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## Chapter 14 The Northern Belt — continued. Arenig, Llandeilo, and Caradoc rocks in the Leadhills district

**Glengonner Water and its tributaries.** — The belt of ground extending from Leadhills [NS 88681 14920] to Crawford [NS 95499 20952] and Abington [NS 93174 23463]. in Clydesdale illustrates in a marked degree the extraordinary reduplication of the Arenig cherts and overlying Glenkiln–Hartfell black shales (Sheet 15 of the Survey Map). This structure is specially developed on the south side of the valley of the Glengonner Water, which falls into the Clyde above Abington. A few of the anticlines near the Leadhills Smelting Mill reveal the underlying volcanic rocks of Arenig age, but the exposures of these rocks become numerous in the Glencaple Burn and adjacent ground, where they form prominent features in the structure of the region.

Two anticlines of volcanic rocks occur to the east of Waterhead, one of which is exposed in a small stream named the Cone Gill [NS 88628 18116]?, on the hill slope west of the Old Toll Bar at Waterhead [NS 88839 18169]. The radiolarian cherts are there followed by the pillowy diabase-lava in the centre of the arch, the cherts reappearing on the north limb of the fold. The south bank presents an excellent illustration of isoclinal folding in the cherts, which are thrown into sharp curves and dip towards the north. Further up stream, the cherts reappear associated with black shales. The following graptolites have been obtained from one of the small exposures to the south of Cone Gill: *Diplograptus tricornis*, *Diplograptus foliaceus*, *Corynoides calycularis*, and *Climacograptus*.

On the moor to the south-west of the Cone Gill, the pillows diabase-lava is laid bare for a breadth of about 40 yards, associated with the cherts and black shales, debris of the latter being visible by the side of the hill-road leading to Leadhills. Small exposures of the lava may be seen also by the side of the road between the Smelting Mill and the Old Toll Bar at Waterhead. There the lava and cherts are much sheared and rendered schistose.

**Bellgill Burn.** — [NS 89222 17850] This stream, which joins the Glengonner Water from the east not far to the south of the Old Toll Bar at Waterhead, displays a fine section of the Glenkiln–Hartfell black shales, extending up stream for a distance of half a mile. The folds are represented mainly in the black shales; the cherts appear only on some of them, while in one instance the Arenig lava is visible, about one-third of a mile up from the foot of the stream. In general the black shales are well bedded, and might yield graptolites in fair preservation. At the foot of this stream, at the base of the hill slope on the right bank, a grit seems to be intercalated between the mudstones and flints and the black shales.

On the ridge separating Bellgill Burn from Clow Gill [NS 89214 18141], that flows north-west from Wellgrain Dod to join Glengonner Water, much of the evidence is obscured by a continuous covering of heather; but even on the top of the ridge the cherts and black shales occur. The slope facing the Smelting Mill is marked by some small exposures of Arenig lava cleaved in part; and along the eastern face the cherts and black shales frequently protrude.

The accompanying diagram (Figure 68), drawn in a north-west direction from the Wellgrain Dod [NS 90090 17948] to Brown Neeze [NS 88594 18731] along the course of the Clowgill Burn [NS 89362 18283], illustrates the reduplication of the Arenig cherts and the Glenkiln–Hartfell black shales. Only the broader folds are here represented, the strata being highly puckered. On the hill slope east of the burn, and about a quarter of a mile above the foot of the Clowgill Burn, two small arches of the volcanic rocks (diabase-lava) may be observed, which are not visible in the stream. Along this line of section the beds are all much cleaved, so that graptolites are not easily obtained from them. It is further noteworthy that as the folds of Arenig cherts and overlying black shales at the head of Clowgill Burn are followed along the strike into the head-waters of Laggan Gill, they plunge underneath the Caradoc greywackes and shales

On the eastern slope of the Black Hill a burn which joins the Glengonner Water about a quarter of a mile below the Clowgill Burn gives a continuous section, in the lower part of its course mainly of black shales, and in the upper part, of the cherts and black shales. About 300 yards up from the foot of the stream a band of agglomerate occurs in the cherts, with bombs of lava and blocks of chert in a fine ashy matrix.

In the Glengonner Burn [NS 90042 19468] — a tributary of the Glengonner Water — an excellent section of the black shale series is laid open. The isoclinal folds, like those in the Clowgill Burn (Figure 68), dip to the south-east, save near the foot of the stream. The cherts are well represented, but none of the folds reveals the underlying lavas. About a quarter of a mile up from the foot of the burn, the Hartfell black shales have yielded the following forms:

*Climacograptus caudatus* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Climacograptus tridentatus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Dicranograptus Nicholsoni* (Hopk.)

*Diplograptus foliaceus* (Murch.)

*Cryptograptus tricornis* (Carr.)

*Glossograptus Hincksi* (Hopk.)

*Cbrynoides calycularis* (Nich.)

This band of black shale asses downwards (up stream) into black flinty ribbed shales (Glenkiln) with partings of black shales, succeeded by the cherts, which are faulted against greywackes.

In the Laggan Gill, [NS 90623 19358] which rises on the north slope of the Wellgrain Dod and joins the Glengonner Water below Lettershaws, similar evidence is obtained of the extraordinary compression of the strata in this portion of the Leadhills region. In the scars at the sources of the burn some folds reveal the Arenig cherts with the black shales, but the streams crags mainly the greywackes and shales of the overlying series. About three-quarters of a mile down stream from Wellgrain. Dod, the folds bring up the diabase-lava much deformed and schistose. The cherts at this point are likewise highly cleaved, and the black shales are much shattered. Below the junction of the Coom Gill, that joins Glengonner Burn [NS 88905 18234] about a mile north of Wellgrain Dod, numerous folds of the Arenig cherts and black shales make their appearance. About a quarter of a mile below the foot of the Coom Gill, a section of Hartfell black shales on the south side of a fold of cherts has supplied the following list of graptolites:

*Diplograptus foliaceus* (Murch.)

*Climacograptus caudatus* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Dicellograptus Forchhammeri* (Gein.)

*Dicranograptus ramosus* (Hall.)

*Glossograptus Hincksi* (Hopk.)

*Corynoides calycularis* (Nich.)

On the north side of this fold *Dicranograptus zic-zac* was found.

The following species were collected by A. Macconochie from the Laggan Gill:

*Caenograptus* sp.

*Dicranograptus ramosus* (Hall.)

*Dicranograptus formosus* (Hopk.)

*Dicellograptus patulosus* (Lapw.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus moffatensis* (Carr.)

*Glossograptus Hincksi* (Hopk.)

*Climacograptus bicornis* (Hall.)

*Climacograptus* like *Schärenbergi*(Lapw.)

*Climacograptus caudatus* (Lapw.)

*Diplograptus angustifolius* (Hall.)

*Diplograptus foliaceus* (Murch.)

*Diplograptus perexcavatus* (Lapw.)

Much of the stratigraphical evidence in this part of the district is concealed under drift and alluvium in the lower part of the stream, the only rocks visible consisting of greywackes and shales.

**Kirk Burn.** — [NS 91481 20402] This stream, to the east of Laggan Gill, supplies similar evidence of the reduplication of the strata. On the following page a horizontal section is given, drawn along the course of the Kirk Burn. Below it is placed a section drawn along the ridge to the east, which includes Ravengill Dod and Craig Dod.

In the Kirk Burn three folds expose the Arenig lava in tracts varying from fifteen to twenty-five yards in breadth. This section shows the irregular arrangement of the strata, for the beds change the direction of dip within a short distance, the northerly being nearly as frequent as the southerly dips.

Rather less than a mile from the foot of the stream the following graptolites were got in black shales:

*Dicranograptus ramosus* (Hall.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus moffatensis* (Carr.)

*Dicellograptus Forchhammeri* (Gein.)

*Diplograptus foliaceus* (Murch.)

*Cryptograptus tricornis* (Carr.)

*Leptograptus flaccidus*

**Craig Dod Hill.** — [NS 91940 20530] The Arenig volcanic rocks on this hill are better seen than at any locality to the west. They occur in two folds on the hill-top, about 100 yards distant from each other. In the most northerly fold the breadth of volcanic rock is about 70 yards, the northern boundary line crossing the hill near the Cairn. The mass is composed mainly, if not wholly, of a coarsely crystalline intrusive rock, either an ophitic dolerite or gabbro. As it is bounded on both sides by the radiolarian cherts, there is no evidence of its intrusion being more recent than the

radiolarian zone. Northwards towards the Glengonner valley several arches of the cherts and black shales are indicated by small outcrops and debris of black shales.

Another exposure of volcanic rock, about 100 yards further south, forms a prominent rocky knoll about 40 yards broad running in an E.N.E. and W.S.W. direction. The mass consists of diabase-lava, showing the pillow structure so common in the Ballantrae area. The cherts protrude through the surface on the north limb of this fold, and the black shales are found in a turf-covered hollow, occupying evidently the centre of a synclinal trough between the two prominent arches of the volcanic rocks. There must, however, be compound folds in the radiolarian chert zone between the outcrops of igneous rocks, for along the strike of the cherts a small exposure of lava appears in a tributary of the Kirk Burn, draining the western slope of the Craig Dod.

Southwards, in the direction of the Ravengill Dod [NS 91924 20094], the several anticlines reveal the cherts in the col between the Craig Dod and that hill. Good sections of black shales yielding graptolites are found in two tributaries of the Glencaple Burn [NS 92350 19197], in the strike of the ridge of high ground.

**Dry Cleuch.** — [NS 92303 20531] In the most northerly of these streams, named the Dry Cleuch, which drains the east slope of the Craig Dod Hill, an arch of radiolarian chert may be seen near the head of the scar, associated with black shales, which have yielded the following graptolites:

*Dicranograptus zic-zac* (Lapw.)

*Climacograptus peltifer* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Climacograptus tridentatus* (Lapw.)

*Schärenbergi* (Lapw.)

*Diplograptus foliaceus* (Murch.)

**Hortin Gill.** — [NS 92412 20264] About 250 yards further south, the burn named the Hortin Gill, which drains the connecting ridge between Craig Dod and Ravengill Dod, has in the higher part of its course carved a deep rocky ravine out of cherts and black shales. About 200 yards up from the foot of this stream the cherts appear, followed immediately by black shales, which have yielded the following fossils:

*Loganograptus Logani* (Hall.)

*Caenograptus gracilis* (Hall.)

*Caenograptus pertenuis* (Lapw.)

*Caenograptus nitidulus* (Lapw.)

*Dicranograptus formosus* (Hopk.)

*Dicranograptus ramosus* (Hall.)

*Dicranograptus minimus* (Lapw.)

*Climacograptus peltifer* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Climacograptus Schärenbergi* (Lapw.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus moffatensis* (Carr.)

*Dicellograptus patulosus* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Corynoides calycularis* (Nich.)

*Diplograptus foliaceus* (Murch.)

*Leptograptus flaccidus* (Hall.)

This list contains most of the characteristic zonal forms of the Glenkiln group, together with one form, *Loganograptus Logani*, commonly restricted to a lower horizon than the Upper Llandeilo.

This outcrop of the Glenkiln Shales is followed by another of chert. At some distance from the latter, greywackes and shales appear, and in the scars at the very head of the Gill sharp folds of the black shales protrude through the grey shales and greywackes, from which specimens of *Climacograptus caudatus* were obtained (Lower Harden).

**Raven Gill.** — [NS 92369 19911] Not far to the south, at the head of another tributary of the Glencaple Burn which rises on the slope of the Ravengill Dod, a series of deep scars on the east slope of the hill, visible from a distance as prominent features, display a section of special interest, owing to the presence of a thin zone of Shelly mudstones between the volcanic rocks and the radiolarian cherts. The accompanying ground plan (Figure 71) and section (Figure 72) illustrate the relations of the strata. Of three scars or gullies at the head of the Raven Gill, the most southerly, which is the deepest, reveals a fault that brings the volcanic rocks in contact with greywackes and shales (f in (Figure 71) and (Figure 72)). To the north of this fault, the volcanic rocks are thrown into a series of folds, admirably seen on the slopes of the north scar. The exposures of these rocks include representatives both of the bedded and intrusive series. The bedded type consists of a basic lava highly decomposed, with larger vesicles than usually occur; while the intrusive mass consists of a coarse dolerite or gabbro, well seen on the little dividing ridge between the north and mid scar (1B in (Figure 71) and (Figure 72)).

Along the bottom of the middle scar and on the slopes of the north scar, the volcanic rocks are immediately overlain by bands of olive-green flaky mudstones, slightly flinty or siliceous in places, and containing derivative mica, probably muscovite (1 in (Figure 71) and (Figure 72)). These mudstones resemble to some extent those that surround the nodular cherts with abundant radiolaria. Their distinguishing feature is the occurrence in them of various hingeless brachiopods, all of which have been deep-water organisms, together with *Tetragraptus fruticosus* and *Tetragraptus quadribrachiatus* — graptolites of Middle Arenig age—thereby connecting the underlying volcanic zone with the lavas and tuffs of the same age at Ballantrae. The fossils obtained from the Raven Gill mudstones are given in the subjoined list:

*Tetragraptus fruticosus* (Hall.)

*Tetragraptus quadribrachiatus* (Hall.)

*Caryocaris Wrighti* (Salt.)

*Acrotreta Nicholsoni* (Dav.)

*Acrotreta* sp.

*Acrothele granulata* (Linnr.)

*Acrothele* sp.

*Lingula* sp.

*Lingulella lepis* (Salt.)

*Lingulella quebecensis* (Bill.)

*Lingulella* sp.

*Linnarsonia* sp.

*Obolella* like *Sabrinae* (Callow.)

*Obolella sagittalis* (Salt.)

*Obolella* sp.

*Kutorgina* near *labradorica*.

*Kutorgina* sp.

Discinoid shells.

Annelid jaws (?)

Rods (sponge ?)

The shelly mudstones (1 in (Figure 71) and (Figure 72)), which are about three feet thick, occupy a synclinal fold on the south side of the northmost scar, and reappear on the north face of the same scar. The shells occur in considerable abundance at both these localities and in fine preservation. The mudstones rest apparently on a bed of fine tuff, which is underlain by the lava. Along the north slope of the northmost scar, they can be followed round the various sharp folds as a thin zone between the overlying cherts and the underlying volcanic rocks. This feature is represented in the ground plan (Figure 71). Further east only small pockets of the mudstones are visible in the lava, while again the lavas are overlain by the mudstones and cherts on the north limb of the fold.

These mudstones, as already indicated (page 219), have been found at one or two localities east of the Clyde, in the Abington region, where they contain radiolaria.

**Glencaple Burn.** — [NS 92403 21025] In the lower part of the Glencaple Burn, and also on the ridge to the east (Barmy Rig [NS 92644 21227]) which overlooks the Clyde, important masses of the Arenig igneous rocks make their appearance. About 200 yards above the foot of the stream greywackes and shales come in contact with coarse gabbro, and are much crushed as if a fault intervened. For a distance of 50 yards the coarse intrusive rock occupies at intervals the bed of the burn. It is succeeded by diabase-lava of a pale grey variety, tuff and green mudstones, with nodules and lenticles of chert, occupying the horizon of the shelly mudstones of Raven Gill. The mass of coarse gabbro is traceable up the north face of Barmy Rig, where it is bounded on the north and south by diabase-lava, which extends down the slope towards the valley of the Clyde.

In the Glencaple Burn the cherts and black shales are met with southwards at intervals, repeated by folds, till an important development of the Arenig volcanic rocks occurs about half a mile up from the foot of the burn. This fold reveals about 40 yards of diabase-lava in the stream, bounded on either side by the cherts. On the hill, slope towards the east the breadth of the exposure of volcanic rock is about 200 yards, part of this space being occupied by a trough of cherts. To the south of this outcrop, coarse intrusive rock (dolerite or gabbro) stretches down the hill slope towards the Glencaple Burn. These intrusive rocks of Arenig age appear again on folds still further south, associated with cherts. This portion of the hill is strewn with rock debris, and at one point a Tertiary dyke traverses the Arenig rocks.

These various folds afford no evidence of the coarse Arenig igneous rocks piercing the cherts or black shales. The intrusion does not reach higher than the lavas.

A small section of black shales with fossils of the Hartfell horizon may be seen on the left bank of the Glencaple Burn, about 300 yards below the foot of Hortin. Gill. At the north end, on the bank, the Hartfell black shales are associated with thin grey seams, and thus have a banded appearance of grey and black seams, sometimes a quarter of an inch thick. In these black seams specimens of *Corynoides calycularis*, *Climacograptus caudatus*, and *Diplograptus foliaceus* occur.

Further south the grey seams disappear, and give place to a solid mass of black shales. About eight feet south from the grey seams, the first highly fossiliferous bands yield slabs which are crowded with large specimens of *Corynoides calycularis*. Here may be found in considerable abundance well preserved specimens of *Climacograptus caudatus* and *Diplograptus foliaceus*. In another layer, fine specimens of *Dicranograptus ramosus*, *Corynoides calycularis*, and *Diplograptus foliaceus*, with an occasional example of *Climacograptus caudatus*, have been obtained. The bands near this latter point also yield *Climacograptus bicornis* and *Cryptograptus tricornis*. The relation of this black shale band to other rocks is not visible.

Before concluding this description of the Moffat series, as developed in the Glengonner Water and its tributaries, we must refer to the fact that many of the folds of the black shales lie in the line of strike of the fossiliferous grits and conglomerates of Duntercleuch and the Snar (Caradoc). In the absence of special stratigraphical zones, it is not possible to demonstrate the extensive folding of the grits, but from the manner in which the Caradoc grits anastomose with the underlying radiolarian cherts and Glenkiln–Hartfell shales, it is probable, if not certain, that the upper series is as much folded as the lower.

**Clyde above Glengonnerfoot** — [NS 93035 22314] At the foot of the Glengonner Water, green and red cherts are visible, and after a blank in the section, reappear in the river Clyde about 200 yards up from Glengonnerfoot. Another blank in the section then occurs for a short distance, but thereafter up to the island in the river, about half a mile from Glengonner, a section may be followed of cherts, black shales, and greywackes, with two outcrops of lava. The rocks are much crushed and disturbed, and hardly ever appear in normal sequence.

The first exposure of the lava lies about 300 yards above Glengonnerfoot. [NS 92749 21952]? The rock is here brecciated and of the type to be referred to presently as occurring in the hills east of the Clyde. In the black shales south of it, the following graptolites were found: *Leptograptus flaccidus*, *Dicranograptus ramosus*, *Climacograptus bicornis*, *Diplograptus foliaceus*, and *Acrotreta Nicholsoni*. Two small outcrops of brecciated lava occur about 100 yards to the north of the island. At the island itself there is a great development of black shales.

**Wanlock Water and tributaries.** — [NS 84804 15911] About two miles up the Wanlock Water from the Spango Bridge at the mouth of the Ree Burn, black shales with radiolarian cherts are traceable at intervals for a distance of about 120 yards. This section is of special interest, because at one point it yields remarkably fine specimens of *Climacograptus bicornis* and of the variety *Climacograptus tridentatus*. Just below the mouth of the Ree Burn, vertical or highly inclined grey and green cherts occupy about 12 yards of the stream section. They present all their typical features, forming hard ribs or nodular bands charged abundantly with radiolaria. On the north side they are succeeded immediately by grey and blue shales, and after a blank in the section by greywackes, grits, and blue shales.

On the south side of the fold, the cherts are followed by grey and blue shales, resembling those on the north side, which occupy the stream for a few feet on the right bank, and are succeeded by greywackes. On the left bank of the Wanlock, opposite the mouth of the Ree Burn, though the beds are there much shattered and fossils are not easily obtained, the following graptolites were collected, belonging partly to the Glenkiln group and partly to the lower portion of the Lower Hartfell black shales.

*Cryptograptus tricornis* (Hall), in fine preservation.

*Caenograptus surcularis* (Hall).

*Climacograptus peltifer* (Lapw.).

*Diplograptus foliaceus* (Murch.), in fine preservation.

*Dicranograptus Nicholsoni* (Hopk.), with a wide angle.

*Climacograptus caelatus*, var. *antiquus* (Lapw.), well marked.

*Acrothele granulata* (Linnr.). This brachiopod is beautifully preserved.

On the further side of some greywackes and shales, the black shales reappear, and yield:

*Diplograptus foliaceus* (March.), in fine preservation.

*Cryptograptus tricornis* (Carr.)

*Corynoides calycularis* (Mich.)

*Dicellograptus* sp.

This assemblage seems to indicate the passage zone between the Glenkiln and Hartfell groups.

Still further up the stream, beyond greywackes and shales, graptolites were found in sooty, shattery black shales, having a characteristic Glenkiln facies, as given in the following list:

*Didymograptus superstes* (Lapw.)

*Dicranograptus minima* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Caenograptus gracilis* (Hall.)

*Cryptograptus tricornis* (Carr.)

*Climacograptus Schärenbergi* (Lapw.)

*Climacograptus* sp.

*Diplograptus foliaceus* (Murch.)

*Dicellograptus pandosus* (Lapw.)

Another fold of black shales may be seen higher up on the left bank of the Wanlock, at a point about 70 yards from the mouth of the Ree Burn. This locality yields remarkably fine specimens of *Climacograptus bicornis* and of *Climacograptus tridentatus*. On the left bank the shales dip to the S.S.E. at an angle of about 80°, are well seen, and can be readily searched for fossils; they occur also on the right bank at the foot of the drift slope. They are flaggy, and break into fine slabs from a quarter to half an inch in thickness. No great variety of fossils is here obtained, but in certain seams specimens of *Climacograptus bicornis* and *C. tridentatus* can be procured in great abundance and in excellent preservation. The following species have been collected here:

*Climacograptus bicornis* (Hall.), in fine preservation.

*Climacograptus tridentatus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Dicranograptus Nicholsoni* (Hopk.) with a wide angle.



*Diplograptus foliaceus* (Murch.)

*Siphonotreta micula* (M'Coy.)

This assemblage shows that the layer from which it was obtained occupies the position of the passage zone between the Glenkiln and Hartfell groups.

A short distance further up, black shales, again seen in the Wanlock, represent probably the Glenkiln band. In the line of strike of this outcrop the radiolarian cherts are visible in the Reedy Gutter, about 50 yards to the south-west of the Wanlock Water. In the last-named stream, occasional exposures are met with still higher up of greywackes and shales, together with a few bands of pebbly grit containing fragments of radiolarian chert.

**Glengaber Burn.** — [NS 84891 14391] In this stream — a tributary of the Wanlock Water — which drains the northern slope of the Glengaber Hill, various outcrops of black shale occur, some of which yield characteristic Glenkiln fossils. The cherts appear in a marked fold about half-way up the stream. One of the best localities for fossils occurs on the hill-road leading to Wanlockhead, where it winds round the slope between the two branches of the Glenaber Burn. At a point on the hill-road between the forks, graptolites occur in good preservation, somewhat decomposed, but abundant. The following list was here obtained:

*Didymograptus superstes* (Lapw.)

*Caenograptus pertenuis* (Lapw.)

*Lasiograptus bimucronatus* (Nich.)

*Diplograptus foliaceus* (Murch.)

*Cryptograptus tricornis* (Carr.)

*Climacograptus bicornis* (Hall.)

*Climacograptus Schärenbergi* (Lapw.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus patulosus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

The form *Dicranograptus ramosus* is most abundant. The Glenkiln black shale is obviously here represented.

On the south-west side of the valley of the Wanlock, the slopes of Duntercleuch Hill are drained by two streams — the Back Burn [NS 83311 15945] and the Duntercleuch Burn [NS 84032 15963] — flowing into the Wanlock. The sections laid open by these burns are of special importance, because they exhibit the black shales with characteristic Glenkiln graptolites and the fossiliferous grit and conglomerate of Caradoc age.

**Back Burn.** — [NS 83188 16388] About, one-third of a mile above the foot of the Back Burn, where it joins the Glenbuie Burn, black cherts and black shales with fragments of graptolites occur; and about 1300 yards up from the mouth of the Back Burn, black shales, evidently repeated by folds, with grits between, are exposed on the left bank, where they have furnished the following fossils:

*Caenograptus pertenuis* (Lapw.)

*Lasiograptus bimucronatus* (Nich.)

*Diplograptus foliaceus* (Murch.)

*Cryptograptus tricornis* (Carr.)

*Climacograptus bicornis* (Hall.)

*Dicranograptus ramosus* (Hall.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus patulosus* (Lapw.)

There is no evidence here whether the grits rest unconformably on the black shales. The latter are much smashed and slickensided.

In a scar at the very head of the stream, on the north-east slope of the Well Hill, a fine exposure of the fossiliferous grit (Duntercleuch) may be seen, weathering with a yellowish grey colour. Specimens of a *Theca* were obtained from the grit on this scar; while in the bed of the stream black shales with graptolites are visible.

**Duntercleuch Burn.** — [NS 84044 16106] About 300 yards up this burn from its point of junction with the Waulock Water, the Glenkiln black shales are well displayed on the north bank. At one point the shales split into fine slabs, and yield graptolites in profusion from certain layers. The following species were obtained from this locality:

*Didymograptus superstes* (Lapw.)

*Caenograptus gracilis* (Hall.)

*Caenograptus pertenuis* (Lapw.)

*Dicranograptus minimus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus patalosus* (Lapw.)

*Dicellograptus elegans?* (Carr.)

*Dicellograptus moffatensis* (Carr.)

*Cryptograptus tricornis* (Carr.)

*Climacograptus bicornis* (Hall.)

*Climacograptus caelatus* (Lapw.)

*Climacograptus Schärenbergi* (Lapw.)

*Diplograptus foliaceus* (Murch.)

*Diplograptus euglyphus* (Lapw.)

*Lasiograptus bimucronatus* (Nich.)

*Lasiograptus margaritatus* (Lapw.)

*Leptograptus flaccidus* (Hall.)

*Corynoides calycularis* (Nich.)

Greywackes occur on the south side of this outcrop, and also in a fold in the heart of these shales. From the assemblage of forms given in the foregoing list, it is apparent that this black shale band belongs mainly to the Glenkiln group. The occurrence, however, of *Laisograptus margaritatus* would seem to indicate that the basal portion of the Lower Hartfell black shales is here represented.

**Glenmarch Hope Burn.** — [NS 85321 13396] Near the head of this burn, which is a tributary of the Wanlock Water, on the south-east slope of the Glengaber Hill, besides sections of chert and black shales, both much smashed, a very small exposure of igneous rock is associated on the north side with cherts and black shales, which resembles some of the igneous rocks of Arenig age.

**Sowen Burn (Tributary of the Wanlock at Smelting Mill).** — [NS 85775 14488] This stream furnishes excellent exposures of radiolarian chert with black shales, but the latter are in many places much shattered and disturbed, so that fossils are not easily obtained from them. Near the foot of the burn, close to the Smelting Mill, the following forms were got from black shales which show a core of radiolarian cherts in the centre of the fold: *Caenograptus pertenuis*, *Dicranograptus zic-zac*, *Dicranograptus ramosus*, *Climacograptus bicornis*, *Diplograptus euglyphus*, *D. foliaceus*, *Leptograptus flaccidus*, *Dicellograptus sextans*, *D. Forchhammeri*, *Cryptograptus tricornis*. One of the marked features of the Sowen Dod (1783 feet) is the abundance of chert debris along the line of outcrop occurring close to each other. The hard chert ribs are very conspicuous along the hill-top near the county boundary.

**Snar Water, Wanlockhead.** — [NS 87259 14414] Round the headwaters of the Snar, although the hills have a more or less continuous covering of heather, repeated folds of the Arenig cherts and black shales are nevertheless indicated by debris on the surface exposures in scars or burns on the hill slopes. Along the eastern slope of Sowen Dad and Snarhead Hill there are about twenty separate folds of the Arenig cherts and black shales. Sometimes only the black shales come to the surface along sharp plications, but as a rule the cherts form the prominent feature of the folds. It is important to note, however, that along the strike of these folds, on the ridge forming the watershed between the head-waters of the Snar and Leadhills, the strata consist of grits, greywackes, and shales. The Arenig cherts and the Glenkiln–Hartfell black shales gradually "nose out", and the folds are continued in higher beds.

On the east side of the Snar Water valley, in a scar draining the south slope of Hunt Law [NS 87132 15598], a broad exposure has been laid open of the Arenig cherts and black shales. Here the observer may see the features which these rocks present over a considerable area of the region north of Leadhills. The black shales are bleached white or grey, and their graptolites are in such a very poor state of preservation as to be of little service for zonal classification. Further, the cherts frequently decompose into a white clayey material. To such an extent is this the case in the Lead-hills region that probably some felspathic constituents may enter into the composition of the radiolarian cherts.

About 200 yards south from the foot of the scar just referred to, at the side of the path leading to Leadhills, a very small projection of the diabase-lava in the chert forms the only outcrop of the volcanic zone in the head-waters of the Snar.

For a mile below its source, the Snar Water flows through an alluvial flat, in which no solid rock is visible. Within half a mile of the Snarhead shepherd's house [NS 86548 16058], gritty greywackes and shales appear in the stream, and a little lower a well-marked band of grit may be seen, resembling the fossiliferous grit of Duntercleuch. About 70 yards north of this outcrop the cherts appear with the black shales. Further down stream (300 yards north of Snarhead) [NS 86226 16530] an arch of the cherts with black shales is laid bare in the water-course. In the core of this fold, on the right side of the valley, coarse dolerite or gabbro appears, which is traceable for a short distance. The cherts, however, can be followed eastwards to the crest of the ridge between the Glenkip Burn and Snar Water [NS 86709 16679].

About 60 yards south of the junction of the Reecleuch Burn with the Snar Water [NS 86142 16577], an important section exposes the volcanic rocks. Greywackes in the bed of the stream are followed by pillowy lava, which is visible in an adjoining rocky knoll. The volcanic zone is succeeded southwards by an outcrop of black shales seen in the Snar, and still further south by the radiolarian cherts. A small exposure of radiolarian chert may be seen in the burn on the north side of the mass of lava, so that the latter might occur on a separate fold from that of the cherts south of the black shales.

The cherts occur along this strike to the west of the Reecleuch Burn.

These folds of volcanic rocks, Arenig cherts, and black shales in the Snar Water lie much in the same line of strike as the outcrops of the Reecleuch Hill to the W.S.W.

The fossiliferous breccia or conglomerate is well displayed in the Snar, not far below the shepherd's house [NS 85946 16948]. It occurs also further down the valley on the slope of Snar Law [NS 85662 17908], and in the Slough Burn [NS 85180 17826] on the west side of the valley.

**Glenkip Burn (Tributary of the Snar Water).** — [NS 87583 16020] At the head-waters of this stream great scars display fine sections of the Arenig cherts highly decomposed, and of the black shales, usually bleached to a white or grey tint. The same difficulty is here presented of obtaining fossils for zonal classification. The evidence of rapid reduplication of the strata by folding is abundant, though in this valley denudation has not proceeded far enough to reveal the volcanic rocks.

From an exposure of black shales, about one-third of a mile down this stream, the following fossils were got:

*Caenograptus gracilis* (Hall.)

*Caenograptus pertenuis* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Diplograptus euglyphus* (Lapw.)

*Climacograptus* sp.

The belt of rapidly folded cherts and black shales at the head of Glenkip Burn is upwards of half a mile broad; northwards to the point of junction with the Snar Water — a distance of about a mile and a half — the valley traverses a succession of pebbly grits or conglomerates, greywackes, and shales of Bala age. The dips in opposite directions show that the strata are repeated by folds; but it is clear that many of the folds are isoclinal. Here, as has been already remarked with regard to other parts of the region, there may be quite as much reduplication of the over lying sediments of Bala age as of the Arenig cherts and Glenkiln–Hartfell black shales.

The folds of charts and black shales so conspicuous at the head of the Glenkip Burn are traceable in many cases across the ridge in the direction of Glengonner Water. Eastwards, however, they "nose out", and plunge underneath overlying sediments.

**Glendorch Burn.** — [NS 87246 18998] This stream rises on the slope of the Waterhead Hill north of Leadhills, and joins the Snar at the Old Castle of Snar, about a mile and a half south from Duneaton Water. Near its head several folds of black shales and cherts occur; but northwards to near the foot of Sim's Burn greywackes, pebbly grits or fine conglomerates, and shales or mudstones are exposed. The pebbly bands yield the Duntercleuch series of fossils. There can be no doubt that they are repeated again and again by sharp folds.

From Glendorch shepherd's house to near the foot of the stream, grey flags and mudstones, with occasional bands of grit, dip generally to the S.S.E. at about 70°. About 200 yards above the foot, an outcrop of black shales has supplied the following fossils:

*Diplograptus foliaceus* (Murch.)

*Climacograptus Schärenbergi* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Climacograptus caudatus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Dicellograptus moffatensis* (Carr.)

*Glossograptus Hincksi* (Hopk.)

*Lasiograptus margaritatus* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Acrotreta Nicholsoni* (Dav.)

*Corynoides calycularis* (Nich.)

This assemblage of fossils proves that this shale must belong to the Lower Hartfell horizon. Though the radiolarian cherts are not here visible in the Glendorch Burn, there can be little doubt that the black shales appear along the crest of a sharp fold. The occurrence of this band is of importance, because it helps to fix the age of the brown shales and fossiliferous grits, so well developed in the Glendorch valley.

**Cog Burn and its tributaries (West from Wanlockhead).** — [NS 81808 14791] The lower reaches of this stream, below the point of junction with the Glensalloch Burn, afford few exposures of solid rock. The Cog Burn, in that part of its course, winds through alluvial deposits flanked by high banks of boulder clay. From the mouth of the Glensalloch Burn [NS 81814 14800] upwards to the foot of the Glendorch Burn [NS 82226 13914] — a distance of about three-quarters of a mile — very massive greywackes and grits with blue and grey shales form the section.

At the mouth of the Glendorch Burn, an important section, on the right bank of the stream, shows the sequence from the radiolarian cherts to the Glenkiln black shales, followed by a remarkable breccia at the base of the overlying arenaceous series. At the bend of the stream, cherts with radiolaria occupy about 25 yards of the section, preserve their nodular character, and are there seen to be repeated by sharp folds. On the south side they are followed by a thin seam of shales, succeeded by a bed of breccia about 14 feet thick, composed of angular fragments of grey and dark chert with radiolaria. On weathered surfaces the brecciated character of the rock is very conspicuous, as the included fragments weather with a whitish colour, while the matrix of the rock is grey. This bed of breccia, which probably indicates a local unconformability, is succeeded by a band of black shales, measuring about 24 feet across, which are much jointed, and yield graptolites sparingly and in poor preservation. The following among other forms were here obtained: *Cryptograptus tricornis*, *Dicranograptus ramosus*, *Lasiograptus bimucronatus*, *Climacograptus*, &c. These black shales contain dark siliceous ribs like those of the Glenkiln black shales group; and though the typical Glenkiln assemblage of graptolites has not here been met with, it is evident from the character of the beds and the occurrence in them of *L. bimucronatus* that they belong to that division. They are followed by a bed of grit (six feet thick) containing angular fragments of radiolarian chert and a few pieces of black shale. Further south, dark grey greywackes and shales are visible on the base of the slope and in the stream. On the north side of the anticline, greywackes and dark shales come in conjunction with the radiolarian cherts.

It is interesting to observe that a section showing a sequence from radiolarian cherts to Glenkiln black shales and overlying breccia is visible in a small tributary of the Glensalloch Burn, about half a mile to the E.N.E. of the locality just referred to. The streamlet is not marked even on the six-inch map, but it drains the northern slope of the Lowmill Knowe [NS 83529 14080]. About 80 yards above its junction with the Glensalloch Burn — no rock being visible in this space — the first exposure is met with on the east bank, consisting of grey, green, and dark cherts full of radiolaria. Only about three feet of cherts are seen. These are followed on the south side by three feet of decomposing black shales, weathering grey and rusty brown. About three inches of this band yield graptolites in fairly good preservation. The following forms were here found:

*Dicranograptus minimus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Cryptograptus tricornis* (Carr.)

*Diplograptus foliaceus* (Murch.)

*Climacograptus bicornis* (Hall.)

*Climacograptus tridentatus* (Lapw.)

*Climacograptus Schärenbergi* (Lapw.)

This fossiliferous band is succeeded further south by about 12 feet of grit which passes in places into a fine breccia, with a gritty matrix, containing angular fragments of radiolarian (Alert of the same colour as the chert-band close by. The derived fragments are small, but one was found that measured four inches across. The breccia passes upwards into grits with minute chert fragments and brown shales. These beds are nearly vertical, or dip to the south-east at about 80°. A short distance up the streamlet another band of brecciated conglomerate is seen, containing fairly large fragments of radiolarian cherts. This anticline, of which only one limb is visible, cannot be traced continuously to the Cog Burn, but it is much in the same line of strike as the arch at the foot of Glendorch Burn. The latter streamlet lays open numerous folds of the radiolarian chert with small exposures of black shales, the higher portion of its course being occupied by blue clayey shales with sandy ribs. About 400 yards up the stream, one of the synclinal folds includes another band of brecciated grit with chert fragments.

Before describing the black shale bands in the basin of the Cog Burn above Cogshead, we may refer to the series of brown-weathering greywackes and shales in the Glensalloch Burn, which resemble in certain points the so-called "Margie series" of greywackes and shales in Forfarshire and Kincardineshire. In fresh fracture the rocks are grey and blue.

In the higher reaches of the Cog Burn and its tributaries above Cogshead, sections of black shales yield at some localities well-preserved graptolites. At the Craigy Cleuch [NS 82826 12840]— a tributary of the Cog Burn due south of the shepherd's house at Cogshead [NS 82905 13164] — dark blue shales appear at the foot of the stream, which have not yielded graptolites. At the head of this burn two small branches have cut deep scars in the Silurian rocks. In the westmost branch, on the brow of the hill, grey shales and mudstones with dark shales contain *Diplograptus foliaceus* and *Dicranograptus*. In the eastmost branch, similar beds are visible. Just above the fork of this branch, shattery black shales have yielded *Cryptograptus tricornis*, *Diplograptus foliaceus*, *Acrothele granulata*, *Acrotreta Nicholsoni*, the brachiopods being well preserved. A few feet from the fork, the following forms were obtained in a seam of black shale:

*Dicranograptus zic-zac* (Lapw.)

*Diplograptus euglyphus* (Lapw.)

*Lasiograptus bimucronatus* (Nick.)

*Cryptograptus tricornis* (Carr.)

*Dicranograptus ramosus* (Hall.)

*Dicranograptus Nicholsoni* (Lapw.) (with the wide angle)

*Dicellograptus* ap.

*Climacograptus Schärenbergi* (Lapw.)

**Howcan Burn (Tributary of the Cog Burn).** — [NS 83157 13038] About 300 yards to the east of Cogshead the Howcan Burn joins the Cog Burn from the south-east, and near the Martyrs' Knowe a small exposure of black shales, dark blue and flaggy, have yielded *Cryptograptus tricornis*, *Dicranograptus ramosus*, *D. Nicholsoni* (with the wide angle), *Climacograptus*, and *Acrotreta Nicholsoni*. Further down this tributary there is a better exposure of black shales of a similar type yielding *Dicellograptus sextans*, *D. elegans*, *D. Forchhammeri*, *Cryptograptus tricornis*, *Climacograptus*

*bicornis*.

On the north side of the valley, the Cog Burn receives a tributary — the Glenlosk Burn [NS 84369 13597] — a mile east of Cogshead, which reveals a good section of black shales about 600 yards up from the junction. Gritty greywackes and dark blue shales appear in the lower part of the section, the strata next the black shales on the south side consisting of dark blue shales, sandy and micaceous. The black shales next these sandy shales yield *Diplograptus foliaceus* and *Acrothele granulata*. Further up black shales are well displayed, much crushed and shattery, so that graptolites are not easily obtained from them. The following forms were collected at the bend of the stream:

*Caenograptus gracilis* (Hall.)

*Cryptograptus tricornis* (Carr.)

*Climacograptus bicornis* (Hall.)

*Climacograptus Schärenbergi* (Lapw.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus patulosus* (Lapw.)

*Dicellograptus elegans?* (Carr.)

Another exposure of black shales occurs in the Cog Burn about 120 yards above the point of junction with the Glenlosk Burn [NS 84223 13103]. Smashed and cleaved black shales are there seen next to the greywackes on the north side of the fold. A few yards west from the junction, on the left bank of the stream, well-preserved graptolites occur in flaggy black shales. The following assemblage of fossils was obtained from these shales, the specimens of *Lasiograptus margaritatus* being particularly fine:

*Climacograptus bicornis* (Hall.)

*Climacograptus tridentatus* (Lapw.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus moffatensis* (Carr.)

*Dicellograptus patulosus* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Lasiograptus margaritatus* (Lapw.)

*Diplograptus foliaceus* (Murch.)

*Climacograptus coelatus* var. *antiquus* (Lapw.)

*Acrothele granulata* (Liner.)

In the Black Grain [NS 84697 13062] — a tributary of the north branch of the Cog Burn — three outcrops of the radiolarian, cherts appear on separate folds. The cherts are associated with black shales on the two folds furthest down the stream; in the third, the greywackes are in contact with the cherts. The black shales are so greatly shattered that they cannot be expected to yield graptolites.

**Conrig Burn (one mile N. of Sanquhar).** — [NS 78763 11420] In this burn, at a point about a quarter of a mile above its junction with the Crawick Water and a few yards, above the bridge leading to Conrig Farmhouse, the diabase-lava is to

be seen on the left bank. This rock is of the type so common in the Southern Uplands. It weathers with a rounded pillow-shaped surface, and in fresh fracture is very vesicular. To the east of this lava a band of breccia contains fragments of chert containing radiolaria, and is succeeded by greywackes and shales. Further down, a more acid slaggy lava appears in the bed of the stream, followed by an agglomerate with rounded blocks of slaggy lava. A few yards above the bridge, a small exposure of cherts shows also a pale grey vesicular igneous rock. At the bridge dark shaly clays appear, followed by massive greywackes.

**Fingland Burn (Tributary of the Loch. Burn, 1½ mile N.E. of Sanquhar).** — [NS 80445 12392] Nearly in the line of strike of the arch in the Conrig Burn, the volcanic rocks are exposed further to the north-east in Fingland Burn, and again on Conrig Hill [NS 80445 12392]. In the Fingland Burn they consist mainly of tuff, visible at intervals in the stream for a distance of about 130 yards, and also in a quarry at the-road-side about 430 yards south of Mossholm, where the rock has been quarried for building stone. This quarry is now partly covered with grass, but the rock still protrudes through the surface in two or three places. It is a grey tuff, composed of sub-angular and rounded fragments of various slaggy lavas. The largest fragment observed was 1¼ inch long by ¾ of an inch broad. One of the types of lava represented among these blocks is a pale grey diabase full of minute rounded vesicles filled with zeolitic materials with a black glazed surface. Another type is a pink vesicular diabase. Here and there occasional crystals of augite occur, together with other minerals which are probably decomposed pyroxenes. Some of the finer-grained fragments of lava have green minerals as inclusions. The matrix is cemented by carbonate of lime. The average size of the volcanic fragments is small, but in a hand specimen its fragmental character is very apparent. The tuff is nearly vertical and its strike is E. 20° N.

On the north side of the quarry a few feet of fine-grained slaggy diabase-lava appears, like some of the fragments in the tuff. From the blocks of lava in the adjoining walls, which seem to have been quarried at this spot, it is probable that a thin sheet of lava is here associated with the tuff. Under the microscope the latter rock is identical with many of the pillow lavas associated with the Arenig cherts.

In the ascent of the Fingland Burn, the first exposure of the tuff is to be seen nearly opposite the quarry just referred to. Here the same vertical arrangement of the constituents is observable. A mass of fine-grained slaggy lava, about two feet across, occurs at the south end of the stream section; but may be merely a large included block in the tuff. Beyond this outcrop of tuff, at a distance of 40 feet, a band of shale, about one foot thick, is visible in the bed of the stream. Here follows a blank in the section for four yards, when the tuff again appears with sub-angular fragments of lava. The most northerly exposure occurs about 80 yards south of the bridge leading to Clenries, where fresh specimens were procured [NS 80472 12496]. There is another blank in the section above this point, but underneath the bridge leading to Clenries Farmhouse blue shales are seen. No evidence appears in the Fingland Burn to show the relation of the tuff to the radiolarian cherts or younger sediments, or the continuance of this arch to the south-west as far as the Conrig Burn, nor is there any proof of the continuation of the tuff as far as the arch of lava on Conrig Hill.

**Conrig Hill (Three miles N.E. from Sanquhar).** — [NS 80880 12630] On the south-west slope of the Conrig Hill, about the 1250-feet contour line, and much in the same line of strike as the volcanic tuff in the Fingland Burn, another exposure of igneous rock is to be found. The two outcrops cannot be continuous, however, on the surface, for on the slope of the Conrig Hill, about the 1000-feet contour line, greywackes and grit can be seen on the slope at short intervals. The arch, now to be described, is of considerable importance, because it shows the relation of the Arenig lava to the radiolarian cherts, while in an adjoining fold there is a sequence from the cherts to Glenkiln black shales covered apparently unconformably by a brecciated grit or conglomerate.

The lava occurs on the north side of a grassy gully occupied in wet weather by a stream which issues from a spring. The grey and dark cherts, charged with radiolaria, are seen in two exposures on the south side of the hollow, dipping towards the N.N.W. underneath the lava. The first exposure of lava met with in the hollow is highly decomposed, but a few yards further up, the same rock, in a fresher condition, resembles the lava of Tewsgill, near Abington. Still higher up, the rock assumes the character of a highly vesicular diabase and forms small knobs that project through the grassy covering. The exposed length of the arch of lava is about 125 yards. Along the north side of the fold, the igneous material is not seen in conjunction with any other rock, being concealed by drift, but a few yards northwards the grits and greywackes supervene.



On the south side of the arch, and only a few feet from it, another fold runs parallel with the diabase-lava, in the centre of which grey and dark blue cherts with radiolaria are visible. In this fold also a grassy hollow, formed by a rivulet in wet weather, skirts the edge of the radiolarian cherts. At the head of the gully, black shales, shattery and disturbed, are seen folding round the cherts, while the outer ring of the fold is marked by a band of brecciated grit. The black shales cannot be traced continuously along the south side of the arch, as they are buried under the turf, but they reappear on the south limb of the fold. The bottom of the gully is covered with grass, and there is room for the outcrop of the black shales along the northern limb of the fold. These shales are so shattery and cleaved that graptolites are not easily obtained from them, but after a vigorous search at the eastern end of the fold, certain forms were got, proving the position of this band. Certain typical Glenkiln forms occur, as shown in the following list:

*Caenograptus gracilis* (Hall.)

*Caenograptus pertenuis* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Thamnograptus typus* (Hall.)

*Dicranograptus ramosus* (Hall.)

*Lasiograptus bimucronatus* (Nich.)

*Diplograptus foliaceus* (Murch.)

*Diplograptus euglyphus* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Climacograptus Schärenbergi* (Lapw.)

The breccia above the black shales at the eastern limb of the fold can be traced continuously along the north side of the grassy hollow. Its matrix is a grit, throughout which abundant angular and sub-angular fragments of grey and black chert are scattered, some measuring two inches across. It is apparent that this brecciated grit overlying the Glenkiln black shales indicates a local unconformability at this spot. The cherts must have been exposed either here or near the area of sedimentation.

Certain bands of black shales crop out to the south and southeast of the Conrig Hill. On the moor to the north of Brandleys Cottage [NS 81780 10561] crushed and shattered black shales with thin chert bands are seen in a quarry, and the following fossils were obtained from them:

*Dicranograptus minimus* (Lapw.)

*Diplograptus mucronatus* (Hall.)

*Glossograptus Hincksi* (Hopk.)

*Cryptograptus tricornis* (Carr.)

*Acrothele granulata* (Linnr.)

*Acrotreta Nicholsoni* (Dav.)

In a small tributary of the Coal Burn [NS 81593 11272], one-third of a mile west of Shiel Burn, near Brandleys cottages, to the east of the quarry, beside a sheep ree, black shales are visible, which yielded the following fossils:

*Thamnograptus typus* (Hall.)

*Thamnograptus scoticus* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Dicranograptus zic-zac* (Lapw.)

*Dicranograptus minimus* (Lapw.)

*Dicranograptus ramosus* (Hall.)

*Dicellograptus moffatensis* (Carr.)

*Dicellograptus sextans* (Hall.)

*Dicellograptus patulosus* (Lapw.)

*Climacograptus bicornis* (Hall.)

*Climacograptus peltifer* (Lapw.)

*Corynoides calycularis* (Nich.)

*Diplograptus foliaceus* (Murch.)

About 90 yards up this stream from the sheep ree [NS 81876 11516], an interesting section of black shale occurs in which the shale varies in tint from dark blue to black, breaks into fine slabs, and yields a peculiar assemblage of graptolites, which probably indicate the horizon of the base of the Lower Hartfell group. The following forms were here obtained:

*Climacograptus bicornis* (Hall.)

*Climacograptus* var. *tridentatus* (Lapw.)

*Cryptograptus tricornis* (Carr.)

*Diplograptus foliaceus* (Murch.)

*Climacograptus caudatus* (Lapw.)

*Climacograptus Schärenbergi* (Lapw.)

*Corynoides calycularis* (Nich.)

*Acrotreta Nicholsoni* (Dav.)

There is here no great variety of forms, but their mode of occurrence is noteworthy. Some of the slabs are crowded with *Corynoides calycularis*, others with *Acrotreta Nicholsoni*. Another characteristic is the prevalence of a species of *Climacograptus* of the *caudatus* type.

Towards the col at the head of the Shiel Burn, on the southeast side of Conrig Hill [NS 82541 12605], shatterly dark shales are seen in a gully at the head of a stream that drains into the Cog Burn. They contain *Cryptograptus tricornis*, *Climacograptus bicornis*, *Dicellograptus sextans*, *D. patulosus*, *Lasiograptus bimucronatus*, *D. foliaceus*, and *Acrotreta*.

**Glendyne Burn.** — [NS 84263 11679] This stream, an important tributary of the Menock Water, drains the high ground south-west of Wanlockhead. About a mile from the head of the stream, several small exposures of the volcanic zone beneath the radiolarian cherts are interesting, because the character of the lava on the various folds closely resembles

that of the fine-grained diabase type so common in the Ballantrae and other areas. On the south slope of the Glendyne Burn, solid rock gives rise to debris. Just below the point where the Rough Cleuch [NS 84878 11749] joins the main stream the radiolarian cherts are seen, overlain by about 30 feet of diabase-lava forming the core of an isoclinal fold; which is succeeded on the slope by the cherts and a second small exposure of the lava and cherts. These are followed by greywackes, grits, and shales, but at one or two points thin seams of shattered black shales intervene between the cherts and greywackes. These are too much shattered and corrugated to yield more than traces of graptolites. Further down the stream, but only a short distance off, the Arenig lava again appears on the south slope, associated with the radiolarian cherts and black shales, which contain the following among other fossils: *Corynoides calycularis*, *Diplograptus foliaceus*, and *Cryptograptus tricornis*. The black shale is here lumpy, and yields graptolites sparingly.

Lower in the glen, the radiolarian cherts are again seen at the head of a small gully on the south side of the valley — probably a continuation of the fold that reveals the lava higher up the Nether Rough Cleuch [NS 84560 11460]. At a small tributary of the Glendyne, from the south, the radiolarian cherts and black shales are met with on two separate folds, distant about 50 yards from each other. In the southmost exposure the black shales appear only on the north side of the folds, while in the more northerly fold the black shales occur on both sides of the radiolarian zone. On the north side of the latter fold the black shales, though reduplicated by folding and much shattered and crushed, have supplied the following fossils:

*Caenograptus surcularis* (Hall.)

*Cryptograptus tricornis* (Carr.)

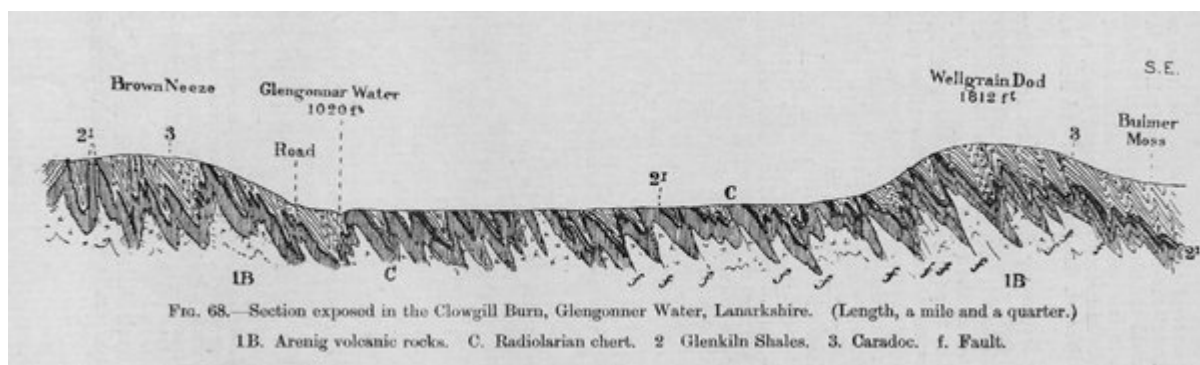
*Climacograptus bicornis* (Hall.)

*Climacograptus Schärenbergi* (Lapw.)

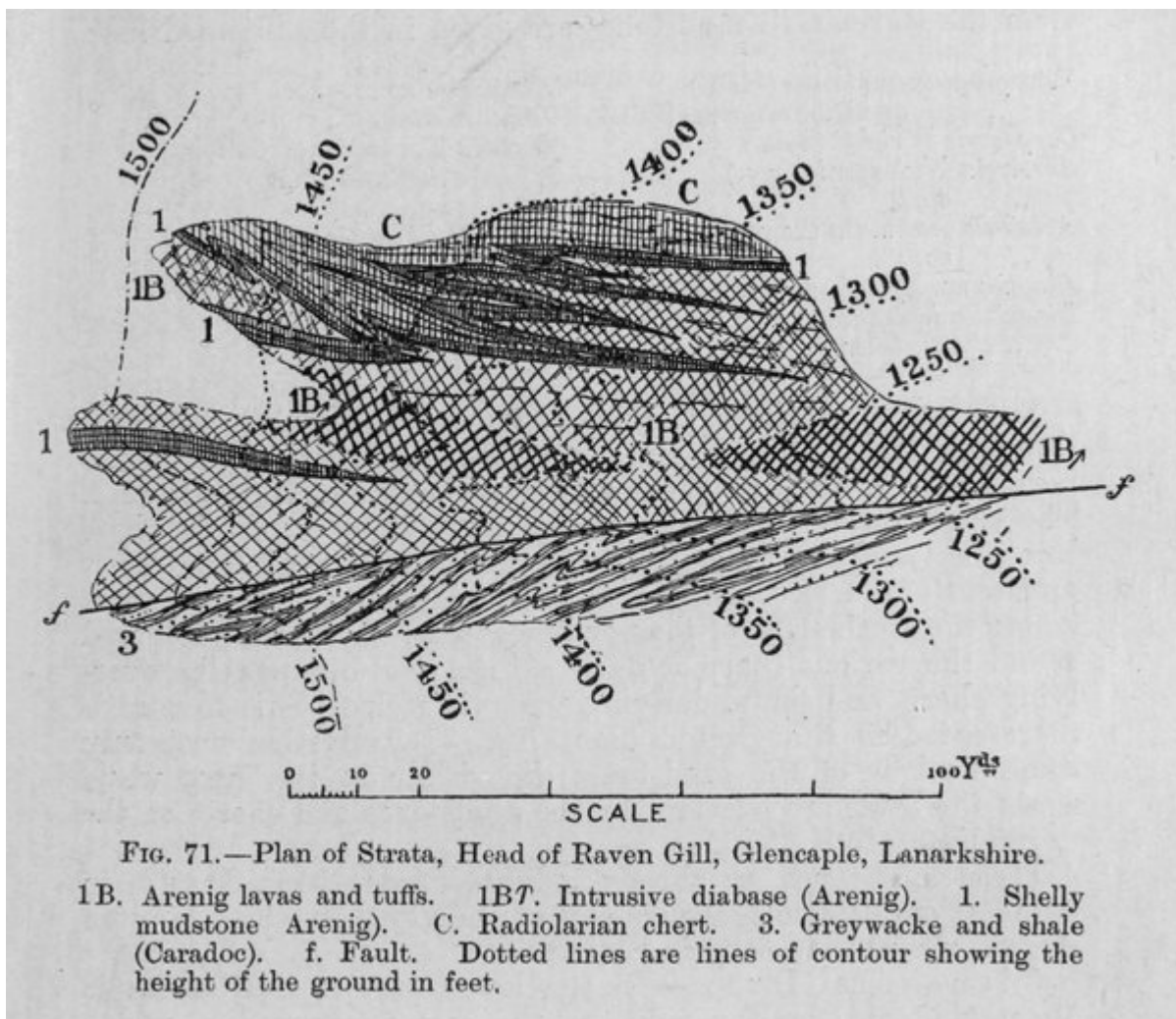
*Dicellograptus sextans* (Hall.)

*Corynoides calycularis* (Nich.)

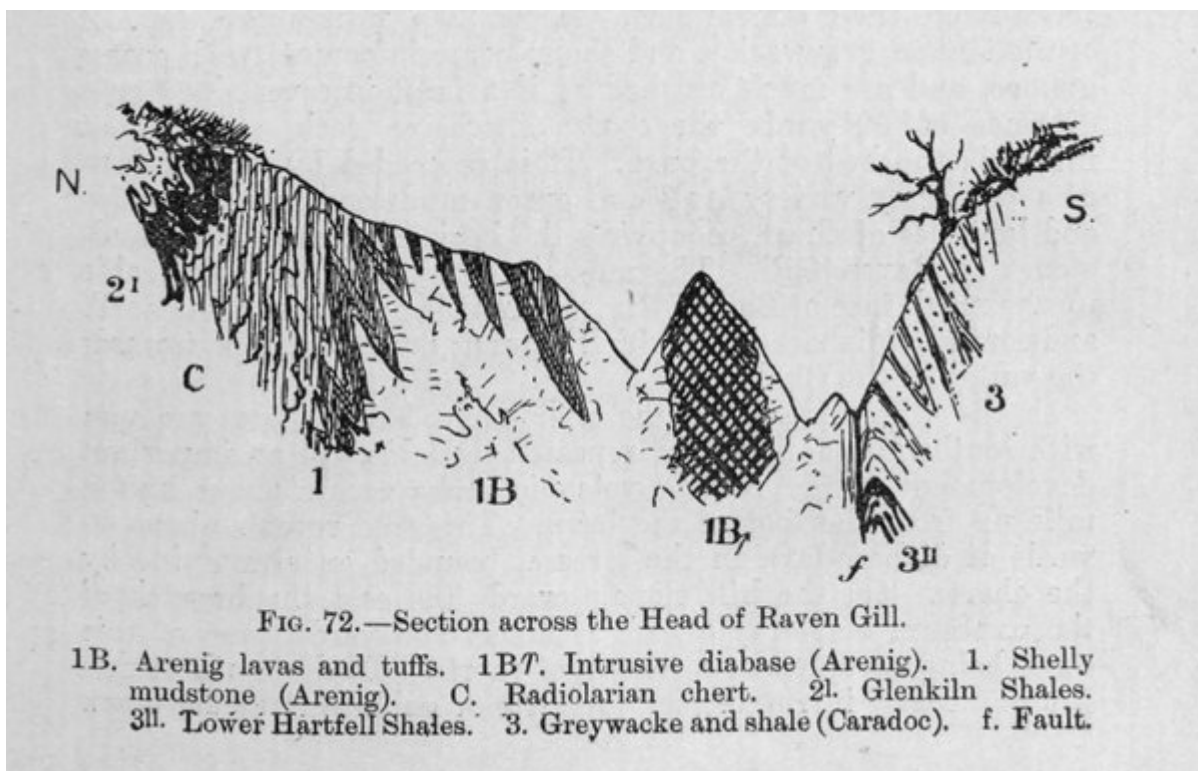
In the higher reaches of the Glendyne Burn [NS 85968 12148], rocky scars display the clayey shales with abundant white mica, which overlie the Glenkiln black shales. Weathering with a yellowish tinge, and containing occasionally more sandy layers, they closely resemble the yellow shales yielding *Maclurea* in the Carcoside Burn.



(Figure 68) Section exposed in the Clowgill Burn, Glengonner Water, Lanarkshire. (Length, a mile and a quarter.) 1B. Arenig volcanic rocks. C. Radiolarian chert. 2 Glenkiln Shales. 3. Caradoc. f. Fault.



(Figure 71) Plan of Strata, Head of Raven Gill, Glencaple, Lanarkshire. 1B. Arenig lavas and tuffs. 1BT. Intrusive diabase (Arenig). 1. Shelly mudstone (Arenig). C. Radiolarian chert. 3. Greywacke and shale (Caradoc). f. Fault. Dotted lines are lines of contour showing the height of the ground in feet.



(Figure 72) Section across the Head of Raven Gill. 1B. Arenig lavas and tuffs. 1B■. Intrusive diabase (Arenig). 1. Shelly mudstone (Arenig). C. Radiolarian chert. 2l. Glenkiln Shales. 3ll. Zovief Harden Shales.' S. Greywacke and shale (Caradoc). f. Fault.