) below the Ben More thrust-plane and the Torridon grits above that plane may be traced to within a few yards of each other. On the slope the Torridon shales, sandstones, and grits dip eastwards in inverted order beneath the Lewisian gneiss, till the local basal conglomerate of the Torridonian series is seen in contact with its old floor of gneiss. The pebbles in this conglomerate consist mainly of white quartz. This inversion was recognised and described by Dr. Callaway. *Quart. Jour. Geol. Soc.*, vol. xxxix., p, 382.

Further to the south-east, on the south slope of Sgonnan Beag, the position of the Ben More thrust-plane is obscured by peat and drift, but above it a small infold of the basal quartzites has been detected in the Torridon Sandstone, while further east these quartzites rest directly on the Lewisian gneiss, and are followed by the pipe-rock.

East of the undisturbed Cambrian strata north of Càrn Loch (Sheet 101) a belt of extremely complicated ground stretches between Ledbeg Hill and the western base of Cnoc na Sroine. As shown in (Figure 38), the Ben More thrust-plane in a nearly horizontal position extends across that area and carries on its "sole" outliers of displaced materials, which, separated by denudation, rest on various zones of the Cambrian system that have been affected by the movements. This tract is further complicated by the metamorphism of the Cambrian strata by the igneous intrusions already described, while part of the ground is also obscured by peat.

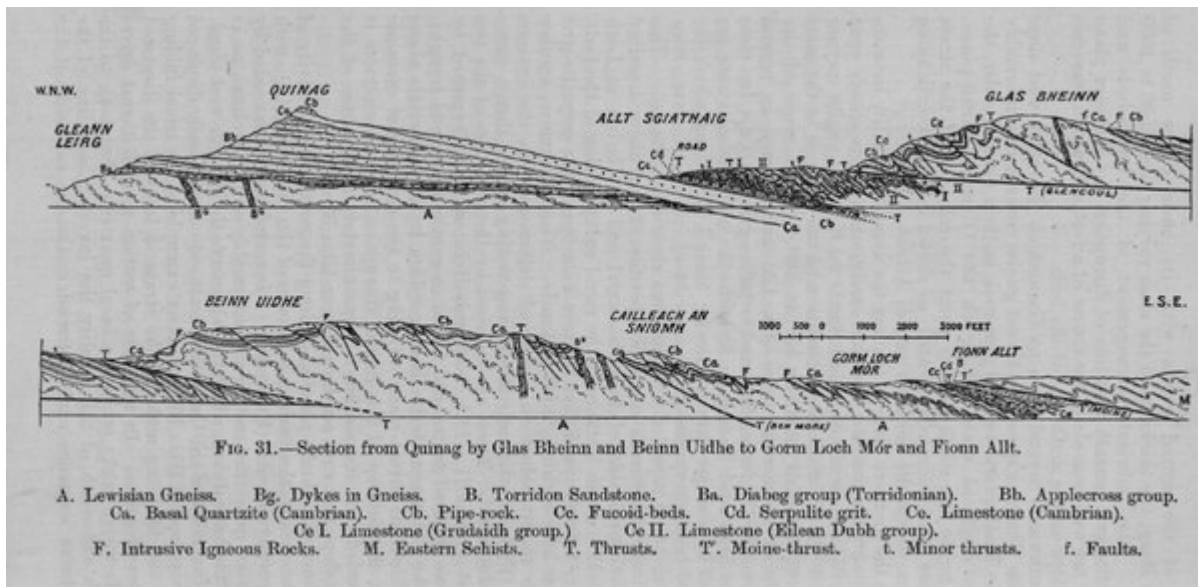
The most westerly outlier which covers the top and southern slope of Ledbeg Hill overlooking Càrn Loch contains a core of Lewisian gneiss (A), with the basal quartzite (Ca) inverted near the thrust-plane, and dipping in normal order on the crest of the hill, followed by the pipe-rock (Cb) in the north-east corner of the displaced materials. Eastwards towards the Ledbeg River the rocks underlying the Ben More thrust-plane consist mainly of altered Cambrian limestone, chiefly of the Eilean Dubh group, pierced by granitic intrusions, while all the outliers above that plane are composed of basal

quartzites, save the most easterly, which includes a portion of the pipe-rock.

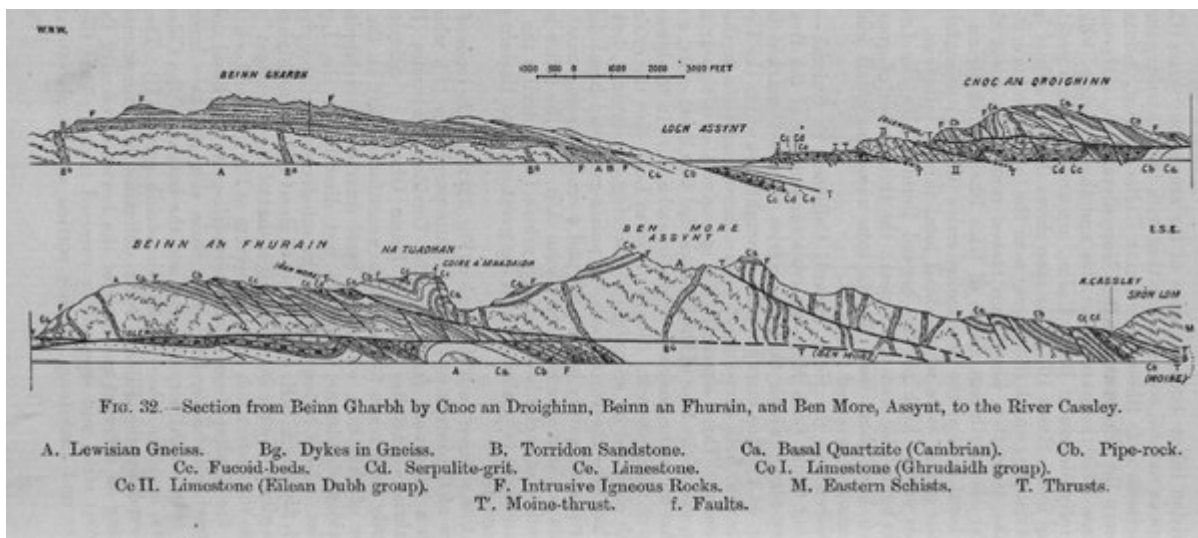
As represented in the section (Figure 38), the plane of the Ben More thrust, which once overlay the large eruptive mass (G), has there been removed by denudation. Its position and the connection of its severed parts are shown by the dotted line above the outline of the ground. At the base of the north-west slope of Cnoc na Sroine the altered Cambrian limestone (A) appears not far from the nepheline syenite (FBo), which stretches eastwards by Allt na Callagach to the plateau west of Cnoc a' Chaoruinn. On the crags near the Allt a Mhullin and in that stream itself the borolanite is well foliated — a feature which may have been produced by the post-Cambrian movements. Various outlying patches of marble (A) occur on the moor between the stream and the outcrop of the Ben More thrust-plane. East of this line of displacement, between the road leading to Kinlochailsh and the top of Cnoc a' Chaoruinn, a constant repetition may be observed of the Cambrian zones from the pipe-rock to the basal dolomite, together with intrusive sills. The reduplication has been caused chiefly by plication, and the strata show increasing deformation as they approach the position of the Moine thrust (T'). Indeed, the alteration of the Cambrian dolomite at this locality and northwards to Loch A ilsh is so conspicuous that Mr. Callaway grouped it with his "Caledonian Series".[Quart. Jour. Geol. Soc., vol. xxxix., p. 410.](#) The last rocks on the right hand of the section (M) are a portion of the great overlying series of Eastern schists.

West of Elphin (Figure 39) the undisturbed strata consist of Lewisian gneiss (A) overlain by the Torridon Sandstone (Applecross group, Bb) with a local basement breccia, covered unconformably by the Cambrian formation, with the zones in normal order from the basal grits (Ca) to the serpulite-grit or *Salterella* quartzite (Cd), and in places the basal dolomite (Ce). At Elphin, close to the road leading to Ullapool, the fucoid-beds and serpulite-grit with occasional lenticles of pipe-rock are truncated by a thrust that has brought forward the piled-up representatives of the *Olenellus* zone. The latter are abruptly cut off by another thrust-plane, along which the Eilean Dubh dolomites and limestones (Ce II.), sometimes altered into marble by injections of borolanite and repeated by minor thrusts, have been driven for a distance of two miles. Throughout this tract the strata dip persistently eastwards at high angles. At Am Pollan these displaced limestones are capped by an outlier of the materials that lie upon the "sole" of the Ben More thrust, consisting of Lewisian rocks covered unconformably by the Torridon Sandstone (Bb) and basal quartzites (Ca), the latter resting unconformably on both. The westward extension of this gently- undulating dislocation and the isolation of denuded outliers of the rocks displaced by it are shown in (Figure 39) as in (Figure 38). Along their southern margin the Torridon Sandstone and basal quartzites are truncated by the Moine thrust, which, as will be mentioned below, skirts the base of the Cromalt Hills. Further east the strata are mainly composed of piled-up Eilean Dubh dolomites, marmorised in places, which, at the base of the west slope of Cnoc na Glas Choille, are overlapped by the Cambrian strata above the main outcrop of the Ben More thrust-plane. In the core of a sharp inverted arch the Lewisian gneiss is exposed by the denudation of the basal quartzites (Ca). In addition to the latter, all the Cambrian zones up to the horizon of the basement dolomite, together with several intrusive sills, have been driven westwards along this disruption plane, and have been arranged in isoclinal folds dipping eastwards at comparatively low angles. Here again a marked gradation can be traced in the metamorphism of the Cambrian sediments and the igneous sheets as they are followed eastwards to Allt Ealag; where the quartzose flagstones or Eastern schists (M) appear above the Moine thrust-plane.

At the Knockan crag, about two miles south of the village of Elphin, conclusive evidence is afforded of the remarkable overlap of the Moine thrust-plane, to which attention has already been directed. From the base of the Stack of Glencoul the course of this remarkable disruption is generally southwards by Kinlochailsh to the River Oykeell and Allt Ealag, where the trend is S.S.W. It then runs west for a distance of six miles along the base of the north slope of the Cromalt Hills to the cliff about one mile S.S.W. of Knockan, passing transgressively across the Ben More thrust-plane and all underlying displaced materials till the quartzose flagstones rest directly on the undisturbed Cambrian strata (Sheet 101).

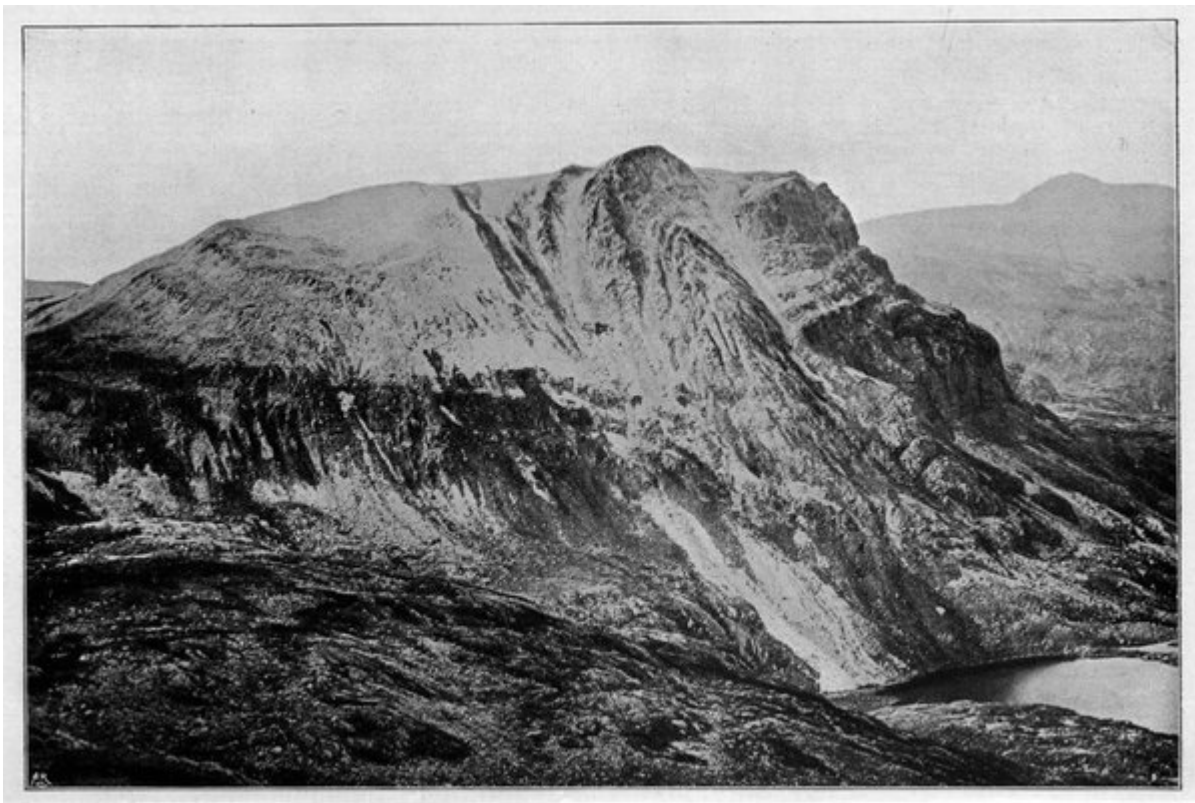


(Figure 31) Section from Quinag by Glas Bheinn and Beinn Uidhe to Gorm Loch Mar and Fionn Allt. A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. B. Torridon Sandstone. Ba. Diabeg group (Torridonian). Bb. Applecross group. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoïd-beds. Cd. Serpulite grit. Ce. Limestone (Cambrian). Ce I. Limestone (Grudaidh group.) Ce II. Limestone (Eilean Dubh group). F. Intrusive Igneous Rocks. M. Eastern Schists. T. Thrusts. T'. Moine-thrust. t. Minor thrusts. f. Faults.

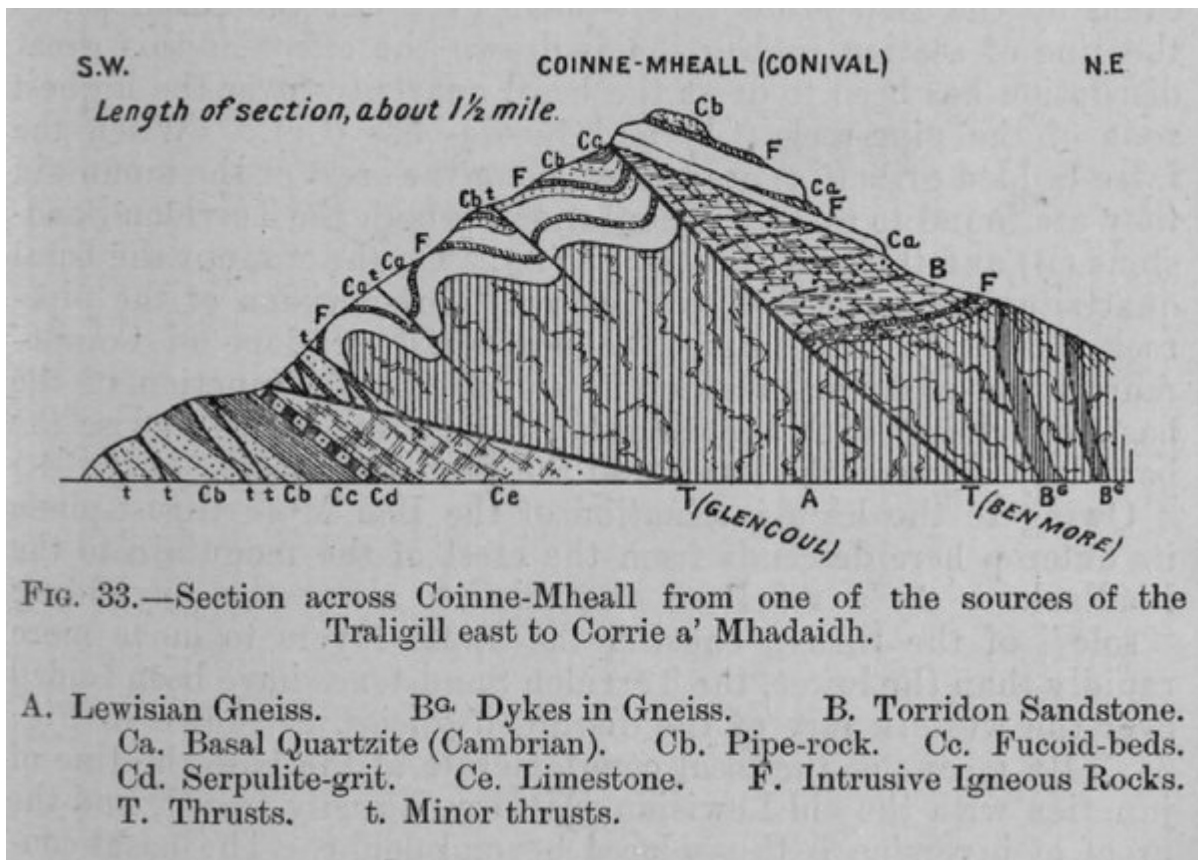


(Figure 32) Section from Beinn Gharbh by Cnoc an Droighinn, Beinn an Fhurain, and Ben More, Assynt, to the River Cassley. A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. B. Torridon Sandstone. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoïd-beds. Cd. Serpulite-grit. Ce. Limestone. Ce I. Limestone (Ghrudaidh group). Ce II. Limestone (Eilean Dubh group). F. Intrusive Igneous Rocks. M. Eastern Schists. T. Thrusts. T'. Moine-thrust. f. Faults.





(Plate 34) Overfolding of Cambrian quartzites above Ben More thrust-plane; Na Tuadhan, north of Ben More, Assynt, Sutherlandshire.



(Figure 33) Section across Coinne-Mheall from one of the sources of the Traligill east to Corrie a' Mhadaidh. A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. B. Torridon Sandstone. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoïd-beds. Cd. Serpulite-grit. Ce. Limestone. F. Intrusive Igneous Rocks. T. Thrusts. t. Minor thrusts.

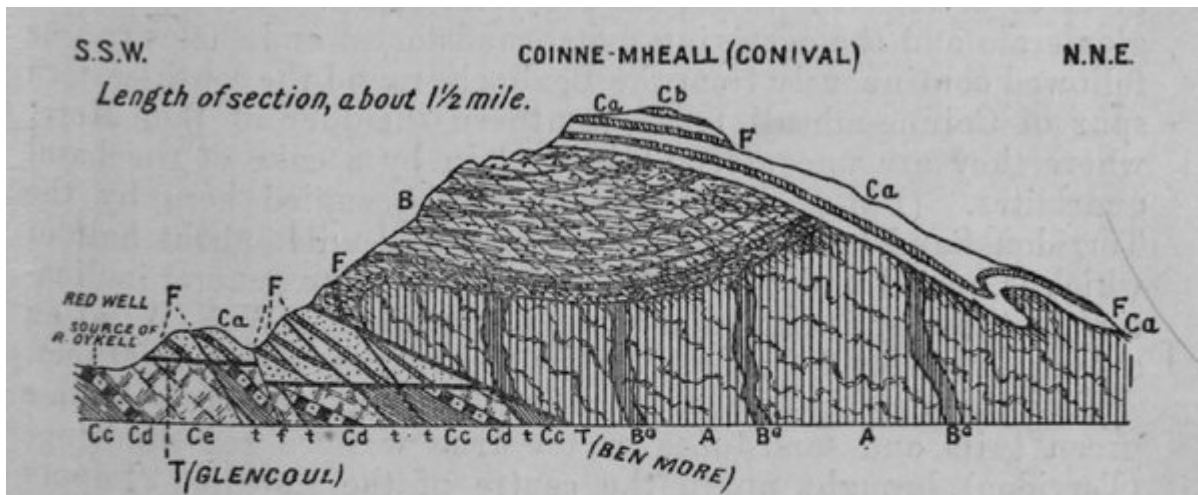
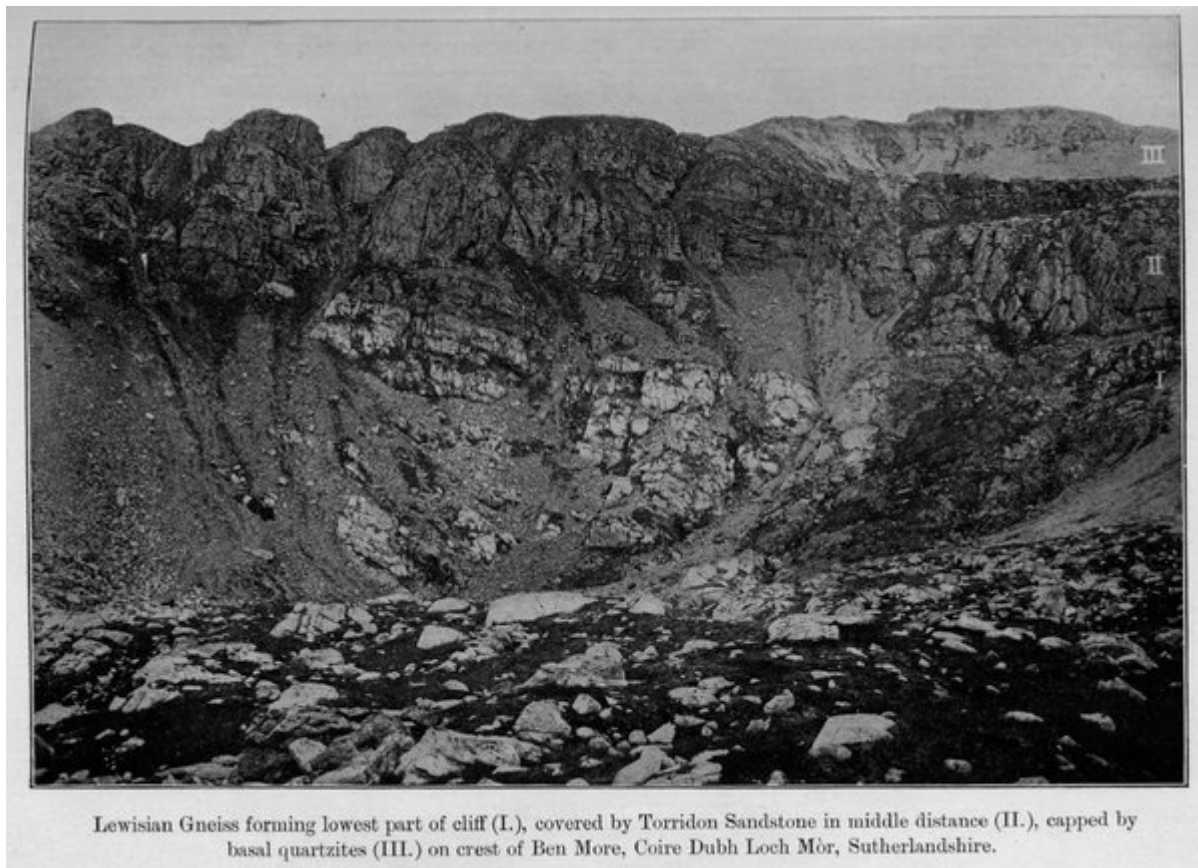


FIG. 34.—Section from the Bheallach across Coinne-Mheall to Corrie a Mhadaidh.

A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. B. Torridon Sandstone.  
 Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Furoid-beds.  
 Cd. Serpulite-grit. Ce. Limestone. F. Intrusive Igneous Rocks.  
 T. Thrusts. t. Minor thrusts. f. Faults.

(Figure 34) Section from the Bheallach across Coinne-Mheall to Corrie a Mhadaidh. A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. B. Torridon Sandstone. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Furoid-beds. Cd. Serpulite-grit. Ce. Limestone. F. Intrusive Igneous Rocks. T. Thrusts. t. Minor thrusts. f. Faults.



Lewisian Gneiss forming lowest part of cliff (I.), covered by Torridon Sandstone in middle distance (II.), capped by basal quartzites (III.) on crest of Ben More, Coire Dubh Loch Mòr, Sutherlandshire.

(Plate 35) Lewisian gneiss forming lowest part of cliff (I.), covered by Torridon sandstone in middle distance (II.), capped by basal quartzites (III.), on crest of Ben More, Coire Dubh Loch Mòr., Sutherlandshire. B34

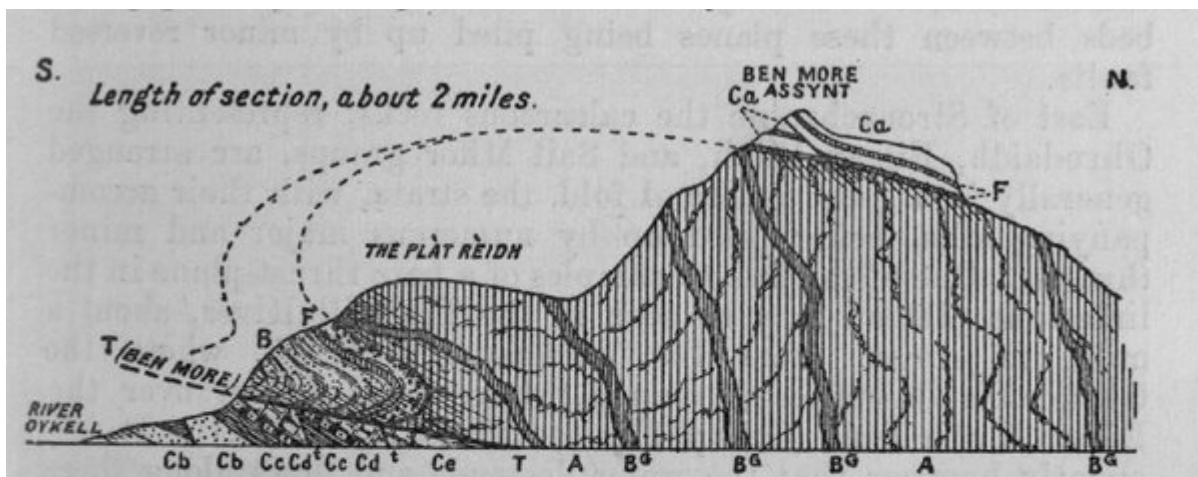
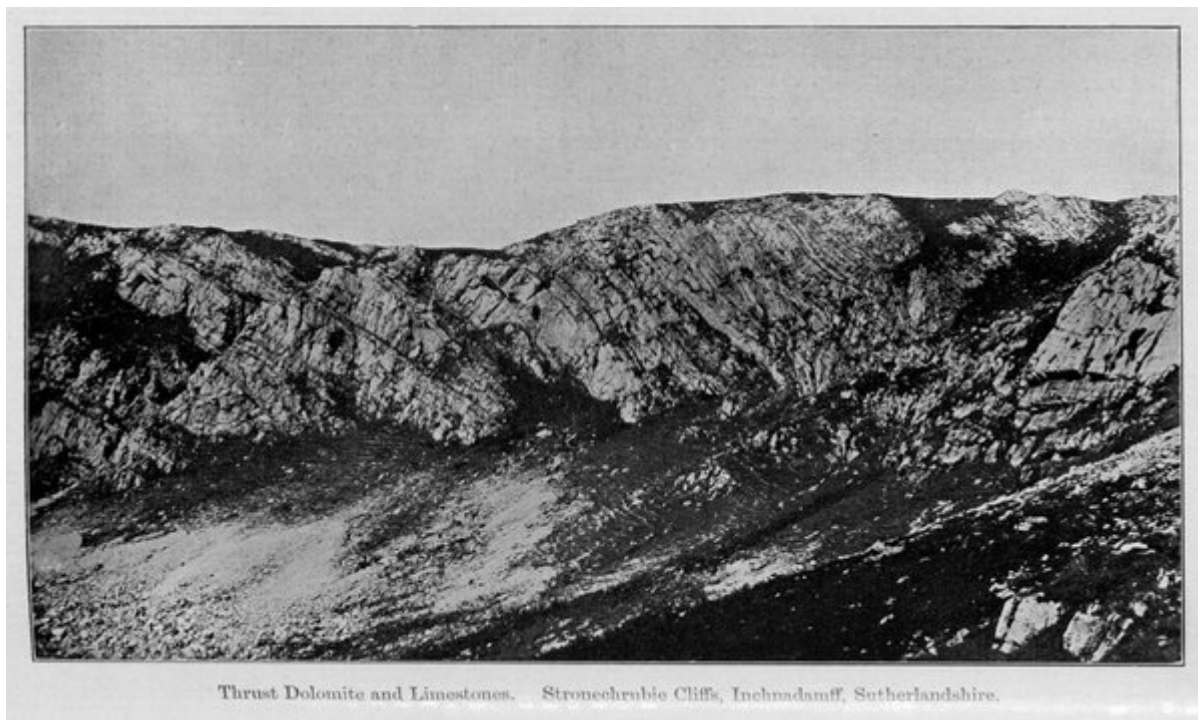


FIG. 35.—Section from the Oyke Valley across the Plat Reidh and Ben More, Assynt.

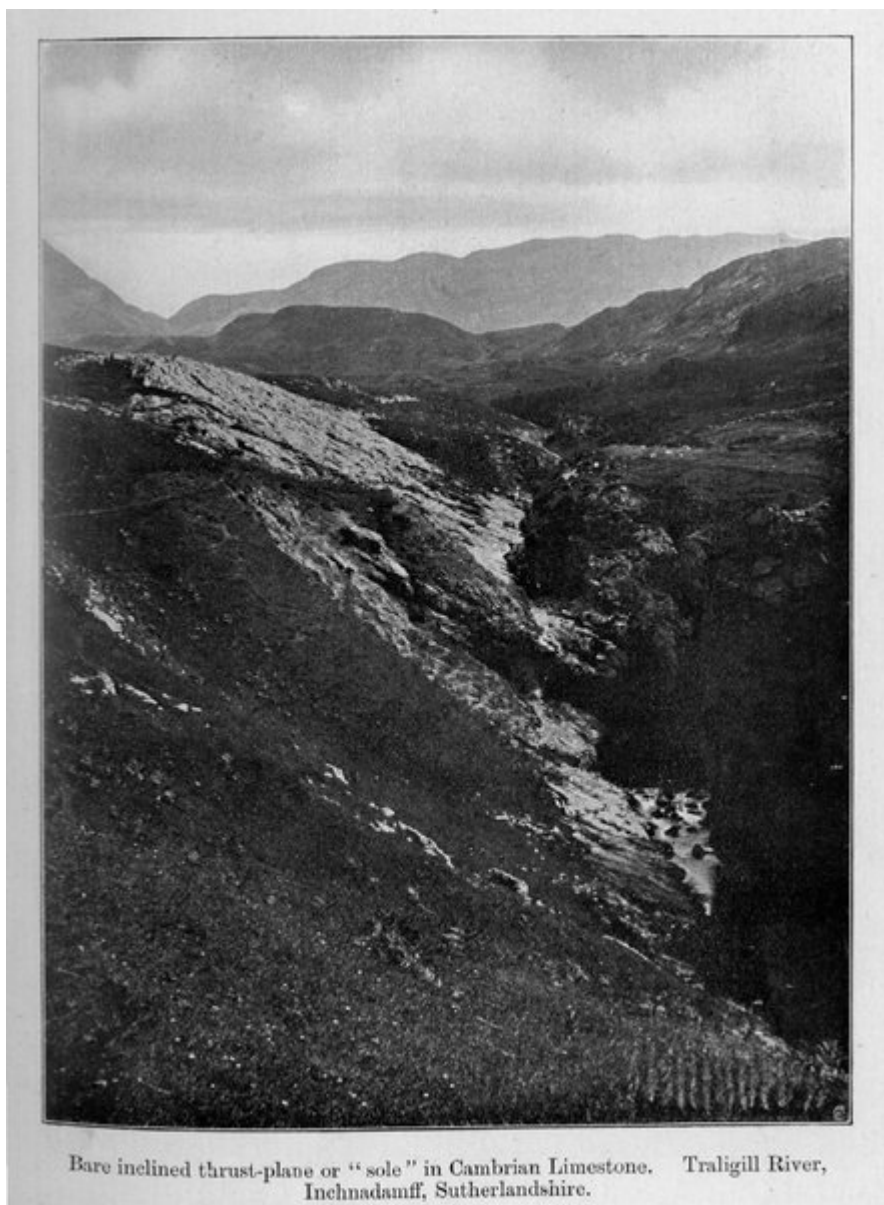
- A. Lewisian Gneiss.      B<sup>G</sup>. Dykes in Gneiss.      B. Torridon Sandstone.  
 Ca. Basal Quartzite (Cambrian).      Cb. Pipe-rock.      Cc. Fucoid-beds.  
 Cd. Serpulite-grit.      Ce. Limestone.      F. Intrusive Igneous Rocks.  
 T. Ben More thrust.      t. Minor thrusts.

(Figure 35) Section from the Oyke Valley across the Plat Reidh and Ben More, Assynt. A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. B. Torridon Sandstone. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoid-beds. Cd. Serpulite-grit. Ce. Limestone. F. Intrusive Igneous Rocks. T. Ben More thrust. t. Minor thrusts.



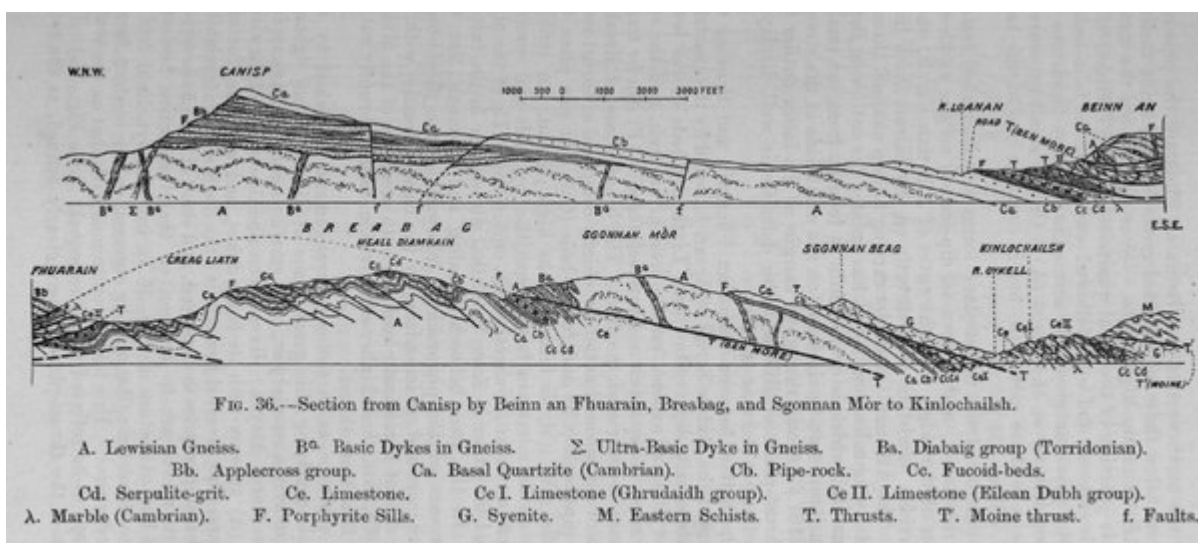
Thrust Dolomite and Limestones. Stronechrubie Cliffs, Inchnadamff, Sutherlandshire.

(Plate 36) Thrust dolomite and limestones, Stronechrubie Cliffs, Inchnadamff, Sutherlandshire B36

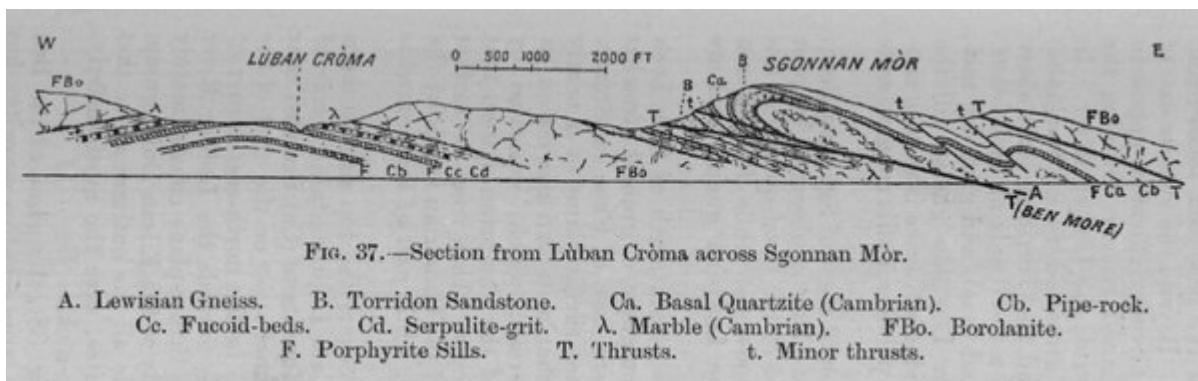


Bare inclined thrust-plane or "sole" in Cambrian Limestone. Traligill River, Inchnadamff, Sutherlandshire.

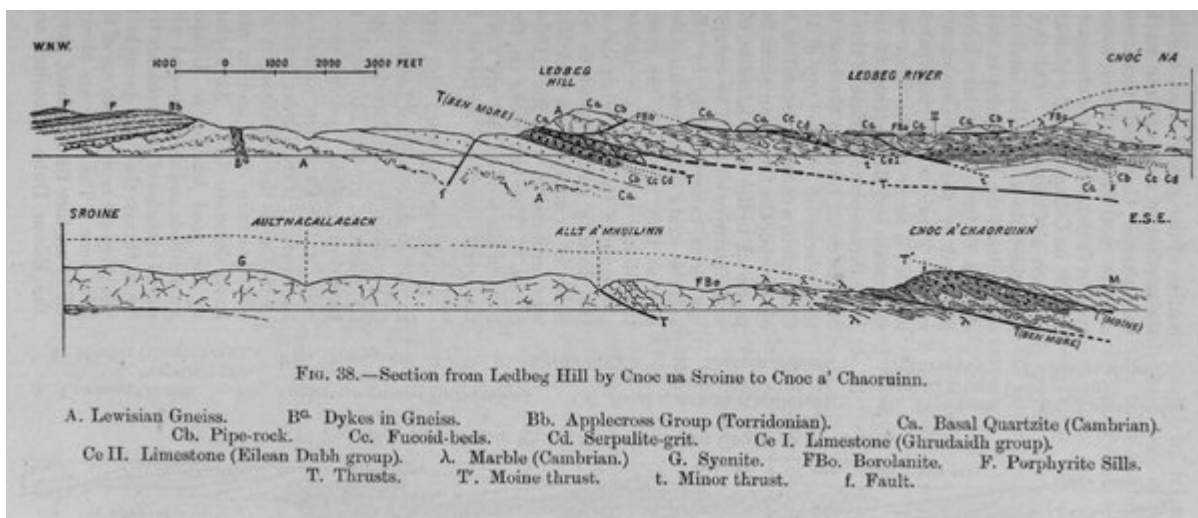
(Plate 37) Bare inclined thrust-plane or "sole" in Cambrian limestone; Traligill River, Inchnadamff, Sutherlandshire.



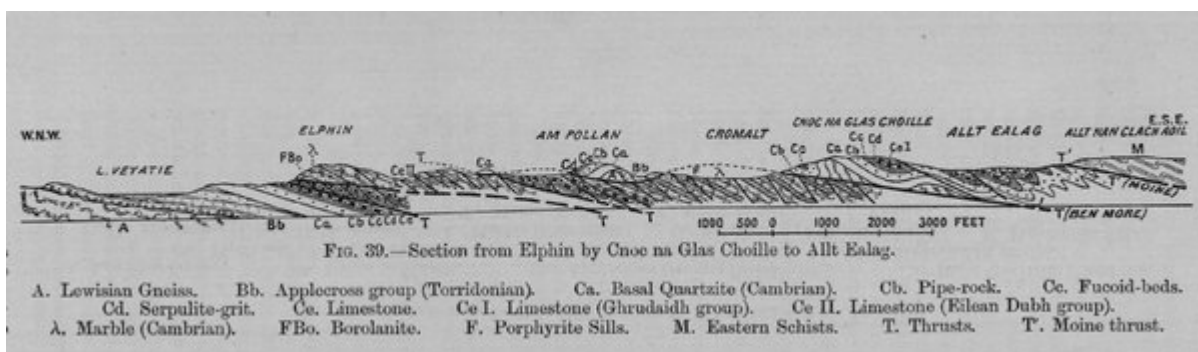
(Figure 36) Section from Canisp by Beinn an Fhuarain, Breabag, and Sgonnan Mòr. to Kinlochailsh. A. Lewisian Gneiss. Σ. Basic Dykes in Gneiss. E. Ultra-Basic Dyke in Gneiss. Ba. Diabaig group (Torridonian). Bb. Applecross group. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoid-beds. Ce I. Limestone (Ghrudaidh group). Ce II. Limestone (Eilean Dubh group). G. Syenite. M. Eastern Schists. T. Thrusts. T'. Moine thrust. f. Faults Cd. Serpulite-grit. Ce. Limestone. λ. Marble (Cambrian). F. Porphyrite Sills.



(Figure 37) Section from Lùban Cròma across Sgonnan Mòr. A. Lewisian Gneiss. B. Torridon Sandstone. Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoid-beds. Cd. Serpulite-grit. λ. Marble (Cambrian). FBo. Borolanite. F. Porphyrite Sills. T. Thrusts. t. Minor thrusts.



(Figure 38) Section from Ledbeg Hill by Cnoc na Sroine to Cnoc a' Chaoruinn. A. Lewisian Gneiss. B<sup>G</sup>. Dykes in Gneiss. Bb. Applecross Group (Torridonian). Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoid-beds. Cd. Serpulite-grit. Ce I. Limestone (Ghrudaidh group). Ce II. Limestone (Eilean Dubh group). λ. Marble (Cambrian.) G. Syenite. FBo. Borolanite. F. Porphyrite Sills. T. Thrusts. T'. Moine thrust. t. Minor thrust. f. Fault.



(Figure 39) Section from Elphin by Cnoc na Glas Choille to Allt Ealag. A. Lewisian Gneiss. Bb. Applecross group (Torridonian). Ca. Basal Quartzite (Cambrian). Cb. Pipe-rock. Cc. Fucoid-beds. Cd. Serpulite-grit. Ce. Limestone. Ce I. Limestone (Ghrudaidh group). Ce II. Limestone (Eilean Dubh group). λ. Marble (Cambrian). FBo. Borolanite. F. Porphyrite Sills. M. Eastern Schists. T. Thrusts. T'. Moine thrust.