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## Chapter 25 Cambrian Strata from Loch More to Strath Banaird

The district described in this chapter is represented in Sheets 101, 102, 107, 108 of the Geological Survey Map of Scotland, on the scale of 1 inch to a mile (1:63360).

### 1 Loch More and Glencoul District

By C. T. Clough.

Between Loch More and Loch Glencoul the Quartzite forms in most places a rather prominent crag with a general N.N.E. strike, its lower beds dipping to south-east or E.S.E. at angles between 8° and 14°. The base is generally concealed under drift, but it is probably not much affected by thrusts. The false-bedded quartzite forms most of the crag, and, excepting for about a mile and a quarter on the north side of Loch an Leathaid Bhuain, its outcrop is rarely more than 150 yards in breadth. The piped quartzite makes a much broader outcrop, partly because of the more gentle slope of the ground which it occupies, and partly because of the folds and thrusts which affect it. On the north side of Loch an Leathaid Bhuain the outcrop of the piped quartzite is unusually wide, often more than three-quarters of a mile. In the eastern half of this tract the dip is very variable; there are some sharp folds with axes striking N.N.E., and probably several thrusts also.

On the north-west side of the Loch More crag a small outlier of quartzite rests unconformably on the Lewisian gneiss of Ben Stack. The outlier has its north-western end 70 or 80 yards south-east from the top of the hill, and extends for 300 yards in a south-easterly direction. It is not more than 116 yards broad in its widest part, and does not contain more than a thickness of about 50 feet of beds. The general dip is here much the same as in the Loch More crag.

On the east side of the Loch More–Loch Glencoul band of quartzite many portions of the same strata have been separated from it by thrusts, usually with considerable intervening breadths of gneiss. In these detached exposures, wherever the unconformable base of the quartzite can be seen, it rests on rocks belonging to the Lewisian gneiss series, as in the unthrust area to the north-west.

The thrust quartzite which runs E.S.E. from near the middle of the south side of Loch na Creige Duibhe, can be traced for more than a mile, and in this space it does not show much disturbance or alteration. South-west of Beinn Lice another exposure of thrust quartzite, more than a mile in length and breadth, rises up in a dome from beneath the fucoid-shales, and reveals in its centre a small inlier of gneiss.

Some of the masses of quartzite which have been brought forward by the higher thrusts have been considerably reduced in thickness by the movement. Thus the dragging out and thinning to which the piped quartzite has been subjected is well shown by the bending and deformation of its pipes. In the undisturbed ground the pipes are always perpendicular to the bedding planes, but in the thrust area they are often diagonal. The deformation has evidently been greatest in the thin-bedded bands and those which contain a certain admixture of shaly material.

### Basal Conglomerate

At each end of the quartzite outlier on Ben Stack a basal conglomerate, at least 18 inches thick, may be observed, in which the larger pebbles, two or three inches long, consist chiefly of red and white quartz, like vein-quartz, and a jasper-like rock. The jasper-like pebbles resemble some of those in the Torridon rocks. Above the conglomerate comes a soft, fine-grained, rather shaly band, which, in the blocks along the outcrop, generally adheres closely to it. The gneiss 180 yards north-west from the outlier contains a pegmatite with a little agalmatolite — a common indication of the proximity of a pre-Cambrian surface. Between Loch More and Loch an Leathaid Bhuain the base of the quartzite is always hidden by drift, but about a mile slightly north of east of Loch Poll an Achaidh Bhuidhe many loose blocks of conglomerate, resembling that on Ben Stack, probably indicate the approximate position of the base of the quartzite.

The basal conglomerate is seen on the north side of Beinn a' Bhùtha (north-east of Loch Glendhu), little more than half a mile north of the hill top; also at the north end of the gneiss inlier a third of a mile west of Lochain nan Ealachan (south of Loch More), where it shows a reversed dip, with pebbles of quartz two or three inches long; about 1100 yards E.S.E. of the foot of Loch Strath nan Asinnteach, where it is well exposed, and is repeated several times by small thrusts. In the gneiss below the quartzite half a mile north-east of the top of Beinn Aird da Loch (between Lochs Glendhu and Glencoul), a pegmatite with the felspar converted into agalmatolite, affords an indication of a pre-Cambrian floor, from which the Cambrian strata have been removed. In the Glencoul River, half a mile slightly west of north of Loch nam Caorach, the basal conglomerate is in some places only an inch thick. A thin basal conglomerate is also seen nearly half a mile south, about 700 yards S.S.E., and three-quarters of a mile S.S.E. of the south end of this loch.

### **False-bedded Quartzite**

The false-bedded quartzite rather more than a quarter of a mile west of Glendhu House shows some shaly partings, probably near the base. This sub-division like-wise appears on the scars on the north side of Loch Glencoul, where the uppermost bed is much redder than those below it, is more conspicuously false-bedded, and occasionally presents the tops of small pipes on its bedding planes. The same sub-division of the quartzite appears in the thrust areas near Lochain Feith an Leathaid, where its thickness is estimated to be about 150 feet.

### **Piped Quartzite**

The piped quartzite between Loch More and Loch Glencoul having been mapped before the zones in the arenaceous series were definitely established, we cannot say whether the zones in this area always agree exactly with those determined elsewhere. In the scars on the north side of Loch Glencoul, about 50 feet above the base of the piped quartzite, are various bands of rather coarse-grained purple piped rock in which the pipes are generally less deeply coloured than the rock at their sides. In most places the purple bands are parallel to the bedding surfaces, but this is not always so, and it is probable that the colour of some parts is due to staining. Bands of a purple tint occur in some places as far down as the base of the piped rock, and even into the top beds of the false-bedded quartzite. The quartzite scar owes its reddish appearance in the landscape partly, perhaps, to these bands, but chiefly to haematite staining on the joint faces and in crush breccias. The base of the trumpet zone is about 80 feet above the bottom of the piped rock. Above this zone comes, first, a rather massive bed which shows no distinct pipes, and which weathers with a dirty yellow colour; then an alternation of thin red and white piped bands — the sub-zone 4 — followed by massive white and pale-pink piped rock, up to the top band, which consists of thin red and purple beds of rather coarse grain, and is between eight and twelve feet thick. The highest band is crowded with pipes, and contains a few thin shaly beds rather like parts of the fucoid shale.

Near the north-east corner of Loch na Creige Duibhe (two miles north of Glendhu) the piped quartzite includes some reddish purple seams, which are sometimes curved and twisted, though the general bedding planes are even. The colour, which may be due to staining, only occurs on certain horizons.

A little south of Lochain Feith an Leathaid (east of Glencoul) most of the pipes near the base of the pipe-rock are, as usual, of much smaller diameter than those higher up, but within the small pipe zone, about 12 feet from the base, some layers enclose broader pipes. For 80 feet above the bottom the piped quartzite is generally of a massive character, and either white or pale-pink in colour. This portion is succeeded by a few thin beds, not more than two feet in thickness altogether, of a red or purple colour, but with paler or almost white pipes, and then comes the trumpet-zone.

Three-quarters of a mile south of Lochan nan Caorach (southeast of Loch Glencoul) a band of thin-bedded purple and blue Pipe-rock lies 40 or 50 feet above the base of the pipe-rock. It comes below the trumpet-pipe zone, from which it is separated by a white compact massive piped rock. The section at the top of the quartzite is here as follows, beginning at the top:

Horizon with some shaly beds, but with distinct pipes, 6–10 feet. Massive white or pale-pink piped rock, with some thin blue and purple bands, 30–40 feet.

Thin-bedded, reddish-purple rock with paler pipes (sub-zone 4) The Trumpet zone.

## **Furoid Shales**

Between Loch More and Loch na Creige Duibhe, only one exposure of furoid shale has not been moved forward by thrusts. It lies about half a mile W.S.W. of Lochmore Lodge, and makes a little scar overlooking the quartzite and continuing distinct for a length of 300 yards or more. It is 50 yards broad, but it may not include the top beds, for a thrust comes in on its southern side before any serpulite grit is seen. Between Loch na Creige Duibhe and Glencoul a continuous outcrop of unthrust furoid shale may possibly overlie the quartzite, but in most places the ground where the shale should be is covered with drift. The same zone is to be seen about 1500 yards east of the foot of Loch an Leathaid Bhuain, and in the burn 220 yards north of Glendhu House. At both these places the full thickness of the shale is probably represented, with the serpulite grit lying naturally over it. In the coast-section nearly a third of a mile north-west of Glencoul House, some furoid shale lies above the quartzite, and below the lowest of the great thrusts — the "sole", which carries the piled-up stripes of furoid shales, serpulite grit, and limestone.

This sub-division of the Cambrian series probably extends over considerable areas in many parts of the thrust region, but most of this ground is largely obscured, owing presumably to the softness of the shales and their tendency to form low ground. The best sections are to be seen on the coast and in the islands near Glencoul, but they are much confused with small thrusts, and the shales are crossed by a conspicuous cleavage. Perhaps the best inland exposures are those which occur about 700 yards northeast of the head of Loch na Creige Duibhe, rather more than a mile south-east of the head of Loch Glendhu, and south-east of Loch nan Caorach. In the last locality the area which is probably occupied by the shales has a length of more than two-thirds of a mile, and in one place a breadth of 300 yards. In several places among the thrust shales about half a mile south-east of Lochmore Lodge, and in the islands near Glencoul, thin bands of compact cream-coloured limestone make their appearance, weathering with a rusty surface, and differing in character from any part of the Ghrudaidh limestone. They are not, probably, to be regarded as wedges of this limestone pushed in along thrusts.

## **Serpulite Grit**

Between Loch More and Glencoul only two exposures of this sub-division appear to occur in an unthrust condition, the one about three-quarters of a mile slightly south of east of the mouth of Loch na Leathaid Bhuain, the other in a little burn 270 yards north of Glendhu House.

Good exposures of the thrust grit may be seen on the south-east side of Lochmore Lodge, on the north side of Loch na Creige Duibhe, on the south and south-east sides of Beinn a' Ghrianain, on the south-east side of Loch na Caorach, and close to Glencoul House. Remains of the serpulites have not been met with in so many places as might have been expected. They are very distinct in the grit 1100 yards E.N.E. of the top of Beinn a' Bhutha, and three-quarters of a mile slightly north of west of the top of Beinn Lice, south side of Loch More.

## **Calcareous Series**

Between Loch More and Glencoul no portion of the Durness Limestone appears in an unthrust condition, and the different outcrops of this series are either much disturbed or else to a large extent hidden under drift. Probably by far the largest outcrop occurs in the valley<sup><ref>Called Strath nan Caran in the six-inch maps.</ref></sup> at the head of Loch na Creige Duibhe. For a mile and a quarter above the loch the limestone may average a third of a mile in width. It continues in a narrower band under Beinn Lice, and further south it appears to expand and to attain again perhaps in one place a width of a third of a mile. In the valley referred to, many swallow holes, generally opening to the surface through drift, indicate the position of the calcareous series below. The bare limestone is almost confined to the loch side or to the banks of the burn a little above the loch.

In the valley above Loch na Creige Duibhe several different zones of the Ghrudaidh limestone may be discerned, including some oolitic bands, a dark-grey brecciated band, and a black massive limestone with worm ejecta; but the exposures are not clear enough to show the thicknesses or relations of the different zones. Rather more than a third of a

mile S.S.E. of the mouth of the burn at the head of the loch, and also on the hill 1100 yards E.N.E. of the loch, the oolitic structure is partially preserved in chert.

In this area the Eilean Dubh limestone is only known on the hill E.N.E. of Loch na Creige Duibhe and in the outcrop which extends south-east from the head of this loch. In the valley above the loch, and also near Beinn Lice, the boundaries between the Ghrudaidh and the Eilean Dubh limestone are much obscured by drift, but we suppose that the latter limestone probably extends all the way from the loch to rather more than a mile south of the top of Beinn Lice. There are also some small detached pieces of it near the loch side. About 300 yards south of the mouth of the burn at the head of Loch na Creige Duibhe, the limestone contains some thin white chert bands.

## 2 Assynt

The first three paragraphs of this section are by L. W. Hinxman; the rest are by B. N. Peach and J. Horne.

The two members of the arenaceous series are well displayed on the eastern slopes of Quinaig. The summit of Spidean Coinich is capped with nearly 300 feet of quartzite, including the whole of the basal zone and the two lower sub-zones of the pipe-rock. A small outlier of the basal beds likewise caps the highest peak, south of Sail Gharbh. From Spidean Coinich long glaciated dip-slopes of pipe-rock, dipping east by south at 12°–15°, descend to the Allt Sgiathaig.

The unconformable junction with the underlying Torridonian series is well seen on the summit, along the flank of Creag Mhor, and on the west side of Druim na h'Uamha Moire. The base of the quartzite is usually a thin bed of conglomerate, containing pebbles of quartz and felspar half an inch to an inch and a half in length. The conglomerate is succeeded by coarse pinkish false-bedded grit, with two or three thin bands of green micaceous sandy shale. The outcrop of the basal quartzite crosses the Kylesku road one-third of a mile north-west of Loch na Gainmhich, and, creeping gradually over the Torridonian strata under Cnoc Coir' a Bhaic, overlaps on to the gneiss half a mile from the shore of Loch Glencoul. Sub-zones (1–4) of the pipe-rock are exposed in the deep gorge cut by the stream flowing out of Loch na Gainmhich; and a good section of the flaggy and often ripple-marked beds of sub-zone (3), with very large pipes, is seen along the Allt Sgiathaig, near Lochan Feoir.

The Cambrian rocks are again seen resting unconformably on the Lewisian gneiss further south between Loch nam Meallan Liatha and the foot of Canisp. A small inlier of gneiss has been exposed by denudation in the lower part of a small burn which falls into the Loanan nearly opposite Stronechrubie. The quartzite covers the summit of Canisp, and extends eastwards to the River Loanan and Loch Awe, and southwards to Cama Loch. Its strata are inclined to E.S.E., at angles varying from 16°–18° on the top of Canisp to 6°–12° on the lower slopes. The general easterly inclination of these slopes nearly coincides in amount with that of the dip of the beds, so that as we descend the hillsides toward the Loanan we pass, as the form of the ground varies, alternately from pipe-rock to basal quartzite. The irregular arrangement of the outcrops is further complicated by the occurrence of numerous normal faults, and by the sills of Canisp porphyry, which are intruded at different horizons in the quartzite along the slopes of Leathad Lionach.

In the undisturbed area between Loch Glencoul and Loch Assynt, the fucoïd-beds follow the pipe-rock in natural sequence, but over the greater part of this distance only the lower portion of the zone lies to the west of the first line of displacement. On the north shore of Loch Assynt, however, and in the ground immediately to the north thereof, the most westerly thrust appears in the lowest group of dolomites (Ghrudaidh group), and at these localities there are excellent sections of all the sub-divisions of the Middle Series, including the bands that yield the *Olenellus* fauna. These appear to the east and northeast of the mouth of Skiag Burn (Allt Sgiathaig on Sheet 107), about two miles N.N.W. of Inchnadamff Hotel, where the fucoïd-beds and serpulite-grit are laid bare on the shore of the loch, and form prominent escarpments on the adjoining slope. The thickness of the former zone is there 42 feet 8 inches, and that of the latter 29 feet 8 inches.

On the slope about 200 yards N.N.E. of Skiag Bridge, A. Macconochie found a thin seam crowded with fragments of *Olenellus*, the position of which is shown in the subjoined section.

feet

inches

8. Serpulite grit with abundant examples of <i>Salterella</i>		
7. Blue shale with small pipes	2	9
6. Soft cream-coloured shale with numerous fragments of <i>Olenellus</i> , particularly of <i>O. Lapworthi</i>	0	3
5. Well-bedded sandy dolomitic bands with flattened wormcasts	4	0
4. Finely-bedded blue shale with <i>Hyoitithes</i>	1	6
3. Irregularly-bedded dolomitic bands	3	0
2. Blue shale	5	0
1. Massive Furoid beds at the base.		

Following this outcrop southward to the margin of the lake, the observer there finds the soft shale, charged with fragments of *Olenellus*, about three feet from the base of the serpulite-grit. It is interesting to note that the position of this important sub-zone at Loch Assynt closely corresponds with its horizon at An t-Sron, on the east shore of Loch Eireboll, and differs to some extent from that in the typical section south of Kinlochewe in Ross-shire (pp. 394 and 414).

The overlying serpulite-grit, which forms a small area on both sides of the road east of Skiag Bridge, is there divisible into two portions — an upper bed with carious layers, crowded with *Salterella Maccullochi*, and a lower one in which that organism occurs sporadically, sometimes as dark solid bodies, and again as hollow casts. The worm burrows are also typically represented, in some instances in the solid form, and in others they are dissolved out, thus giving the rock the appearance of a log of wood bored with teredos. Next in order come the basal beds of the lowest group of dolomites and limestones (Ghrudaidh), comprising the calcareous shales and both bands of dolomite containing *Salterella*, the upper one being 30 feet above the serpulite-grit. A few yards to the east the section is interrupted by the first reversed fault.

For some distance south of Loch Assynt the Furoid-beds are not visible in the undisturbed area, being concealed by drift and alluvium, but beyond Stronechrubie, between Allt nan Uamh and Elphin, they appear at intervals overlain by the serpulite-grit and occasionally by a patch of the basal limestone, all in natural sequence.

In the sequel (Part 4), detailed descriptions are given of the extraordinary reduplication of the members of this system in the area affected by the post-Cambrian movements. Within that area, the double unconformability of the quartzite on the lorrison Sandstone and Lewisian gneiss can still be detected on Ben More, on Sgonnan Mor north of Loch Ailsh, and again on Beinn an Fhuarain, about three miles south of Inchnadamff Hotel. Both divisions of the arenaceous series are largely represented on the lofty ridge that extends from Glas Bheinn by Beinn Uidhe to Ben More, and southwards by Braebag to the sources of the Ledbeg River at Luban Croma. On the east side of that watershed they are traceable from Gorm Loch Mor southwards to near Kinlochailsh, where they display in a marked degree the effects of post-Cambrian movements. South of the mountainous region of Assynt, outliers of quartzite, sometimes with a core of thrust Lewisian gneiss, are found at various localities — as, for instance, one mile south of Elphin, between Cama Loch and Loch Ilrigill, on the moor one and a half miles south of the latter lake, and on Cnoc Glas Choille and Cnoc a' Chaoruinn, about five and six miles respectively south-east of Elphin.

In Assynt, where the five sub-zones of the pipe-rock were first detected, measurements of their thicknesses were taken, and are given below in descending order:

4	Flaggy quartzites with pink and white seams, the pipes usually of a different colour from the matrix; the lower beds varying from 2 to 6 inches in thickness	48 feet
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3	Massive fine-grained white quartzite with 1 rusty surface, probably on the horizon of the <i>Salterella</i> band on Beinn Arcuil	15 feet
3	Flaggy quartzites, sometimes false-bedded, with certain bands containing large pipes 1 3 or 4 inches across, and passing downwards into white pipe-rock	75 feet
2	Massive quartzite in bands from 1 to 3 feet thick, with small pipes about ½-inch in diameter	74 feet
1	Massive white saccharoidal quartzite beds, averaging from 3 to 4 feet in thickness, with small pipes about one-eighth-inch in diameter	27 feet
		275 feet

It is worthy of note that the lithological character of the strata forming the highest sub-zone of the pipe-rock in Assynt differs considerably from that in the Eireboll region. In Assynt the prominent feature is a coarse friable quartzose grit with vertical pipes, while at Eireboll the rock is hard compact quartzite, becoming flaggy towards the top, with bands of rusty shale.

Throughout the thrust area in Assynt the members of the Middle Series have a wide distribution, to which only a brief allusion can here be made. They cover broad areas in the hollow along Allt Sgiathaig, south-east of Quinag, and on the crest of Beinn an Fhurain (two and a half miles east of Inchnadamff).

They extend up the valley of the Traligill, and form narrow strips along the crest and western slopes of Breabag. Far to the east they appear at Loch Ailsh, and on the western slopes of Cnoc a' Chaoruinn, and to the south on the peaty moorland north-west and south-east of Loch Urigill.

In like manner, the members of the Calcareous Series have a large development among the displaced masses in Assynt. From the base of the western slope of Glas Bheinn they stretch southwards by Achumore to the Traligill and Allt nan Uamh (two and a half miles south of Inchnadamff), near which the belt is about two miles broad. The highest beds, forming part of the Sailmhor division (Group III), are exposed on the plateau a mile and a half south-east of Inchnadamff Hotel. It is interesting to observe that all the sub-zones of the lowest group (Ghrudaidh) met with in Eireboll have been identified on the plateau between Achumore and Inchnadamff, where the total thickness of this subdivision is 115 feet. South of the mountainous region the dolomites and limestones stretch across the peaty moorland south-east of Elphin for a distance of four miles, where only the two lowest sub-divisions are represented.

A feature of special interest in the south-eastern part of Assynt is the contact metamorphism of the dolomites and limestones by the post-Cambrian intrusive rocks, to which attention will be directed in Chapter 31. Where these have been invaded by the great plutonic mass of Cnoc na Sroine and Loch Borrolan (six miles south of Inchnadamff), they have been altered into saccharoidal marbles, which, at several localities, were formerly quarried. In the tract between Loch Awe and the Ledbeg River above Loyne a gradual passage can be traced from the normal dolomites and limestones of the Ghrudaidh and Eilean Dubh groups into the crystalline marbles, in which the original characters are effaced. The stratigraphical horizon of the calcareous bands is proved by their position relative to the fucoid-beds and *Salterella*-grit. As shown in Sheet 101, repeated outcrops of the latter zones occur between Loch Awe and Loyne, and again about half a mile up stream from the shepherd's house, in association with the overlying dolomites and limestones.

As the area covered by the granite and syenite east and west of Loch Borrolan is large, the marble has a wide distribution. In addition to the exposures on the south bank of the Ledbeg River above Loyne, it appears in that stream between Loyne and Ledbeg, and on the hill slope about half a mile north-west of the latter cottage. On the southern

margin of the igneous mass, it is found on the north shore of Loch Urigill and on the moor between that lake and Ledraore; on the east, it appears west of Cnoc a' Chaoruinn by the road leading to Loch Ailsh and on the moor northwards to Strathsheaskich (Sheet 102); while towards the north it is visible in some streamlets draining southwestwards towards Luban Croma. At the last of these places the marble is in contact with borolanite.

### 3. Knockan to Strath Kanaird

By L. W. Hinxman.

The fucoid-beds and serpulite-grit are very well displayed along the line of the Ullapool road between Elphin and Strath Kanaird. The eastern slopes of Cùl Mòr are occupied by the basal quartzite, resting unconformably on the Torridonian Sandstone, and succeeded near the foot of the hill by the pipe-rock, both dipping south-east at angles varying from 12° to 20°. The fucoid-beds and serpulite-grit follow in natural sequence, and are seen in vertical section at the roadside immediately west of the village of Knockan, and at the foot of the Knockan cliff. The lower shales of the fucoid-beds are here typically developed, and are crowded with flattened worm-casts (the so-called "fucoids"). The soft shale band, which in other localities has yielded abundant remains of trilobites, was here found to be unproductive, but fragments of *Olenellus Lapworthi* were obtained by A. Macconochie in a thin calcareous band immediately overlying the shale.

At the southern end of Cnoc-an-t-Sasunnaich (two and a half miles south-west of Elphin), a north and south fault crosses Lochan Fasaidd and throws the Cambrian outcrops down below the road. From this point southwards the Cambrian strata are compressed into a belt not more than one-third of a mile in average width, and they rise in a series of low escarpments inclined to south-east at 16°–22° from the valley of the Runie River to the level of the road between Drumrunie Lodge and Achendrean. Craggs of the dolomitic limestone of the fucoidbeds with bright ochreous weathering are conspicuous at several points along the roadside, and are known as the Clachan Ruaidh (Red Stones). At Achendrean the fucoid-beds and serpulite-grit descend to the River Kanaird, and are there shifted half a mile up the valley to Achnacairnen by the left-hand branch of the powerful Strath Kanaird fault.