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## Chapter 4 Jurassic: Oxford Clay to Kimmeridge Clay

The Belemnite Sands in North Skye are succeeded by a series of dark blue-grey shales with thin grey cementstones and lines of calcareous nodules. At the base the shales become bituminous but they are never sufficiently rich to be classed as oil-shales. The fauna consists predominantly of ammonites and belemnites, but at certain horizons are bands locally rich in lamellibranchs. Plant fragments, foraminifera and ostracoda are found throughout and occasionally a brachiopod.

A large collection of ammonites was made during the survey of the area and submitted for identification to the late L. F. Spath who gave valuable assistance in the delimitation of the zones into which the shales have been divided. Except for occasional specimens extracted from a cementstone the material is very badly preserved; nevertheless it has been found possible to apply with certain modifications demanded by the field evidence the zonal scheme which is in use in England. There can be no doubt that the blue shales above the Great Estuarine Series of North Trotternish are equivalent to the Oxford Clay, Corallian and the lower part of the Kimmeridge Clay of England, but they are unique in that the lithology of these beds in Skye is the same throughout, in marked contrast to the varied lithology which is the rule in England.

In the field these shales fall naturally into five divisions according to the ammonite faunas they contain. The zonal scheme is a subdivision of these major groups. With the possible exception of the *Cardioceras cordatum* Zone it is not easy to distinguish the individual zones except by detailed collecting, whereas the major divisions are recognizable without difficulty.

The following are the major divisions based on the ammonite succession:

- e. *Pictonia* Beds
- d. *Amoeboceras* Beds
- c. *Cardioceras* Beds
- b. *Quenstedtoceras* Beds
- a. *Kosmoceras* Beds.

The zonal scheme adopted in this memoir is: (Table Unnumbered 1)

### Oxford Clay

The Oxford Clay in North Skye is very like its equivalent in Dorset, a dark blue-grey clay with grey cementstones and lines of concretionary nodules. Its presence in Skye was first recognized by Forbes (1851, p. 106) who described a section in Staffin Bay obviously not far from the locality here referred to as Point 3 [NG 473 698], (Figure 9). He stated that overlying the Loch Staffin Beds he found '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'.

These beds contain ammonites and belemnites in great abundance and in addition: *Astarte* cf. *cordata* Trautschold, *Nuculana* sp. nov., *Terebratula* cf. *subsella* Leymerie and *Pholadomya* sp. Arkell (1945) recorded *Cardioceras ashtonense* Arkell, *C. costicardia* S. S. Buckman, *C. (Scarburgiceras) excavatoides* Maire and *Peltoceras gerberi* (Prieser) from the Oxford Clay of Staffin Bay but only the second species in this list was found in recent collecting.

On the basis of the ammonite fauna the Oxford Clay has been divided into the following zones:

	<b>Zone</b>	<b>Subzone</b>
Upper Oxford Clay	<i>Cardioceras cordatum</i>	{ <i>C. excavatum</i>
		{ <i>C. cardia</i>
	<i>Quenstedtoceras mariae</i>	{ <i>C. praecordatum</i>

Middle Oxford Clay	<i>Q. lamberti</i> <i>Peltoceras athleta</i>
Lower Oxford Clay	<i>Kosmoceras castor</i> and <i>K. pollux</i> <i>Kosmoceras jason</i>

i. Zone of *Kosmoceras jason*. The *K. jason* Zone has been recognized at Points 3 [NG 473 698], 4 (NG 473 701) and 5 (NG 472 708) in Staffin Bay<ref>Reference points in Staffin Bay are indicated in Figs. 8–12.</ref>. It is represented by about 20 ft of shale with ammonites determined as *Kosmoceras (Gulielmites)* spp. some of which are allied to *K. conlaxatum* S. S. Buckman (*K. conlaxatum* S. S. Buckman = *K. jason* Reinecke sp.).

ii. Zone of *Kosmoceras castor* and *K. pollux*. The 6–7 ft of shale succeeding the *K. jason* Zone at Point 5 contain *Kosmoceras (Gulielmites)* sp. with *Kosmoceras (Spinikosmoceras?)* sp. and according to Spath represents the Zone of *K. castor* and *K. pollux* = the *reginaldi* Zone of A. Morley Davies (1916) = the *coronatum* Zone of Buckman = the *elizabethae* Zone of Neaverson (1925). (The name *coronatum* Zone proposed by d'Orbigny in 1825 has priority.)

iii. Zone of *Peltoceras athleta*. The succeeding 3 ft of shale at Point 5 contains *Kosmocerates* of the *proniae* type and may therefore be tentatively correlated with the *P. athleta* Zone which is here taken to be the equivalent of the *duncani* and *athleta* zones of Morley Davies and Neaverson, the *duncani* Zone of Spath 1926, the *spinosum* = *ornatum* Zone of Buckman (1913), the *proniaeathleta* zone of Pringle (1930), and the *athleta–duncani* zone of Arkell (1933).

iv. Zone of *Quenstedtoceras lamberti*. At Points 3, 4 and 5 in Staffin Bay this zone is represented by 4 ft of shale with *Kosmocerates* of the '*Bikosmoceras*' *deficiens* group of S. S. Buckman, *Quenstedtocerates* like *Q. gregarium* S. S. Buckman, *Eboracicerates* like *E. cadiforme* S. S. Buckman, and at the base forms resembling *Kosmoceras spinosum* (J. de C. Sowerby) (= *ornatum* Douvillé). The fauna is suggestive of the *lamberti* Zone as developed in Dorset.

v. Zone of *Quenstedtoceras mariae*. The next 24 ft of shale at Points 3, 4 and 5 have been referred to the *Q. mariae* Zone. In the lowest 6 ft the fauna belongs to the *Quenstedtoceras* group (see p. 62) whereas the uppermost 18 ft contain a quite distinct *Cardioceras* fauna, so that the zone is readily divided into two subzones.

a. Subzone of *Quenstedtoceras vertumnus*.

Six feet of shale containing *Quenstedtoceras (Vertumniceras) vertumnum* (Leckenby), *Quenstedtocerates* allied to *Q. lamberti* (J. Sowerby) and *Poculisphinctes* sp.

b. Subzone of *Cardioceras praecordatum*.

Eighteen feet of shales containing *Cardioceras (Scarburgiceras) praecordatum* (R. Douville), *Cardioceras* sp. like a large *C. costellatum—anacanthum* and *Cylindroteuthis oweni* (Pratt). This fauna may be compared with that found at Warboy's Pit, Huntingdonshire.

vi. Zone of *Cardioceras cordatum*. The uppermost beds of the Oxford Clay in Staffin Bay consist of 60 ft of shale and as exposed at Points 3, 4 and 5 contain a rich fauna of *Cardiocerates* indicative of the *C. cordatum* Zone. It is here divisible into two subzones :

a. Subzone of *Cardioceras cardia* (= lower *cordatum*).

Thirty feet of shale with *Cardioceras* cf. *costicardia* S. S. Buckman, *C. cf. costellatum* S. S. Buckman, *C. cf. cardia* S. S. Buckman, *C. cf. cordatum auctorum*, *C. cf. rouilleri* (Nikitin) Lahusen, and *Peltoceratoides* aff. *williamsoni* (Phillips). This subzone probably represents the equivalent of the uppermost Oxford Clay at Studley Brickyard and of Dorset, and of the Lower Calcareous Grit of Yorkshire.

b. Subzone of *Cardioceras excavatum* (= upper *cordatum*).

Thirty feet of shales with *Cardioceras excavatum* (J. Sowerby), *C. cf. costellatum* S. S. Buckman, *C. cf. nikitianum* (Lahusen), *C. cf. papilionense* Boden, *C. cf. tenuicostatum* (Nikitin) and *C. cf. coelatum* Pavlov. The fauna is very like that of the *C. excavatum* limestone of Ardassie Point. This subzone is probably the equivalent of the Lower Calcareous Grit of Wiltshire and approximates to the Zone of Ammonites catena Arkell 1936.

## Details

The most complete and least disturbed section of the Oxford Clay is that to be found at Point 5, Staffin Bay, for though several small faults cross the beach they are parallel to the dip of the beds and do not cause any great dislocation of the strata (see section p. 52). At Points 3 and 4 the Oxford Clay is disturbed by small faults and dykes, especially at Point 4 where the Kildorais Fault ends in numerous virgations which split up the strata into wedge-shaped fragments.

Section in the beach of Staffin Bay, midway between Points 3 [NG 473 698] and 4 [NG 473 701]

	feet	inches
<b>Oxford Clay</b>		
13. Dark blue shale with <i>Cardioceras</i> , <i>Peltoceratoides</i> , <i>Pachyteuthis</i> , <i>Astarte cf. cordata</i> , Trautschold, <i>Nuculana</i> sp. nov. and <i>Parallelodon</i> <i>aemulum</i> (Phillips)	30	0
12. Dark grey cementstone weathering red		4 in to 5
11. Dark blue shales with <i>Quenstedtoceras</i> and <i>Nuculana</i> sp. nov.	15	0
10. Hard grey cementstone weathering yellow		9 in to 12
9. Dark blue shale	1	7
8. Hard grey cementstone weathering yellow		6 in to 12
7. Dark shales with <i>Kosmoceras</i> and fragments of wood; a few feet of bituminous shale at the base with <i>Hibolites</i> sp.	24	0
<b>Belemnite Sands</b>		
6. Hard, calcareous, concretionary, sandy bed weathering red, with belemnites		9
5. Dark green shale with belemnites	1	6
4. Hard, calcareous, concretionary and pebbly bed with belemnites		6
3. Grey-green streaky shaly sands with <i>Pleuromya</i> etc.	4	0
2. Hard calcareous sandstone with <i>Pleuromya</i> , <i>Modiola</i> , <i>Trigonia</i> etc.	2	6
1. Grey-green, streaky, shale with <i>Ostrea</i> and <i>Pleuromya</i>	10	0
Strike fault repeating Oxford Clay.		
<b>Oxford Clay</b>		
d. Dark blue shales	6	0
c. Hard, calcareous shales with belemnites		3

b. Indurated, dark blue shale with <i>Cardioceras</i>	1	0
Dolerite Sill	3	0
a. Indurated, dark blue shale with belemnites	4	0

The section recorded above is seen in the beach between high-and low-water marks but higher beds are exposed in a small cliff just above high-water mark at Point 3. They are as follows:

	feet	inches
<b>Oxford Clay</b>		
19. Dark blue shale	15	0
18. Irregular and impersistent grey cementstone		3
17. Dark blue shale	4	0
16. Hard grey cementstone weathering yellow		3 in to 9
15. Dark blue shale	9	0
14. Dark blue shale with abundant <i>Cardioceras</i> , <i>Pleuromya uniformis</i> (J. Sowerby), <i>P. cf. alduini</i> (Brongniart), <i>Parallellodon aemulum</i> (Phillips) <i>Oxytoma</i> sp., <i>Camptonectes</i> sp., and phosphatic concretions	15	0

At the southern end of this section the beds are disturbed by a small fault and a few yards to the south of this a larger fault occupied by a dyke brings the Upper Oxford Clay on its northern side against Middle Corallian shales on the south. There must be 5–6 ft of strata unexposed between the top of the Staffin Bay beach section and the beds seen in the small cliff.

Owing to the disturbed nature of the section at Point 3 systematic collecting is difficult and it was not found possible to establish all the zones found to be present to the north at Point 5. The general sequence however is identical at the two localities.

From the base of the blue shales (Bed 7, Staffin Bay section) *Kosmoceras (Gulielmites) aff. conlaxatum* S. S. Buckman was collected but is not at all common and 16 ft higher *Kosmoceras (Gulielmites) sp.*, *Pseudocadoceras (Longaeviceras?) sp.* and *Hibolites hastatus* (Blainville) were found. Thus approximately the lowest 20 ft of these shales may be regarded as belonging to the K. Jason Zone.

A few feet above the two cementstones (i.e. at the base of Bed 11, Staffin Bay section) *Quenstedtoceras (Prorsiceras), cf. gregarium* (Leckenby), *Eboraciceras cf. cadiforme* Buckman and the outer whorls of large *Kosmocerates* such as are found at Tidmoor Point Weymouth, indicate the presence of the *Q. lamberti* Zone which cannot however occupy more than a few feet of shale, for 6 ft above the upper of the two cementstones the *Q. maria* Zone (*Q. vertumnus* Subzone) is indicated by the presence of *Quenstedtoceras (Vertumniceras) vertumnus* (Leckenby), *Quenstedtoceras cf. lamberti* (J. Sowerby) Lahusen pars., and a doubtful *Poculispinctes* sp. *Cardioceras cf. praecordatum* (R. Douville) occurs a few feet above the red weathering cementstone (Bed 12, Staffin Bay section) so that the lower part of Bed 13 is in the *C. praecordatum* Subzone of the *Q. maria* Zone. The upper half of Bed 13 near the top of the beach section is crowded with ammonites mainly *Cardiocerates*. The following forms have been collected here:

*Cardioceras cf. cardia* S. S. Buckman, *C. spp. (cardia group)*, *C. cf. costicardia* S. S. Buckman, *C. cf. cordatum auctorum*, *C. cf. costellatum* S. S. Buckman, *C. spp. (costellatum group)*, *C. cf. excavatum* Lahusen non Sowerby?, *C. spp. (nikitnianum group)*, *C. spp. (praecordatum group)*, *C. cf. rouillieri* (Nikitin) Lahusen, *Peltoceratoides aff. williamsoni* (Phillips), *Peltoceratoides sp.*, *Perispinctes (Pachyplanulites?) sp.*, (*Properispinctes?*) cf. *indogermanus* Boden non

Waagen, *Cylindroteuthis* sp., and *Pachyteuthis* aff. *panderiana* (d'Orbigny) *auctorum*.

This fauna is taken to indicate the *C. cardia* Subzone of the *C. cordatum* Zone. The higher beds in the cliff at Point 3 (Beds 14–19) yielded a fauna indicating the upper *C. cordatum* Zone (*C. excavatum* Subzone): *Cardioceras* (*Scoticardioceras*?) cf. *excavatum auctorum*, *C. sp.* (*cordatum* group), *C. cf. cordatum* (J. Sowerby), *C. cf. schellwieni* ? Boden, *C. sp.* (*schellwieni* group), *C. cf. papiloniense* Boden.

This section of the Oxford Clay can be traced northwards along the beach to Point 4 where the beds are even more badly shattered by faulting and indurated by dykes. At the two most northerly dykes at Point 4 higher beds are exposed than any at Point 3. Seawards and slightly north of these dykes about 60 ft of Oxford Clay is seen in the beach at low tide. Almost the whole of the *C. cordatum* Zone is exposed and though the ammonites are not particularly well preserved the two subzones *C. cardia* and *C. excavatum* can be recognized. The *C. cardia* Subzone, extending from a cementstone at low-water mark upwards through 30 ft of strata contains a finely ribbed form of *Cardioceras* (*Scarburgiceras*) *praecordatum* (R. Douville), *C. cf. cardia* S. S. Buckman and *Cardiocerates* probably of the *costellatum*—*anacanthum* group. Above, the *C. excavatum* sub-zone, 20–30 ft thick, contains an evolute variety of *Cardioceras* (*Scoticardioceras*?) cf. *excavatum* (J. Sowerby) and several *Cardiocerates* which appear to be the inner whorls of forms belonging to the *excavatum* group.

Northwards of Point 4 the Oxford Clay extends along the beach to Point 5 where very good sections are to be seen (see section p. 52). As at Point 3 the lowest 12 in of blue shale contains a Kosmocerate fauna indicative of the K. Jason Zone. The ammonites are badly preserved but may be referred to *Kosmoceras* (*Gulielmites*) sp. Immediately below the two cementstones (i.e. at the top of Bed 18, section p. 52) the shales contain *Kosmoceras* (*Gulielmites*) sp. and *Kosmoceras* (*Spinikosmoceras*?) sp. which suggest the presence of the Zone of *K. castor* and *K. pollux*. The shales immediately above the two cementstones probably belong to the *Peltoceras athleta* Zone for they contain poorly preserved *Kosmoceras* sp. (cf. *proniae* var. *crassa* R. Douville). Three to four feet higher the *Q. lamberti* Zone is indicated by *Quenstedtoceras* sp., *Kosmoceras* cf. *spinosum* (J. de C. Sowerby = *ornatum* R. Douville) and *Eboraciceras* sp. The zones of *K. castor* and *K. pollux*, *P. athleta* and *Q. lamberti* are very poorly developed and together occupy less than 15 ft of shale.

From 7 ft above the upper of the two cementstones, for a thickness of 22 ft, the shales contain ammonites of the *Q. mariae* Zone. Here the *Q. vertumnus* Subzone is obscure, containing only indeterminate *Quenstedtoceras* but the upper 18 ft have yielded *Cardioceras* (*Scarburgiceras*) spp. (*praecordatum* group), *Quenstedtoceras* sp. and *Cylindroteuthis oweni* (Pratt) and therefore belong to the *C. praecordatum* Subzone.

The top of the *Q. mariae* Zone may be conveniently taken at a 4 to 5-in cementstone (Bed 25, section p. 52), above which for the next 30 ft the shales contain a fauna indicative of the *C. cardia* Subzone (lower *C. cordatum* Zone) i.e. *Cardioceras* cf. *costellatum* S. S. Buckman, *Cardioceras* sp. (*costellatum* group), *Cardioceras* sp. (*praecordatum* group) and *Peltoceratoides* aff. *williamsoni* (Phillips).

At the northern end of the Point 5 section the uppermost beds of the Oxford Clay are exposed, i.e. the *C. excavatum* Subzone (upper *C. cordatum* Zone). The ammonites are badly preserved but the following forms can be recognized:

*Cardioceras* aff. *costellatum* S. S. Buckman, *C. cf. cordatum* (J. Sowerby), *C. cf. excavatum* (Sowerby) Boden pars., *C. sp.* (*excavatum* group), *C. cf. nikitinianum* (Lahusen) Boden, and *C. cf. papiloniense* ?Boden.

A small exposure a few yards inland from High Water Mark at Point 8 [NG 467 723], has yielded ammonites indicative of the uppermost Oxford Clay. They are badly preserved *Cardiocerates* probably of the *C. excavatum* group.

At the seaward end of a small burn entering the south-west corner of Staff n Bay between Glashvin and Digg, blue-grey shales are exposed which contain obscure *Cardiocerates* with *Pholadomya* sp. and *Terebratula* sp. Apart from these there are no inland exposures of undoubted Oxford Clay but a small patch of blue clay 300 yd N.E. of the cross-roads at Brogaig may belong to this division. The lowest 5 ft of drift in Brogaig Burn north of the main road contain pebbles of shale with *Cardioceratid* and *Perisphinctid* fragments and belemnites so that this stream probably flows over Oxford Clay before it descends to the raised beach.

Where Lon a' Mhuilinn joins Lon Glas and turns to flow northwards, is a small exposure of grey shale in the east bank of the stream in which a fragment of belemnite was found. This is probably an inclusion of Oxford Clay in the sill which is here transgressing upwards.

Bryce (1873, p. 332) thought that Oxford Clay was present at Duntulm but a careful search of this neighbourhood has so far failed to find any trace of it.

Oxford Clay is almost certain to be present on the western side of the valley running from Lincro to Knockhoe according to the fossils recorded by Murchison from the canal cut to drain Loch Chaluim Chille (see p. 54), but it is not now exposed.

Blue shale in the screes below the lava scarp south of Totscore probably indicate the presence of Oxford Clay under the superficial deposits.

## Corallian

The Corallian beds in Skye are exceptional in that they consist entirely of blue shales with exactly the same lithology as the Oxford Clay below and the Kimmeridge Clay above. As exposed in Staffin Bay the Corallian shales are 140 ft thick and have been divided into the following ammonite zones:

Upper Corallian. *Ringsteadia anglica* Zone

Middle Corallian. *Perisphinctes variocostatus* Zone Lower Corallian. *Cardioceras cawtonense* Zone

### (i) Zone of *Cardioceras cawtonense*.

The lowest 40 ft of the Corallian contains a Cardiocerate fauna and is exposed for some distance south of Point 1 [NG 474 694], and north of Point 4 [NG 473 701], Staffin Bay. The Zone is poorly exposed and the ammonites are badly preserved but the fauna certainly includes a large number of *Cardiocerates* which can be referred to *C. cawtonense* (Blake), and *C. maltonense* (Young and Bird), together with *Cardioceras (Cawtoniceras) aff. blakei* Spath, and *C. (Cawtoniceras) cf. zietini* (Rouillier) *auctorum*. Correlation is suggested with the Headington Shell Bed and the lowest 18 ft of the Amphill Clay at Gamlingay.

### (ii) Zone of *Perisphinctes variocostatus*.

The middle Corallian consists of 40 ft of shales exposed at Points 1 [NG 474 694], 2 [NG 473 696], 3 [NG 473 698] and 7 [NG 468 715] (Figure 11) in Staffin Bay and at Flodigarry. The Cardiocerate fauna of the zone below has been succeeded by abundant *Amoebocerates* such as *A. alternans*, and forms like *A. serratum* (J. Sowerby), *A. marchense* Spath, *A. vagum* Ilovaisky, and Perisphinctids comparable with *P. variocostatus auctorum*, and *P. dichotomum* (S. S. Buckman). These beds are probably the equivalent of the Middle Amphill Clay and the Trigonia Beds of Dorset.

### (iii) Zone of *Ringsteadia anglica*.

The uppermost 50 ft of the Corallian exposed in Staffin Bay at Points 1, 2 and 7 is referred to the *R. anglica* Zone. Ammonites are very abundant and consist predominantly of *Amoebocerates*.

The shales contain numerous individuals of *Amoeboceras (Priondoceras) serratum* (J. Sowerby), *A. (Priondoceras) aff. serratum* (J. Sowerby), *A. (P.) alternans* of Russian authors, *A. (P.) cf. alternans* (Nikitin) and *A. (P.) cf. excentricum* (S. S. Buckman), with an occasional *Ringsteadea* sp., *Pictonia* sp. and *Prorasenia* sp. (*witteana* group).

## Details

Corallian shales are extensively if not well exposed on the shores of Staffin Bay. At the boat-slip south of Point 1 shales of the *C. cawtonense* Zone are faulted against Mottled Clays. The strike is here north-east, parallel to the direction of the

fault but as the beds approach Point 1 they swing round parallel to the coast-line, bend round the irregular intrusive mass of dolerite at Point 1 and continue northwards to within a few yards of Point 3. A very large boulder on the south side of the boat-slip stands on *C. cawtonense* shales. From here the following fossils have been obtained: *Cardioceras* (*Cawtoniceras*?) sp., *Perisphinctes* (*Dichotomosphinctes*?) sp., *C. (Cawtoniceras?) cf. zietini* (Rouillier) *auctorum*, *Gryphaea dilatata auctorum*, *Parallelodon cf. aemulum* (Phillips), *Pleuromya alduini* (Brongniart), *Pholadomya* sp.

Nearer Point 1 higher beds are exposed and though somewhat disturbed and altered by the intrusion, the *P. variocostatus* and *R. anglica* zones can be recognized. Shales belonging to the former zone are seen near low-water mark and contain: *Amoeboceras (Prionodoceras) alternans* (Nikitin) and *A. (P.) marchense* Spath. Near the seaward margin of the storm-beach shales with *Amoeboceras (Prionodoceras)* spp. of the *ogivale—marchense* group and forms suggestive of *A. (P.) semicoelatum* Spath indicate the lower part of the *R. anglica* Zone.

Burnt shales exposed on the footpath over the cliff spur at Point 1 are probably Kimmeridge in age.

In the beach at Point 2 the upper half of the Corallian is well exposed.

### Section in the beach immediately north of Point 2 [NG 473 696], Staffin Bay

	feet	inches	
	Dolerite sill		
	<b><i>P. baylei</i> Zone (Kimmeridge Clay)</b>		
18.	Dark grey shale	2 ft to 3	0
17.	Grey cementstone	1	0
16.	Dark grey shale	4	0
15.	Band of calcareous concretions		0 to 12
14.	Dark grey shale	3	0
13.	Band of calcareous concretions		0 to 12
12.	Dark grey shale	6	0
11.	Grey cementstone	1	0
10.	Dark grey shale with <i>Pictonia</i>	3	0
	<b><i>R. anglica</i> Zone. Corallian</b>		
9.	Grey shale	24	0
8.	Dark grey shale with <i>Amoeboceras</i>	3	0
7.	Grey cementstone		0 to 12
6.	Dark grey shale with <i>Amoeboceras</i>	15	0
	Dolerite sill		
5.	Dark grey shale with <i>Amoeboceras</i>	3	0
4.	Dark grey shale	11	0
	<b><i>P. variocostatus</i> Zone. Corallian</b>		
3.	Dark grey shale	11	0
2.	Dark grey shale with <i>Amoeboceras</i> and <i>Goniomya litcrata</i> (J. Sowerby)	5	0
	Dolerite sill		
1.	Dark grey shale with <i>Amoeboceras</i>	2	6
		8	0

The lowest beds, which are only exposed at very low tides, contain a rich ammonite fauna indicative of the *P. variocostatus* Zone. Below a 2 ft 6 in leaf of sill the following were collected: *Amoeboceras* (*Prionodoceras*) *alternans auctorum* (Nikitin 1916, pars) *A. (P.) alternans* of Russian authors (= aff. *freboldi* Spath) *A. (P.) alternans* Sokolov 1912, *A. (P.)* aff. *marchense* Spath, *A. (P.)* cf. *marchense* Spath, *A. (P.)* sp. (*serratum* group).

From the 5 ft of shales above the sill an abundant fauna was obtained: *Amoeboceras* (*Prionodoceras*) *alternans* Ilovaisky 1904 (= aff. *freboldi* Spath), *A. (P.)* aff. *alternans* of Russian authors, (trans. to *serratum* group), *A. (P.)* aff. *marchense* Spath, *A. (P.)* sp. (prionodus—excentricus group), *A. (P.)* cf. *serratum* (J. Sowerby), *A. (P.)* aff. *serratum* (J. Sowerby), *Perisphinctes* sp. (biplex group, cf. *variocostatus auctorum*), *P.* cf. *dichotomus* (S. S. Buckman), *P.* sp.

Bed 5, 22 ft higher, contains a fauna clearly indicating the *R. anglica* Zone: *Amoeboceras* (*Prionodoceras*) aff. *alternans* of Russian authors (= regulare Spath), *A. (P.)* cf. *alternans* of Russian authors (= regulare Spath), *A. (P.)* aff. *semicoelatum* Spath, *A. (P.)* sp. (*serratum* group).

Between an 8-in sill and the cementstone 15 ft above (Bed 6) the shales yielded: *Amoeboceras* (*Prionodoceras*) sp. juv. (inner whorls of *A. prionodes* group) and *Pictonia* sp. The following species were obtained from above the cementstone (Bed 8): *Amoeboceras* (*Prionodoceras*) aff. *alternans* of Russian authors (= aff. *freboldi* Spath), *A. (P.)* cf. *alternans* of Russian authors, cymodoce cf. *freboldi* Spath, *A. (P.) alternans* of Russian authors (= aff. regulare Spath), *A. (P.)* spp. (inner whorls of regulare, *freboldi*, excentricum etc.), *A. (P.)* sp. juv. (inner whorls of forms of regulare—excentricum group).

In dark grey shales immediately below a cementstone (Bed 10) the basal fauna of the Kimmeridge Clay (*P. baylei* Zone) is represented by *Pictonia* cf. *cymodoce* Salfeld and *Pictonia* sp. (*normandiana-latecostata* group). The sequence here (see section p. 66) agrees very closely with that at Kildorais (Point 7).

From Point 2 the Corallian shales cross a small bay, on the north side of which they can be seen faulted against Oxford Clay by a N.N.W. fault, the site of which is marked by a large dyke.

North of Point 4 [NG 473 701] two large dykes exposed in the storm-beach penetrate lower Corallian shales. The beds are badly burnt by the dykes; thus the fossils are poorly preserved so that specific determination of individuals is difficult. There is no doubt, however, that the fauna includes *Cardioceras* (*Cawtoniceras*) aff. *blakei* Spath, *C. cawtonense* (Blake) and *C. maltonense* (Young and Bird) with *Pachyteuthis* aff. *panderiana* (d'Orbigny) *auctorum*, *Lima* (*Plagiostoma*) *laeviuscula* J. Sowerby, *Inoceramus* sp. (near *nitescens* Arkell), *Gryphaea* sp., *Perampliata ampliata* (Phillips), and *Parallelodon* (*Beushausenia*) cf. *aemulum* (Phillips). Out of the large number of specimens collected, the two species *Cardioceras cawtonense* and *C. maltonense* were so markedly predominant that these lowest beds of the Corallian have been separated off as the zone of *C. cawtonense* (= perarmatum Zone of Spath 1933, table ii, p. 872).

A small triangular mass of Corallian of the *R. anglica* Zone is faulted in just south of Point 6 [NG 470 712]. In the few feet of shale exposed *Amoeboceras* (*Prionodoceras*) cf. *alternans* of Russian authors and *A. (P.)* sp. (*ogivale-marchense* group) were obtained.

Between Points 6 and 7 [NG 468 715] the whole of the *R. anglica* Zone and the basal beds of the Kimmeridge Clay are well exposed in the beach. A typical section is that seen a little way south of Kildorais (Point 7).

#### Section in beach at Kildorais, Point 7 [NG 468 715], Staffin Bay

	feet	inches
	<b><i>P. baylei</i> Zone (Kimmeridge Clay)</b>	
15.	Dark blue-grey shale with several bands of calcareous concretions (septaria). <i>Pictonia</i> , <i>Amoeboceras</i> , <i>Astarte</i> etc.	35
		0



14.	Grey cementstone	0 to 1	4
13.	Dark blue-grey shale with <i>Amoeboceras</i> , <i>Pictonia</i> and <i>Astarte subdepressa</i> Blake and Hudleston	4	0
12.	Grey cementstone	0 to 1	0
11.	Dark blue-grey shale with <i>Prorosenia</i> , <i>Pictonia</i> , <i>Goniomya literata</i> (J. Sowerby), <i>Oxytoma expansa</i> (Phillips), <i>Pholadomya</i> cf. <i>aequalis</i> (J. de C. Sowerby)i	2	0
<b>R. anglica Zone (Corallian)</b>			
10.	Dark blue-grey shale with <i>Amoeboceras</i> , <i>Prorosenia</i> , <i>Pleuromya alduini</i> (Brongniart), <i>Oxytoma</i> <i>expansa</i> (Phillips) in lowest 5 ft	18	0
9.	Band of calcareous concretions		0 to 3
8.	Dark blue-grey shale	10	0
7.	Dark blue-grey shales with <i>Amoeboceras</i> and <i>Ringsteadia</i>	5	0
6.	Grey cementstone	0 to 3	0
5.	Dark blue-grey shale	6 ft to 7	0
4.	Grey cementstone		6 in to 12
3.	Dark blue-grey shale	13	0
<b>P. variocostatus Zone (Corallian)</b>			
2.	Dark grey shale	17	0
	Dolerite sill	10	0
1.	Dark blue-grey shale with <i>Amoeboceras</i>	20	0

Beds 1 and 2 of this section are exposed near low water-mark and represent the upper part of the *P. variocostatus* Zone. They contain the following ammonites: *Amoeboceras* (*Prionodoceras*) aff. *alternans* (Nikitin) (= aff. *regulare* Spath), *A. (P.)* cf. *marchense* Spath, *A. (P.)* cf. *vagum* (Ilovaisky), *A. (P.)* aff. *serratum* J. Sowerby sp. (cf. Spath 1935, p. 74).

Above the lower pair of cementstones (Bed 7) the shales contain a fauna indicative of the lower part of the *R. anglica* Zone: *Amoeboceras* (*Prionodoceras*) cf. *alternans* (Nikitin) of Russian authors, *A. (P.)* cf. *excentricum* (S. S. Buckman), *A. (P.)* sp. (*prionodes* group), *A. (P.) serratum* (J. Sowerby), *A. (P.)* aff. *serratum* (J. Sowerby), *A. (P.)* sp. (*serratum* group), *Ringsteadia* sp. (cf. Spath, 1935, pl. 9, fig. 2).

In the shales 3–5 ft above the band of calcareous concretions (Bed 10) are ammonites indicating the middle of the *R. anglica* Zone: *Amoeboceras* (*Prionodoceras*) sp. (cf. *alternans* Nikitin = *regulare* Spath), *A. (P.)* aff. *serratum* (J. Sowerby), *A. (P.)* sp. (*serratum* group), *Pictonia* ?, *Prorosenia* sp. (*witteana* group).

Immediately below the two upper cementstones (upper two feet of Bed 11) the shales contain a fauna indicating the *P. baylei* Zone of the Kimmeridge Clay.

In the lower part of this section the dip is westwards at 30–40° but the beds turn over rapidly and at the top of the section are practically vertical.

At Point 7 an E.N.E. fault, the position of which is marked by a dyke, brings Corallian on the southern side against Kimmeridge Clay to the north.

Between Points 7 and 8 [NG 467 723] several small leaves of sill cross the beach usually with a little burnt shale on either side. Some of this shale must be of Corallian age but the fossils are altered beyond recognition.

Inland the exposures of Corallian shale are few and poor. In the grounds of Flodigarry Hotel is a small quarry showing a lenticle of indurated shale in dolerite sill. The beds contain fragmentary and much altered ammonites referable to *Amoeboceras* (*Prionodoceras*) aff. *serratum* (J. Sowerby) and indeterminate Perisphinctids and therefore probably belong to the *R. anglica* Zone.

In a small roadside quarry west of Flodigarry Hotel and across the main road are several small exposures of much weathered and altered shale. Some of these beds have yielded a fauna which suggests a horizon not met with elsewhere in North Skye, i.e. the *A. alternans* Zone of Spath (1935, p. 74), which in the zonal scheme here adopted would be at the base of the *P. variocostatus* Zone or at the top of the *C. cawtonense* Zone. This fauna consists of: *Amoeboceras* sp. (*alternans* group), *A. cf. tuberculato-alternans* (Nikitin), Perisphinctid, *Pictonia* ?, *Prorasenia* ? sp. (*witteana* group), *Ringsteadia*?, *Astarte* sp., *Lima* (*Plagiostoma*) sp., *Nucula* ?, *Oxytoma* sp. and *Pholadomya* sp.

The dark shales exposed in the north-west side of a cart road 250 yd S.W. of Kilmaruy burial ground north of Brogaig Burn are probably Corallian in age but are too badly weathered and fragmentary to yield fossils.

Corallian shales do not appear to be exposed north of Flodigarry or on the west side of the Trotternish peninsula, north of Uig Bay.

Near Uig uppermost Corallian Beds are exposed near a small waterfall in Lon an t-Sratha at Balnaknock at the eastern end of the River Conon inlier. About 15 ft of shales contain abundant examples of *Amoeboceras* (*Prionodoceras*) sp. juv. These appear to be the inner whorls of *A. excentricum*, *A. serratus* and allies with perhaps also *A. (P.) alternoides* Spath or *A. freboldi* Spath with the lamellibranch *Pleuromya alduini* (Brongniart). An upper Corallian (*R. anglica* Zone) horizon is indicated. Some 8 ft of shales above are basal Kimmeridge in age (*P. baylei* Zone; p. 71).

On the south side of Ru Idrigal are shales partly incorporated in sill and extensively altered but yielding an ammonite fauna indicative of the *C. excavatum* sub-zone, i.e. *Cardioceras* (*Scoticardioceras*) *excavatum* (J. Sowerby) *C. cordatum auctorum*, *C. (Plasmatoceras) cf. tenuiostatum* (Nikitin), *C. praecordatum*?, *C. cf. anacanthum costellatum* S. S. Buckman, Perisphinctid (cf. *P. sayni* de Riaz, Borissjak), *C. (Vertebriceras?)* sp., with the belemnite *Cylindroteuthis oweni* (Pratt) and the lamellibranchs *Pholadomya* sp., *Camptonectes* sp. and *Parallelodon aemulum* (Phillips).

On the south side of Uig Bay, about mile south of the mouth of the River Conon, beds of this same zone are again seen on the beach. The horizon may be a little different, for although *Cardioceras* (*Scoticardioceras*) *excavatum* is still the dominant form, there are examples of species not seen at Idrigil Point, i.e. *Cardioceras* cf. *persecans* S. S. Buckman and *C. cf. caelatum* Pavlow. *C. cf. tenuicostatum* (Nikitin) and *C. cordatum auctorum* also occur.

## **Kimmeridge Clay**

Only the lowest beds of the Kimmeridge Clay now remain in North Trotternish. Most of the outcrop is hidden beneath the Quirang landslip or is covered by Tertiary lavas. Much of the shale is indurated and distorted by an upper leaf of the dolerite sill which at the northern end of the syncline transgresses upwards to occupy a position 30–40 ft above the base of the Kimmeridge Clay. Such fragments as still remain have special interest for it is here that the *P. baylei* Zone has what is probably its finest development in Great Britain, occupying a minimum of 20 ft of shale, a thickness which by further collecting might be found to be much greater.

The Kimmeridge Clay follows the Corallian with no change of lithology except that cementstone bands and nodules are rather more abundant than in the beds below. The change of horizon is indicated only by the change in ammonite fauna.

The most complete section is that at Kildorais, Point 7 [NG 468 715] in Staffin Bay. Beds 11–15 (Section p. 67) are exposed near high tide-mark and have yielded a rich ammonite fauna consisting predominantly of *Pictonia* spp. with some species of *Amoeboceras*. Belemnites are very abundant. The almost vertical beds owe their inclination to the easterly thrust of the moving landslip. They contain several bands of calcareous concretionary nodules, usually in the form of septaria, and two impersistent cementstones.

In the two feet of shale immediately below the lower cementstone (Bed 11) the following have been collected: *Pictonia* aff. *bigoti* Tornquist, *Pictonia* sp. (cf. *bigoti* Tornquist), *Prorrasenia* sp. (*hardyi* group?), *Prorrasenia* sp. (*witteana* group), *Goniomya literata* (J. Sowerby), *Oxytonia expansa* (Phillips) and *Pholadomya* cf. *aequalis* (J. de C. Sowerby).

Between the two cementstones (Bed 13) ammonites are very abundant though badly preserved. From here the following forms were obtained :

*Amoeboceras* (*Prionodoceras*) cf. *banhini* Ilovaisky non Oppel, *A. (P.)* cf. *alternans* (Nikitin) *auctorum* = *regulare* Spath?, *A. (Amoebites?)* sp., *Pictonia* cf. *bigoti* Tornquist, *P. aff. bigoti*, *P. cf. normandiana* (Tornquist), *P. cf. parva* Tornquist, *P. cf. laticostata* Tornquist, *P. aff. laticostata*, *P. sp. (laticostata–normandiana group)*, *P. sp. (normandiana group)* *P. aff. baylei* Salfeld, *P. aff. costigera* S. S. Buckman, *Prorrasenia* sp., *Astarte subdepressa* Blake and Hudleston.

For 15 ft above the two cementstones (Bed 15) belemnites are abundant and ammonites fairly common but are crushed and difficult to extract. The fauna indicates: *Amoeboceras* (*Amoebites?*) sp. (*beaugrandi* (Sauvage) group), *Pictonia* aff. *baylei* Salfeld, *P. cf. laticostata*, *P. cf. parva*, *Prorrasenia* sp., *Astarte contejeani* de Loriol, *A. subdepressa* Blake and Hudleston, and *Oxytoma expansa* (Phillips).

So far no fossils have been found above this horizon though the shales continue for another 20 ft before disappearing below landslip.

North of the fault at Point 7 [NG 468 715], Kimmeridge Clay underlies the beach for some distance but is poorly exposed. At Point 6 [NG 470 712], south of a large dyke and beneath a mass of slipped Palagonite Tuff-breccia, a few feet of blue shale are exposed containing obscure ammonites not specifically determinable. They are predominantly *Pictonia* however, which suggests a horizon near the base of the Kimmeridge Clay. Further south at Point 2 [NG 473 696], about 20 ft of Kimmeridge Clay are exposed beneath a leaf of sill (Section p. 66). The shale is poorly fossiliferous and much disturbed by the intrusion, but *Pictonia* cf. *cymadoce* Salfeld and *P. sp. (normandiana–laticostata group)* are present and indicate a horizon in the *P. baylei* Zone.

Inland a wedge of Kimmeridge Clay is faulted in amongst the Great Estuarine strata exposed in the Kilmaluag River. Three small exposures in the eastern bank below Kendrom show grey shale with an 18-in cementstone. The numerous ammonites collected from the latter include: *Amoeboceras* (*Prionodoceras*) cf. *alternans* Nikitin, *A. (P.)* sp. (?cf. *bigoti* Tornquist) and *Pictonia* spp. suggesting a horizon in the *P. baylei* Zone.

North-west of Kendrom in the west bank of the river, a small exposure of clay is probably at about the same horizon but appeared to be unfossiliferous. Shales belonging to the *P. baylei* Zone are also exposed beside a small waterfall at Balnaknock in the Lon an t-Sratha, a tributary of the River Conon.

About 25 ft of shale are exposed including a 6-in cementstone. The uppermost 8 ft of this section contain *Amoeboceras* (*Prionodoceras*) sp. and *Pictonia* aff. *baylei* (Salfeld); the lower 15 ft represents the upper part of the *R. anglica* Zone. (p. 70).

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Kimmeridge Clay		<i>Pictonia baylei</i> Zone
Corallian	<i>Amoeboceras</i> Beds	<i>Ringsteadia anglica</i> Zone <i>Perisphinctes variocostatus</i> Zone <i>Cardioceras cawtonense</i> Zone
Upper Oxford Clay	<i>Cardioceras</i> Beds	<i>Cardioceras cordatum</i> Zone
	<i>Quenstedtoceras</i> Beds	<i>Quenstedtoceras mariae</i> Zone
Middle Oxford Clay	<i>Kosmoceras</i> Beds	<i>Quenstedtoceras lamberti</i> Zone
Lower Oxford Clay		<i>Peltoceras athleta</i> Zone <i>Kosmoceras castor</i> & <i>K. pollux</i> Zone <i>Kosmoceras jason</i> Zone

Unnumbered table. Zonal scheme of the Jurassic: Oxford Clay to Kimmeridge Clay.

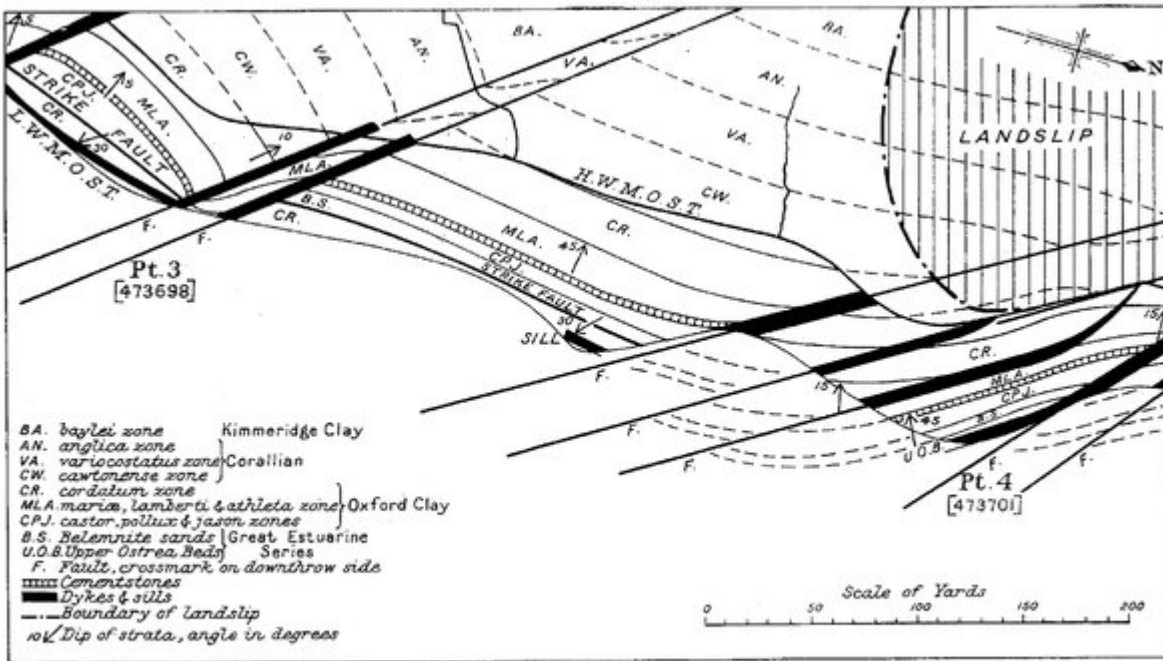


FIG. 9. Map of Jurassic strata in Staffin Bay, coast east of Loch Leum nam Bradh. Grid references in square brackets

(Figure 9) Map of Jurassic strata in Staffin Bay, coast east of Loch Leum nam Bradh. Grid references in square brackets.

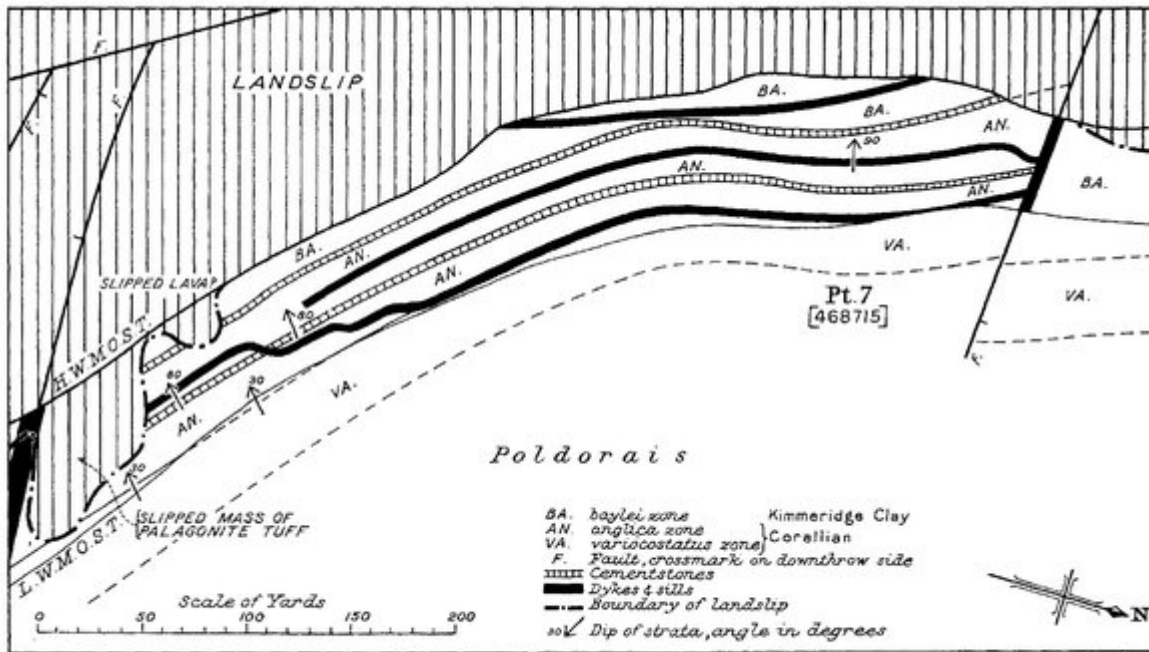


FIG. 11. Map of Jurassic strata in Staffin Bay, coast south-east of Flodigarry Hotel. Grid references in square brackets

(Figure 11) Map of Jurassic strata in Staffin Bay, coast south-east of Flodigarry Hotel. Grid references in square brackets.