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## Chapter 2 Jurassic: General, Lias and Inferior Oolite

### General account

The Jurassic System consists of a lower marine series (Lias and Inferior Oolite) followed by estuarine deposits (Great Estuarine Series), after which marine deposits were again laid down (Oxford Clay, Corallian, Kimmeridge Clay).

Though forming the substratum over the whole of the area, the Jurassic rocks in North Skye are not very satisfactorily exposed. For the most part they underlie the Tertiary lavas or are distributed and altered by sills and dykes of the same volcanic episode; for the rest they are obscured in the north and west by peat and boulder clay and in the east by the great development of landslip from the lava-scarp. The remaining occurrences however, can be pieced together to give a connected account of the sequence of sedimentation in Jurassic times.

The earliest reference to the Jurassic rocks in Skye is to be found in Pennant's Tours in Scotland and the Hebrides in 1769 and 1772 (Pennant 1771, 1790) in which the author mentioned the occurrence of compressed ammonites in the strata at Duntulm. Observations on the Secondary rocks of Mull, Eigg and Skye are given in Jameson's Mineralogy of the Scottish Isles, published in 1800, and references to the Mesozoic rocks of the Hebrides generally are to be found in the letters of Mills (1790) and in the works of several foreign geologists, Saint-Fond (1799), Anti Boue (1820), Necker-de-Saussure (1821), von Oeynhausen and von Decken (1829), who visited these regions in the late 18th and early part of the 19th century.

Serious study of the Jurassic strata in Skye and the Hebrides generally owes its initiation to the work of Macculloch, who for so many years explored these regions in spite of the considerable difficulties of climate and transport. Since the publication of his Description of the Western Islands (Macculloch 1819, vol. 1, pp. 262–362), in which the Jurassic rocks of Skye were for the first time described, many eminent geologists have studied the sedimentary strata of this island. Sir Roderick Murchison during his visit to North Skye in 1827 (Murchison 1829, p. 358) examined an exposure of shales and shelly limestones in Staffin Bay to which he gave the name Loch Staffin Beds. The fossils collected on this occasion led him erroneously to correlate these beds with the Wealden of the Isle of Wight and the Isle of Purbeck.

In 1850 Forbes (1851, pp. 104–13) made a special visit to Staffin Bay in order to examine the beds described by Murchison. In his account of this visit he described the finding of 'numerous specimens of *Ammonites cordatus* and *Belemnites Owenii* and *Beaumontianus*, indicating the age of these shales beyond a question to be that of the Oxford clay' and 'beneath them in conformable succession... yellowish crumbly limestone and shale with estuary fossils' (p. 106).

These fossils from below the Oxford Clay were described by Forbes and were regarded as characteristic of the estuarine Loch Staffin Beds and consequently of what is now called the Great Estuarine Series. The publication of this work has unfortunately led to considerable misunderstanding for three reasons; firstly the correct designation of the locality is Staffin Bay, there is no Loch Staffin; secondly, several of the species described by Forbes as typically estuarine had previously been recorded by Phillips under other names from the marine 'Kellaways' of Yorkshire; thirdly the so-called Loch Staffin Beds are in the nature of passage beds to the marine Oxford Clay and are by no means typical of the Skye estuarine deposits as a whole. Consequently, though bearing the stamp of antiquity, the name Loch Staffin Beds is best avoided as being too fruitful of error (Anderson and Cox 1948).

James Bryce (1873), described the Great Estuarine and Oxford Clay strata of 'Loch Staffin', the 'Kelt Rock', Uig and Duntulm. Much of the confusion which has existed regarding the nature of the 'Loch Staffin Beds' must be attributed to Bryce. He described a section (Section VII on page 329) which is said to be at Loch Staffin and of which he stated "The section given by Prof. E. Forbes [1851, p. 106] is not in exact harmony with ours; but there is a general agreement" (p. 330). Bryce's section is clearly that given on p. 32 of this memoir and is three-quarters of a mile south-east of Rubha Garbhaig, and is not in Staffin Bay. Further this section is in the Concretionary Sandstones and the Lower '*Ostrea*' Beds and is entirely below (at least 120 ft) the section given by Forbes (p. 106) which represents the Upper '*Ostrea*' Beds and

Belemnite Sands and is in Staffin Bay. There is no agreement whatever between the two sections. In the appendix to this paper new species of fossils were described by Tate (in Bryce 1873, p. 339) and some of Forbes's species were revised.

In a general account of the Mesozoic Rocks in the west of Scotland, Judd (1878, p. 722) introduced the name Great Estuarine Series for the sediments lying between the Inferior Oolite and the Oxford Clay, including the Loch Staffin Beds of Murchison.

References to the Jurassic Rocks in Skye are also to be found in a summary of the Mesozoic rocks in Scotland given by Lee and Pringle in 1932, and in W. J. Arkell (1933). Malcolm MacGregor (1934) added considerably to our knowledge of the Jurassic sediments in North Trotternish. He recognized for the first time the presence of shales of Corallian and Kimmeridge Clay age in Staffin Bay. Anderson (1948) and Anderson and Cox (1948) described the Algal beds in the Great Estuarine Series and the stratigraphy and palaeontology of the Great Estuarine Series of Staffin Bay. In his account of the Great Estuarine Series of the Inner Hebrides J. D. Hudson (1962) included their development in Northern Skye.

The Jurassic sediments exposed in N. Skye range from the Middle Lias to the lower part of the Kimmeridge Clay (Sequanian). The Lower Lias, though seen a few miles to the south and in Raasay, is not exposed in the present area.

The following major divisions are recognized:

	feet
Kimmeridge Clay	40
Corallian Shales	170
Oxford Clay	90
Great Estuarine Series	about 600
Inferior Oolite Sandstone	375
Upper Lias Shales	about 100
Middle Lias Sandstone	about 240

The zonal sequence adopted in this memoir is that proposed by Spath in 1939 as best fitting the sequence of ammonite faunas found in Skye.

## **Middle Lias**

The Middle Lias, of Upper Pliensbachian or Domerian Age, consists of the Scalpa Sandstone, probably more than 100 ft thick. It falls within the Zone of *Pleuroceras spinatum*, the underlying Zone of *Amaltheus margaritatus* not having been recognized in northern Skye.

The Middle Lias, named the 'Scalpa Series' by Judd since it constitutes the main mass of the Liassic rocks on the island of Scalpa, is extensively developed in the Hebrides. It consists primarily of a fine-grained, calcareous sandstone, white, yellow or greyish in colour, distinctly bedded towards the base but tending to be massive in the upper part. There are, however, intercalations of sandy shales, especially in the middle. Both the shale and sandstone are highly micaceous. A characteristic feature of these beds is the occurrence of numerous large calcareous doggers which may reach 6 ft in diameter. They are generally in the form of flattened ellipsoids, the surface of which frequently exhibits honeycomb weathering.

## **Details**

In North Skye the Middle Lias Sandstone is exposed in the eastern sea-cliff at intervals from Camastianavaig to Holm. It was first noted in the Portree area by Murchison in 1829. Later, Bryce (1873) described sections in the same area (his Tanna Point is now known as Udairn), at Camastianavaig, and Prince Charles's Cave. The beds were first mapped by H. B. Woodward in 1896 and in 1920 G. W. Lee added a number of notes to the map and gave a short account of the Middle Lias of Skye in the memoir on North-east Skye and Raasay (Lee 1920). Reference has also been made to these

beds by Lee and Pringle (1932) Arkell (1933) and Richey (1935).

The most southerly exposures of the Middle Lias in North Skye are in the Portree area. At Creagan na Sgalain, the promontory east of Camastianavaig, the topmost beds appear from below sea-level. They consist of yellowish calcareous sandstone and sandy shale with *Pseudopecten aequivalvis* (J. Sowerby), *Gryphaea cymbium* Lamarck, *G. gigantea* J. Sowerby and *Tetrahynchia tetrahedra* (J. Sowerby). Four hundred yards further north they are sandstones with doggers, but beyond this point they are hidden beneath scree and landslip, except for isolated reefs in the beach, until Bryce's section at Udaim is reached. Here, immediately east of three conspicuous dykes the Middle Lias consists of a greenish sandstone with doggers and abundant *Pseudopecten aequivalvis*.

Further west, near the Scarf Caves, the Middle Lias comprises two distinct sedimentary groups, the upper part a hard sandstone with doggers 40 ft thick, the lower a soft grey shaly sandstone with doggers. *Tetrahynchia*, *Pseudopecten* and fragmentary ammonites are abundant in the upper portion, which Bryce probably correctly assigned to the *Paltopleuroceras spinatum* Zone. Tate in his appendix to Bryce's paper (Bryce 1873, pp. 344–5) listed a number of fossils from these beds on the basis of which he assigned the upper part to the *Paltopleuroceras spinatum* Zone and the lower to the *Amaltheus margaritatus* Zone. From the basal beds he identified *Prodactylioceras davoei* (p. 343) but this record has not been confirmed by later work. The sections are almost entirely in landslipped and broken ground so that exact measurements are impossible but the field-evidence suggests that only the upper part of the Scalpa Series is visible. In Raasay, recent work by Howarth (1956) has shown that the *Pleuroceras spinatum* Zone occupies 133 ft 10 in of strata and the *Amaltheus margaritatus* Zone 140 ft, whereas the thickest section in the Middle Lias in Skye, that near Holm Island, shows only 100 ft of sandstone. At Udairn only about 60 ft of Middle Lias is exposed above sea-level, all of which is sandstone like that forming the bulk of the *P. spinatum* Zone and the upper 28 ft of the *A. margaritatus* Zone in Raasay, and with no indication at the base of shaly beds like those which comprise the lower three-quarters of the *A. margaritatus* Zone and much of the *Prodactylioceras davoei* and *Tragophylloceras ibex* zones.

At Scorr Skerry, west of the Scarf Caves, the Middle Lias sandstones are faulted down to the west and are not seen again until they appear from below sea-level about half a mile north of Beal Point (Rubha na h-Airde Glaise), north of Portree. Northwards for three miles these beds form a sea-cliff often covered by scree and slip but here and there, as at Prince Charles's Cave, the highest beds, which are crinoidal and contain nests of Rhynchonellids, can be examined.

Bryce (1873, p. 326) gave a section at this point and described the Middle Lias as 'Close-grained hard calciferous sandstone, with intercalated, slightly ferruginous bands, and fossiliferous in the lower part chiefly. Thickness indeterminate, as it is continued under the sea-line. The leading fossils are, in the *Ammonites-spinatus* zone ; *A. spinatus*, rare; *Belemnites paxillosus* common,... *Pecten aequivalvis*, common ;... *Rhynchonella tetrahedra*, very common...'

The most northerly exposures of the Middle Lias are on the beach opposite and south-west of Holm Island and here again the sandstones are very fossiliferous.

Woodward (Lee 1920, p. 29) noted that the upper beds of the Scalpa Series in Skye, as in Raasay, contained both spinate and annulate ammonites indicating that the upper few feet of the sandstone should be classed as Upper Lias. This observation has been confirmed in Raasay by Howarth (1956, p. 362) who recorded 6 ft of 'Sandstone, massive with some calcified parts; *Dactylioceras* spp. indicating the *Tenuicostatum* Zone'.

Since the *D. tenuicostatum* Zone is apparently missing from the base of the Upper Lias it may be entirely within the underlying sandy beds. But, as Buckman (in Lee 1920, p. 76) has pointed out, the lowest 14 ft of the Upper Lias has been insufficiently explored and *Dactylioceras* of the *holandei* and *athleticum* types occur from 6 ft below the top of the Scalpa Sandstone to some 40 ft above.

## Upper Lias

The succession in the Upper Lias is as follows:

Fiurnean Shales	(? <i>Lytoceras jurense</i> Zone) =Dun Caan Shales of Raasay
non sequence	( <i>Hildoceras Bifrons</i> Zone not recognized)
Raasay Ironstone	
Portree Shales	( <i>Harpoceras falcifer</i> Zone and perhaps <i>Dactylioceras tenuicostatum</i> Zone)

The beds fall within the Toarcian Stage.

In Skye and Raasay the lowest zone found in the Upper Lias, that of *Dactylioceras tenuicostatum*, may also include the uppermost six feet or so of the Scalpa Sandstone. The Upper Lias itself consists entirely of soft, dark micaceous shale with occasional calcareous bands and nodules and a two-foot band of ironstone, the equivalent of the Raasay Ironstone.

## Details

Owing to the nature of the deposit the Upper Lias is nowhere clearly exposed, being usually more or less covered by slipped masses of the overlying rocks; thus its full thickness is not seen in any one place.

The most southerly exposure of the Upper Lias is at Creagan na Sgalain east of Camastianavaig. Here the shales are only 12 ft, and 400 yd farther north 5 ft thick and badly crushed. These localities are however involved in the Ben Tianavaig landslide so that a complete exposure of such incompetent strata is hardly to be expected.

To the north, 200 yd south of Udairn, Upper Lias shales with calcareous lenticles and ammonites (*Dactylioceras* and *Harpoceras*) are again exposed and still only 12 ft thick, but north of the Udairn Fault at least 40 ft of shale can be seen. North of Portree, below Sithean Bhealaich Chumhaing, the cliff-section exhibits 75 ft of Upper Lias shales whilst some 700 yd further north the following section is exposed:

	feet
<b>Upper Lias</b>	
Micaceous dark weathering shale about	40
Oolitic Ironstone (slipped?)	1
Grey micaceous, ferruginous shale with small irregular nodules of limestone and a layer of <i>Posidonia bronni</i> at the base	3
Soft, micaceous, light grey shale full of <i>Dactylioceras</i> , broken and slipped	17?
<b>Middle Lias</b>	
Sandstone with doggers	60

The most northerly, and best exposure of the Upper Lias is a little above sea-level at the foot of the cliff opposite Holm Island and also a few hundred yards to the south. Here Mr. Tait discovered a thin band of jet closely associated with ammonites *Harpoceras* aff. *exaratum* (Young and Bird) and *Eleganticeras elegantulum* (Young and Bird), which indicate a horizon in the *H. exaratum* Subzone. It is interesting to note that the well-known Jet Rock horizon of Yorkshire is also in this subzone. This jet band is estimated to be about 14 ft above the top of the Scalpa Sandstone, thus below it there is ample room for deposits of the *D. tenuicostatum* zone. The *H. exaratum* fauna continues for two feet or so above the jet band and then for about 30 ft, i.e. to the top of the section exposed at this point, the shales belong to the *H. falcifer* Zone. In the first 10 ft of this zone the fauna consists mainly of ammonites: *Dactylioceras* cf. *anguinum* (Reinsch), *D.* cf. *crassiusculum* (Simpson) *D.* cf. *holandrei* (d'Orbigny) and *Harpoceras* aff. *mulgravium* (Young and Bird). A line of calcareous nodules at about 10 ft up contained *D.* cf. *gracile* (Simpson), *D.* cf. *holandrei*, *Coeloceras* cf. *foveatum* (Simpson), a *Harpoceras* of the *falcifer* type and *Harpoceratoides*, together with the gastropods *Natica adducta* (Phillips) and ?*Pleurotomaria actinomphala* (Deslongchamps). In the shale surrounding these nodules *Phylloceras* sp., *D. gracile* ?, *Astarte* sp., *Lucina* sp., and *Inoceramus* sp. were found. Three feet higher were nodules with numerous *Dactylioceras*, in particular *D.* cf. *vermis* (Simpson) which also occurred in rusty, decalcified nodules a few feet higher still in the sequence. *D.* cf. *holandrei* recurs in abundance above this level accompanied by *Pseudolioceras*? and cf. *Harpoceras*.

Finally, about 8 ft below the position of the Raasay Ironstone *D. cf. athleticum* (Simpson) was recovered. Nothing is known of the fauna in this 8 ft of shale below the ironstone position.

Borings put down by Messrs. Baird near the mouth of the Berreraig River showed the ironstone to be 5 ft 9 in thick at this locality. In Raasay the ironstone is a sideritic chamosite-oolite, but in Skye is poor iron-carbonate rock with an average iron-percentage of 11.96, too low to be of economic value. The only fossils seen are the belemnite *Dactyloteuthis digitalis* (Phillips), several of which are rounded and worn, which supports Buckman's suggestion that the ironstone is a remanié deposit.

The shale above the ironstone is more arenaceous and harder than that below, and its fauna shows it to be Aalenian in age (?*Lytoceras jureense* Zone). Thus, as in Raasay there is a considerable non-sequence at the top of the ironstone and the Yeovilian and part of the Whitbian are missing. The fauna consists largely of species of *Cotteswoldia* e.g. *C. superba* S. S. Buckman, *C. costulata* (Zeiten), ?*C. crinita*, S. S. Buckman, ?*C. misera* S. S. Buckman, and ?*Walkericeras lotharingicum* (Branco), found 3 ft above the ironstone.

Between Holm island and the Berreraig River the generalized section is:

		feet
Fiurnean Shales (Aalenian)	Sandstone (base of Inferior Oolite)	50
	Sandy shales (no fossils recorded)	12
	Sandy shales (? <i>Lytoceras jureense</i> or <i>Pleydellia aalensis</i> Zone)	13
	non-sequence	
Raasay Ironstone ( <i>Frechiella subcarinata</i> Subzone)		2-5¾
	Micaceous shales with thin limestone bands and nodules ( <i>H. falcifer</i> Zone)	22-55
Portree Shales (Whitbian)	( <i>H. exaratum</i> Subzone)	2
	Jet Band	1
	Micaceous shales ( ?part <i>H. exaratum</i> Subzone) ( ?part <i>D. tenuicostatum</i> Zone)	14
Scalpa Sandstone		

## Inferior Oolite

The succession in the Inferior Oolite is as follows:

Garantiana Clay and Sandstone (*Garantiana garantiana* Zone)

Berreraig Grit (*Strenoiceras subfurcatum* Zone)

Rigg Sandstone (*Stephanoceras humphresianum* Zone)

Holm Sandstone (*Otoites sauzei* Zone)

Udairn Shales (*Sonninia sowerbyi* Zone)

Ollach Sandstone (*Ludwigia murchisonae* and *Leioceras opalinum* zones).

The Inferior Oolite (Bajocian) of the Inner Hebrides consists almost entirely of marine deposits, mainly sandstones, laid down not far from land as the common occurrence in them of fossil drift-wood testifies. The evidence from Skye and Raasay together shows that the succession is complete from the *L. jureense* Zone of the Upper Lias to the *G. garantiana* Zone of the Inferior Oolite. If deposits of the *Parkinsonia parkinsoni* Zone are present they are not represented by marine

strata but perhaps by the Oil-Shale and White Sandstone at the base of the Great Estuarine Series. The former appears to contain, in Skye, only *Neomiodon* and plant remains. Recently, however, Forsyth (1959) has found marine fossils in beds which he believed to be of this age near Storav's Grave in Raasay.

The Inferior Oolite is well developed in N. Skye, forming precipitous cliffs from Camastianavaig to Upper Tote, but the nature of the ground makes zonal collecting difficult. Enough has been done, however, to allow direct comparison with the sequence in Raasay where the beds are more accessible.

There are certain differences both in sedimentation and distribution of fauna between Skye and Raasay but the general succession remains the same in both islands. The lithological sequence in N. Skye is :

GREAT ESTUARINE SERIES: (Oil-Shale)	feet
Garantiana Clay: Clay passing into black sandstone	5
Berreraig Grit: Hard gritty calcareous sandstone full of shell fragments	about 50
Rigg Sandstone: Calcareous sandstone with numerous doggers	about 150
Holm Sandstone: Hard massive calcareous sandstone, variable, but usually about	30
Udairn Shales : Sandy calcareous shale with doggers	about 150
Ollach Sandstone: Hard calcareous sandstone with doggers	about 50
UPPER LIAS	

## Details

The most southerly outcrop of the Inferior Oolite in N. Skye forms the shore between Lower Ollach and Camastianavaig. Shaly sandstones with doggers emerge from below the Tertiary beds about 700 yd north of Lower Ollach and form a low cliff. The base of the sandstone is not seen but cannot be far below sea-level for the Inferior Oolite strata exposed here are not more than 15 ft thick and represent only the basal portion of the series. The greater part has been cut out by the overlap of the Tertiary sediments above.

At a point 400 yd N. of Creagan na Sgalain, east of Camastianavaig the Inferior Oolite is represented again by 15 ft of sandstone with doggers, belemnites and with phosphatic nodules at the base. It is overlain by a 2-ft greenish sandstone belonging to the Tertiary plant beds (see p. 75).

At Udairn the Ollach Sandstone and Udairn Shales are together about 150 ft thick; above these strata about 200 ft of massive white and yellow sandstone with doggers, the Holm and Rigg sandstones, are visible.

Northwards the lower shaly division (Udairn Shales) increases in thickness to 225 ft whilst the upper yellow sandstone thins to 150 ft.

North of Portree the Berreraig Grit is well exposed at Port a'Bhata (Figure 5) north of Ben Chraic where it forms the top of the sea-cliff. It is here about 30 ft thick and crowded with belemnites, Rhynchonellids and lamellibranch shell fragments. The overlying *Garantiana* Clay is weathered back for 100 yd or so from the cliff top and hidden beneath scree and slip from the overlying White Sandstone and Palagonite Tufts. Below the grit bed about 150 ft of yellowish sandstones with doggers are exposed, near the base of which is a band containing ammonites of the genus *Sonninia*. At the foot of the cliff a shaly fucoidal sandstone (Udairn Shales) with belemnites appears but is generally badly exposed. The Port a'Bhata section is in a block (horst) faulted off on both sides so that northwards the Berreraig Grit is brought down almost to sea-level again but the whole thickness of the Inferior Oolite gradually emerges until at Sithean Bhealaich Chumhaing the full thickness is seen for the first time. There is however a great deal of scree and the section given below is a composite one measured in the cliff between Craig Ulatota and Fiurnean (Figure 3).

## Section in sea-cliff at Fiurnean

<b>Tertiary:</b>	feet
Palagonite Tuff	160
Sandstones with plant debris	60
Dolerite sill	18
<b>Jurassic:</b>	
<b>Great Estuarine Series</b>	-
Black Shales (' <i>Estheria</i> ' Shales)	40
White Sandstone	100
Bituminous sandy shale	3
<b>Inferior Oolite</b>	
Clay ( <i>Garantiana</i> Clay)	7
Hard sandstone with belemnites, Rhynchonellids and shell fragments (Berreraig Grit)	20
Soft yellow sandstone with doggers, Stepheoceratids (Rigg Sandstone)	140
Hard calcareous sandstone (Holm Sandstone)	40
Soft, green-grey, sandy shale or shalt' sandstone, <i>Sonninia</i> and large belemnites (Udairn Shales)	160
Beds of hard sandstone with doggers (Ollach Sandstone)	50
<b>Upper Lias</b>	
Sandy micaceous shale (Fiurnean Shales)	25
Soft dark shale (Portree Shales)	75
<b>Middle Lias</b>	
Hard calcareous sandstone (Scalpa Sandstone)	seen 100

Much the most accessible of the Inferior Oolite outcrops are those in Berreraig Bay. On the south side of the river a wave-cut platform of flaggy sandstone (Ollach Sandstone) offers the richest collecting in the formation. Here Lady Murchison collected the type specimen of *Ludwigia murchisonae* (J. de C. Sowerby), the species which gave its name to the zone.

In addition to the type a large number and variety of Ludwigioids are to be found. Buckman (in Lee 1920, p. 77) compared this fauna with that of the Wild Bed of Chideock near Bridport, in Dorset, and further commented on the rarity or absence of certain southern species in the *L. murchisonae* beds of Skye, in particular on the entire absence of the very massive forms of which *L. (Kiliania) armipotens* S. S. Buckman is typical. There is one specimen in the Edinburgh collections, however, which was obtained from a loose block between Holm Island and Berreraig Bay which L. F. Spath thought was related to *L. (K.) armipotens* so that further collecting may disclose the presence of this and other southern species.

In Raasay ammonites of the *Leioceras opalinum* Zone (*Tmetoceras scissum* Zone of Buckman) were found in large numbers 3 ft below the *L. murchisonae* Zone, being mainly species of *Leioceras*. In Skye the presence of this zone was no more than indicated by a few specimens of *Leioceras* collected by the author during the last survey, one of which was identified by Spath as *L. aff. bifidatum* (S. S. Buckman). Its thickness and exact relationship to the zones above and below could not be determined.

The known fauna of the *L. murchisonae* Zone at Berreraig Bay is as follows, r denoting rare and c common:

*Brasilia decipiens* (S. S. Buckman), *Ludwigia ambigua* S. S. Buckman r, *L. (Kiliania?)* sp. nov., aff. *armipotens* S. S. Buckman r, *L. (Apedogyria) baylei* (S. S. Buckman) r, *L. (Hyattia) brasili* (S. S. Buckman), *L. (Cosmogyrria) extralaevis* (Quenstedt), *L. (Apedogyria) aff. falcata* (Quenstedt) r, *L. gradata* S. S. Buckman, *L. laevigatct* S. S. Buckman, *L. (Ludwigina) literata* (S. S. Buckman) var. r, *L. murchisonae* (J. Sowerby), r, *L. (Cosmogyrria) obtusa* (Quenstedt), *L. patellaria* (S. S. Buckman) r, *L. (Crikia) reflua* (S. S. Buckman) c, *L. (Apedogyria) subcornuta* (S. S. Buckman) c, *L. aff. tuberculata* (S. S. Buckman), *L. (Ludwigina) umbilicata* (S. S. Buckman) c, *Stephanoceras aff. cosmopolitum* (Moericke) r, and *Belemnopsis cf. canaliculatus auctorum* (non Phillips).

North of Bearreraig Bay fallen blocks of sandstone have yielded ammonites which indicate the presence of higher zones, but systematic collecting from these precipitous cliffs is virtually impossible and so far it has not proved possible to delimit them with any accuracy.

The dip of the beds however, brings higher horizons down to sea-level northwards and in the last survey an attempt was made to collect fossils in situ at least up to the middle of the Rigg Sandstone.

The lowest 40 ft or so of the Udairn Shales, best seen below the lowest fall in the the Bearreraig River, appear also to belong to the *L. murchisonae* Zone. From loose blocks of these shales, just south of the river, the ammonites *Graphoceras (Ludwigella) arcitenens* (S. S. Buckman), *G. (Lucya) magnum* (S. S. Buckman), *G. (Ludwigella) aff. rudis* (S. S. Buckman), *G. (L.) aff. sublineatum* (S. S. Buckman) were collected. *Hyperlioceras* ('*Dissoroceras*') *excavatum* (S. S. Buckman) was found in situ 30 ft above sea-level and *Brasilia decipiens* (S. S. Buckman) 20 ft higher. These appear to indicate the presence of the *bradfordensis*, *concava* and *discites* zones of Lee (1920, p. 49) but not in the order given by him. Here they are regarded as the uppermost beds of the *L. murchisonae* Zone but could equally well be regarded as the basal portion of the *Sonninia sowerbyi* Zone.

The ammonite fauna of the upper half of the Udairn Shales consists almost entirely of species of *Sonninia*, only one of which, *Sonninia aff. mesacantha* (Waagen), recovered from just below the Holm Sandstone at Rubha Sughar, was in situ, the remainder, *S. carinodiscus* (Quenstedt), *S. sowerbyi* (Miller), and *S. aff. alsatica* (Haug) were collected from loose blocks. Lee (1920, p. 49) referred to a very large specimen which may be *Shirburnia trigonalis* S. S. Buckman and a single specimen of *Witchellia*, both collected from loose blocks but which probably came from the middle of the Udairn Shales.

The *Otoites sauzei* Zone is probably represented by the Holm Sandstone which forms the lowest sea-cliff from Rubha Sughar north to Upper Tote. The species *Otoites cf. bigoti* (Munier-Chalmas) Masske and *Poecilomorphus macer* S. S. Buckman collected from loose blocks north of Bearreraig Bay are the only indications that the zone is present.

North of Rubha Sughar the majority of the fallen rock must have come from the Rigg Sandstone; from these blocks an ammonite fauna indicative of the *Stephanoceras humphriesianum* Zone has been collected. *Stephanoceras aff. gibbosus* (S. S. Buckman), *S. aff. kretur* (S.S. Buckman), *S. humphriesianum* (J. de C. Sowerby), *Stemmatoceras aff. subcoronatum* (Quenstedt), were all found in loose blocks but *Skirroceras cf. nodosum* (Quenstedt) was collected in situ in the bed of the stream ■-mile south-west of Holm. In the Bearreraig River the middle fall is caused by a 30-ft bed of calcareous sandstone with large belemnites *Megateuthis cf. aalensis* (Voltz). The horizon appears to be in the *S. humphriesianum* Zone and Buckman was probably correct in correlating this bed with the Belemnite Beds of the Scarborough Limestone.

The Bearreraig Grit has not yielded any recognizable fossils though here, as in Raasay, it is crowded with broken lamellibranch fragments. It may however, represent the *Stenoiceras subfurcatum* Zone as the *S. humphriesianum* beds are not far below and it is directly overlain by the Garantiana Clay. A mile and a half north-east of Portree this subdivision exhibits large-scale slump bedding.

Inland the Bearreraig Grit is exposed in the Bearreraig River at the north end of Loch Leathan.

At Holm the Bearreraig Grit is succeeded by a plastic clay identical with that of the same age in Raasay. It is rarely exposed but a single specimen of *Garantiana* has been found in it. North of Bearreraig and westwards the clay passes laterally into a soft black sandstone which may be seen on the east side of Loch Leathan where it is 8 ft thick.

This sudden change of facies marks the Vesulian transgression which in southern England followed an important orogenic episode. In Skye and Raasay, however, this marine transgression was short-lived for even if the Oil-Shale above is included with the Garantiana Clay, estuarine conditions were established after not more than 30 ft of strata had been laid down. The Garantiana Clay passes upwards into a bituminous shale at the base of the Great Estuarine Series.

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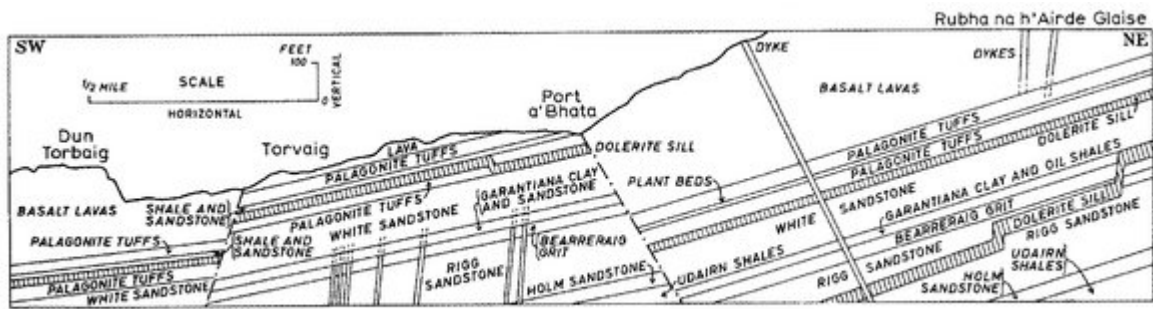


FIG. 5. Section in sea-cliff on north side of Portree Bay

None

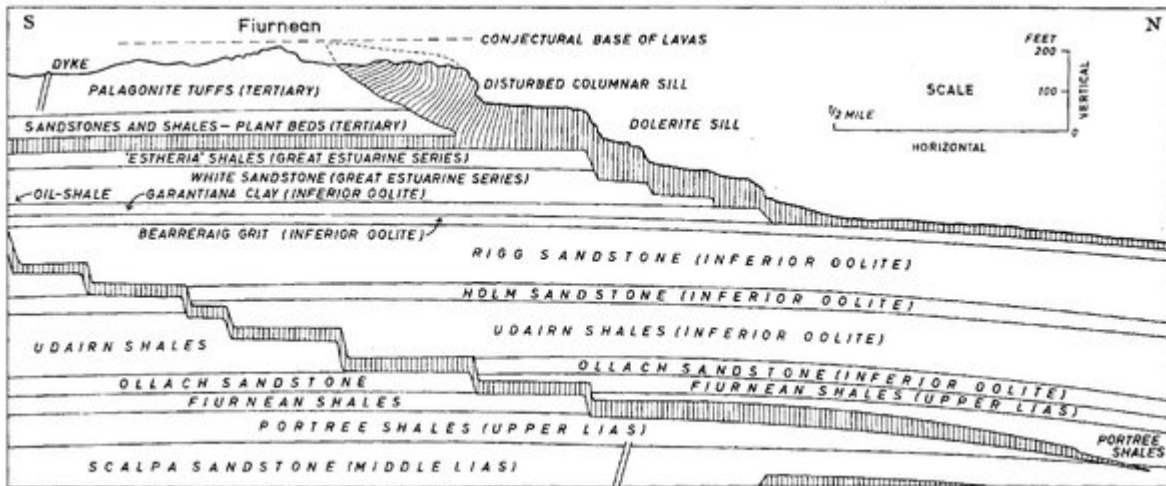


FIG. 3. Section in sea-cliff at Fiurnean, 4 miles N.N.E. of Portree

(Figure 3) Section in sea-cliff at Fiurnean, 4 miles N.N.E. of Portree.