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# Prince Charles' Cave to Holm, Isle of Skye, Highland

[NG 517 480]–[NG 519 515]

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## Introduction

The Prince Charles' Cave to Holm GCR site is remote and poorly documented. The succession at the site includes a virtually complete uppermost Pliensbachian to Bajocian sequence of the Hebrides Basin and presents several differences from other correlative Hebridean successions. In particular the Portree Shale Formation is thicker and more complete here than elsewhere, and this site accordingly is proposed as the type section for the formation.

The east coast of the Trotternish Peninsula, from Portree north to Holm, is dominated by a high cliff composed of Jurassic sediments overlain by Tertiary lavas. The main part of the cliff consists of the Middle Jurassic Berreraig Sandstone Formation, but from just south of Prince Charles' Cave (at [NG 515 470]) to south of Holm (at [NG 520 507]) the sea-cliff is formed by the Pliensbachian Scalpay Sandstone Formation (Figure 8.11). Above this is a ledge or slope formed by the softer Toarcian Portree Shale Formation, Raasay Ironstone Formation and the Dun Caan Shale Member of the Berreraig Sandstone Formation. The latter is not described here, but was included in the Berreraig GCR site report in the Middle Jurassic GCR volume (Cox and Sumbler, 2002). The Lower Jurassic GCR site described here includes most of the Lower Jurassic outcrop. From just over 1 km south of the GCR site at [NG 514 465], below Sithean Bhealaich Chumhaing, southwards to east of Torvaig (at [NG 505 445]) Jurassic rocks are hidden beneath scree and landslipped material. North of Holm the top of the Lower Jurassic sediments dips below sea level.

Lower Jurassic strata also crop out on the south side of Portree Bay, between Scorr Skerry [NG 504 428] and Scarf Caves [NG 511 427], north-east and south-east of Bein Tianavaig [NG 529 417] and [NG 515 390], and on the foreshore at Braes [NG 520 366]. These are the only outcrops of Lower Jurassic rocks in northern Skye outside of the GCR site and brief reference to them will be included in this account where appropriate.

In this GCR area the lowest part of the Lower Jurassic succession exposed is the upper part of the Scalpay Sandstone Formation (Upper Pliensbachian to basal Toarcian). The Portree Shale Formation (lower Toarcian) is much thicker here (the type section) than elsewhere on Skye or on Raasay. However, the Raasay Ironstone Formation is much thinner in Trotternish than on Raasay.

The structure of the area is simple, with dips of 5°–10° towards just north of west, so that the coast is exactly along-strike through the GCR site. There are no major faults and only a few minor NNW–SSE faults with displacements of 1 m or less have been observed. Some are associated with dykes, often eroded to form the caves such as Prince Charles' Cave, but these cause only very limited (< 1 m) baking of the adjacent sediments. The only substantial sill within the GCR site forms Holm Island and is intruded at the level of the Raasay Ironstone Formation, not seen here, for some 2 km to the south. This sill has thermally altered the Portree Shale Formation for 2 m below its base and the overlying Dun Caan Shale Member for about 3 m.

The Lower Jurassic rocks of the area were noted by Murchison (1829), and a description was given by Bryce (1873). However, there are only two significant published accounts of the stratigraphy of the Lower Jurassic succession in this GCR site, both [British] Geological Survey memoirs, by Lee (1920) and Anderson and Dunham (1966), although the latter adds little new information on the Lower Jurassic succession. The description and discussion given here are based mainly on unpublished work, including unpublished field observations and MSc theses by Bruce Farrer (1994) (on which descriptions of the Portree Shale and Raasay Ironstone formations are largely based) and Neville Brookes (1989), both at Birkbeck College. Murray Edmunds has also provided valuable unpublished information based on his collections and those of other amateur collectors who have visited the site. However, it is clear that further work is required to fully document this site.

The outcrops are difficult to access, involving a long walk across rough coastal terrain. They can be reached either from Bearreraig to the north (> 2 km to the northernmost outcrop) or from Torvaig to the south (4 km to the southernmost outcrop). Walking from the nearest point on the Portree–Staffin road, at the top of the hill south of Storr Lochs, and descending the cliffs between Craig Ulatota and Fiurnean is inadvisable. In good weather conditions access by boat to the shore at Prince Charles' Cave is possible.

## Description

The Scalpay Sandstone Formation forms an almost continuous sea-cliff in the GCR site, especially around Prince Charles' Cave, but fallen blocks and the rough nature of the coast place practical limits on the sections that can be examined (Figure 8.11). The measured section and description given here are based on three selected sections:

- at the point south-west of Holm Island [NG 520 506] near the northern end of the sea-cliff;
- approximately 1 km north of Prince Charles' Cave [NG 518 490];
- near the southern end of the sea-cliff 1 km south of Prince Charles' Cave [NG 515 471].

All of these sections expose only the upper part of the Scalpay Sandstone Formation. There is a more complete section on the south side of Portree Bay, between Scorr Skerry and Scarf Caves, but this is almost inaccessible and there is no published description. Farther south, east of Tianavaig Bay [NG 515 390] and at Eilean Tioram [NG 520 366], only the upper part of the formation is exposed.

Outcrops of the Portree Shale and Raasay Ironstone formations on the ledge and gentler slope above the sea-cliff are rarer. The most accessible section is 1 km south of Prince Charles' Cave [NG 515 471] while another, 1 km north of Prince Charles' Cave (at [NG 518 490]), exposes only the lower part of the shales; these sections were recorded where landslips had stripped off the vegetation. During the earlier work by the [British] Geological Survey, Tait excavated a section through the Raasay Ironstone Formation and all but the lowest 4 m of the Portree Shale Formation. Lee (1920) gave the location as 0.75 miles (1.2 km) south of Holm and 5.5 miles (8.9 km) north of Portree, i.e. approximately halfway between Holm and Prince Charles' Cave [NG 520 500]. The Portree Shale Formation also crops out just south of Holm but the shales here, though fossiliferous, have been baked by a thick dolerite sill (Figure 8.11).

The succession recorded at the sections studied in and immediately south of the GCR site is summarized in (Figure 8.12). It is possible that slightly lower strata may be visible above sea level at Prince Charles' Cave, but no details are available. Details of the top of the Scalpay Sandstone Formation, the Portree Shale Formation and the Raasay Ironstone Formation are modified from Farrer (1994), and the bed numbering has been added to help cross-reference with the descriptions.

The main (upper) part of the Scalpay Sandstone Formation seen in the GCR site consists of more-or-less massive, medium- to light-grey, mottled, fine- to medium-grained sandstones that weather pale brown. Bioturbation is extensive and pervasive but recognizable trace fossils have not been recorded. Large, up to 1 m diameter, calcareous doggers occur throughout but their distribution is irregular. Lithological details, and subdivision into beds 1 to 4, are based on the Holm section but can mostly be recognized farther south. At Holm a prominent band of large doggers (Bed 3) is a distinctive marker bed and contains *Pleuroceras spinatum*. It can also be recognized at Prince Charles' Cave, and to the north where it forms the roof of an overhang. Here Murray Edmunds recorded *Pseudoamalthus engelhardti* and *Pleuroceras spinatum*. Below this bed at Holm there is distinguishable a slightly softer sandstone which is clearly cross-bedded (Bed 2), but this cannot be readily separated farther south. The underlying strata (Bed 1) are grey, slightly silty, sandstones that contain fewer, more scattered, large doggers. In the larger outcrops near Prince Charles' Cave, where a greater thickness of strata is exposed, patches of crinoid debris occur, either as collapsed colonies or in small channels, together with large bivalves, especially *Pseudopecten equivalvis*. Murray Edmunds recorded *Amalthus gibbosus* here. Bed 4 is a more-or-less massive, grey, pale-yellow weathering, sandstone with fewer scattered doggers. It is relatively homogeneous but also shows cross-bedding in places. The top is not exposed at Holm. Where it is more accessible farther south it can be seen to contain large bivalves, especially *Pseudopecten equivalvis*, some nests of brachiopods, notably *Tetrahynchia tetrahedra*, belemnites and lenses of crinoid debris, mostly *Hispidocrinus*

*schlumbergeri* with some *Balanocrinus donovani* (Simms, 1989). The belemnites do not show any preferred orientation, with some even perpendicular to the bedding indicating the extent of bioturbation. Ammonites are rare but *Pleuroceras spinatum* occurs at several levels.

The top beds of the Scalpay Sandstone Formation are well exposed north of Prince Charles' Cave. Here Bed 4 becomes slightly finer grained and silty towards the top. The overlying Bed 5 continues the fining-up, from fine-grained sandstone at the base to a coarse micaceous siltstone. Occasional nodules occur and Murray Edmunds has recorded *Dactylioceras* (*Orthodactylites*) cf. *tenuicostatum* (more serpenticone than typical Whitby specimens). Bed 6 at the top of the Scalpay Sandstone Formation is a calcareous sandy siltstone with a strongly ferruginous layer at the top, and contains *Dactylioceras* sp.. In outcrops south of Portree Bay, east of Beinn Tianavaig and at Eilean Tioram, there is a bed of grey micaceous silty limestone crowded with small ammonites including *Dactylioceras toxophorum*, *Harpoceras serpentinum* and *Hildaites* sp. (M. Howarth, pers. comm., 1984). It is not clear whether this represents a bed within the Portree Shale Formation or Bed 6 at the top of the Scalpay Sandstone Formation. The grain size of the terrigenous component is significantly coarser than the argillaceous limestones which typically occur within the Portree Shale Formation. This, together with the observed field setting suggest that the latter is more likely, and is suggested here, but neither is conclusive and further work is required.

The base of the Portree Shale Formation (Bed 7) is overall a daystone, but becomes silty and even sandy towards the base and finer grained and more fissile towards the top. Small calcareous nodules occur in the top 0.5 m. Belemnites occur at several levels and there is a layer with *Dactylioceras* and *Lytoceras* 1 m above the base (see further discussion below). Bed 8 is a light grey-brown daystone with iron- and sulphur-staining, suggesting weathering of pyritic material. Belemnites occur but no ammonites. Bed 9 is a band of iron-stained nodules and Bed 10 is a silty nodular limestone with shell debris.

The overlying beds are light-, medium- or dark-grey daystones that mostly have a blocky fracture but locally are fissile, with some pyritic or iron- or sulphur-stained layers. There are several bands of calcareous nodules, some forming more continuous limestone beds, such as beds 12 and 16. Fossils generally are not abundant, but some bedding planes contain small thin-shelled bivalves and occasional belemnites. Ammonites are common in some layers, such as beds 11, 13, 15 and 19, but not throughout, and tend to be crushed. These include *Dactylioceras anguiforme*, *Cleviceras exaratum* and *Eleganticeras elegantulum*. Details of the ammonite succession, are discussed below.

The upward continuation of the succession, with a gap of about 1 m, can be seen in a parallel shallow gully 15 m to the south. The top beds of the Portree Shale Formation, beds 23 and 24, contain scattered iron-ooliths and some layers crowded with belemnites (also seen on Raasay at the main opencast workings, [NG 5690 3645]) and the ammonites *Dactylioceras* sp. and *Lytoceras*. The occurrence of scattered iron-ooliths indicates a transition into the overlying Raasay Ironstone Formation.

The base of the Raasay Ironstone Formation is taken at the first hard ironstone bed (Bed 25). At this locality the formation can be divided into three parts. The basal 0.49 m (Bed 25) consists of hard, massive, crystalline calcareous ironstones or ferruginous limestones with a claystone parting. *Harpoceras subplanatum* was recorded by Farrer (1994). The middle part (Bed 26) is mainly claystone with two bands of ironstone nodules. Belemnites are abundant, especially in the top layer, while the ammonites recorded are *Harpoceras* sp. and *Peronoceras fibulatum* in the lower part and *Phylloceras heterophyllum* in the upper part. The upper part (Bed 27) is more similar to the ironstone seen in central Raasay — a light- or medium-grey oolitic ironstone, weathering rusty-brown to yellow-brown.

The Raasay Ironstone Formation is overlain by a thick succession of dark-grey micaceous shales (Bed 28: only base shown in (Figure 8.12)) belonging to the Dun Caan Shale Member of the Bearreraig Sandstone Formation. No ammonites were recorded near Prince Charles' Cave, but *Pleydellia* sp., indicating the topmost Toarcian Aalensis Zone, occurs 5.5 m above the base at Holm (see Morton and Hudson, 1995).

## Interpretation

The Jurassic succession within the Prince Charles' Cave to Holm GCR site includes Lower and Middle Jurassic rocks ranging from Upper Pliensbachian to Upper Bajocian (and possibly Lower Bathonian) in age. In this account only the rocks up to lower Toarcian age are discussed. These are classified as the Scalpay Sandstone Formation, the Portree Shale Formation and the Raasay Ironstone Formation (Figure 8.12). Although the last two are very thin, they are lithologically distinctive through much of the Hebrides Basin, justifying formation status. The boundary between the mostly sandy Scalpay Sandstone Formation and the clays of the Portree Shale Formation is more gradational and less abrupt here than in Raasay or Strathaird. It is placed at the top of Bed 6 as described above. The topmost Toarcian (to lower Aalenian) Dun Caan Shale Member is excluded here because it is described in the Bearreraig GCR site report of the Middle Jurassic GCR volume (Cox and Sumbler, 2002).

Only limited lithostratigraphical information about the Scalpay Sandstone Formation in Trotternish is available. For example there is almost no description in the [British] Geological Survey memoir (Lee, 1920), contrasting with the situation on the Isle of Raasay where the formation is well described. For more detailed descriptions and discussions of this part of the successions see the Rubha na' Leac, Hallaig Shore and Cadha Carnach GCR site reports. The shales which succeeded the Scalpay Sandstone Formation, and below the Raasay Ironstone Formation, were named the Portree Shale (Formation) by the [British] Geological Survey (proposed by S.S. Buckman in Lee, 1920). The type locality, though not formally defined was clearly intended to be in the area of Prince Charles' Cave. In fact the best currently available section is south of the cave, 1 km south of the southern boundary of the defined GCR site (Figure 8.11). This section, at [NG 515 471], is formally proposed here as the type section; the details on (Figure 8.12) are mainly from this locality. The succeeding Raasay Ironstone Formation is much thinner on Trotternish than in southern Raasay. It has not been identified south of Portree Bay but does occur south of Prince Charles' Cave (Figure 8.12). Although there are few exposures to the north it can be traced to at least Bearreraig where a borehole (Lee, 1920) proved the ironstone to be slightly thicker than at the GCR site. There is a transition from the Portree Shale Formation, with the boundary traditionally taken at the first harder bed.

The oldest known ammonites within the area included in this account, which extends slightly south of the GCR site, are *Amaltheus gibbosus* from Bed 1 indicating the Gibbosus Subzone of the Margaritatus Zone. This would correlate Bed 1 with beds 25–27 of the succession south of Rubha na' Leac on Raasay. Bed 3, a band of large calcareous doggers, is a distinctive traceable unit characterized by the common occurrence of ammonites, especially *Pleuroceras spinatum* and *Pseudoamaltheus engelhardtii*. These are characteristic of the Spinatum Zone, with the latter suggesting the Apyrenum Subzone, and correlation with beds 28–30 at Rubha na' Leac. Bed 4 contains *Pleuroceras spinatum* at several levels, but no other ammonites have been recorded confirming that this bed also belongs to the Spinatum Zone, Hawskerense Subzone according to Howarth (1958). This correlates with beds 36–37 at Rubha na' Leac and indicates that this part of the Scalpay Sandstone Formation is much thinner on Trotternish than on Raasay. The occurrence of *Dactylioceras* (*Orthodactylites*) cf. *tenuicostatum* in Bed 5 (M. Edmunds, pers. comm.) indicates that this bed belongs to the Tenuicostatum Zone, but identification of the subzone is not possible at present. It may be correlated with Bed 38 (undated) at Rubha na' Leac although it is finer grained (Figure 8.12). The top bed of the Scalpay Sandstone Formation, Bed 6 (Figure 8.12), is a distinctive more calcareous and ferruginous bed which therefore correlates with Bed 39 of the Raasay succession, and is again finer grained and more silty in Trotternish than on Raasay. *Dactylioceras* sp. is widely recorded and, although specific identity remains uncertain, correlation with the Tenuicostatum Zone has long been accepted (since Lee, 1920). However, if, as suggested above, the correlation with the silty limestone bed found south of Portree Bay is correct, then this dating must be revised because this bed contains ammonites of the Serpentinum Zone, *Dactylioceras toxophorum*, *Haploceras serpentinum* and *Hildaites* sp.. This would indicate that the top of the Scalpay Sandstone Formation is slightly younger than previously thought (Howarth, 1992).

The most complete ammonite succession from the Portree Shale Formation was obtained by Tait from the trench excavated during the [British] Geological Survey field mapping. The ammonites were submitted to S.S. Buckman and were reported in the appendix in Lee (1920). The formation belongs almost entirely to the Serpentinum Zone, with the possible exception of the basal bed. The basal 4 m was not exposed by Tait. To date only *Dactylioceras* sp. and *Lytoceras* sp. have been found in Bed 7. Therefore the age cannot yet be independently verified as either Tenuicostatum Zone or, if the correlation of the top bed of the Scalpay Sandstone Formation is correct, Serpentinum Zone. The latter is provisionally adopted here. In the overlying beds 8–13 ammonites, including *Eleganticeras elegantulum*, *Cleviceras*

*exaratum* and *Dactylioceras anguiforme*, are common. These are characteristic of the Exaratum Subzone of the Serpentinum Zone (Howarth, 1992).

The position of the boundary between the lower Exaratum Subzone and the higher Falciferum Subzone is placed near the base of Bed 15 (Figure 8.12), which equates with the level between 4.8 m and 5.8 m above the base of the formation identified by Buckman (in Lee, 1920). Higher beds contain mainly *Dactylioceras* spp., which are less reliable for dating, but are placed in the Falciferum Subzone.

Dating the Raasay Ironstone Formation with confidence has proven difficult because of poor preservation and limited numbers of ammonites recorded. Traditionally it has been placed in the Bifrons Zone, following Buckman's identifications of the ammonite fauna on Raasay. However, Howarth (1992) questioned the evidence for this and considered that all the ammonites he had seen were consistent with a Falciferum Subzone age. This was based on material collected on Raasay by Andrew Smith near the old mine buildings and confirmed subsequently from above the pier. However, both of these collections are from spoil tips that contain much shaly ironstone which may have come from the lower part of the formation, which is, therefore, certainly of Falciferum Subzone age. Those identified in Trotternish include *Harpoceras subplanatum*, *Peronoceras fibulatum*, *Dactylioceras (toxophorum)*, *Phylloceras heterophyllum*. However, Bruce Farrer identified in the middle bed (Bed 26) of the Raasay Ironstone Formation at Prince Charles' Cave *Harpoceras subplanatum* and *Peronoceras fibulatum*, together with *Dactylioceras* and *Phylloceras heterophyllum*. The first two, if confirmed by further work, are characteristic of the Bifrons Zone (Howarth, 1992). The allocation of part of the Raasay Ironstone Formation to the Bifrons Zone is supported by Murray Edmunds (pers. comm.) who found loose specimens of poorly preserved Bifrons Zone *Hildoceras semipolatum* near Prince Charles' Cave.

Detailed descriptions and interpretations of the facies and deposition of the Scalpay Sandstone Formation can be found in the descriptions of the three Raasay sites. The main difference in Trotternish seems to be that towards the top the formation becomes finer grained. The base of the succeeding Portree Shale Formation differs here from elsewhere in the Hebrides, in that there is some transition with fining-up in the basal bed as well as in the top of the Scalpay Sandstone Formation. The actual boundary is sharp but the lithological change is less extreme than elsewhere. This change in lithology reflects a marine flooding event and can be correlated with a global deepening event of the Serpentinum Zone (Hallam, 2001). The shales were deposited in a restricted distal marine environment. The occurrence of bivalves, mostly small thin-shelled genera, and the blocky fracture suggests that some benthos was present, but other layers are fissile and may have been deposited in anoxic conditions.

The Raasay Ironstone Formation in Trotternish differs in facies from the thicker developments seen in central Raasay (e.g. at the opencast workings). The crystalline ferruginous limestones may be more similar to the crinoidal facies seen at Gualann na Leac (see Rubha na' Leac GCR site report). The 'typical' facies is seen only in the uppermost Bed 27. The outcrops give little useful information about the controversial depositional environment of the ironstone. Fossils other than belemnites are rare, and even these are frequently worn or corroded.

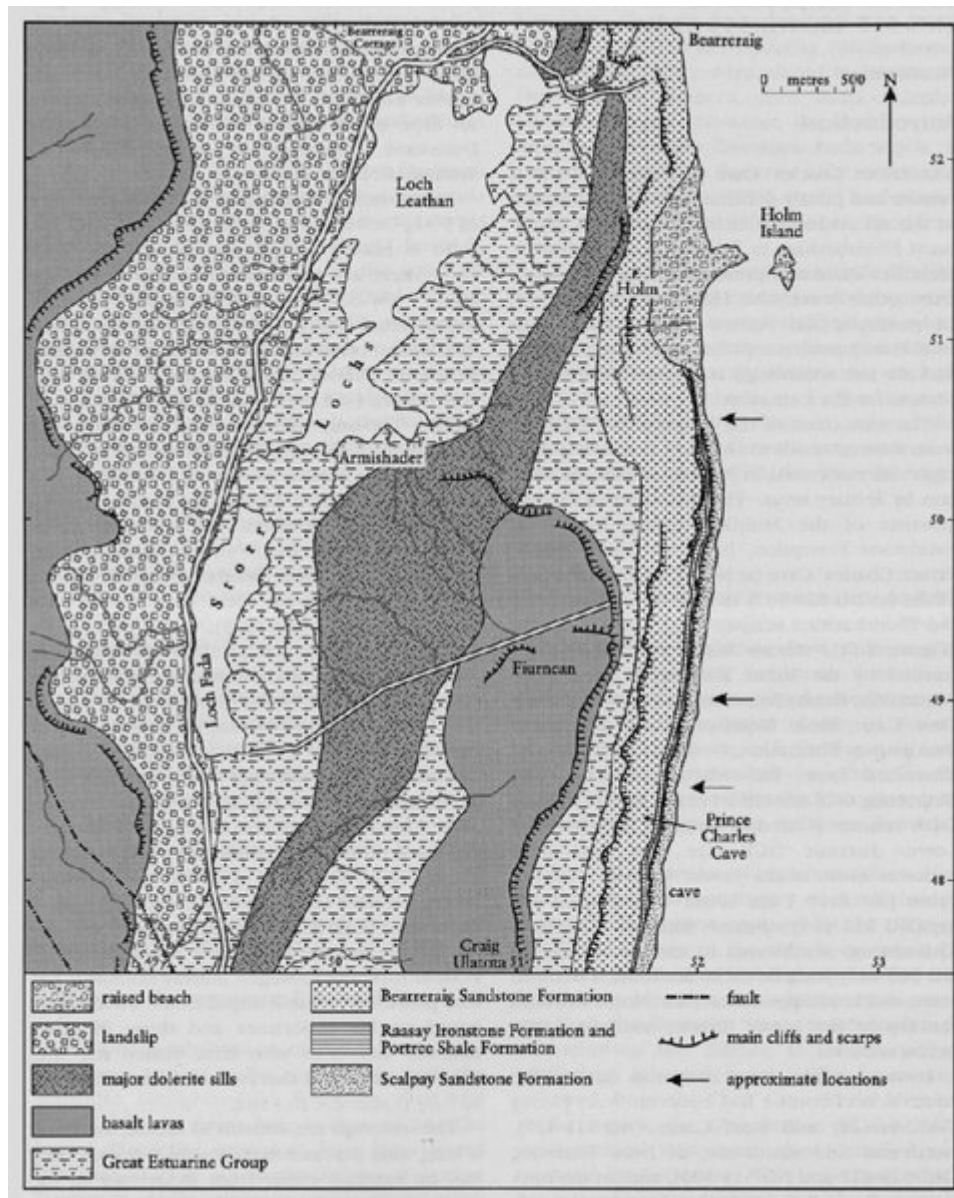
## Conclusions

The cliffs along the shore of Trotternish from south of Prince Charles' Cave to Holm (Figure 8.11) show the most northerly extensive Lower Jurassic outcrops in the Skye area (excluding the limited outcrops in the Shiant Isles). However, through a combination of relative inaccessibility and poor exposure of the Toarcian shales the amount of data available about this area is very limited. It is clear that the descriptions given here could be improved with further determined fieldwork, and it is known that some amateur collectors have collections and data that are as yet unpublished.

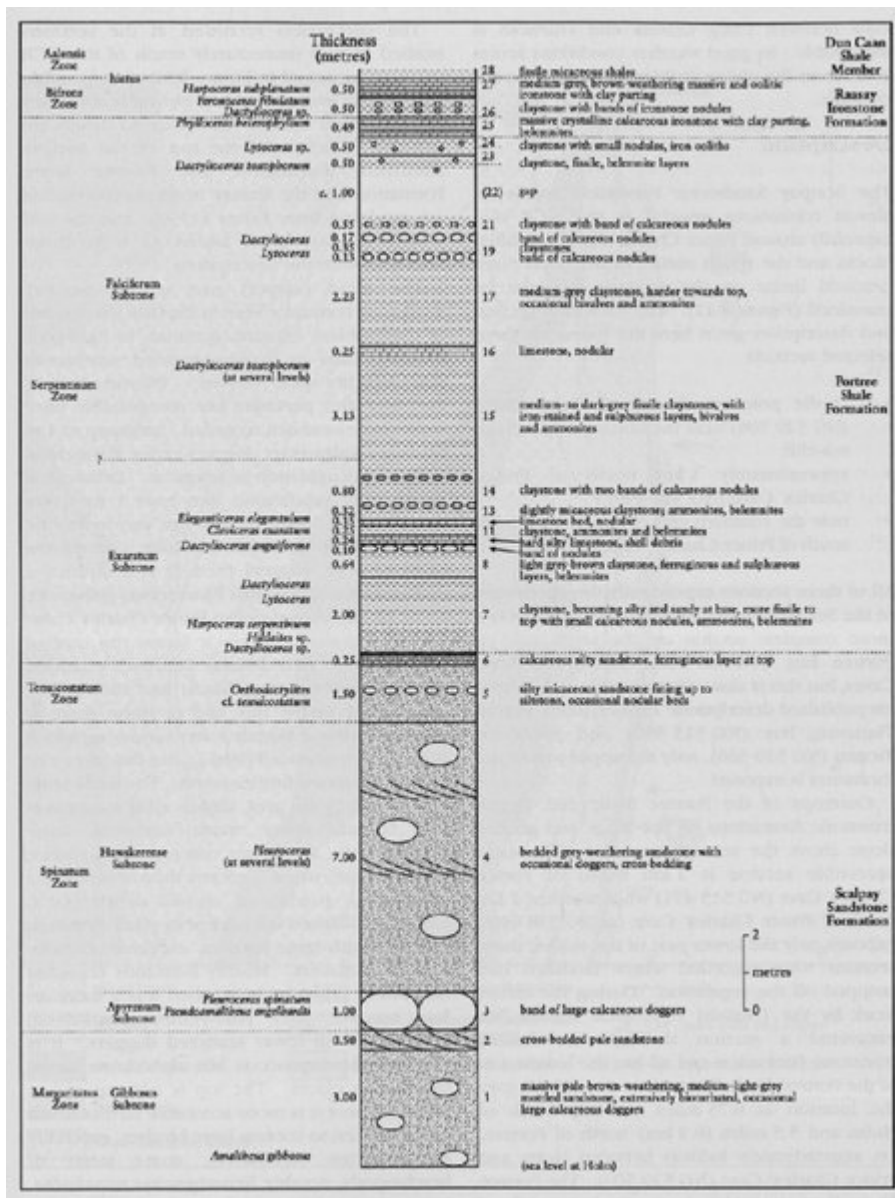
At this site there are good outcrops of the upper part of the Scalpay Sandstone Formation and the faunas are similar to those documented on Raasay, with ammonite evidence for the Upper Pliensbachian Gibbosus, Apyrenum and Hawskerense subzones, and of the Lower Toarcian Tenuicostatum Zone. The facies are also similar, except that the boundary with the overlying Portree Shale Formation is more gradational and less abrupt than elsewhere in Skye and Raasay. However, the thicknesses are significantly less. The correlation and dating of the top calcareous bed of the Scalpay Sandstone Formation is unresolved. If the correlations suggested here can be verified by further work it may belong in the Exaratum Subzone rather than Tenuicostatum Zone. The Portree Shale Formation is not well exposed

anywhere in the Hebrides, but the section south of Prince Charles' Cave is more complete and the formation much thicker than at other documented outcrops. This section is proposed here as the type section for the formation. Depending on resolution of the problem of the top bed of the Scalpay Sandstone Formation, the basal part of the Portree Shale Formation may still lie within the Tenuicostatum Zone rather than the Serpentinum Zone. The available ammonite faunas are not yet conclusive for independent verification. In the overlying shales both the Exaratum and Falciferum sub-zones have been identified; again the latter requires further proof. The few outcrops of the Raasay Ironstone Formation show a thinner more 'marginal' facies than at the type section of the formation in Raasay. The ammonites found to date in the middle part of the formation appear to conflict with Howarth's interpretation (based on Raasay material) of a Serpentinum Zone rather than Bifrons Zone age.

## References



(Figure 8.11) Simplified geology and locality map of the Storr Lochs–Holm–Prince Charles' Cave area north of Portree, Trotternish, Isle of Skye, showing locations of the main sections (especially for the Toarcian Stage).



(Figure 8.12) Succession from the upper Scalpay Sandstone Formation to the Dun Caan Shale Member at Trotternish, north of Portree, Isle of Skye, based mainly on unpublished descriptions by Bruce Farrer (1994), observations by Morton (unpublished), and data from Murray Edmunds (unpublished) and Lee (1920). The composite section is based on three main localities: south of Holm [NG 520 506] (by Nicol Morton); between Holm and Prince Charles' Cave (approx. [NG 518 490]) (by Bruce Farrer) and south of Prince Charles' Cave [NG 515 471] (Bruce Farrer and Nicol Morton).