Bearreraig Bay, Isle of Skye

[NG 520 545]–[NG 519 515]

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Introduction

The Bearreraig Sandstone Formation forms the main part of the coastal cliffs on the eastern side of the Trotternish Peninsula on the Isle of Skye, from Ben Tianavaig on the south side of Portree Bay to Leac Treshnish [NG 524 528], 14 km north of Portree. The base of the formation can be seen on the east side of Ben Tianavaig [NG 515 425] and north of Portree, between Prince Charles' Cave [NG 512 466] and Holm [NG 519 505]. Within the GCR site, north of Holm, the dip brings progressively higher beds down to sea level and the top of the formation reaches sea level at the mouth of the Lealt River [NG 522 603] (see Valtos GCR site report, this volume). Breaks in the cliff allowing access to the outcrop occur at Holm and at Bearreraig Bay [NG 518 527], the type section of the Bearreraig Sandstone Formation (Morton and Hudson, 1964; Morton, 1965, 1976). Bearreraig Bay became more readily accessible as a result of the construction of a small hydroelectric power station, completed in 1953, which included an access road from the main A855 Portree–Staffin road (at [NG 506 526]) across the dam to a small parking area at the top of the cliff [NG 517 524] (Figure 6.41). From here, a footpath to the shore has been constructed recently, together with information panels on the geology. North and south of Bearreraig Bay, within the GCR site, outcrops of the Bearreraig Sandstone Formation occur in the cliffs. These are mostly too steep to be accessible, but provide large numbers of fallen blocks along the shore south of the bay and at Rudha Sughar north of the bay. Accessible outcrop sections through the Bearreraig Sandstone Formation can be seen in the Bearreraig Burn downstream from the dam [NG 513 524] to [NG 516 527], and on the foreshore south of [NG 518 527] ((Figure 6.41) and (Figure 6.42)). Details are given in Morton and Hudson (1995).

Bearreraig has long been known for its succession of Aalenian and Bajocian ammonite faunas. A visit by Murchison in 1826 resulted in the finding of an ammonite by Lady Murchison that became the type specimen of the species *Ludwigia murchisonae,* first named and figured by J. de C. Sowerby (1829) (Figure 6.43); it must have been found less than 0.5 km south of Bearreraig Bay, and therefore within the GCR site. The species is widely cited, and is the index taxon for one of the standard zones of the Aalenian Stage. The importance of Bearreraig Bay as an international reference section for Aalenian and Bajocian ammonites was established with the publication of the [British] Geological Survey memoir by Lee (1920), which included reports on the ammonites by S.S. Buckman; subsequent [British] Geological Survey work (Anderson and Dunham, 1966) added little new information. More recent work on the ammonite faunas has been undertaken by Morton (1965, 1971, 1972, 1973, 1975, 1976, 1983a,b, 1988, 1990), which has led to the section here being a candidate Global Standard Stratotype and Point for the Aalenian–Bajocian stage boundary. It has now been formally designated as an Auxiliary Stratotype Point for the base of the Bajocian Stage.

Description

The beds of the Bearreraig Sandstone Formation dip at 6° to just north of west. They are cut by two minor faults, with throws of 4 m and 2 m (Figure 6.41), the former easily recognized on the shore section where calcareous tufa is developed above the high water mark. They are also cut by several Tertiary dykes (not shown on the map) and two, thick, dolerite sills, one of which crops out in the Bearreraig Burn and pipeline cutting, but dies out northwards. A larger sill, with characteristic columnar jointing, cuts down through the highest part of the Bearreraig Sandstone Formation and caps the cliff north of Bearreraig Bay. Thermal metamorphism of the sediments by the intrusions is extremely local.

The succession in the Bearreraig Sandstone Formation is summarized in (Figure 6.44); the lithostratigraphical terminology follows Morton (1976), combining older names proposed by Morton (1965), and Anderson and Dunham (1966). The basal 3.5 m of the formation are not exposed within the GCR site, but can be seen south of Holm (at [NG 520 505]) where, above the Toarcian Raasay Ironstone Formation, there is a major hiatus and most of the Toarcian succession is missing. The basal beds of the Bearreraig Sandstone Formation are the micaceous shales of the Dun

Caan Shale Member (uppermost Toarcian). The shales become more silty upwards, with several small-scale (*c.* 2 m thick) cycles, and are intensely bioturbated. Fossils are scattered, but include belemnites, occasional large fragments of driftwood, which occur throughout, and, locally, the bivalve *Mesomiltha* in life position. About two thirds of the way up the Dun Caan Shale Member, two bands (the lower discontinuous) of elongate calcareous nodules form useful marker beds and contain the ammonoids *Leioceras* and large *Pachylytoceras.* The shales coarsen up into fine-grained silty sandstones at the base of the Ollach Sandstone Member. The beds also become more calcareous with several layers of sandy limestones, which, in patches, are highly fossiliferous and include predominantly juvenile ammonites, belemnites, bivalves, and permineralized land-plant fragments. The ammonites include species of the genera *Ludwigia* and *Brasilia.* The main part of the Ollach Sandstone Member is a more massive yellow sandstone with calcareous doggers and nodules. One bed shows tabular cross-bedding and, in the upper part, thin lenticles preserve ripple-drift cross-lamination. Fossils are less common, mostly small bivalves but with occasional ammonites.

The upper part of the Ollach Sandstone Member becomes darker in colour and more silty, and there is then a rapid transition into dark-grey micaceous shales of the Udairn Shale Member, which becomes progressively more silty, with interbedded harder, more calcareous silty layers. It grades up into paler mottled grey sandstones of the Holm Sandstone Member. The main part of the Holm Sandstone Member is a more massive, cream sandstone with large-scale, low-angle cross-bedding. Calcareous nodules and doggers occur throughout, sometimes in distinct layers; some are highly fossiliferous and formed at very early stages of diagenesis before compaction, others are generally larger and unfossiliferous, and formed much later (Wilkinson, 1991). The nodules in the lower part of the Udairn Shale Member contain numerous ammonites including both *Graphoceras* and *Hyperlioceras.* In the ammonite populations, juveniles again dominate (Morton, 1988), and there are unusually high proportions of pathological specimens (Morton, 1983b). Fossils are generally less abundant in the middle and upper parts of the Udairn Shale Member; in the Holm Sandstone Member, they occur mainly in some nodules.

There is a rapid transition from the Holm Sandstone Member into the overlying Rigg Sandstone Member, with interbedding of the two facies. The latter member consists of alternating beds of softer muddy or silty sandstones, and harder calcareous sandstones or sandy limestones. The thickness of the beds averages 0.5–1 m in the lower part, but only 0.3–0.5 m in the upper part. Large belemnites are common, particularly on some bedding planes. The bivalve *Camptonectes* is also common in places, together with large oysters and fragments of driftwood. Large ammonites, particularly *Stephanoceras* and *Dorsetensia,* occur occasionally. The top beds of the Rigg Sandstone Member, exposed at the foot of the dam, are thinly bedded, cross-bedded, coarse, calcareous sandstones with quartz granules and abundant comminuted shell-debris. These beds, sometimes referred to as the 'Bearreraig Grit', represent the northernmost and youngest limit of progradation of the cross-bedded facies of the Bearreraig Sandstone Formation.

The sharp lithological change from sandstones to the dark-grey or black shales of the Garantiana Clay Member is not now exposed at Bearreraig Bay. However, a distinct ledge marking the position of the shales can be traced northwards from near the foot of the dam. Outcrops can be seen farther south in the cliff below Fiurnean (Morton and Hudson, 1995), and here the Garantiana Clay Member is succeeded by the Cullaidh Shale Formation, which coarsens up into the Elgol Sandstone Formation, both part of the Great Estuarine Group.

Interpretation

There is clear evidence from the domination of the faunas by stenohaline groups, such as ammonites and belemnites, that the Bearreraig Sandstone Formation was deposited in an environment of normal marine salinity. However, the abundance of well-preserved permineralized land-plant fragments suggests that land was not far distant. The plants were derived from at least two distinct floral communities — a coastal-deltaic community dominated by the araucarian conifer *Brachyphyllum,* and an inland community represented primarily by burnt foliage of the matoniaceous fern *Phlebopteris.* The fine preservation of anatomical detail enables recognition of xeromorphic adaptations (unpublished work by R.M. Bateman, reported in Morton and Hudson, 1995).

The Bearreraig Sandstone Formation consists of three major coarsening-upwards cycles, and part of a fourth. The shales and siltstones in the lower parts of the cycles are generally extensively bioturbated and characterized by benthic

assemblages typical of organic-rich soft-sediment sea floors below wave base (Morton, 1990). At the base of the first cycle, in the Dun Caan Shale Member, the most common bivalve is the lucinoid *Mesomiltha,* in life position, joined in the lower beds of the Ollach Sandstone Member by nuculids (especially *Nuculoma*)*, Pleuromya,* small gastropods, etc. Discrete patches of crinoid debris indicate local disarticulation of crinoids without significant lateral transport, and bioturbation is interpreted as the main cause of disturbance of shell material before fossilization.

At the base of the second cycle, in the lower part of the Udairn Shale Member, the dominant bivalves are *Nuculoma variabilis* J. de C. Sowerby), *Mesomiltha lirata* (Phillips) and *Grammatodon inaequivalvis* (Goldfuss). At the Aalenian–Bajocian boundary (see below), *Mytiloceramus polyplocus* (Roemer) appears and dominates the higher parts of the Udairn Shale Member (Morton, 1990) but the associated faunas, including the foraminifera (Gregory, 1990, 1991), indicate no apparent palaeoenvironmental change.

The silty shales typical of the lower parts of the cycles also contain calcareous nodules; in thin section, these are seen to comprise fine-sand grade, angular to subangular, quartz grains in a lime-mud matrix. The quartz grains are interpreted as having been washed into a depositional environment below wave base from a nearby higher-energy environment, and this interpretation is consistent with the abundance of well-preserved land-plant fragments.

The sandstones in the upper parts of the cycles show characteristics of deposition by the migration and build-up of offshore sand-bars in depths above wave base. Both the Ollach Sandstone and Holm Sandstone members consist of fine- to medium-grained sandstones, with small-scale ripple-drift cross-lamination and one cross-bedded unit in the Ollach Sandstone Member, and large-scale, low-angle cross-bedding in the Holm Sandstone Member. Cross-bedding dips are consistently towards the north. Marine fossils occur, particularly in calcareous nodules, and bioturbation is widespread. In the Holm Sandstone Member, the benthic faunas are dominated by the infaunal bivalves *Mesomiltha, Grammatodon* and *Pleuromya,* and some epifaunal bivalves such as *Oxytoma* and pectinids. In the upper part of the Ollach Sandstone Member, shelly lenticles are characterized by small bivalves such as *Meleagrinella.*

The succession of ammonite faunas enables the recognition of all of the zones, nearly all of the subzones and many of the ammonite biohorizons established in the Aalenian and Lower Bajocian strata of southern England (see Chapter 1). All of the Upper Bajocian zones are also recognized except for the Parkinsoni Zone, which has not been proved in the Hebrides.

Work on the succession of ammonite faunas across the Aalenian–Bajocian boundary (Morton, 1984, 1990, 1991, 1994) has led to Bearreraig Bay being recognized as an Auxiliary Stratotype Point for the base of the Bajocian Stage. The precise point is at the base of Bed U10, 12.27 m above the base of the Udairn Shale Member at the section beside the lower part of the pipeline [NG 5170 5271] (Figure 6.45). It is marked by the incoming of a distinctive faunal assemblage that includes *Hyperlioceras mundum* (S.S. Buckman), *H. furcatum* (*S.S.* Buckman) (macroconch) and *H. aspera* (S.S. Buckman) (microconch), as well as *Graphoceras limitatum* S.S. Buckman (macroconch) and *G. carbatinum* (S.S. Buckman) (microconch). Details of the succession are shown in (Figure 6.46). The Aalenian–Bajocian boundary is also marked by the incoming of the bivalve *Mytiloceramuspolyplocus.* This does not appear to be a local palaeoecological event, and comparison with other areas in Europe suggests that it may be of geochronological significance.

The palynostratigraphy of the succession at Bearreraig Bay has been documented by Riding *et al.* (1991), who established some marker events tied to the ammonite-based stratigraphy, although with a wide spacing between samples. A more detailed, closely sampled study of the Aalenian–Bajocian boundary was carried out by Gregory (1990, 1991) who established a major diversification of the foraminiferal fauna, with the incoming of several species of *Lenticulina, Nodosaria, Falsopalmula* and *Palaeomiliolina* in the uppermost part of the Aalenian Concavum Zone, below the base of the Bajocian Stage.

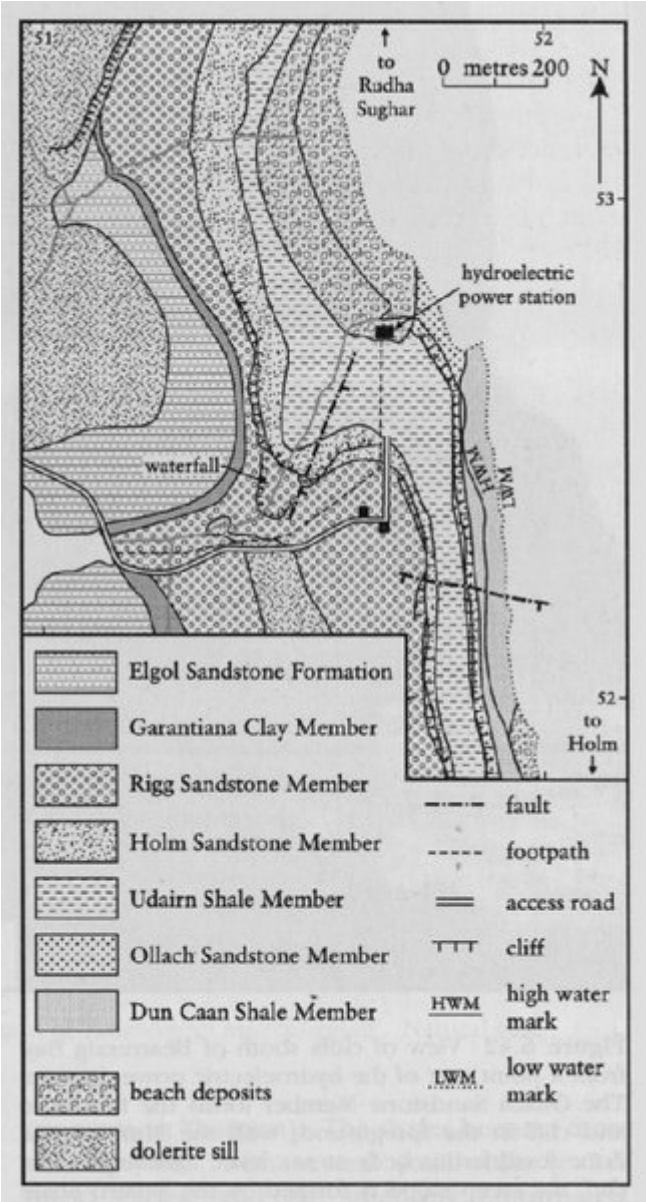
Conclusions

The GCR site at Bearreraig Bay includes the type section of the Bearreraig Sandstone Formation, which is the main lithostratigraphical unit in the Aalenian and Bajocian strata of the Hebrides Basin. The lithostratigraphical subdivisions (members) recognized here are restricted to Trotternish in northern Skye; elsewhere, there are major facies changes and

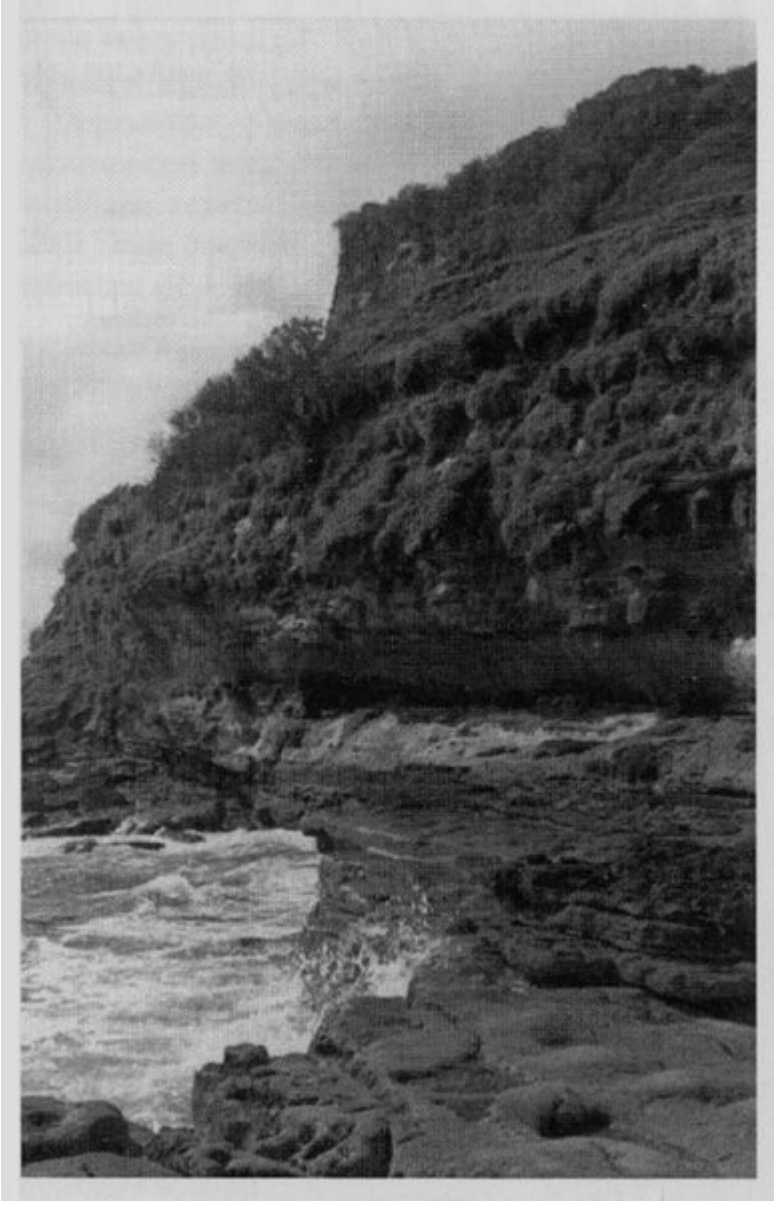
different subdivisions are used.

Bearreraig Bay is most widely known for ammonite faunas, which are abundant and well preserved in some parts of the succession. It is the type locality of the widely recognized and important Aalenian ammonite species, *Ludwigia murchisonae.* Of greater significance, Bearreraig Bay is an international reference section for Aalenian and Lower Bajocian ammonite faunas and their biostratigraphy. In particular, it has recently been selected as Auxiliary Stratotype Point for the base of the Bajocian Stage. The palynomorphs and foraminifera have also been investigated and provide additional biostratigraphical data for the Aalenian–Bajocian of the Hebrides Basin. Although the Aalenian–Bajocian sediments at Bearreraig Bay were deposited in a fully marine environment, they have yielded exceptionally well-preserved land-plant floras, which reveal unusual anatomical detail and palaeoecological information about adjacent land areas.

References

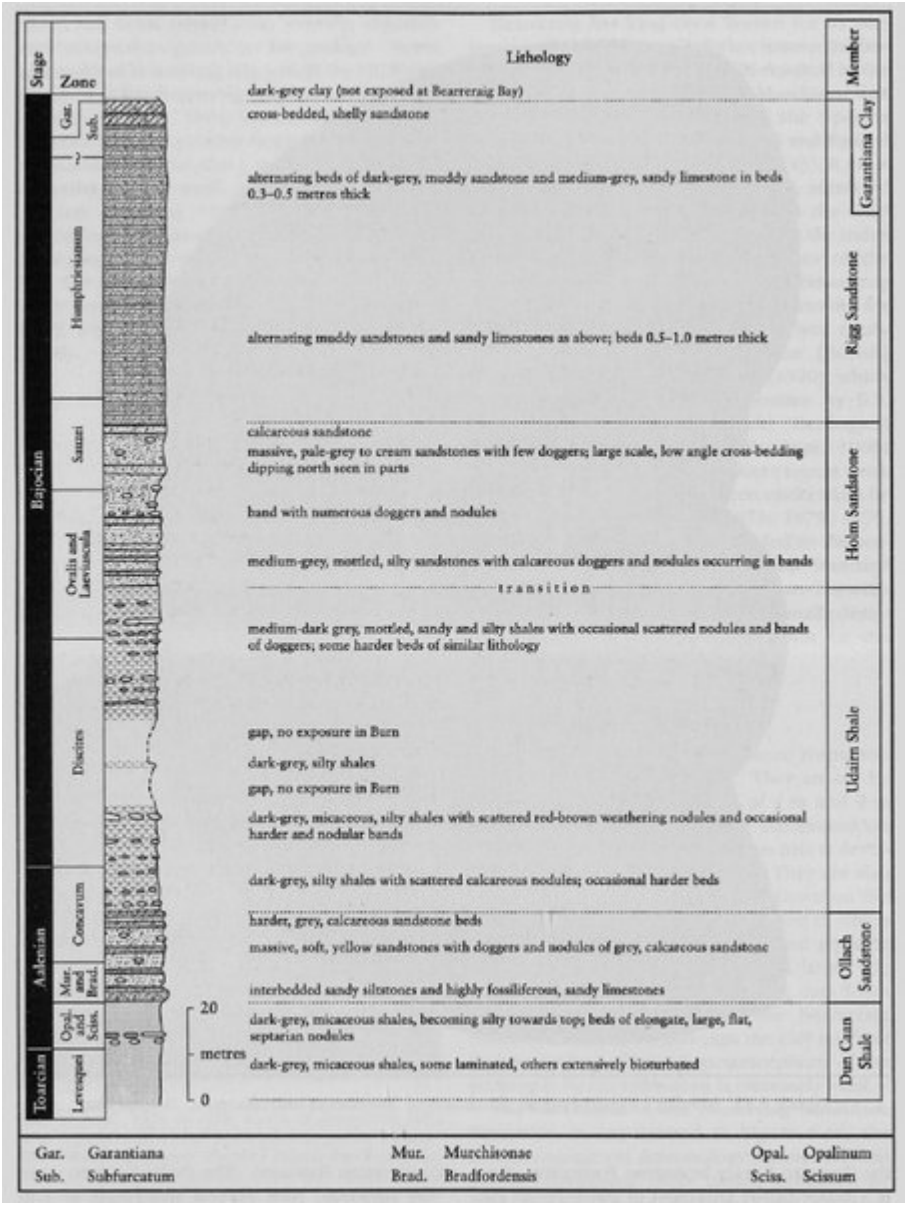


(Figure 6.41) Geological map of Bearreraig Bay, Trotternish, Isle of Skye. (After Morton and Hudson, 1995, fig. 24.))

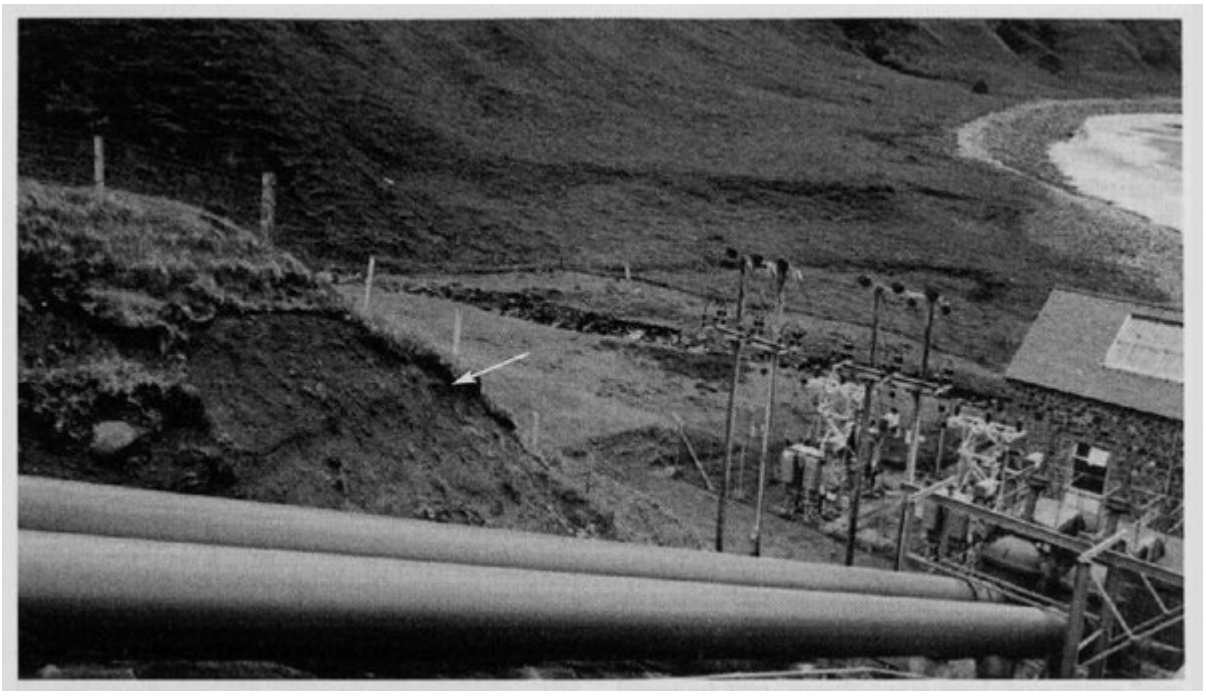


(Figure 6.42) View of cliffs south of Bearreraig Bay, from a point east of the hydroelectric power station. The Ollach Sandstone Member forms the foreshore and cliff in the foreground, with the Murchisonae Zone fossiliferous beds at sea level. Above the low cliff, the steep slope is formed by the Udairn Shale Member and above this, the high cliff is formed by the Holm Sandstone and Rigg Sandstone members. (Photo: N. Morton.))

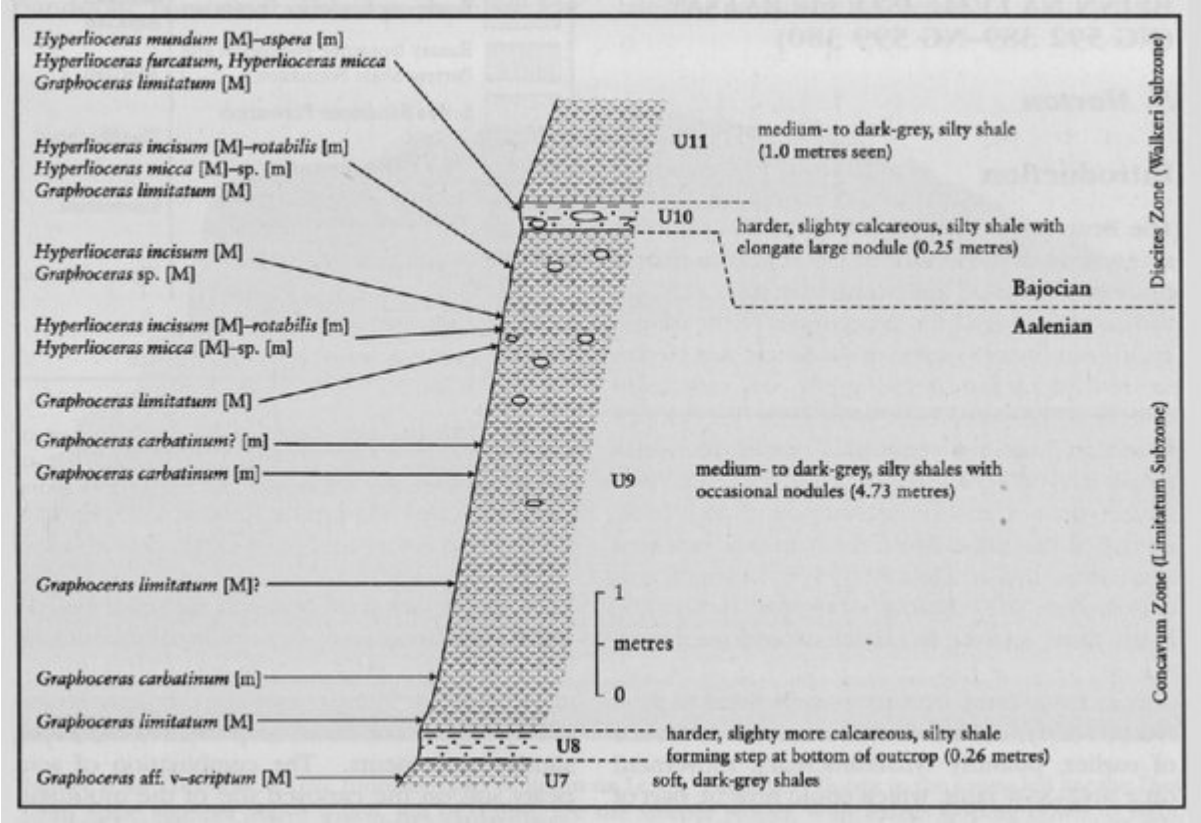
(Figure 6.43) Sowerby's (1829) original illustration of 'Ammonites murchisonae'. Natural size.)



(Figure 6.44) Schematic graphic log of the Bearreraig Sandstone Formation at Bearreraig Bay, showing lithostratigraphical and chronostratigraphical subdivisions. More detailed bed-by-bed descriptions and measured successions can be found in Morton and Hudson (1995).)



(Figure 6.45) The Aalenian–Bajocian stage boundary section beside the pipeline at Bearreraig Bay. The boundary is taken at the base of the slightly harder bed (arrowed) which is Bed U10 of (Figure 6.46). (Photo: M.G. Sumbler.))



(Figure 6.46) Details of the succession across the Aalenian–Bajocian boundary at the Auxiliary Stratotype Point at Bearreraig Bay (outcrop near bottom of pipeline cutting [NG 5170 5271]. (After Morton and Hudson, 1995, fig. 28.) ([M] = macroconch; [m] = microconch.) Bed numbers follow Morton and Hudson (1995).)