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## Chapter 17 Cape Wrath to Loch Lurgan

By L. W. Hinman, with notes by B. N. Peach and C. T. Clough. The district described in this chapter lies in the ground represented on Sheets Jul, 107, 113, and 114 of the Geological Survey Map of Scotland on the scale of one inch to a mile 1:63360

The district described in the present chapter includes a strip of country which runs along the western margin of the counties of Sutherland and Ross from the northern cliffs of Cape Wrath, across the Parph, Ederachillis, and Assynt to the chain of lakes that runs through the heart of Coigach. Several easily separable tracts of Torridonian strata can be distinguished along this belt. At the northern end a group of much-faulted outliers of these rocks covers most of the ground between the northern cliffs and Loch Inchard. After a considerable interval in which the Torridonian covering has been completely removed from the plateau of gneiss a detached outlier is found in Handa Island. To the south of another intervening tract of gneiss we come upon the huge detached outliers of Assynt with the long outlier of Rhu Stoer, while still further southward the Torridon formation gathers into a more continuous development and sweeps up into the great mountainous range of the Coigach Hills.

### Cape Wrath district

The area between Cape Wrath and Loch Inchard includes near its northern limits the desolate tract known as the Parph — for the most part a barren treeless waste, where dreary expanses of wet peat-moss alternate with bare and rocky or peat-covered hills. These hills, as is usually the case with Torridonian mountains, have no definite arrangement, but form isolated clusters or solitary peaks — the denuded fragments of the once widespread covering of sandstone. Of the former type of ground, the hilly district immediately north of Strath Sinairidh is the best example. It includes Beinn Dearg Mhor, Meall Dearg, Meall na Moine, and Creag Riabhach, all of which reach a height of over 1500 feet. Fasbheinn and Farmheall are the most conspicuous of the solitary peaks, the latter, with its capping of Cambrian quartzite, rising to 1709 feet. In striking contrast to the tameness and monotony of the interior are the stupendous vertical precipices of the northern coast-line, 600 to 700 feet in height, formed by the nearly horizontal sandstones of the Clo Mhor, between Cearbhag Bay and the north end of Sgriblann. Less lofty but equally precipitous cliffs of purple grit and sandstone extend along the greater part of the western shore-line between Cape Wrath and the mouth of Loch Inchard. They rise directly from deep water and present a steep unbroken front, save where a narrow gully marks a line of fault, or a streamlet has cut a deep ravine down to the sea.

The Torridonian rocks of this northern portion of the district have been divided into three zones possessing well-marked characteristics. The distribution of these zones is shown on Sheet 113 of the Survey Map, where they are distinguished by the letters t', t'', t■, and their order and general lithological characters are shown in the subjoined table:

	Average thickness
3. Upper Zone (t■)	Fine-grained, friable, banded and mottled, purple and yellow false-bedded sandstones. 250 feet
2. Middle Zone (t'')	Coarse false-bedded sandstones and grits, with pebbly bands at several horizons. 1000 feet
1. Lower Zone (t')	Coarse pebbly conglomerate. 100 feet

Although the upper and middle zones may be regarded as probably equivalent to portions of the Aultbea and Applecross groups respectively, it must be understood that the sub-divisions given above are only of local application, and do not correspond to the three main groups into which the Torridonian series of the more typical region further south has been divided. The basal conglomerate can be traced more or less continuously throughout the tract near Cape Wrath, but ceases to form the base of the series further to the south. Lower strata continually come in as the middle or arkose group thickens, and these conglomerates, while preserving their relative position, pass up into the series, thin out, and finally

cease to be noticeable as a horizon south of the Quinag area.

**(1) Basal Conglomerate** — This is a coarse accumulation of well-rounded pebbles ranging in size from that of a hazel-nut up to fragments 4 inches in length, set in a purplish or red sandy matrix composed of rounded grains of quartz and felspar. So compact is this matrix that, where the conglomerate is undisintegrated, the pebbles are found to break across more readily than to part from it along a joint-face.

An examination of the pebbles at various places shows the great majority of them to be composed of vein-quartz or red jasper, the former predominating. A small proportion are of quartzite, chert, and felsite, and occasional fragments of mica-schist, gneiss, and a dark-greenish porcellanous volcanic rock are also met with. The origin of most of these pebbles from some distant source has already been referred to, while their large size and uniformly well-rounded appearance seems to indicate the near vicinity of a shore-line and the frequent influx of stream-borne material.

The following localities are those where the basal conglomerate is best seen and most typically developed: Between Dail and Cnoc na Ba Ruaidhe at the mouth of the Kyle of Durness; immediately south of Cape Wrath Lighthouse; round the base of Fasbheinn, where the zone reaches its maximum thickness of 180 feet; Sheigra and Ballnacraig, along the north shore of Loch Inchar; north of Kinloch Bervie, where it is from 50 to 100 feet thick and contains some pebbles of green schist; along the north face of Creag Riabhach (5–100 feet); in the Achricsgill Water at the road side near Rhiconich; and on the west and north faces of Farmheall.

**(2) Grits and sandstones** — The rocks included in the middle zone, which occupy by far the largest area of the three divisions, consist of a series of red, purple, and chocolate-coloured coarse sandstones and grits, with occasional seams or thin bands of fine-grained red and purple sandstone and frequent pebbly bands. These last are especially developed near the base, either as beds of conglomerate or as lines of small, less completely rounded pebbles scattered sparsely through a sandy matrix. They are distinguished from the basal conglomerate by the smaller size of their pebbles and the frequent intercalations of grit and sandstone in them. False-bedding characterises the whole of the finer-grained members of the series, but is most frequent in the upper portion. These planes, due to current action, are often inclined at a considerable angle to the true bedding planes.

The rocks of this zone are well exposed along the cliffs of the west coast between Cape Wrath and Sheigra, and on the north from Bagh Cearbhag to the Geodha Sligeach, where they form a range of vertical precipices which at Clo Mòr reach a height of more than 600 feet. False-bedding is conspicuous in the finer sandstones along the top of these cliffs. It dips in the opposite direction to the true bedding, to which it is inclined at angles of 10°–15°. The rocks can also be studied on the summit and western peaks of Farmheall, on Fasbheinn, and on the hills on either side of Strath Sinairidh. The thickness of the zone on the west side of Beinn Dearg Mhor is at least 1100 feet, but decreases to the eastwards, and on Farmheall does not exceed 900 feet.

**(3) Banded sandstones** — The highest zone of the series is made up of fine-grained, friable, striped and mottled, purple and yellow sandstones, with occasional intercalations of grit. These strata usually occur in thin layers, and are false-bedded throughout. Their friable nature causes them to disintegrate readily, and the amount of loose crumbly debris that covers the surface on the hill-tops where they occur suggests that a large portion of them may not improbably have been removed by denudation prior to the laying down of the Cambrian quartzite upon them, as well as since their re-exposure after the removal of the quartzite. This zone caps the summit of most of the higher hills of the northern area, and forms the upper 50 feet or so of the cliffs between Bagh Geisgeach and Geodha Ruadh an t' Seannabhaid, four miles south of Cape Wrath.

A reference to Sheets 113 and 114 will show that the areas occupied by Torridonian strata south of Cape Wrath are arranged in roughly parallel bands that stretch across the country from south-west to north-east. These areas are in every case determined by faults that bound them on one or more sides. These dislocations, by letting down the sandstones against the harder underlying gneiss, have doubtless preserved them to some degree from the effects of denudation. The small outlier of conglomerate above Loch na Gainmhich, between Fasbheinn and Beinn Dearg Bheag, is indeed the only outlier without any flanking fault where the whole of the remnant of the Torridonian covering can be seen in its original unconformable relation to the gneiss below. These boundary faults arrange themselves in two

well-marked conjugate systems, their general trend being respectively from south-west to north-east and south-east to north-west. The downthrow of the north-west faults is invariably to the east, and these dislocations appear to be of later origin than the north-easterly series, which in several instances have been shifted or cut off by them.

Six to eight of the north-east lines of fracture have been mapped from Cape Wrath southward. The first of them crosses the headland of the Cape from sea to sea and lets down two small patches of the basal conglomerate, one of which is well seen capping the gneiss along the roadside near the lighthouse gateway, where it consists of a thin cake of coarse conglomerate, disintegrating into loose sand and pebbles, some of which are from two to four inches in length. The next fault, a mile further south, is of much greater magnitude, and produces a striking feature on the coast. An almost vertical fault-face of gneiss-walls is there seen to run up a narrow gorge for some distance from the sea, the downthrow being, as in the first case, to the south. The course of this fault inland is for the most part conjectural, but it probably reaches the northern coast and forms the straight cliff-feature which bounds the Geodha na Seamraig on the west.

From Bagh Geisgach another fault, also with a southerly hade, traverses the col between Sithean na h-Iolair and Cnoc a' Ghiubhais, bringing the banded sandstones of the highest zone down against the pebbly grits of the former hill, and shifting the main outcrop of the conglomerate more than half a mile back to the east along the eastern slope of Cnoc a' Ghiubhais. These banded purple sandstones continue southwards along the coast and form the upper part of the cliffs as far as Geodha Ruadh an t-Seannabhaid, where they are cut off by a small fault running in an E.S.E. direction. The false-bedded grits and sandstones of Cnoc a' Geodha Ruaidh dip steadily to the south at  $9^{\circ}$  to  $12^{\circ}$  till within a short distance of the mouth of the Strath na Caillich burn, where they become much disturbed. Finally the basal conglomerate, brought up by a small fault and a reversed dip to the north, is seen faulted against the gneiss by a powerful dislocation with a downthrow to the north, which runs eastward past the foot of Loch Geisgeach and loses itself under the peat-mosses of the Parph.

A narrow tongue of gneiss separates the Geisgach outlier from the next Torridonian area to the south. This is the most important development of this formation in the Cape Wrath area, since it covers a space of some 25 square miles, divided into two nearly equal parts by Loch Sandwood and Strath Sinairidh. The area is bounded on the north by the natural outcrop of the basal conglomerate, which runs north-eastwards with a sinuous course from the mouth of Loch Sandwood to the Chearbhaig burn, where it is shifted 2 miles to the north by a small cross fault. It then sweeps round the lower contours of Maol Meallach till it is cut off by the large fault which forms the eastern limit of the area as far as the foot of Creag Riabhaich. This fault, which thus throws back the Torridonian outcrop fully three miles to the south, is perhaps the most powerful of the north-east system of dislocations, and its downthrow on Creag Riabhaich, where it brings together the highest and lowest zones of the Torridonian, must be at least 1000 feet. It is continued over the summit of Beinn Dearg Mhòr, letting down the banded sandstones against the grits of the middle zone, and crosses Strath Sinairidh, after which its course is concealed by the thick covering of peat and drift that surrounds Loch Mhòr a' Chraisg.

Less than two miles further to the east, another parallel fault with a downthrow to the north crosses the area and shifts the outcrop of the conglomerate along the north side of Meall na Moine. The course of this fault west of Strath Sinairidh is marked by the strong feature seen along the hillside between Loch Coir à Phris and Loch Carn à Mharbhais Aite, where the dislocation runs along the centre of a shallow synclinal trough. On the north-eastern slopes of Meall na Moine the conglomerate is again cut off by another fault having north, which forms the boundary of the area for four miles westwards as far as the small burn flowing into the head of Loch Carn à Mharbhais Aite. From this point the natural base line of the Torridonian extends westwards, shifted by two or three cross faults, to the head of Loch Innis na Ba Buidhe, where it is once more truncated by the Meall na Moine fault referred to above. The basal conglomerates are well exposed on the hill slope north of the Free Church, where they dip north and northwest at  $5^{\circ}$ – $12^{\circ}$ .

The western boundary of this tract of Torridon Sandstone is largely determined by the powerful fault that runs S.S.E. from Rudh' an Fhir Leithe to Kinloch Bervie, south of which its course is probably indicated by the straight western shore-line of Loch Inchard and the valley of the Garbet Beag river. For nearly three miles north from Loch na Claise, and again along the east side of Cnoc Poll a' Mhurain, the grits and sandstones of the middle zone are brought against the gneiss; but, as the fault runs for the most part along a peaty hollow, the actual junction of the two formations can nowhere be seen. Between Blarmor and Sheigra, and along the coast from the latter place to Ruadh' an Fhir Leithe, the lower

Torrignonian strata rest unconformably upon the gneiss on the west side of the fault, forming two irregular patches much cut up by small parallel cross faults. Coarse pebbly grits and conglomerates dipping north-west at 8°–15° rise in a series of craggy knolls and escarpments about Blarmor and Ballnacraig, and the unconformable junction is well seen along the base of the cliff at Sheigra and on the shore at the mouth of the Loch Poll à Mhurain burn. Other small outliers of conglomerate occur on Eilean na h'Adaig (two miles north-west of Kinloch Bervie) and among the blown-sand hills at Old Shore More.

The southernmost of the Torrignonian areas between Cape Wrath and Loch Inchard lies immediately to the west of the Durness and Rhiconich road, and includes the conspicuous ridge of Farmheall and the lower heights of An-t-Socach, Creag Riabhach, and Meall na Moine. In this outlier also the effect of faults in producing an extremely irregular outline is well shown. By a series of parallel north-east faults the outcrop of the zones is continually shifted, as may be seen round the flanks of An-t-Socach and along the north side of the outlier, though there is reason to suppose that the irregularity may be here due in some measure to the uneven surface of the gneiss on which the Torrignonian strata were laid down. The basement bed along the north face of An-t-Socach is a coarse breccia containing large angular fragments of the underlying gneiss. This is the only locality in the Cape Wrath area where such a type of basal breccia has been observed, though it is of such frequent occurrence as a local base to the Torrignonian rocks further south, where it invariably indicates an uneven surface. It may be mentioned that at the head of the Allt Garbh, half a mile to the west of An-t-Socach, a small dome of gneiss, from which the beds dip away on every side, protrudes through the conglomerate and affords the first direct evidence of such an uneven floor.

Another small inlier of gneiss will be noticed among the conglomerates about ½ mile west by north of Loch Gainimh, and though it is shown on the map as cut off on the south side by a fault, it may not improbably also represent a prominence of the pre-Torrignonian surface.

The south-eastern limit of the Cape Wrath area is marked by the powerful line of dislocation that runs from the head of Loch Inchard to the north coast at Smoo and defines the eastern side of the Durness basin. The line of this fault almost coincides with that of the high road for some distance westwards from the Gualainn House. At the point where it leaves the road, about two miles north of Rhiconich, the basal conglomerate, here faulted against the gneiss, is well exposed in the deep ravines cut by the two streams that here join to form the Achrisgill Water. Coarse conglomerate composed of pebbles of vein-quartz, quartzite, jasper, and felsite, from an inch to four inches in length, is seen at the waterfall, both resting unconformably upon and faulted against the gneiss. Higher up the Allt Leacach the conglomerate alternates with beds of purple grit and sandstone, one to three feet in thickness, dipping east at 6° to 11°. Similar rocks, which with a southerly dip appear along the roadside between this point and the Gualainn House, belong to the lower part of the middle zone, and are in faulted conjunction with the gneiss which is exposed on the shores of Loch an Tarbhach Mòr (three miles north-east of Rhiconich). A cross fault, which comes down to the road a few hundred yards beyond the Gualainn House, cuts off the basal conglomerate round the end of Meall na Moine, and throws down the middle grits along the flank of Farmheall against the gneiss in the hollow between the Feur lochs and the Gualainn burn. Half a mile further north the main fault leaves the road for the course of the Dionard river, and a branch fault with a contrary downthrow cuts off the Torrignonian strata along the base of Farmheall. This fault has a downthrow to south-east, and brings the Cambrian grits, that rest unconformably on the sandstones over the summit of the hill, against the Torrignonian grits below the road. The Cambrian strata thus lie in a trough-fault at the apex of the triangle formed by the Durness basin.

In the Fasbheinn outlier, which occupies an area one mile in length by half a mile in breadth immediately to the west of Loch Airidh na Beinne, the Torrignonian strata rest unconformably upon the gneiss, except at the south-east corner, where the lowest beds are cut off for a short distance by a branch of the Creag Riabhach dislocation. But for this interruption the basal conglomerate can be traced almost continuously round the hill. On the north-west face it attains a thickness of about 180 feet. The upper part of the hill is made up of the grits of the middle Zone, dipping S.S.E. at an average angle of 10°.

A smaller outlier on Beinn a' Bhacaidh, one mile south-east of Loch Airidh na Beinne, shows on its western side the conglomerates resting unconformably upon the gneiss and rising in successive escarpments, their dip being to south-east at angles of 10°–15°. A few hundred yards further east they are overlain by the Cambrian quartzite, which is

inclined in the same direction but at a considerably higher angle (30°–35°). The unconformable relation of these two formations is well seen here, the escarpments of Torridonian conglomerate being successively cut off by the scarped outcrop of the Cambrian quartzite. A short distance further eastwards the overlap is still more strongly marked, for the quartzite is there seen to rest directly upon the gneiss without the intervention of the conglomerate.

The powerful dislocation which crosses the Kyle of Durness at Keoldale, and runs north-west to Cearbhag Bay, throws down to the north two considerable areas of Torridonian rocks. In the smaller of these, which lies to the west and north of Dail, at the mouth of the Kyle, the basal conglomerates are well exposed at the roadside a little beyond the shepherd's house, and on the eastern side of the area near the track leading to the pier. The outcrop on this eastern side is extremely irregular, the conglomerate lying in tongues and small outlying patches among the hollows of the gneiss. An irregularity of this kind may be partly due to deposition on an uneven surface, but probably partly also to a system of small parallel faults which have shifted the outcrop and determined the steeper sides of the trough-like hollows in which the conglomerate appears.

## **Handa**

This island, about a square mile in extent, consists entirely of Torridon Sandstone. Its bold sea-cliffs are mostly inaccessible, but where the rocks can be reached they are found to consist of pebbly beds and coarse sandstones. An examination of the pebbles at the north-east corner of the island shows that, in addition to the usual quartz, jasper, and quartzite, the pebbles include fragments of purple and red porphyryite or felstone with pink porphyritic feldspars, a porphyritic ash-like rock, and grey sedimentary and greenish-white schistose rocks. Over the greater part of the island the strata are very gently inclined or almost flat. Towards the eastern side the E.S.E. dip becomes more pronounced and rises to 20° or 25°. This increase of dip is probably due to the effect of a large fault which, running through the Sound of Honda, throws down the Torridonian strata of the island against the gneiss of the mainland. This fault is possibly a continuation of the fault that runs north-east through Loch Dubh and Loch na Gualainn to the southern shore of Loch Laxford. Several crush-lines with hade to west, marking subordinate parallel faults, are seen along the eastern side of the island.

## **Ben Dreavie**

An impressive proof of the denudation which the Torridonian formation has suffered is furnished by a small outlier of false-bedded conglomerate and pebbly sandstone which caps the summit of Ben Dreavie, two miles to the south of Loch Stack. This isolated patch measures no more than 450 yards in length from east to west, 260 yards in breadth, and is only 50 or 60 feet in thickness. The pebbles in the conglomerate here reach a length of three inches, and consist mainly of quartz, jasper, and purple quartzite, while the finer bands contain abundant fragments of feldspar and pegmatite.

The fault with a downthrow to the south which runs along Strath an Staca, the glen to the north of Ben Dreavie, and the uneven surface of the gneiss, are together probably sufficient to account for the absence of Torridonian strata on the much higher summit of Ben Stack (2364 feet), a mile and a half to the north. But the further extension of the Torridonian rocks in this area is indicated by the purple staining of the gneiss around the outlier.

## **Quinag**

(Plate 31) — A Torridonian area of considerable size and roughly triangular in shape lies between Loch Cairn Ban and Loch Assynt, and forms the imposing mass known collectively as Quinag. This mountain rises abruptly on its northern side in two steep bluffs — Sail Garbh and Sail Ghorm separated by the deep corrie at the head of the Allt a' Bhathaich. On the west side it is flanked by precipitous cliffs, 500–700 feet in height, forming a line of escarpment that extends north by west for upwards of two miles. The extreme summit (2653 feet) lies a quarter of a mile south of Sail Garbh, and is capped with a small outlier of the Cambrian basal quartzite, which dips in the same south-easterly direction as the underlying sandstones, but at a higher angle. Spidean Coinich, the southern peak, is also covered unconformably with 150 feet of Cambrian strata which, extending down the eastern side of the hill in a long dip-slope inclined to E.S.E. at an average angle of 15°, rapidly transgress the successive beds of the Torridonian series which dip east by south at only 5°

to 6°.

The rocks included in the Quinag area may be referred to the middle or Applecross group of the Torridonian formation. They consist for the most part of massive false-bedded purple grits and sandstones with pebbly bands. On the summit of Sail Ghorm and in the upper part of the cliffs on either side of the Bealach Chornaich some beds of banded purple sandstones with seams of green and purple shale are intercalated with the grits. They seem to be of local occurrence, and are not to be regarded as belonging to a higher group.

Local basement beds of coarse conglomerate and breccia are found along the northern outcrop; and finer conglomerates composed of well-marked pebbles, and resembling the conglomerates of the Cape Wrath area, occur some 400 feet above the base along the southern slope of Spidean Coinich. The total thickness of the Torridonian strata on Sail Garbh is about 1700 feet, and on Spidean Coinich 1900 feet, this difference being probably in great measure due to the unevenness of the surface on which these sediments were laid down. A good section of the lower portion of the series is exposed in the Allt Saobhaidh Moire on the east side of Sail Garbh. The stream in the upper part of its course flows over long ripple-marked slabs of red grit and sandstone, with occasional bands of large scattered pebbles. Lower down, at the 700-foot contour-line, a small prominence of the uneven surface of the gneiss is seen protruding through the surrounding beds of coarse conglomerate and breccia, the latter of which contains blocks of gneiss 12 to 18 inches in length. The base is reached at 600 feet, and the unconformable junction with the gneiss is well seen between the burn and Loch nan Eun. The basement beds here exhibit large rounded and angular masses of gneiss scattered through a purple sandy matrix, succeeded above by coarse conglomerates dipping E.S.E. at low angles.

The Torridonian area narrows rapidly from Quinag eastwards towards Loch Glen Coul until it is completely overlapped by the Cambrian quartzite at a point half a mile east of the bridge crossing the Unapool burn. The most interesting feature of the Quinag outlier is the striking evidence which it affords of the irregularity of the surface of gneiss on which the Torridonian strata were deposited. The northern outcrop rises rapidly westwards from the 600-foot level at Allt Saobhaidh Moire to nearly 1500 feet on the north-west face of Sail Garbh. The basal conglomerate is seen in the Allt a Bhathaich corrie, but as the observer climbs the slope of Sail Ghorm on the further side of the hollow he finds the sandstones rapidly overlapping against the flank of a pre-Torridonian hill of gneiss which rises to a height of nearly 2000 feet above the sea and about 1200 feet above the general level of the gneiss-plateau. The steep northern face of Sail Ghorm affords several good vertical sections in which the relations of the Torridonian strata with the gneiss on the sides and summit of this ancient mountain can be studied. Purple grits and sandstones with bands of shale, well up in the series, here rest on the eroded surface of the gneiss, the hollows in which are in most cases filled with a basement breccia made up of angular fragments of the underlying rocks.

On the west side of Sail Ghorm the Torridonian outcrop drops rapidly to the 1000-foot level above Loch an Leothaid. A short distance further south it is stepped down by two cross faults to the 800-foot contour-line, which it follows to the head of Gleann Leirg, where it is cut off by the fault which follows the line of the pass. The natural outcrop is seen again on the south side of the pass, but its course is for the most part concealed by moraines and drift. The base of the Torridonian series is well exposed for some distance along the roadside under Lochan na Dunaich, three miles north-west of Inchnadamff, until a small fault brings it down to the shore of Loch Assynt, a mile to the west of Skiag Bridge (two and a half miles north-west of Inchnadamff). The basement bed that here rests on the uneven surface of the gneiss is not an ordinary breccia, but consists of large well-rounded pebbles and angular blocks of gneiss scattered irregularly through a finer-grained matrix.

## **Outlier of Stoer**

The whole of the peninsula of Stoer, which forms the most westerly portion of Sutherland and covers about eight square miles, is occupied by the Torridonian formation, in which the groups of strata represented in descending order in the following table have been recognised:

The prevalent dip throughout is towards the west, so that the rocks of the lower or Diabaig group, which are here peculiarly developed, occupy the base of the peninsula, while those of the Applecross group form its extremity. A line drawn from Culkein Bay on the north to Ballchladdich Bay on the south coincides with the junction-line of the two groups.

Owing to the extreme irregularity of the surface of the Lewisian Gneiss upon which the Torridonian rocks rest in this region, the sub-divisions Nos 1, 2, and 3 of the Diabaig group only appear on that part of the eastern margin of the area which lies to the north of Stoer Free Church, where they appear to fill what was a hollow in the gneiss. The conglomerate (1) is thickest about half-way between the Church and the township of Achucarnan, and dies out both towards the north and the south before the sea is reached in either direction. This deposit is singularly coarse, its large, well-rounded pebbles consisting of the Lewisian rocks of the region, especially of acid grey gneiss, which furnishes the largest blocks and the greatest number. The reddish sandstones or arkoses of No. 2 follow the outcrop of the conglomerate, passing out to sea northwards and dying out southwards against the gneiss near the Free Church. No. 3 is a conglomerate similar to No. 1, but its pebbles are not so large. It thins towards the north, and also passes out to sea in that direction, but extends southwards as far as Rienachait (one mile north of Stoer), where it abuts against the old gneiss ridge.

		Thickness in feet
Applecross Group	9. Purple and grey arkose or coarse felspathic sandstone, highly false-bedded, and including layers with scattered well-rounded pebbles of gneiss, felsite, quartzite, quartz-schists, &c.	2500
	8. Bright red, more siliceous, false-bedded sandstone, with a conglomerate bed at base containing pebbles of gneiss, quartzite, quartz-schist, &c.	900
	7. Red mudstones	150
	6. Green mudstones with layers of carbonaceous shale and thin limestone band, some layers showing worm-tracks and sun-cracks	150
Diabaig Group	5. Hard rib of sandy calcareous mudstone, with fragments of igneous rock	100
	4. Red mudstones and sandstones	900
	3. Conglomerate with well-rounded pebbles of Lewisian gneiss of local origin	150
	2. Red sandstone	200
	1. Conglomerate with large well-rounded pebbles of Lewisian gneiss of local origin	250

The dip of these groups of strata is towards W.N.W. at about 20°. Their outcrops are shifted by a large north-east and southwest fault, which coincides with the hollow at Achucarnan, and has a downthrow to the south-east of over 800 feet. On the south side of the ridge of gneiss shown on the map (107) the strata consist of sandstone and arkose, with a thin local breccia of gneiss fragments at the base. As all these beds dip towards the W.N.W. at angles of over 20° they must exceed a thickness of 600 feet, so that some of the lower beds may be the equivalents of Nos. 3, 2, and perhaps also of No. 1 as represented on the other side of the ridge. The conditions of deposit would thus seem to have been different on the two sides of the ridge in Torridonian time. When the junction of the Torridonian rocks with the gneiss is followed away from this ridge towards the south, the irregularity of the old gneiss surface becomes still further apparent. At Loch an Sgeirach the mudstones and sandstones of Band No. 4 are there seen to be in contact with the gneiss, while further south the presence of another old hollow is indicated by bed after bed abutting against the gneiss. The deepest point of the hollow coincides with the bend of the road south of Clachtoll, where local breccias represent Bands No. 3, 2, and 1. Bands 4, 5, 6, and 7 are most typically represented in the low cliffs on the north shore of Stoer Bay, where they follow

one another in unbroken sequence towards W.N.W. with a dip of about 25°. Further north they continue to dip in the same direction but at a steeper angle of dip. No. 4 can be traced inland across the peninsula to the sea on the north-east coast, but it is interrupted by some minor faults near Totag and by the large fault already mentioned as occurring at Achnacarnan.

Band No. 5 follows the same course, but dies out before reaching the north coast. From its hardness being greater than that of the mudstones, between which it is intercalated, its outcrop, interrupted by faults, gives rise to a series of eminences appropriately called drums or ridges, such as Druim Mòr and Druim Bheag (Big and Little Drums), and Druim na Claise (Drum of the Clash or Hollow). No. 6 is well seen on the shore near a small waterfall. At about three-quarters of a mile inland from the shore openings were made on the outcrop, and the carbonaceous shales and limestones were subjected to a long search for fossils, but the only evidence of organisms met with were some obscure worm-tracks. Some of the layers are covered with sun-cracks. As these beds are traced northwards they change character by becoming split up by coarser sediments, so that they become hardly recognisable on the northern shore. Band No. 7 follows the outcrop of the underlying strata, and in this case also the mudstones are replaced by coarser sediment as they pass northwards.

The sandstones of Band No. 8, which form the uppermost zone of the Diabaig group as here developed, are hard, siliceous, and of a bright-red colour. They are well displayed round the Rudh a' Mhill Dearg (Point of the Red Hill), whence they can be traced northwards across the fields of the Clashmore township to the southern shore of Culkein Bay.

The junction of these sandstones with those of the arkoses of the Applecross group which form the rest of the peninsula can nowhere be seen, since it is concealed at the heads of Culkein and Ballchladdich Bays under beach-deposits and blown-sand, and over the intervening ground under a covering of glacial deposits. There can be little doubt, however, that the junction is a faulted one. The arkoses on the west side of the Bay of Ballchladdich are much shattered and crushed, and as the dip is towards southeast at 20° for a mile further west without any of the Diabaig beds coming up to the surface, the strata exposed in Ballchladdich Bay must lie at least 1000 feet above the base of the group. The fault must therefore be a large one, with a downthrow to the west. Along the shore beyond Rafan the arkoses roll over an anticline and continue dipping towards the west to the lighthouse. The axis of this anticline crosses the peninsula in a north-easterly direction and passes out to sea on the west side of Culkein Bay.

The north coast presents the finest and most continuous section of the rocks in the peninsula. They consist of massive bands of purplish and reddish arkose, varied only by a few intercalations of shale near Rudh' an Dunain (Point of the Hill Fort) and occasional pebbly bands, which are best seen on the Point of Stoer. From Rudh' an Dunain, where the dip is towards the west of north at angles of 5°–15°, the angle of inclination gradually increases till, near the bend in the coast-line, it reaches 50°. Further westwards it decreases, until near the Point of Stoer it becomes reversed for a short distance, so as to give rise to a shallow syncline. This structure favours the formation of cliffs. Hence on both sides of the point the finest precipices on the promontory rise from 200 to 400 feet above the surf. The "Old Man" of Stoer, which is a well-known sea stack and landmark, consists of a pile of arkoses dipping at a gentle angle seawards. Its isolation has been determined by the influence of two great systems of nearly vertical joints by which the strata are here traversed, and which have guided the sea in its destructive action on the coast.

## **Beinn Gharbh and Beinn Reidh**

On the south side of Loch Assynt opposite Quinag another striking outlier of the Torridon Sandstone, which rises into the ridge of Beinn Garbh, is more especially interesting to the geologist inasmuch as it shows clearly the double unconformability of the Cambrian, Torridonian, and Lewisian groups of rock. This feature is well seen from the northern margin of the lake. Standing on the roadside, the observer has the unconformable relations of the Cambrian to the Torridoman, and of the latter to the Lewisian, at once in view to the north on the slopes of Quinag above him; while looking southward across the loch he can easily trace the same two strati-graphical breaks admirably displayed on the northern slopes of Beinn Garbh. The quartzites are there seen gradually to creep over the successive beds of sandstone until they rest directly upon the Lewisian Gneiss at the foot of the hill. The sedimentary strata of this hill and its neighbour, Beinn Reidh, contain several intrusive sills of red porphyry, which are described in a later chapter, together with the other



post-Cambrian igneous rocks. Intruded at a low angle between the beds of sandstone, they form conspicuous features along the steep hillsides and to a large extent cover the flat top of Beinn Reidh.

## Canisp

(Plate 31) — The next area of Torridonian rocks to the south forms the isolated ridge of Canisp, which, as is well shown on the map (Sheet 101), runs in the same north-westerly direction that is followed by the main geological structure-lines as well as by the other physical features of this part of the district. The ridge at its north-western end is rather less than three-quarters of a mile broad measured between the junction of the sandstones with the gneiss on the two sides, but towards the south-east it widens out to a breadth of a mile before the sandstones are overlain by the quartzite. From the summit (2779 feet) the north-western front of the ridge descends a thousand feet in three-quarters of a mile to the Torridonian base. The declivities on either flank are much steeper, so as to form precipitous cliffs.

These rapid slopes belong entirely to the Torridonian escarpment, for immediately below it the gneiss plateau shows its characteristic undulating surface. In a south-easterly direction the crest of the ridge falls much more gradually across the dip slopes of the quartzite, until in a distance of three miles and a half the ground reaches the 500-foot contour-line in the valley of the River Loanan.

The highest point and eastern slope of Canisp are covered unconformably by the basal beds of the Cambrian quartzite, which form merely a cake on the upper part of the ridge. Underneath this covering purple false-bedded gritty sandstones intercalated with bands of green and purple shale rise one above another on the face of the cliffs. The steepest portions of these precipices, however, are due to successive sills of porphyry, 20 to 60 feet in thickness, which have resisted denudation better than the surrounding sediments. These sheets of intrusive rock belong to a series of igneous masses which have been injected into the various formations of this district since Cambrian time. Here they have been intercalated more or less parallel to the bedding of the strata, and have long been known to geologists by the name of "Canisp porphyry".

In Canisp the Torridonian Sandstones are inclined towards the east — that is, in the same direction as the overlying quartzite, but at an angle which does not exceed 6°, while the inclination of the Cambrian strata rises to 10° or 15°. On the south side of Canisp, a little to the north of Lochan Fada, a coarse basal conglomerate made up of locally-derived pebbles, 1–5 inches in length, rests on the eroded surface of the gneiss.

## Suilven

Of all the singular eminences into which the Torridon Sandstone of the North-West of Scotland has been carved by denudation, this mountain is certainly the most remarkable. It forms another of the north-west and south-east ridges above referred to. Seen from the north-west, it seems like a colossal ruined pillar with steeply-shelving sides and blunted top, rising to a height of 2399 feet above the sea and at least 1800 feet above the average level of the gneiss plateau between its base and the sea. (See (Plate 31)) Hence it stands out from among all the cones and other shapes of the Torridonian rocks as a unique feature in the landscape of the North-West Highlands. From the south or the north it appears as a long rugged ridge with precipitous flanks and a seaboard front which descends rapidly to the gneiss plateau below.

The Torridonian outlier to which Suilven belongs stands on a long ridge of gneiss between two important valleys with chains of lakes. It shows even more impressively than Canisp the dependence of the topography upon enormous denudation guided by the tectonic arrangement of the rocks. The great lines of displacement in the gneiss and the multitude of dykes in this part of the district all run in a general north-westerly direction. The outlier follows the same trend, the Torridonian strata forming a ridge four miles and a half long and about half a mile wide towards either end, but diminishing in the middle to less than a quarter of a mile. Of this ridge Suilven forms the north-western and highest portion, where for nearly two miles the sandstone scarps rise much above the rest of the ground to the south-east. Unlike Canisp, this outlier is entirely isolated on the gneiss, and in no place has retained the cover of Cambrian quartzite.

With the exception of a thin local breccia, derived from the underlying Lewisian rocks, which is not constant, the outlier consists of the typical arkose of the Applecross group. A pile of these strata, 1600 feet thick, in nearly horizontal beds, is exposed along the cliff on the north face of Casteal Liath (Grey Castle), the western peak of Suilven. Though almost flat, the sandstones over the greater part of the outlier have a gentle south-easterly inclination at an average angle of 3°, but at the south-east end for a short distance from the margin the dip is in the opposite direction.

The surface of the gneiss upon which the strata rest is somewhat uneven. This feature is most conspicuous towards the eastern extremity of the ridge on the slopes overlooking Càrn Loch (crooked lake) and Lochan Fada (long lakelet). On the ground between these lochs the escarpments representing the outcrops of massive beds of arkose are seen to abut successively against the gneiss. Near the shores of Càrn Loch knobs of the gneiss protrude through the arkose and breccia, and in one case the knob is seen to be under-cut, so that the breccia actually Ruses underneath the gneiss. About a quarter of a mile from Càrn Loch and close to the footpath leading to the ruins of the shepherd's house of Bracklach cracks in the gneiss are seen to have been filled in from above by sand and breccia of the basement beds of the outlier. Similar cracks with their infilling of Torridonian sediments may be seen on the north side of the ridge near Lochan Fada. Again, at a point in Gleannan a' Mhadaidh (Wolf's Glen), a little to the west of a loch of that name, wide cracks in the Lewisian Gneiss and in its basic dykes are filled in with breccia and arkose similar to the material which makes up the basement Torridonian rocks, while the surrounding gneiss is much reddened, weathered, and epidotised. We may, therefore, infer that the Torridonian strata have only comparatively recently been denuded from off this ground. That at the time of the deposition of the Torridon Sandstone a hollow in the gneiss lay to the north of the Suilven outlier is indicated by the Torridonian rocks passing beneath the waters of Lochan Fada, although their dip is away from the loch. The platform of old gneiss to the north on which the Torridonian outlier of Canisp rests, lies more than 600 feet higher than the base of the Torridonian rocks in Lochan Fada. Part of this difference of level may be accounted for by a fault which runs along the length of Lochan Fada and the Gleann Porcha (dark glen); but this fault has only a throw of 300 feet down to the south-west, where it affects the outcrops of the Cambrian quartzite at a little distance to the south-east from Lochan Fada.

Not only were the Torridonian strata of the Suilven outlier laid down upon an uneven surface of gneiss, but the basement breccias contain every type of rock now to be found in the Lewisian series. It is thus clear that these ancient rocks had passed through their many vicissitudes prior to Torridonian time. Several faults cross the outlier. Some of these were of older date than the intrusion of the "Canisp porphyry", for the uppermost sill sends a tongue into the fault-fissure which cuts off the eastern peak from the rest of the mountain, while other later faults shift the continuation of the lowest sill to the north-west. One of these faults has a downthrow of 500 feet to the north-west. These igneous sills consist of the same rock as the Canisp porphyry, and they may have been continuous with those on that mountain, the connecting interval having been worn away in the stupendous denudation of this region.

## **Creagan Mór**

An outlier, more than a square mile in extent, lies between Càrn Loch and Loch Veyatie and partakes in the general north-west, south-east trend. Its summit, like those of the loftier ridges further north, stands near its north-western front, but is only 787 feet in height above the sea. It slopes gently southward and passes under the quartzite. The Torridonian strata here consist entirely of arkose, but at their base a local breccia of gneiss fragments is occasionally seen to fill up old hollows in the gneiss. The general dip is to the south-east at 10°.

## **Loch Veyatie to Loch Lurgan**

We now enter upon the more continuous belt of Torridon Sandstone which spreads as a broad belt along the western margin of Ross-shire and stretches as far as the southern point of Skye. The small portion of it to be here described presents the same disposition in ridges running from north-west to south-east and having their summits near their north-western ends. Two of these ridges are comprised between the Lochs Veyatie and Lurgan. The more northerly of them forms the massive mountain Cùl Mòr (2786 feet), which, seen from the east, looks like a gigantic prostrate female figure, the head lying far to the west, the breasts formed by the Cambrian outliers on the double summit, and the trunk and limbs sloping gradually eastward to the lower ground. Its western and northern flanks rise in a long line of noble

precipices. The southern ridge is its centre longer and more varied in outline. A depression in its centre between Loch Gainmheich and Loch Lurgan, where its level sinks to between 500 and 600 feet, separates it into two mountainous masses, Cul Beag (2523 feet) on the south-east and An Stac (Stack Polly, 2009 feet) on the north-west. Cul Beag resembles its northern neighbour in the precipitous front which it presents to the west and north. An Stac displays on its long summit ridge one of the most rugged crests anywhere to be seen in the Torridonian topography.

The rocks of which these mountains are composed belong entirely to the Applecross group, and vary little in character. The whole thickness of the strata of which Cùl Mòr is built up can be seen on the north shore of Loch Gainmheich, where more than 2000 feet of false-bedded purple grits and sandstones rise from the gneiss in a succession of huge terraced escarpments to the double summit of the mountain, each peak of which is capped with a thin cake of Cambrian quartzite. The general dip is south-easterly at angles of 6° to 8°, but in the extreme upper portion, where bands of fine-grained striped sandstone begin to make their appearance, the beds are nearly flat and the direction of dip uncertain. At the head of the grassy corrie that lies between the twin peaks a thick deposit of blown sand has been formed by the sub-aerial waste of the sandstone.

The irregularity of the surface on which the Torridonian strata were deposited is well exemplified along the northern foot of Cùl Mòr and around the shores of Loch Skinaskink and Loch Gainmheich. The coarse locally-derived breccia which here marks the base of the series runs westwards from Loch na Claise along the hollow of the Allt a' Chinn Gairbh, on the further side of which the gneiss rises in rounded hillocks 100 to 250 feet in height. The lowest Torridonian beds dip south at an angle not sufficient to carry them over the higher ground to the north, and though the breccia sometimes crosses the glen and is found on the steep slopes on the further side, it forms there only a thin skin, cemented to the surface of the gneiss by the decomposition and infiltration of certain constituents of the overlying sandstones. In this, as in other similar areas where the Torridonian rocks have been recently removed, the gneiss is generally epidotic at, and for some distance below, the surface. Outliers of breccia, in the form of thin cakes through which knobs of gneiss protrude, cover the summit of several of the rock knolls south of Loch a' Mhiotailt and along the eastern shores of Loch Skinaskink.

The unevenness of the ancient surface of gneiss is still more evident on the ground between Lochan Dearg and Loch na Doire Seirbhe, on the north side of An Stac. The base of the Torridonian is repeatedly shifted by a series of cross-faults having a downthrow to the west, so that the irregularities described in the foregoing paragraph are here repeated in many places amongst the hollows and rocky eminences that surround these lochs.

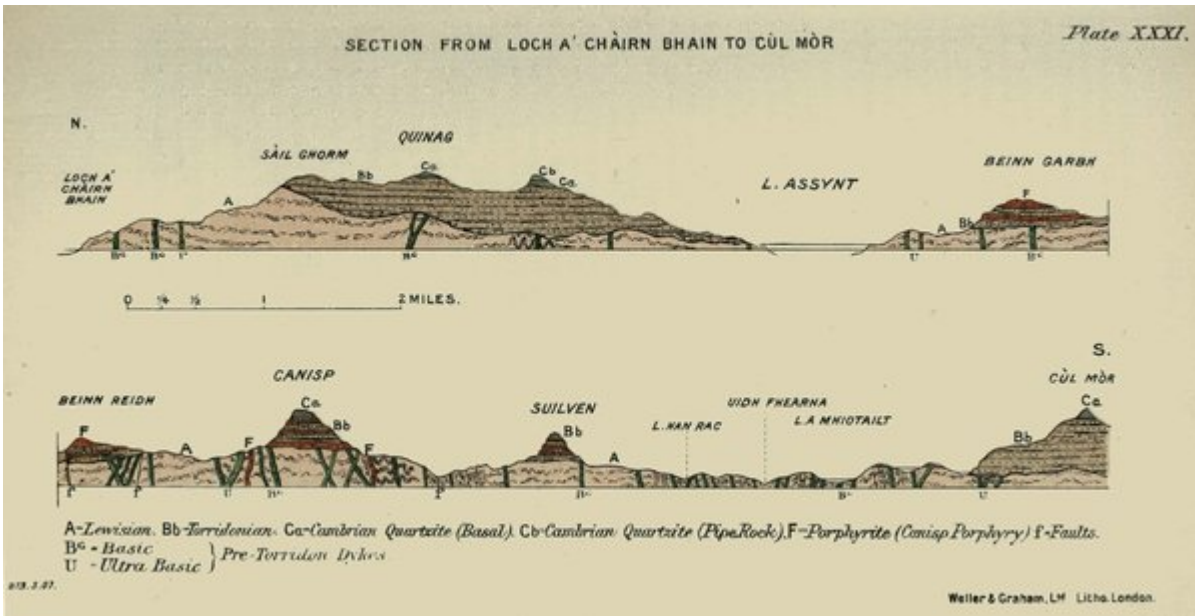
The arkose series thickens towards the south. The false-bedded grits and sandstones of Cul Beag, measured from the shore of Loch Lurgan where the base is not seen, reach a thickness of at least 2300 feet. The inclination remains steadily to south-east at an average angle of about 14°, and as the general slope of the eastern side of the mountain is about 18°, it forms very nearly a dip slope. The lowest beds at the foot of this mountain often consist of coarse pebbly grits, containing pebbles a quarter to three-quarters of an inch in length scattered irregularly through a sandy matrix. There are also intercalations of striped purple sandstone, while bands of green shale and flagstone occur at the roadside a quarter of a mile south and two miles west of the shepherd's house at Lineraineach on Loch Lurgan.

The junction of the Torridonian rocks with the overlying Cambrian quartzite is well exposed for nearly two miles along the lower course of the Allt an Liath Dhoire, immediately to the west of Drumruinie Lodge (one and a half miles south-east of Loch Lurgan). The coarse Torridonian grits and pebbly basal quartzite present at this place a deceptive appearance of conformity. Both series dip in the same south-easterly direction at angles of 15°–20°, the difference of inclination between the two being rarely more than one degree.

On the west side of Cul Beag the grits rise in a vertical escarpment several hundred feet in height, seamed by deep gullies cut by the streams along joints or lines of fault. The Torridonian rocks extend for some miles further westward through the Aird of Coigach, forming a smooth ridge mostly covered with morainic drift, but rising steeply to form the weathered serrated crest of An Stac, already quoted as an instance of a Torridonian mountain in an extreme stage of decay.

SECTION FROM LOCH A' CHÀIRN BHAIN TO CÙL MÒR

Plate XXXI.



(Plate 31) Coloured section from Loch a' Chairn Bhain to Cùl Mòr, showing denudation of the Torridon sandstone on the plateau of Lewisian gneiss.