XXIII.—*Supplementary Remarks on the Strata of the Oolitic Series, and the Rocks associated with them, in the Counties of Sutherland and Ross, and in the Hebrides.*

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[Read Nov. 16th, 1827.]

HAVING revisited the district of Brora and those other tracts in the Hebrides which I described in a memoir published in the Transactions of the Geological Society*, and, upon this latter occasion, having enjoyed the advantage of Professor Sedgwick's company, I am enabled to make some further observations, and to present many illustrative fossils, in addition to those noticed in the former list; which serve to confirm the existence and order of superposition of the strata of the oolitic series.

I must, however, preface these observations by a few remarks on the structure of the crystalline rocks which flank these secondary deposits on the east coast of Sutherland.

Granite.

The promontory called the Ord of Caithness, which constitutes the north-eastern termination of the deposits of the oolitic series in Sutherland, has been described as a "granitic rock, composed of much felspar and quartz, with a green substance in a decomposed state which may have been mica†." Now, although such is the prevailing character near its junction with the secondary strata, an examination carried on more in the centre of the mass has detected so many examples of well crystallized mica, that this rock must be considered a true granite‡.

In the previous memoir I stated, that wherever this rock comes in contact with the beds of the oolitic series, the latter are compounded into a remarkable breccia: and recent observation has not only fully confirmed the conclusion which I drew from these phænomena; viz. "that the granite of this

* Ante, page 293. † Page 294.

‡ This rock of the Ord has been described by Professor Jameson as "compact granite composed of felspar and quartz."—*Mineralogy: Scottish Isles.* p. 259.

coast must have been elevated at a period subsequent to the deposition of the oolitic strata*," but has also led Professor Sedgwick and myself to the conviction, that it has been upheaved in a solid form, and that, in breaking through those submarine deposits which might not perhaps have been originally in contact, it has so fractured and dislocated their beds as to have prepared them for reconsolidation in the state of a brecciated rock.

At the Ord of Caithness this granite occupies a vertical cliff upon the coast for nearly two miles, throwing off the old red conglomerate on its northern flank towards the plains of Caithness; whilst to the south it forms a lower and broken cliff somewhat within the sea line, and which occasionally protruding on the shore, exposes upon its edges the brecciated rock. This breccia is exclusively derived from the oolitic series of this coast, the fragments of which, consisting of shale, sandstone, limestone, and fossil organic remains, are united into a compact mass by a calcareous cement; which, near the Ord, has a stratified appearance, rising from ledges below the tidal level to the height of fifty or sixty feet in the cliff, and dipping S.E. at a high angle. Thence to Navidale the shore is formed of the breccia, and the cliff of granite; but the latter is here so decomposed as to assume the general character which induced me to apply the term "granitic rock" to the whole.

The higher portions of the cliff are covered by thick diluvial accumulations derived from the primary mountains of the interior. In one situation, well crystallized granite protrudes upon the shore; and there the brecciated beds in contact with it are tilted at high angles, in various directions from the subjacent points of the crystalline rock; but as soon as the granite recedes inland, the regular strata (the fragments of which form the breccia) begin to occupy their regular places in the series exhibited on this coast.

The extraordinary appearances accompanying a contact of the granite with these deposits near Portgower have been cursorily noticed†; but they merit a more detailed description. The sandstone and shale rising from the shore at a moderate inclination, occupy both sides of a ravine, where the superior beds are first seen assuming arched and tortuous forms, apparently owing to irregular and fractured masses of the lower beds, which are driven upwards, and wedged vertically into overlying shale.

On further ascending the stream, all the strata on both banks from the base to the summit are observed to be broken up into countless fragments, and in one part to form a conical hillock resting upon the granite which is disclosed in the bed of the burn. These phænomena seem clearly to prove, not only that the granite has been elevated after the deposition of the overlying strata,

* Ante, page 307. † Ante, page 306. Pl. XXXI. fig. 2. Portgower.

but also that the amount of disturbance in the latter is proportioned to the degree of proximity of the former. Hence we might expect, that where the granite disappears, a more full development of the secondary strata would take place,—and such is the case in this district; for with the recession of the granitic ridge, the regular formations of the oolitic series, from the sandstone of the calcareous grit down to the base of the inferior oolite, are laid open, including the coal-field of Brora*.

Thin bands of primary slaty rocks are occasionally interposed between the granite and the secondary deposits along the inland boundary of the vale of Brora. These consist chiefly of a quartzose gneiss, and their occurrence in the chasm above Clyne Kirk has already been noticed†: they have since been observed in the bed of a small rivulet which falls into the river Brora near the loch of that name, where they dip E.N.E. 55°, are traversed by numerous veins of granite, and, as above Clyne Kirk, are here also surmounted by an unconformable mountain of red conglomerate.

Granite of the Sutors of Cromarty.

In my first visit to these remarkable elevated ridges I was unable to examine their structure in detail, being prevented by stormy weather from disembarking at various interesting points under their precipitous and rugged cliffs. I was, therefore, induced to employ nearly all my time in collecting organic remains from those detached beds upon the shore, which have, I hope, been identified with the lias of English geologists.

I have since ascertained that the portion of the Sutors which consists of primary rock, is chiefly a feldspathose and quartzose gneiss, much foliated, and generally nearly vertical; but in many situations so decomposed as not to be distinguishable from some varieties of the granite of the Ord of Caithness. This gneiss is associated with subordinate slaty rocks, hornblendic and talcose, and is repeatedly traversed by large and small veins of true granite.

Many writers have contended (and it seems now to be pretty generally admitted), that the granite must have been in a fluid state at the period when these veins issued from its mass; and others have further presumed that the

* When the granite recedes from the coast, the beds assume their natural and low degree of inclination, varying from horizontality to dips never exceeding 20°. In the previous memoir on this district and in the accompanying map, the angle of dip at Dunrobin, Strathsteven, and other places in the immediate neighbourhood of the coal-field, has been rated too high; whilst, on the other hand, where the granite approaches the coast at Portgower, some of the beds which form reefs on that shore are inclined at the high angle of 80° instead of 70°, as marked in the map. See Pl. XXXI.

† Ante, page 295. Pl. XXXI. fig. 1, 2.

gneiss must then also have been in a state of softness. But, in whatever mode these ramifying and tortuous veins in primary rocks may have been produced, a very different explanation is requisite to account for the fractured and brecciated beds of the oolitic series which accompany the elevation of the granite on the coast of Sutherland. There, it is evident, that the granite, when upheaved, could not have been in a fluid state, since it has neither penetrated nor overflowed the contiguous masses of solid breccia. In such situations therefore, the disturbing rock was, at the period of its elevation, most probably in a compact and crystalline form; in which case, when forced up against the overlying strata, it must have fractured the sandstone, limestone, and shale, thus preparing the materials which, when re-cemented, formed the breccia above described. But we have additional evidence of the elevation of the granite *en masse* upon this N.E. coast of Sutherland, where it has not only brecciated the beds of the oolitic series, but has also thrown up the red conglomerate to the summits of many of the mountains, whose bases consist either of granite or of gneiss charged with granitic veins. In these positions, the old red conglomerate which, when undisturbed, passes beneath the oolitic series, and its coal-field of Brora, presents that anomalous appearance represented in Pl. XXXI. fig. 2. which, without explanation, might lead to the supposition of its being an overlying deposit.

If an adequate cause be required to explain the great upheaving of the granite upon this coast, may we not seek for it in some deeply seated volcanic agency, struggling in vain to expand its forces from beneath the vast mass of primary rocks of which the mountains in the north-eastern Highlands are composed? In reasoning upon this subject it is worthy of remark, that no trap shows itself in association with primary rocks on the north-eastern coast. This is however no objection to the hypothesis here started, for trappean or porphyritic rocks may have acted upon the base of the primary mountains as disturbing agents, without traversing the superincumbent mass so as to appear on their surface. On the contrary, trap being developed to a prodigious extent among the *secondary* formations in the Hebrides and in the south of Scotland, may it not be presumed that these latter deposits, owing to their structure and their extent, were more easily traversed, altered, and even obliterated by igneous operations of which they afford so many indications?

Red Conglomerate.

I offer no additional remarks upon the varied relations of that widely extended conglomerate which succeeds to the oolitic series, as it will hereafter be treated of in detail by Professor Sedgwick and myself. But in relation to this

district I may here state, that the subdivisions, which we hope to establish, induce me to assign that portion of it which flanks the Brora coal-field to the old red sandstone.

Oolitic Series.

Denudation of Braambury and Hare hills.

The limestone and sandstone of these hills constituting the highest beds of the Brora district, have, by means of their abundance of characteristic fossils, been identified with the calcareous grit beneath the coral rag. I remarked in my former paper, that these hills probably owe their present form to denudation; which supposition is now confirmed by the exposure on their surface of innumerable parallel small furrows and irregular scratches, both deep and shallow,—such, in short, as can scarcely have been produced by any other operation than the rush of rock-fragments transported by some powerful current. Upon my first visit, these markings being only imperfectly visible in one situation near the quarries, I was unwilling to enlarge upon the fact; but Mr. Barton, the director of these works, has since cleared away the turf from other parts of the surface, and these operations have uniformly exposed similar phænomena. These hills have been swept free of all gravel, except on the N. and S. of E., towards which points the beds are prolonged into the plain of Clyne Milltown, where there is a thick accumulation of boulders of the old red conglomerate mixed up with the softer detritus of the denuded hills. The furrows and scratches appear to have been made by stones of all sizes, which (with the occasional exception of lines slightly diverging, probably occasioned by the smaller pebbles coming forcibly in contact with the larger,) preserve a general parallelism with a direction from N.W. to S.E.* By a prolongation of these lines into the interior, the boulders of red conglomerate may be traced from the plain of Clyne Milltown to the mountain range which is composed of that rock, and particularly to the precipitous escarpments on the south of Loch Brora. Although the dip varies much on the different sides and summit of the denuded hills, being about 20° north on their north-western flank, and only 10° E. near the quarries; still in all such situations the furrows and scratches preserve an uniform direction from N.W. to S.E.; thus indicating the great force of a current, unaltered in its course by any inequalities of the surface over which it rolled. These appearances so closely resemble those in other places described by Sir James Hall and Dr. Buckland, that further detail seems unnecessary; and the large slabs which I have had the pleasure of presenting to the Society, completely elucidate the case.

* By compass.

In the annexed tabular arrangement will be found a list of all the additional fossils which the district of Brora has afforded; and they will be found to confirm the comparison which has been established between these strata and those of the English oolitic series included between the calcareous grit of the coral rag and the base of the inferior oolite.

Western Islands.

Loch Staffin.—Skye.

Freshwater Formation.*

No indications of secondary strata in a higher part of the series than the upper portions of the great oolite had been noticed in my previous memoir on the coasts of the Hebrides: but, as masses of shale and other beds are found in elevated positions in the Isle of Skye, between the coast and the central chain of trappean hills of which the Storr forms the leading feature, it might be conjectured without further evidence, that some of these belong to a still higher part of the secondary formations. In confirmation of this opinion may be stated the important fact, that in the low and ruinous cliffs of blue shale associated with zeolitic and amygdaloidal trap on the north-eastern shores of Loch Staffin, were found during my late excursion with Professor Sedgwick flattened masses of shelly limestone containing five species of cyclas, one paludina, one neritina? one ostrea, one mytilus, and some undescribed bivalves. It adds materially to the interest of these remains, that two species of the cyclas, the paludina, and the ostrea, prove to be identical with the fossils of one of the upper beds of the weald clay described by Dr. Fitton as occurring in Swanage Bay, Dorsetshire, and in the Isle of Wight. Here, therefore, we have a decided indication of a formation of freshwater—or, at all events, of æstuary—origin, which had never before been traced north of Aylesbury in England; and this would seem to prove, that, although the continuity of such deposits may have been more limited in extent than those of marine origin, still the causes which gave rise to a deposit of the former class in England, may at the same epoch have been producing corresponding effects in the north of Scotland, and in other widely distant localities.

Oolitic Series in the Hebrides.

It has been already stated that the highest observed beds of the oolitic series, representing the cornbrash or forest marble, are traversed by severa trap dykes at Beal near Portree in Skye. One of these, consisting of por-

* In the following pages the strata are described in their descending order. See Pl. XXXV.

phyritic greenstone, bifurcates upon reaching the summit of the cliff*. Professor Sedgwick and myself have since observed, that the extremities of the horizontal prisms of which the larger branch of this dyke is composed, consist of a dark green pitchstone, forming a band of about four inches in thickness, which, where not disintegrated, is seen in contact with the fossil limestone; the latter being apparently unaltered in its character. I am not aware that the existence of pitchstone in association with so recent a formation in Scotland has been hitherto noticed, and the fact is of importance in assisting us to limit the antiquity of those trap rocks which contain that mineral. In the Isle of Arran† it is extensively developed in the new red sandstone, from which formation it appears to have extended upwards through all the beds of the oolitic series in the Hebrides; for we again met with it at Carsaig on the south coast of Mull, forming the principal part of one of the numerous trap dykes, which there traverse the lias and inferior oolite. This latter dyke is about four feet in width, and is formed of horizontal prisms, the extremities of which consist of thin coats (two inches thick each) of blueish compact felspar rock, followed on either side by broader bands of greenstone, the centre being composed of about two feet of dark green porphyritic pitchstone; some veins of which penetrate through the exterior zones. Another trap dyke on this shore cuts through the lias, indurating the beds in contact, and sending out numerous veins, one of the largest of which envelops fragments of the lias shale including gryphites and belemnites. In this and many other situations, particularly in the cliffs east of Loch Buy‡, the presence of the trap seems to have converted the lias into Lydian stone, and the sand of the inferior oolite into a compact siliceous rock; whilst, in an equal number of cases throughout the Hebrides, the intrusive rock traverses the beds of these same deposits without producing the slightest alteration in them. The altered masses, however, chiefly predominate in those places where the masses of basaltic trap are of the greatest magnitude; as on the south coast of Mull, at the Inimore of Carsaig, or at the mouth of Loch Buy, and on the north-eastern coasts of Skye.

The organic remains collected on this last occasion in various parts of the Western Islands§, comprise many characteristic fossils tending to confirm the comparison already instituted, and to identify these deposits with the oolitic series and lias of English geology. If assiduous fossilists could devote

* Ante, page 310; and see Pl. XXXI. fig. 4.

† A memoir has recently been read before the Geological Society on the Secondary Strata of the Isle of Arran, in which Professor Sedgwick and myself have assigned the sandstone of the south-eastern and southern coasts of that island to the new red sandstone.

‡ See Pl. XXXV.

§ See the Supplemental Table, page 365.

a sufficient period to the examination of these coasts, they would find a rich harvest in those splendid cliffs on the north-eastern coast of Skye, which, between Portree and Holm, rise to the height of six or seven hundred feet, and also in those of Scrapidale on the S.E. coast of Rasay where the escarpment is equally magnificent;—both of which exhibit the several formations from the cornbrash down to the lias. In these localities the beds abovementioned are perhaps as fully developed as in any part of England: for the trap, which so generally obscures the stratification in the Hebrides, is here omitted; and the beds, being usually horizontal and little altered, afford a vast variety in their zoological contents.

It has been deemed impossible to load the pages of the "Transactions" with the numberless details which are exhibited in the detached coast sections of the Hebrides; but the following account of the succession of beds forming a part of the N.E. coast of Skye, may serve as an example of the kind of evidence upon which the conclusions of this and the preceding paper are founded. At the distance of nearly two miles from the valley of Beal, the high ridge of trap recedes from the cliff, and ranging round to the western flank of Holm, from Scoribrick to the Storr, leaves an elevated elliptical plateau about six hundred feet above the sea, of one mile and a half in length, and nearly half a mile in its greatest width. The whole section, as exhibited in the cliffs commencing at the western end of this plateau, and terminating at the level of the sea near the Prince's Cave, presents the following descending order.

1. Sandstone, appearing at the base of the trap, and also seen in the green talus sloping from it.
2. Shelly limestone, representing by its structure and organic remains cornbrash and forest marble, about forty feet.
3. Great white sandstone, fifty or sixty feet thick, overlaid by a thin bed of fissile shale. The lower beds more slaty, containing vegetable impressions, and passing gradually into
4. Shale and sandstone, alternating in bands, and forming another projecting terrace perhaps two hundred and fifty feet thick. Few fossils were observed in these beds, but much carbonaceous matter, and some obscure impressions of vegetables.
5. A lower calcareous zone, the upper beds of which (twenty or thirty feet thick) consist of calciferous sandstone, containing small nodules of indurated limestone grit with fossils, and having thin layers of shale with belemnites. The belemnites are also found in subordinate sandy beds.
6. Shale, dark blue, much more unctuous than the shale No. 4, containing many fossils of the inferior oolite, as belemnites, terebratulæ, &c., with small blue calcareous concretions, which mark the dip of the strata.
7. Base of cliff. Sandstone of inferior oolite with very large concretionary nodules of limestone, containing the pecten æquivalvis, ammonites Murchisonæ, &c.,—thirty feet exposed, shale of lias appearing below.

The beds numbered 5, 6, 7, may be considered as subordinate to the inferior oolite; No. 5 only differing from No. 7, in not having nodules of the same enormous size, and in exhibiting in its upper portion a passage into the carboniferous sandstone. Shale, No. 6, is thus decidedly included in the inferior oolite. These alternating beds of sandstone and shale are both in their mode of grouping, character, and contents, identical with the strata above the alum shale on the Yorkshire coast. All this section, from the great white sandstone, No. 3, which forms the principal projecting terrace of the plateau, is best seen at one view from a small waterfall, situated about half way between the Prince's Cave * and the western termination of the escarpment. This waterfall successively exposes each of the formations, and shows in a remarkably distinct manner the shale overlying the lowest or fossil beds of the inferior oolite.

The deposits of the oolitic series have further been observed extending to several localities where they had not been previously noticed. On the North-east coast of Mull, at or near Tobermory, the sandstone of the inferior oolite is quarried for building, and is seen resting upon lias, containing the Gryphæa incurva, the whole being overlaid by zeolitic trap. The same secondary formations are found on the mainland side of the Sound of Mull, in Morvern and Airdnamurchan, indicating a probable continuity at a former period with those of the islands. Lastly, we discovered lias limestone at Applecross, on the western coast of Rosshire, directly opposite to the great development of the same system in Skye, Rasay, and Pabba. At Applecross the beds rise from the southern shore of a small bay, at a gentle inclination, to the height of several hundred feet above the sea level, and repose upon the red-sandstone of the western coast, which here swells into very lofty mountains, the strata dipping to the N.W.

A section near the mill at Applecross exposes the following beds associated with the lias limestone.

No. 1. Beds of shale and sand slightly calcareous with many imperfect fossils;—one foot to one and a half.

2. Blueish limestone containing wood, pentacrinites, gryphites, ammonites, pinnæ, &c., with sand occasionally interposed;—two to three feet.

3. Calcareous gray gritty limestone, compact, quartzose, and void of fossils, but charged with veins of carbonate of lime;—four feet.

4. White conglomerate with quartz pebbles, cemented by calcareous matter;—three feet.

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* One of the numerous stalactitic caves on the shores of these islands: it is said to have afforded shelter to the unfortunate Charles Edward.

No. 5. Impure calciferous gray gritty limestone.

6. Blueish limestone with a structure approaching to oolite. The laminæ coated with white calcareous powder.

The blue limestone, No. 2, occupies a part of the shore, where it forms a natural quay for the space of three or four hundred yards. In appearance and fossils, it is identical with that of Broadford in Skye. The calcareous conglomerate, No. 4, also agrees with a similar bed at Broadford, and is not to be distinguished from the white pebbly conglomerate in the lias at Shepton Mallet, Somerset, and the neighbourhood of Bristol; whilst the oolitic blue limestone, No. 6, has a precise equivalent in beds of lias at Cowbridge, Glamorganshire *.

These beds at Applecross are of high geological interest, and lead us to suppose that they must have been, at one period, connected with the similar analogous deposits in the opposite islands, which have been already noticed with great accuracy of detail, by Dr. MacCulloch, in his "Western Islands."

There are, however, some beds in Lucy Bay, Skye, belonging to the very lowest part of this series, which, although agreeing in position, and in some of their characters, with those just described, still seem to claim a distinct enumeration, from a peculiarity of composition in some of them, and from their containing very remarkable organic remains:—

No. 1. Upper beds of gray compact limestone of conchoidal fracture, alternating with thin courses of calcareous sandstone inclosing belemnites.

2. Thin beds of compact blue limestone with gryphites.

3. Thicker beds of grayish limestone, with bunches of polypifers of the genus astrea, which much resemble those of the madreporite limestone in the carboniferous series; but at the same time it must be observed, that, in the oolitic series of England, coralline bodies are occasionally found even in the lowest beds of lias, as, for instance, near Sodbury.

4. Calciferous grit.

5. Concretionary bed (two feet thick), containing a compressed mass of fossils, apparently those of the lias; the weathered surface of the rock displaying madrepores.

6. Greenish marly sandstone, passing into a yellow and green concretionary mass, which, on fracture, discloses large flakes of crystallized carbonate of lime.

The whole of these beds do not exceed forty feet in thickness; and, by their gentle dip to the N.W., they are carried under the dark-coloured mica-

* For the knowledge of the existence of oolitic lias at Cowbridge, Glamorganshire, I am indebted to Dr. Buckland, whose description of it, and also of the lias conglomerate at Shepton Mallet (Ante, vol. i. pp. 301, 303. N.S.), applies very aptly to the varieties of lias at Broadford, Lucy, and Applecross.

ceous shale of the adjoining island of Pabba. This shale appears therefore, from its position, to belong to the upper part of the lias ;—a conclusion which is strikingly confirmed by a most abundant suite of well preserved fossils, of which the greater number of the species have been identified as characteristic of that formation.

By way of concluding my remarks on the oolitic series of the Western Islands, it may be necessary to refer to the Section (Pl. XXXV.) which exhibits the succession of those deposits on the eastern coasts of Skye, from the highest beds in Trotternish in a descending order through the contiguous isles of Rasay, Scalpa, and Pabba, to the lowest lias limestone of Broadford and Lucy. In this section the overlying and intrusive trap rocks are entirely omitted, and the regular strata are alone represented. It is from this observed order, combined with the characteristic fossil shells in the several beds, that satisfactory evidence has been obtained for the establishment of the groups described in this and the preceding Memoir. At Applecross, only one small trap dyke has been noticed; and the strata being there undisturbed, the lias is superimposed on the red sandstone of the west coast, in an order similar to that which has been described on the east coast near Cromarty. From these instances of junction, in situations so far distant from each other, it may be inferred that the lias and oolitic series of the North of Scotland succeeded generally to the red sandstone and conglomerate, occupying perhaps large tracts, of which isolated patches are all that now remain ; owing to the elevation of granite, the intrusion of trap, and various other operations which may have subsequently affected the earth's surface.

Since the publication of the former part of this memoir, two small patches of blue clay, one of which is about forty feet thick, containing organic remains, have been discovered overlying the red sandstone and conglomerate, in a ravine at Gamrie*, near Troup Head, Banffshire. Through the urbanity of Dr. Knight and Mr. A. Murray of Aberdeen, the Geological Society was furnished with a portion of these fossils; they consisted entirely of fish, too imperfect to be

* I examined this coast in detail, Sept. 1826; but at that period the existence of these fossils at Gamrie was unknown, and they were only discovered in the subsequent winter by a great fall of blue shale, occasioned by the overflow of a mill-course. Professor Sedgwick and myself having in our recent excursion passed by another route to the south, we had no opportunity of examining the locality; and I have therefore availed myself of the information communicated by the gentlemen named in the text.

identified, imbedded in calcareous nodules of a subcrystalline radiating fibrous structure. Better preserved specimens of these same nodular ichthyolites have since been forwarded to me by Mr. Christie, through Mr. G. Anderson of Inverness; and from an examination of these, Mr. Pentland has been enabled to give the following interesting description. "Among the ichthyolites of Gamrie," Mr. P. observes, "there appear to be at least two distinct species. The first, an abdominal fish, with a single dorsal fin, placed over the anal; characters which belong to the genus Esox of the older zoologists: to this character, which places the ichthyolite in the natural order Esocii, may be added, its large pentagonal scales, and that very peculiar structure of the caudal fin, in which the radii all arise beneath the vertebral prolongation; a character existing in the fossil fish of Caithness mentioned by Mr. Murchison *, and in the Lepisosteus among living species.

"The second ichthyolite is evidently also an abdominal fish, but of a very different species, if not of a distinct family; although the imperfect state of the specimens do not permit me to speak positively as to the relative position of the fins, or to judge how far the two species resembled each other in that very peculiar structure of the caudal fin observed in the former. This second species, however, possesses a combination of characters, which seems to distinguish it from all other ichthyolites I have seen; namely, having the fins covered with very fine quadrangular scales, a character employed by Cuvier to distinguish the family of Squamipinnæ in his Ichthyological arrangement. The scales on the body are disposed obliquely, as in the ichthyolites of Thuringia, and in those of the magnesian limestone of England; on the other hand, the bones of the head are covered with osseous papillæ or mamillary processes, as in certain species of Silurus, and in the fossil Dapedium of the lias. The elongated form however of this Gamrie ichthyolite, the minuteness of its quadrangular scales, and the scaly coating which covers its fins, offer characters sufficiently precise, even in these imperfect examples, to separate it from any of the species above referred to; and still further from any of the genera of recent or fossil fish described by the older authors. There appears to be also, in the same calcareous nodules, a third species of ichthyolite, much larger than either of those above mentioned, which is characterized by very large pentagonal scales; but no fins are discoverable, and to what family or genus it may belong, cannot be decided without more perfect specimens."

* See Geol. Trans. ante, p. 315. Baron Cuvier having now favoured me with an account of these Caithness ichthyolites, a full description of them, accompanied by engravings, will appear hereafter in a joint memoir by Professor Sedgwick and myself.—R. I. M.

In addition to the fossil fish, however, it would appear from the contents of a letter from Mr. Christie, that the blue shale of Gamrie has been also found to contain vegetable impressions and other fossil remains, of an obscure character; but these are not sufficient to enable us to determine the exact place of this deposit in our secondary series*: it gains, however, additional interest, from the fact that chalk flints, with their characteristic organic remains, had been discovered in considerable abundance on the granite of the neighbouring shire of Aberdeen near Peterhead; an important observation, first made by Dr. Knight, and afterwards verified by Dr. Buckland and Mr. Lyell.

* It is to be remarked that some of these calcareous nodules upon being broken transversely exhibit portions of galena.

SUPPLEMENTAL TABLE OF FOSSIL SHELLS.

The Figures refer to "Mineral Conchology," and the new species have been named by Mr. Sowerby.

List of Species and their Localities in	*Formations and Localities in which the same Species occur in*
SCOTLAND.	*ENGLAND.*
Braambury Hill quarries or highest beds in the Brora district, consisting of rubbly limestone and siliceous sandstone.	Calcareous grit and sandstone, or base of the coral rag formation.
Chambered Univalves.	
Ammonites, new species, much resembling A. cordatus	Shotover Hill, Oxon.
Belemnite (Cast of).	
Univalves.	
Melania Headingtoniensis. Tab. 39. . . .	Headington Hill, Oxon.
Bivalves.	
Lima rudis. Tab. 214. fig. 1.	Headington Hill, Oxon; Calne, &c.
Pecten fibrosus. Tab. 136.	Oxfordshire.
——— vagans. Tab. 543. fig. 3, 4, 5 . . .	Malton.
——— vimineus. Tab. 543.	Malton.
——— new species, with concentric laminæ (large shell).	
Trigonia, much resembling T. clavellata . .	Weymouth.
Terebratula ovoides. Tab. 100.	Figured from a specimen in gravel (Min. Con.)

SCOTLAND.	*ENGLAND.*
Reefs at Dunrobin, &c.	Oxford clay, shale, &c.
Bivalves.	
Gryphæa, differing slightly from G. obliquata. Tab. 112. fig. 3.	
Modiola, new species, longitudinally striated.	
Pecten, new species, striated.	
Plagiostoma duplicata. Tab. 559.	Malton oolite and cornbrash, Wilts, &c.
Terebratula media. Tab. 83.	Aynhoe, &c. Northampton.
A new species of gibbose shell resembling Unio.	
Venus, undescribed.	

Roof of coal, saltpans, &c.; Inverbrora.	Coal-field above the lias; East Moorlands of Yorkshire.
Bivalves.	
Cardium, new species (ribbed).	
Nucula, new species.	
Pullastra? large species.	

WESTERN ISLANDS.	*ENGLAND.*
Loch Staffin, Skye, blue clay and shale.	Weald clay? or some analogous Freshwater formation.
Univalves.	
Paludina, not figured	Weald clay; Isle of Wight, Swanage Bay.
Nerita or Neritina, not figured	Resembling Woolwich shells.
Bivalves.	
1. Cyclas media (Cyrena Lamarck), Tab. 527. fig. 2.	Weald clay; Sussex, Isle of Wight, and Swanage, Dorsetshire.
2. ——— larger species, not figured . . .	Identical with that found by Dr. Fitton, in Weald clay, Isle of Wight. (See Annals of Philosophy, Nov. 1824.)
3. ——— obovata. Tab. 162. fig. 4, 5, 6. .	Barton Cliff, Hants.
4. ——— new species, not figured.	
5. ——— new species, not figured.	
Ostrea, flat species, not figured.	Found with Cyclades 1 and 2 in the Isle of Wight.
Mytilus?	
A transversely elongated bivalve, not yet named or figured.	Weald clay, Isle of Wight. (See Annals of Philosophy, Nov. 1824.)
A bivalve referrible to Unio or Anodon.	

Oolitic Series.

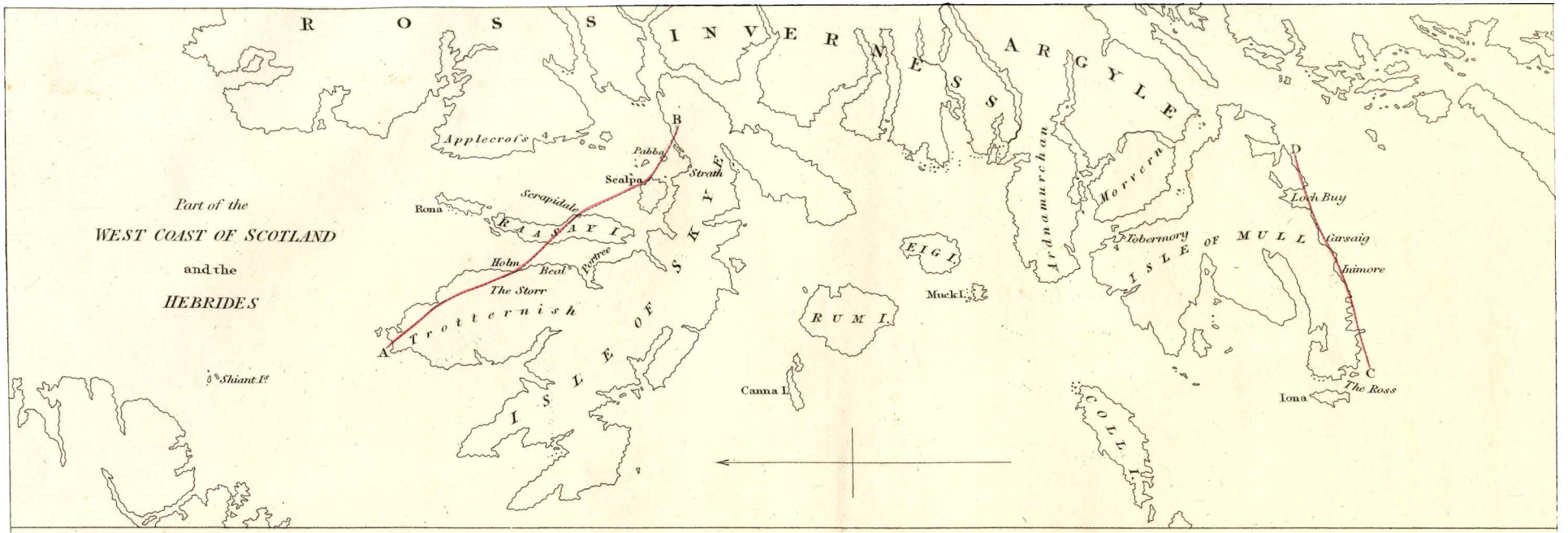
Upper beds of shelly limestone, overlaid by sandstone (See page 321.)	Cornbrash, Forest marble, &c.
Pentacrinites.	Oxfordshire, Dorsetshire, &c.

WESTERN ISLANDS.	*ENGLAND.*
Great arenaceous formation, with subordinate beds of shale; the lower beds of sandstone containing very large nodules charged with organic remains.	Sand and shale of the eastern coast of Yorkshire, great and inferior oolite.
Chambered Univalves.	
Ammonites omphaloides, Tab. 242.	Weymouth.
——— new species.	
Serpulæ, Dentalia, Belemnites, &c.	
Bivalves.	
Astarte elegans? Tab. 137. fig. 3.	Babling Hill, Yeovil; Scarborough coast.
——— new species, unfigured.	
Avicula inæquivalvis. Tab. 244. fig. 2. . . .	Frethern, Gloucestershire; Kelloway, &c.
Gryphæa dilatata. Tab. 169. fig. 2. . . .	Kelloway oolite.
——— gigantea. Tab. 371. (E. of Carsaig, Scoribreck, Skye, Scrapidale, Rasay.)	Lias and inferior oolite.
Lucina crassa. Tab. 557. fig. 3. (also at Brora.)	Horncastle.
Nucula, unfigured.	
Plicatula spinosa. Tab. 245. (Scalpa, Scrapidale, Rasay).	Lowest beds of inferior oolite, and top of lias; Braunston Tunnel, Northamptonshire.
Trigonia, new species, approaching angulata . .	Oolite of Yorkshire coast.
Saurian tooth? associated with Ammonites, Terebratulæ, &c. (Scoribreck, Skye.)	

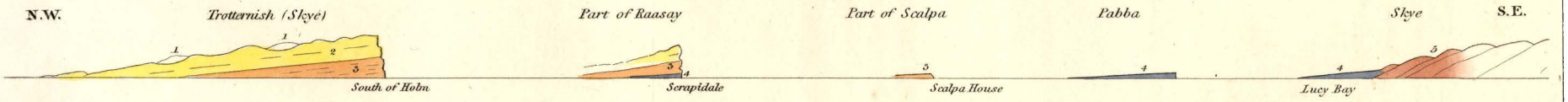
Micaceous shale and blue limestone.	Lias.
Chambered Univalves.	
Ammonites communis. Tab. 107. (Holm, Skye.)	Whitby, Lyme Regis.
——— Conybeari. Tab. 131. (Swishnish, Rasay, Carsaig, Mull.)	Lyme Regis, Bath, &c.
Bivalves.	
Gryphæa incurva. Tab. 112. (Carsaig.) . .	Whitby, Lyme Regis.
Modiola cuneata. Tab. 248. fig. 2.	Banbury.
Pecten, three new species, 2 striated, 1 plain. (Carsaig, Mull, Pabba.)	

WESTERN ISLANDS.	*ENGLAND.*
Plagiostoma gigantea, (Pabba. Tab. 77.) . .	Lias, Somersetshire, &c.
———— punctata. Tab. 113.	Pickeridge Hill.
———— new species. (Pabba.)	
Spirifer Walcotti. Tab. 377. (Carsaig, Mull.)	Pyrton Passage, Somersetshire, &c.
Terebratula punctata. Tab. 15. fig. 4. (Carsaig, Pabba.)	
———— tetraedra. Tab. 83. fig. 4. (Carsaig, Holm, Skye.)	Banbury, Oxfordshire.
———— new species (plaited), not figured. (Scalpa.)	
Polypifers of the genus Astrea.	Coralline bodies in the lias at Ledbury near Bridgwater.

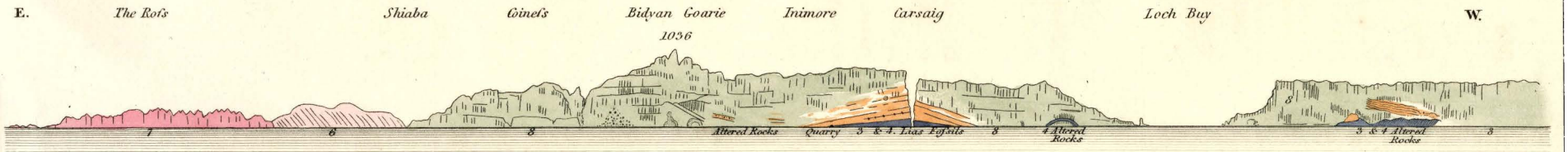
Note.—I have the authority of Mons. Adolphe Brongniart for stating that he considers the fossil plant of the Brora coal, which Mr. König has described as Oncylogonatum carbonarium (ante p. 300), to be a species of Equisetum which he has named Equisetum columnare. It is figured in M. Brongniart's new history of vegetable fossils (vol. I. Plate XIII.), and will be described in the forthcoming number of that work. This plant, which appears to be generally characteristic of the inferior oolite, and which has never been discovered among the vegetables of the ancient coal measures, has been found at Balbronn, department of the Lower Rhine—in the neighbourhood of Stutgard—and even at Baldissero in Piedmont. Specimens from these localities are now in the museum at Strasburgh, and are all in the same compressed state as those in the shale at Brora.—R.I.M.



SECTION ON THE LINE AB OF MAP.



SOUTH COAST OF MULL ON THE LINE CD OF MAP.



1 Fresh Water
2 Cornbrash For.r Marble &c.
3 Inferior Oolite
4 Lias
5 Red Sandst.
6 Gneiss Mica Schist &c.
7 Granite
8 Trap & Basalt

Oolitic Series