Beinn Iadain and Beinn na h-Uamha, Morvern

[NM 670 541]–[NM 689 528], [NM 6 8]

Introduction

On the Scottish mainland, to the north of Lochaline and Loch Arienas (Figure 6.1) a mountainous wilderness composed primarily of Moine Schists, is capped on the highest peaks by thin elements of Mesozoic sediments and Tertiary lavas. Beneath the lavas on two of these mountains, Beinn Iadain and Beinn na h-Uamha, are exposures of the Upper Cretaceous Inner Hebrides Group, probably more complete in the former than anywhere else. It was at Beinn Iadain that Judd (1878) and Scott (1928) collected (inferred) Campanian belemnites (possibly *Belemnitella mucronata*) from a thin bed of chalk (to Scott, much of this was real chalk). Later, in the 1960s, Santonian sponges were collected from the bed of clayey greensands with phosphates under the chalk (Rawson *et al.,* 1978). It is also an area where lignite is present beneath the mudstones, in former times recognized as coal seams by shepherds (Judd, 1878). Bailey (1922) interpreted the excellent exposures of the Lochaline White Sandstone Formation in this area as further evidence of the desert shores of the chalk seas.

Description

The mountains of Beinn Iadain and Beinn na h-Uamha include several exposures of the Inner Hebrides Upper Cretaceous Group (Figure 6.28). Approached from the west by the estate track from Kinloch [NM 658 558], the Beinn Iadain sections occur in three main exposures, two on the south-east corner are west of the marked north-south fault crossing the mountain (British Geological Survey 1:50 000 Map Sheet 52(E), Strontian). The other section is on the west side of a deep stream gully on the northeast side of the mountain. Judd's (1878, pp. 735–6) original section is on the south-east side of Beinn Iadain (spelt Beinn-y-Hattan by Judd), and is directly north of the shielings (abandoned shepherds' cottages) in a currently obscured exposure [NM 694 549], partly in a stream and waterfall. Currrently the best exposure (labelled Section 1 on (Figure 6.28)) is above and to the west of the ruined shielings [NM 692 551]. This section was also studied by the [British] Geological Survey (Bailey, 1922, reporting on the work of Simpson and Manson) (see (Figure 6.29)). Subsequent work on this section includes the records of Scott (1928, p. 169), unpublished sections and collections of Jeans and Platten with fossil identifications by Reid (1968), and Braley's unpublished PhD thesis (1990). As part of this review, the two main Beinn ladain sections on the south-east side were visited (1998–1999) and remeasured and sampled, in order to establish the current state of the exposures around the mountains and to attempt to date the succession.

The second main Beinn Iadain section (Figure 6.28) is found on the north-east slopes in the Coire Riabhach stream bed and cliffs [NM 697 564]. Coire Riabhach is the main stream flowing north on the north-eastern side of Beinn Iadain. It cuts a steep-sided valley into Moine Schists and is joined by a number of small tributary streams (Figure 6.30). One of these smaller streams joins from the west where it flows off basalts along the edge of a small fault-controlled outlier of Mesozoic rocks. The Upper Cretaceous exposure here is a small fault-controlled outlier on the steep west bank of the main stream below the confluence with a smaller stream. The bed of the main stream and the east bank are in coarse mica schists of the Moine rocks. An unconformity between the Moine rocks and the basal Triassic cornstones is exposed in a small waterfall on the tributary stream.

Judd (1878, pp. 734–5) recorded a similar succession at Coire Riabhach to that at the south end of the mountain, albeit with thinner Lochaline White Sandstone Formation, overlying oyster-rich greensands and argillaceous greensands resting on Lias and Trias. This broadly agrees with the description given below. Braley (1990) recorded the higher part of what is presumably the same section, but the details differ. Dr C.V. Jeans and Dr I. Platten (unpublished data) have measured several sections showing marked lateral variation in the beds with lignites overlying the chalk. The Coire Riabhach section was re-measured (1999) by stripping all vegetation from the section down to the Trias (Figure 6.31). This revealed a hitherto undocumented stratigraphy. Other exposures along the north side of Beinn Iadain are small and only occasional, relying on cliff falls.

On Beinn na h-Uamha (Figure 6.28) there is no unequivocal evidence for the existence of Chalk between the Lochaline White Sandstone Formation and the basalt. However, the British Geological Survey 1:50 000 (Strontian) Geological Map shows the existence of (supposed Tertiary) sediments with lignites beneath the lavas, and the memoir (Bailey *et al.,* 1924) implies that the basalts are underlain by mudstones everywhere in the surrounding area, including the sections at Lochaline.

The south-east and north-west ends of Beinn na h-Uamha have provided good exposures of the Lochaline White Sandstone Formation. The [British] Geological Survey recognized that the best exposure was at the north-western end. Here, above a fault that drops the basalt and Cretaceous strata by about 150 m down to the west, there is a continuous exposure in the Lochaline White Sandstone Formation, and an indication of the erosive base of the Upper Cretaceous succession, which rests on Moine Schist on the southern side of the mountain and on Trias on the northern side (Scott, 1928).

Beinn Iadain provided a standard Inner Hebrides Upper Cretaceous section for Judd (1878, pp. 734–5), in which he recognized four beds in the Upper Cretaceous strata. These he referred to as 'Upper Greensand' at the base, 'Estuarine Beds' of white sand, 'Upper Chalk', which included some argillaceous beds, greensand and silicified chalk, and finally an 'Upper Estuarine Series' including a bed of lignite and mudstone. Following Bailey *et al.* (1924), Lee and Bailey (1925) and Scott (1928, p. 167) referred to the white sands (Estuarine Beds) as the 'White desert sandstone'.

Lithostratigraphy

The main Beinn Iadain section on the south-east side of the mountain above the shielings provides the most complete lithostratigraphy (Figure 6.29). It is presumed that the Upper Cretaceous rocks here rest on the Lias Pabba Shales and Gryphea Beds (Judd, 1878; Scott, 1928). These Liassic shales are not currently exposed but create the wet boggy ground below the Cretaceous strata. The first exposures are in the Cenomanian greensands, which are more sandy and expanded here than at Gribun. At the top of this unit, a bed of abundant large *Amphidonte* in a lumpy nodular glauconitic sand compares with similar beds at Gribun and Carsaig. This bed is overlain by beds of fine-to medium-grained sandstone, some laminated, with sporadic concretions, passing up into oyster-shell rich sandstones capped by a concretionary sandstone with *Thalassinoides* burrows. The Lochaline White Sandstone Formation above is poorly exposed but forms a massive 5–6 m thick bed, which becomes weakly glauconitic towards the top.

The most variable part of the succession lies above the Lochaline White Sandstone Formation. At Beinn Iadain Section 1, a thin glauconitic sandy clay packed with weathered, brown phosphate clasts including sponges, internal moulds of brachiopods and bivalves, and sharks teeth is intercalated between the Lochaline White Sandstone Formation and the overlying silicified chalk. The basal contact is burrowed, but the nature of the contact with the overlying chalk is unclear. As at other localities, the chalk is silicified, but Scott (1928) noted that the degree of silicification changes within the expo sure, some chalk appearing to be softer, leaving a white powder when handled, and more like a real chalk. At the top of the 1 m-thick chalk is a variable succession, which, in the most complete section, comprises a thin layer of silicified chalk intraclasts in a greensand matrix, overlain by thin units of grey marl, pale buff sandstone, dark black lignite and orange mudstone.

It is uncertain which bed is actually the base of the Cretaceous succession in the Coire Riabhach section on the north-east slopes of Beinn Iadain. A 0.6 m thick, dark green, micaceous and glauconitic, sandy silt with wavy laminations overlies what is presumed to be the top Triassic blue-grey, silty clay. This is succeeded by a thin (0.3 m thick) pebble bed of well-rounded quartz pebbles in a 0.3 m thick true glauconitic greensand which could also be the basal Upper Cretaceous bed. The overlying 0.5 m thick dark green, gaize-like lithology contains oyster shells. This bed grades progressively upwards into the very thickly bedded white sandstone, here about 3 m thick, which forms a buttress along the side of the valley. The next bed above is of particular importance for stratigraphical correlation as there is an unusually thick glauconitic greensand with five well-developed phosphate horizons rich in sponges and sharks teeth. The silicified chalk is very thin (0.25 m), and is capped by a flint conglomerate and a lignitic bed overlain by a pale sandstone that contains further scattered flint fragments. Another thin lignite above is succeeded by 1 m of mudstones up to the first lava.

Biostratigraphy

Judd recognized the age of the Cenomanian greensands at Carsaig and Gribun on Mull, and found similar fossils (mostly oysters) at Beinn Iadain. Bailey *et al.* (1924), and Lee and Bailey (1925), supported these age determinations, adding the record of the ammonite *Schloenbachia intermedia* in the greensands at Auchnacraig, Mull.

The age of the Lochaline White Sandstone Formation remained problematic, with Lee and Bailey (1925) emphasizing that no age-diagnostic fossils had been found and speculating that these sands might be Turonian in age.

Reid (in *litt.* to Dr C.V. Jeans, 1967) identified sponges, including the hexactinellid *Rhizopoterion cribrosum* (Phillips), in the phosphates in the clayey bed beneath the silicified chalk (Rawson *et al.,* 1978, p. 55). Reid observed that these sponges occurred in a similar preservation and matrix in the higher part of the Santonian Cloghfin Sponge Beds of Northern Ireland (Fletcher and Wood, 1982, fig. 17). Judd (1878) and Scott (1928), both recorded specimens of the belemnite *Belemnitella mucronata* (Schlotheim) from the Chalk of Beinn Iadain. These critical records would imply, if the belemnites were correctly identified, that at least part of the Scottish Chalk was Upper Campanian in age. Unfortunately, attempts to locate the original material in order to check the determinations have proved unsuccessful. It is emphasized that *Belemnitella* also occurs lower in the succession, notably (as *B. praecursor* (Stoney)) in Northern Ireland at the base of the Lower Campanian *Gonioteuthis quadrata* Zone. All observers have noted the presence of inoceramid fragments in the silicified chalk here.

From the intraclast beds upwards to the lavas there are no satisfactory dates and these could therefore be either Upper Cretacous or Tertiary sediments.

Interpretation

The Upper Cretaceous succession on the mountain sections of Morvern at Beinn Iadain and Beinn na h-Uamha show great similarities with correlative sections on Mull ((Figure 6.34), p. 471), particularly the Gribun Clachandhu boulders and Allt na Teangaidh sections, and Carsaig. This similarity occurs in the Cenomanian greensands, the buff laminated, concretionary sandstone with *Thalassinoides,* the Lochaline White Sandstone Formation, the greensands below the Chalk, and the flint conglomerate above, partly in greensand. As on Mull, there is a glauconitic bed (here more clayey at Beinn Iadain Section 1) between the Lochaline White Sandstone Formation and the Chalk. The Chalk is silicified and fragmental towards the top. Above the Chalk the Beinn Iadain succession is more variable, and includes a bed of lignite at Section 1 and two lignite beds at Coire Riabhach. Mudstones are present everywhere immediately beneath the lavas.

The similarities between the Carsaig, Gribun and Morvern successions serve to emphasize the conspicuous differences between these sections and the other Mull sections at Torosay and Auchnacraig.

The Lochaline Mines, Morvern, provide exposures which show some variation from the mountain sections (Figure 6.32) and (Figure 6.33). A once very good section through the entire Cretaceous succession in the Lochaline area is exposed in the west face of the track leading into the main entrance to the mine (known as the 'adit section', [NM 680 453]). The basal Upper Cretaceous pebble bed is followed by a silty greensand succession, a calcareous nodular bed, beds with abundant *Rhynchostreon* oyster shells and finally the main mass of the Lochaline White Sandstone Formation. At the top, but out of reach, red mudstones are present beneath the basalts.

Part of the old adits [NM 678 455], revealed the hard, green *Rhynchostreon* beds with serpulids which form the basal unit of the Lochaline White Sandstone Formation. Two hard bands in the Lochaline White Sandstone (Figure 6.32) locally form the roof of the adits. There is no obvious petrological difference between the hard bands and the main sandstone.

There is little extra fossil information to support the age dating of the Upper Cretaceous deposits in this region. Cenomanian ammonites (*Schloenbachia*) confirm the age of the Morvern Greensand Formation but no diagnostic fossil records exist for beds above the Greensand. The ages of the Lochaline White Sandstone Formation and the highest beds remain controversial.

Judd (1878) interpreted all the beds between the Cenomanian Morvern Greensand Formation and the chalk (Table 6.1) as estuarine (his 'Lower Estuarine beds'). In contrast, Bailey (1924) interpreted the Lochaline White Sandstone Formation as derived from sand blown into the sea from a desert because of its incredible purity and the presence of 'millet-seed' quartz grains, considered typical of desert conditions. The continued presence of similar millet-seed grains in the sands between the silicified chalk clasts, and the silicification of the chalk itself, led Bailey to suggest that desert conditions continued to the top of the succession (i.e. into the Tertiary deposits). He considered the silicification to be a soil-forming process (a silcrete) similar to the processes seen in the present day Kalahari Desert. For Bailey, this explained the angular, fragmental nature of the chalk, which was then reworked in overlying layers as a flint conglomerate.

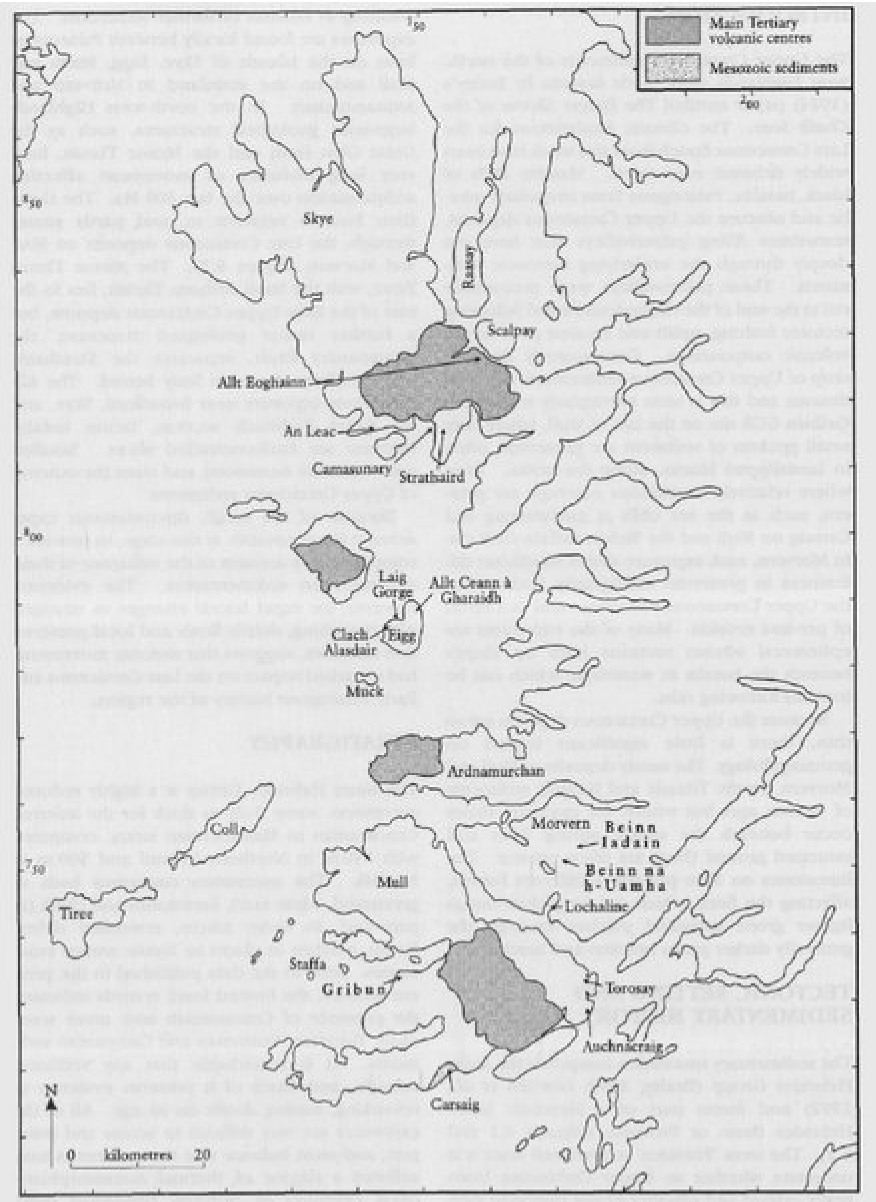
Other evidence from the [British] Geological Survey indicated the presence of marine shells in the Lochaline White Sandstone Formation (Lee and Bailey 1925, p. 116). The find of a well-preserved starfish in these sands at Lochaline (MacLennan, 1949) and poorly preserved echinoids (collected by Dr Oates and now in the British Geological Survey collections) shows, unequivocally, that these are marine sandstones, probably shallow water. Increasing glauconite towards the top and the presence of burrows provides further supporting evidence of the environment of deposition.

The purity of the quartz-rich Lochaline White Sandstone Formation is of particular economic importance in the area (Lowden *et al.,* 1992). These sands are mined at Lochaline where the overlying chalk and other beds are missing, the lava resting directly on the Lochaline White Sandstone, often forming a roof to the mine adits. Understanding the origin and extent of these deposits has a bearing on the lateral variation, reserves and quality of the product. The Lochaline White Sandstone at Lochaline rests on a standard greensand succession, which includes Lower Cenomanian ammonites (e.g. *Schloenbachia).*

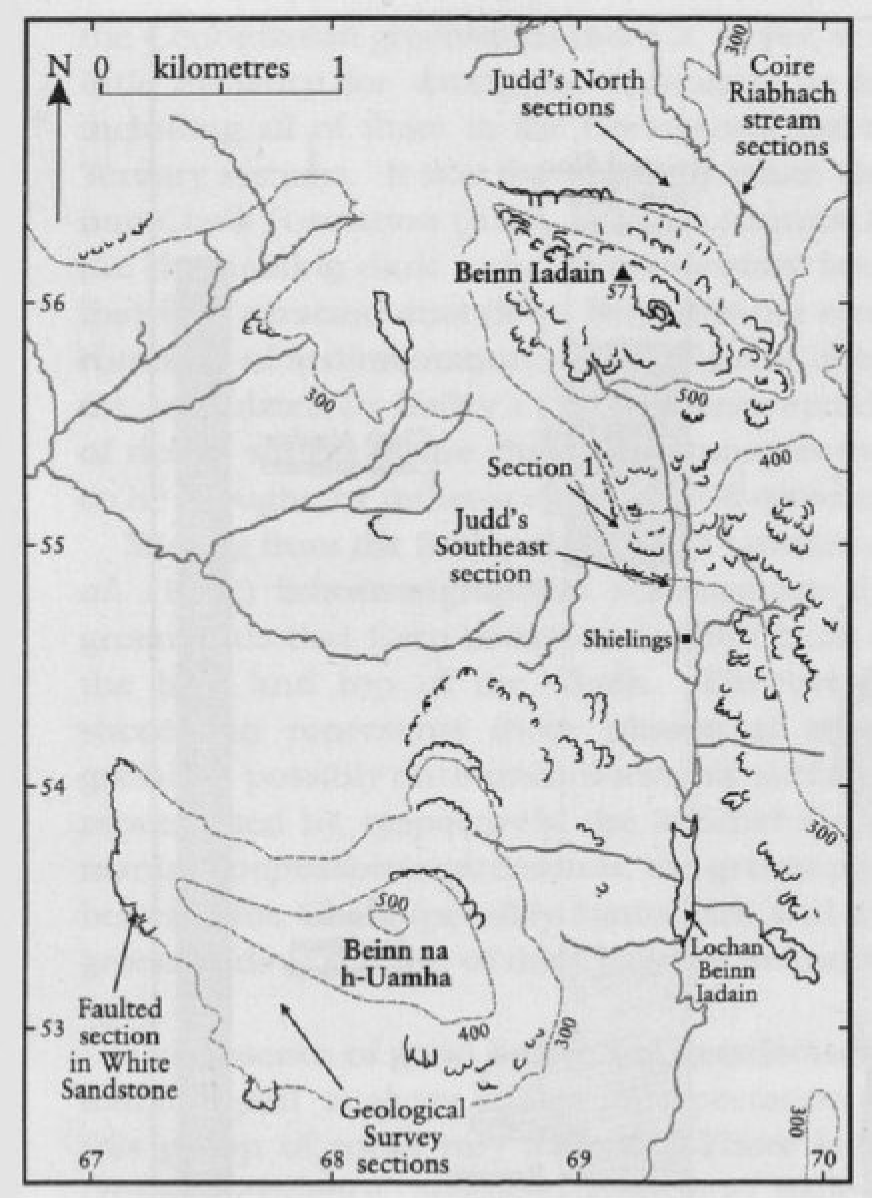
Conclusions

Beinn Iadain appears to provide the most complete shelf section in the Inner Hebrides Upper Cretaceous succession. Fossils, including belemnites, indicate that Campanian Chalk once existed in this region. Whether all the chalk is now *remanié* Cretaceous in a Tertiary matrix remains to be proved. The Morvern stratigraphy confirms and complements observations made at Gribun, Mull.

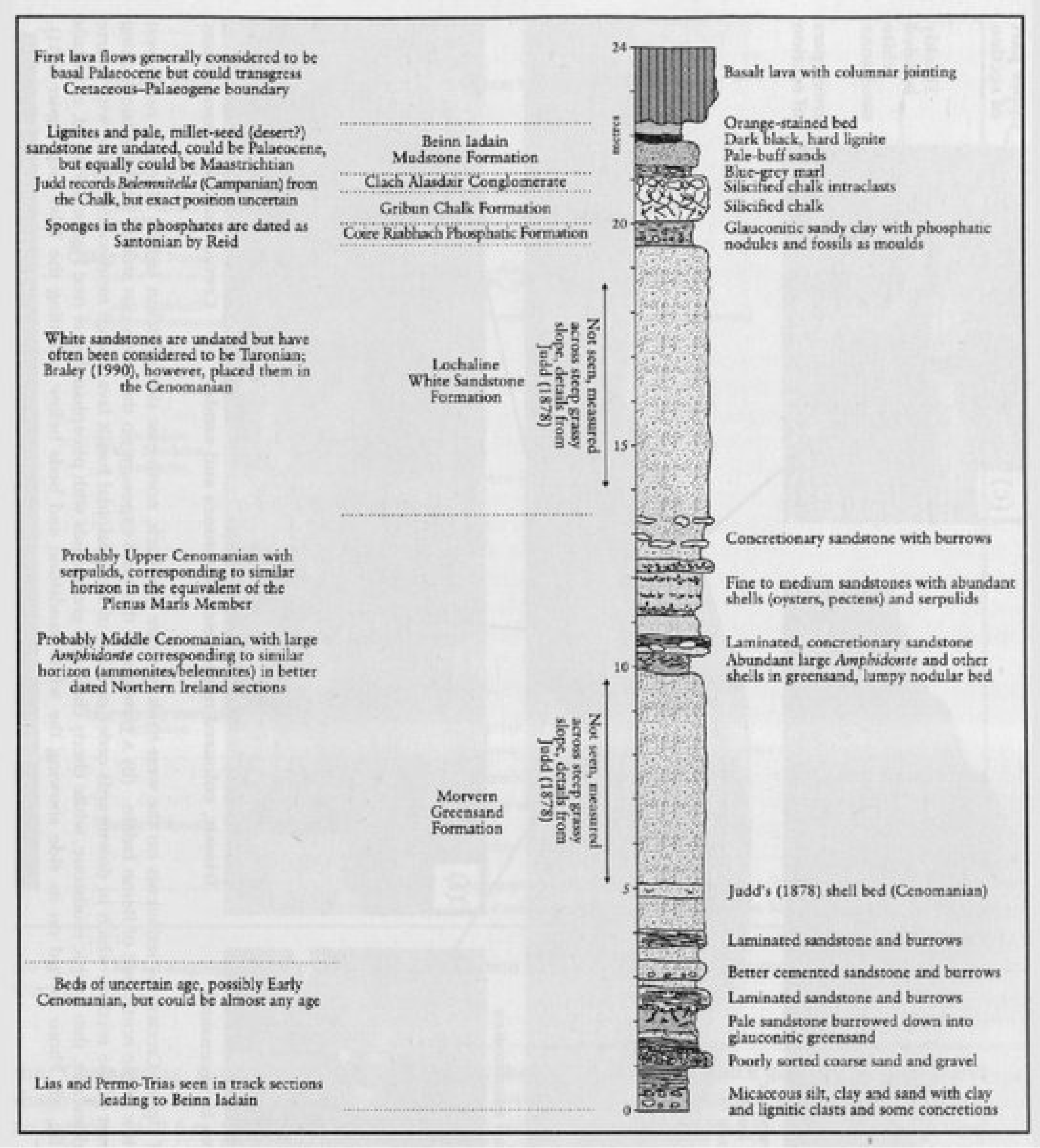
References



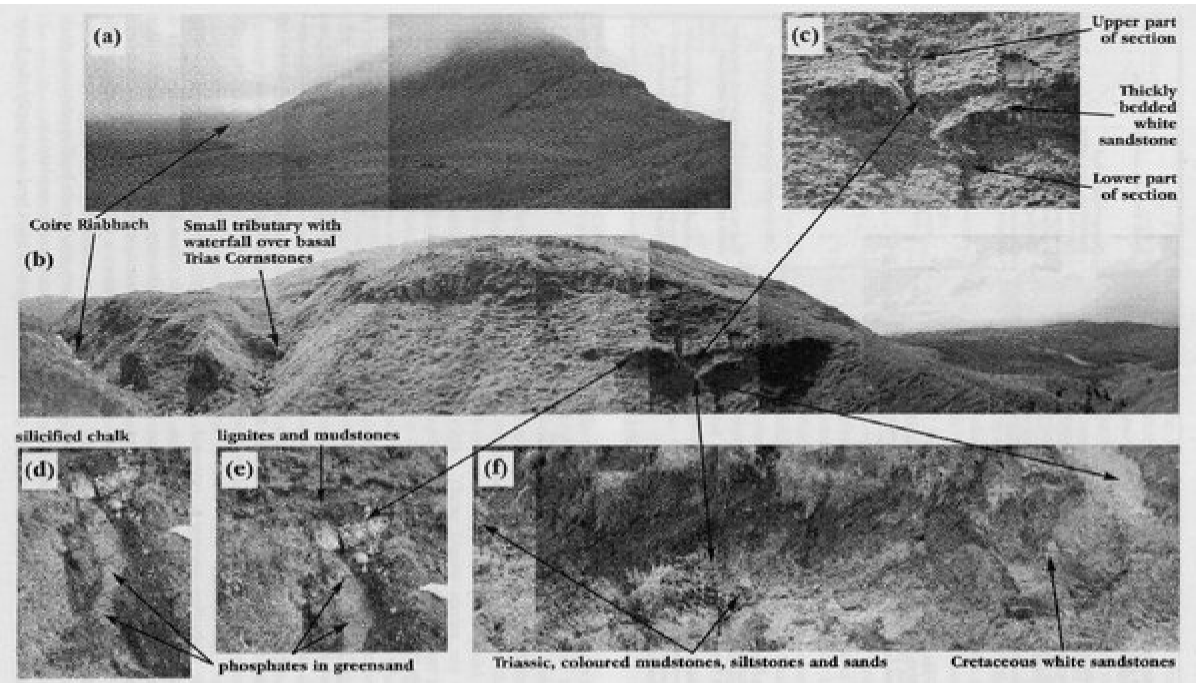
(Figure 6.1) Main Upper Cretaceous localities in the Inner Hebrides Province; GCR sites are in bold type face.



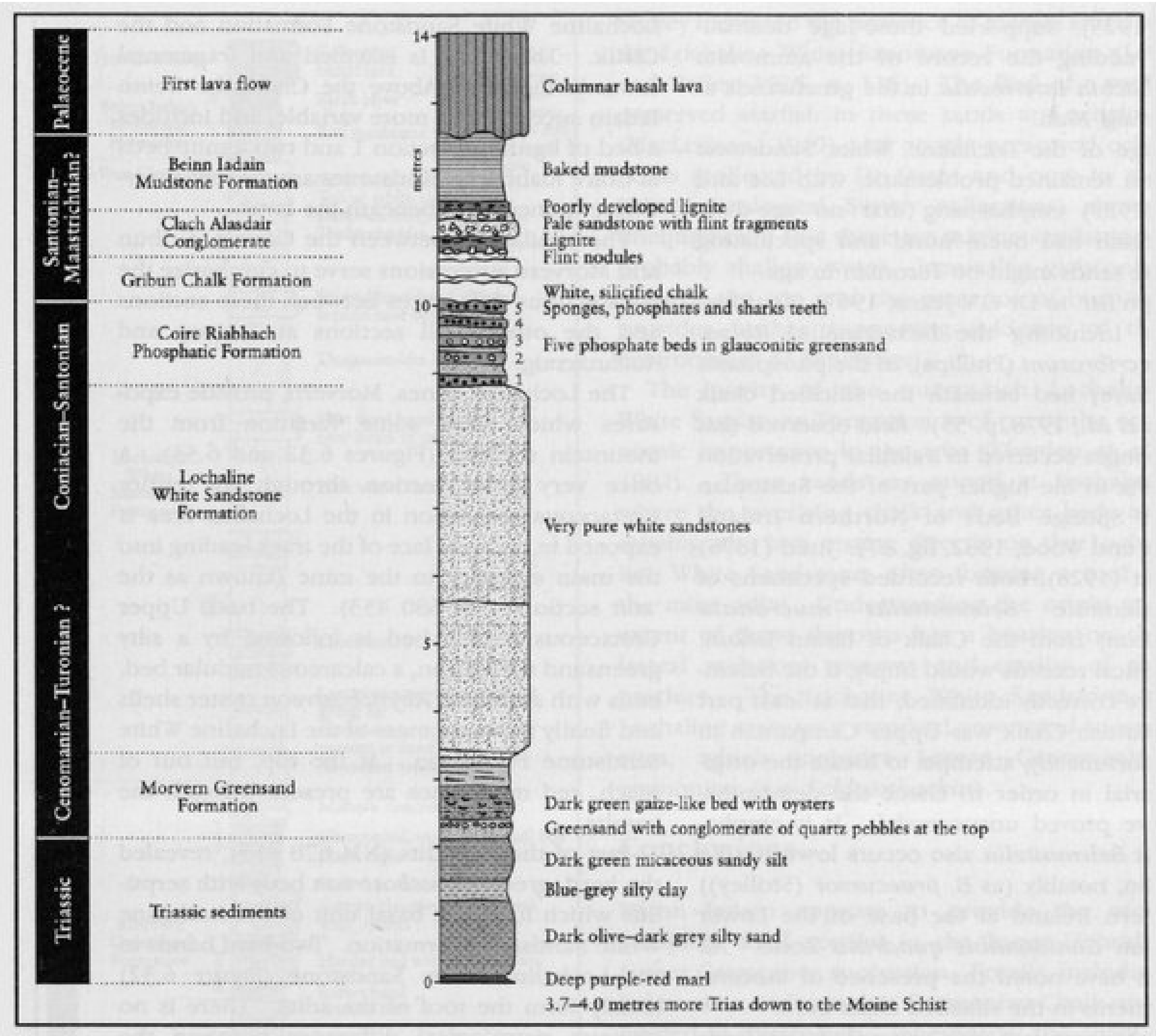
(Figure 6.28) The Morvern Upper Cretaceous GCR sites at Beinn Iadain and Beinn na h-Uamha.



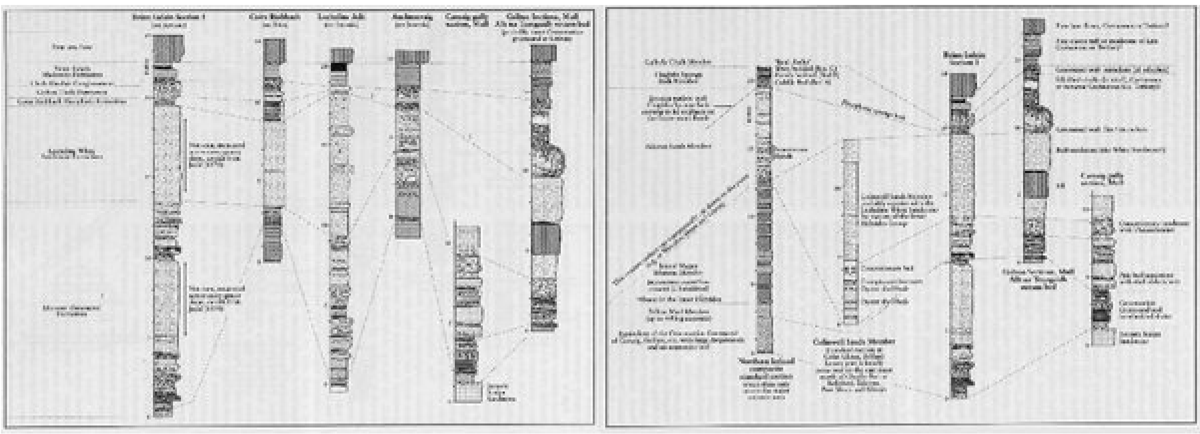
(Figure 6.29) Upper Cretaceous GCR Sites at Morvern, Argyll, the main Beinn Iadain section on the south-east corner. ((Figure 6.28), Section 1; re-measured 1998 by R.N. Mortimore and C.J. Wood.)



(Figure 6.30) Small, faulted outlier of Upper Cretaceous sediments on the west bank of Coire Riabhach, north-east side of Beinn Iadain, Morvern, north-west Highlands, Scotland. (a) Panoramic view of the north side of Beinn Iadain. (b) A view across the main exposure on the north-east side of Beinn Iadain looking south-west. (c) Detail of the upper part of the section, which in downwards order consists of amygdaloidal basalt lava, baked mudstones, lignite with coarse flint pebbles, sandstone and flint conglomerate, thin lignitic mudstone, white cherry chalk and greensands with phosphate layers (see (Figure 6.31)). (d, e) Details of the conspicuous rib of white chalk. (f) Photo turned on its side showing the white sandstone and beds below including the Trias (see (Figure 6.31)). (Photomosaics: R.N. Mortimore.)

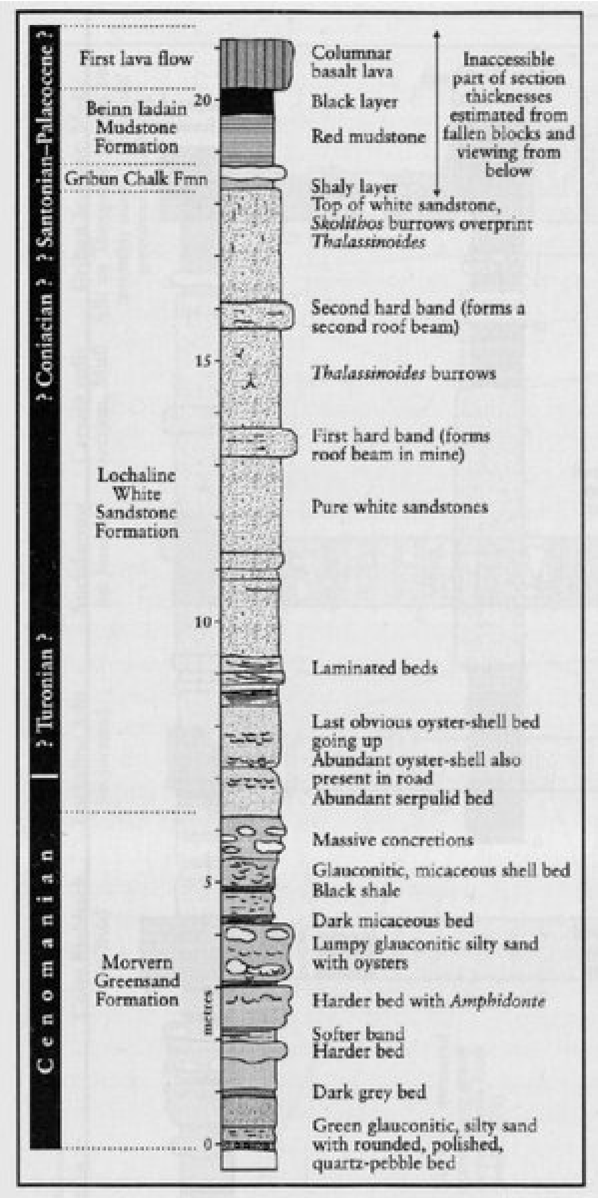


(Figure 6.31) The stratigraphy of the Coire Riabhach stream section, Beinn Iadain, Morven. (Measured by R.N. Mortimore, 1999.)

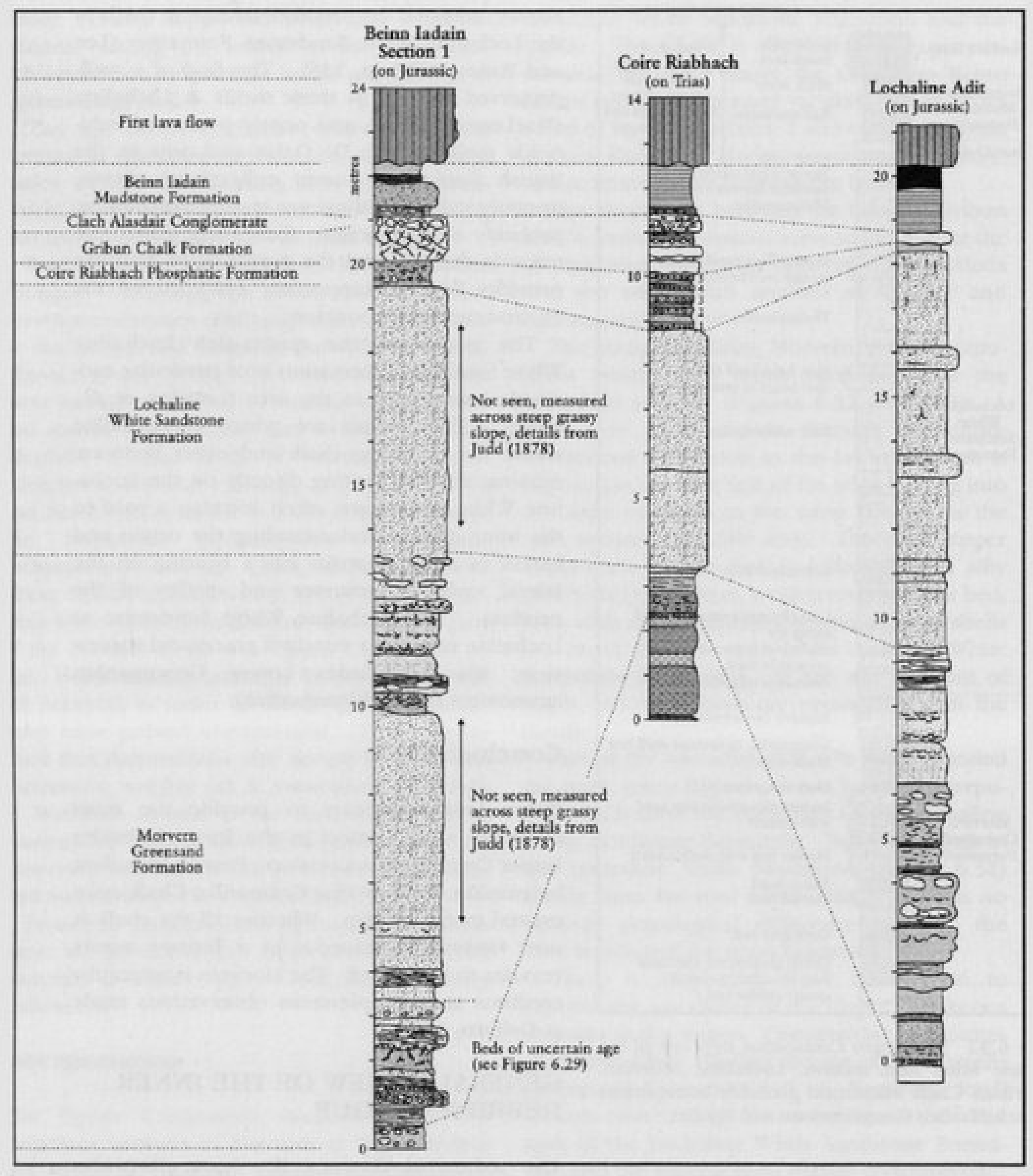


(Figure 6.34) Correlation of the Upper Cretaceous GCR sites in the Inner Hebrides at Morvern, Argyll (Beinn Iadain and Lochaline) and at Auchnacraig, Carsaig, and Gribun, Mull. Note the restructuring of the lithostratigraphy of the Inner

Hebrides Group.



(Figure 6.32) The Upper Cretaceous deposits of the Lochaline Mine Adit section, Lochaline, Morvern. The Gribun Chalk Formation probably incorporates the Clach Alasdair Conglomerate and lignites.



(Figure 6.33) Correlation of the Upper Cretaceous GCR sites at Morvern, Argyll, the main Beinn Iadain sections linked to Lochaline.

Succession after Braley (1990); Lowden *et al.* (1992);	More complete succession (Allt na Teangaidh)	Less complete succession (Torosay Track)	Variations Torosay Quarry	Variations Feorlin Cottage Carsaig
	Lava (presumed Tertiary)	Lava		Lava
Beinn Iadain Mudstone Formation	8. Mudstone (presumed Tertiary – possibly argillized ash); laterites	Mudstone	Top of section unknown	Mudstone with lignite
Clach Alasdair Conglomerate Member	7. Silicified pale sandstone with flint intraclasts (presumed Upper Cretaceous);	Flint conglomerate in sandy matrix showing evidence of debris flows	Flint conglomerate at the top	Flint conglomerate
Clach Alasdair Conglomerate Member	6. Silicified glauconitic greensand with flint clasts also piped down into or forming the matrix to the Gribun silicified chalk	Possible thin dark-grey limestone with planktonic foraminifera	Thick dark grey limestone in Torosay Quarry	Thick wedge of white sandstone on top of chalk conglomerate at Feorlin Cottage
Gribun Chalk Formation	5. The Gribun or Scottish Chalk, in places with hints of internal bedding, containing inoceramid shell debris bands, sponges etc. (the inoceramids are Cretaceous but may be reworked as silicified chalks into younger greensand; or the chalk may represent silcrete formation first in the Late Cretaceous, then the Tertiary?)	Resting on Rhaetic, Lias or Oxfordian	Resting on Oxfordian	Chalk conglomerate
	4. Glauconitic greensand with flint intraclasts			
Lochaline White Sandstone Formation	3. Pale buff sandstone (the White Sands)			Thick white sandstone
	2. Laminated and concretionary sandstone with oyster shell beds and *Thalassinoides* burrow bed			
Morvern Greensand Formation	1. Cenomanian greensand with marly units in expanded sections and containing Lower and/or Middle Cenomanian fossils. Basal pebble bed			
Unconformity	Upper Cretaceous resting on Lias or Oxfordian sediments			Base of section unknown

(Table 6.1) The Upper Cretaceous Inner Hebrides Group Succession in Mull.