Valtos, Isle of Skye

[NG 523 601]–[NG 522 610], [NG 528 622]–[NG 521 628], [NG 517 638]–[NG 509 654]

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Introduction

The GCR site known as ‘Valtos' comprises three separate stretches of coast and a river section on the east side of Trotternish in northern Skye (Figure 6.35).

1. The most southerly locality [NG 523 601]–[NG 522 610] comprises a section in the Lealt River, and on the shore at its mouth at Invertote. It exposes a complete but discontinuous succession from the ?uppermost Bearreraig Sandstone Formation, through the overlying Elgol Sandstone Formation, Leah Shale Formation (including its type section), and up into the lower part of the Valtos Sandstone Formation. Thick dolerite sills intrude the Leak Shale Formation, and part of the succession is faulted.
2. nbsp; About 1.5 km farther north, foreshore and cliff exposures [NG 528 622]–[NG 521 628] around the promontory of Rubha nam Brathairean, between Sgeir Dhubh and the mouth of the Lonfearn Burn, show the most complete section of the Lealt Shale Formation and include the type section of its Lonfearn Member.
3. A farther 1 km to the north, an almost continuous section through the Valtos Sandstone Formation is seen in the cliffs below Valtos and Dun Dearg to Mealt Falls [NG 517 638]–[NG 509 654], and is the type section for that formation.

Description

(A) Invertote and Lealt River

The sections here (e.g. see (Figure 6.36)) have been described by Anderson and Dunham (1966), Hudson and Morton (1969), Harris (1989) and Morton and Hudson (1995). The cliff to the south of the Lealt River at Invertote exposes the Elgol Sandstone Formation, which here is the basal formation of the Great Estuarine Group, overlying similar coarse sandy beds that are questionably assigned to the Bearreraig Sandstone Formation. The following section is based on Morton and Hudson (1995).

	Thickness (m)
Elgol Sandstone Formation	
7: Sandstone, coarse with erosional base and prominent planar cross-bedding	seen *c.* 0.30
?**Bearreraig Sandstone Formation**	
Rigg Sandstone Member	
6: Sandstone, fine- to medium-grained, uncemented; clay flasars; bioturbated (marked by carbonaceous wisps)	0.62
5: Sandstone, medium grained, wood fragments, mudstone clasts; abundant *Meleagrinella, Globularia, Procerithium?; Thalassinoides* and *Planolites,* especially at base	0.24
4: Shale, hard, black; thin siltstone layers increasing upwards	0.07
3: Sandstone, medium grained, calcareous and carbonaceous; nerineid gastropods, *Globularia, Grammatodon?, Pleuromya; Teichichnus, Planolites;* sharp base	0.48
2c: Shale, dark-grey	0.05

2b: Sandstone, grey, fine- to medium-grained; convoluted flame-structures at base	0.14
2a: Sandstone, grey, becoming more carbonaceous upwards; top 0.06 m with lignitic lenses	*c.* 1.90
1: Sandstone, mainly coarse-grained, cross-bedded in 0.20 m sets; foresets with carbonaceous laminae	seen to 6.00

The Elgol Sandstone Formation at Invertote comprises a 1.5 m-thick burrowed sandstone overlain by two, complex, fining-upwards sequences with prominent scour-surfaces and lags of quartz pebbles (Harris, 1989). Trough and tabular cross-stratification (0.05–0.30 m) dominate the basal parts of these sequences and gives a complex polymodal palaeocurrent pattern with both northerly and southerly modes. The sequences also include planar lamination and a single large-scale (1.5 m) tabular set (inclined towards 160°) with mud drapes on foreset surfaces. The two sequences are separated by a laterally persistent mudstone with *Monocraterion* and branching *Thalassinoides?* burrows. Graphic logs of the Elgol Sandstone Formation close to the mouth of the Lealt River and on the foreshore 750 m to the north are given by Harris (1989).

The top of the Elgol Sandstone Formation, overlain by the Leak Shale Formation, is well exposed near the mouth of the Lealt River. Between the shore and the road bridge over the river, two dolerite sills form waterfalls. The lower part of the Leak Shale Formation is not well exposed here but the following section through the upper beds, as exposed between the road bridge and the first waterfall below it (Figure 6.36), is taken from Morton and Hudson (1995); only the upper part of the section is normally accessible. The bed numbers relate to the more complete sections in the Lonfearn area (see below).

	Thickness (m)
Lealt Shale Formation	
Lonfearn Member	
15: Shale, dark, fissile; conchostracans	0.60
14: Limestone, thin bedded, shelly; fibrous calcite, pyrite	0.08
11–13?: Shale, as Bed 15; conchostracans	1.50
10: Limestone, oosparite and intrasparite; ostracods; upper part massive oolite, lower part with partings and fibrous veins	0.20
9: Shale, dark, fissile; conchostracans, *Neomiodon,* ostracods	0.78
8: Limestone with coarse (2 mm) intraclasts; forming prominent regular bed (top of fall at low water)	0.24
3–7?: Shale, less fissile (very baked)	0.78
Limestone, thin-bedded, shelly, partings	0.26
Shale, dark, baked	0.90
Limestone, shelly	0.08
Shale, ?with thin limestones	c. 3.0
2: Limestone, coarsely shelly; base deformed by concretion growth below	0.19
1b: Shale, very shelly (*Isognomon?,* heterodont bivalves); concretions up to 0.12 m thick and 0.70 m diameter	0.07
1a: Shale, dark, irregular top and base	up to 0.35
Kildonnan Member	
12: *Stromatolite Bed*	
12c.: Limestone, laminated, irregular upper surface, weathering pale-grey	0.10
12b: Limestone, irregular, brecciated	up to 0.10
12a: Limestone, laminated, shelly; abundant *Placunopsis, Cuspidaria*	0.12

11: Shale, dark	0.90
10: Limestone, calcilutite; whole, small heterodont bivalves	0.09
9: Shale, hard, variably shelly; ostracods, fish scales and bone fragments 0.60 m from top; basal 0.20 m shelly with *Neomiodon?, Isognomon* or *Praemytilus?*	1.00
8: Limestone, coarsely shelly with jumbled shells; beneath it, 0.15 m thick and 0.70 m diameter septarian concretions with black calcite	0.02
7: Shale or mudstone, very baked, paler than above; conchostracans at 1.10 m below concretions	c. 3.50
Top of thick dolerite sill forming waterfall	

The overlying Valtos Sandstone Formation is seen higher up in the Leak River (Harris, 1992), outside of the GCR site.

(B) Rubha nam Brathairean (Sgeir Dhubh to mouth of Lonfearn Burn)

The coastal exposures from south of Rubha nam Brathairean to the mouth of the Lonfearn Burn are the best sections of the Lonfearn Member of the Lealt Shale Formation, and constitute its type section. The underlying Kildonnan Member is here dominated by the ostracods *Limnocythere incerniculum* Wakefield and *Darwinula pulmo* Wakefield, the bivalve *Neomiodon brycei* (Tate), the conchostracan *Neopolygrapta lealtensis* Chen and Hudson, the gastropod *Viviparus scoticus* (Tate), as well as numerous fish and plant fragments (Wakefield, 1995). Its boundary with the Lonfearn Member is exposed at sea level in a small embayment south of Rubha nam Braithairean, behind dolerite skerries that extend south to Sgeir Dhubh [NG 526 625]. The succession is similar to that described above in the Lealt River but the section is superior because the beds are not metamorphosed and are much more accessible (though not for those prone to vertigo). They have yielded rich ostracod and conchostracan faunas (Chen and Hudson, 1991) and a dinosaur footprint (Andrews and Hudson, 1984). The boundary with the overlying Valtos Sandstone Formation is exposed at the mouth of the Lonfearn Burn [NG 521 627] and in the lower part of the burn itself. Shales with desiccation cracks and conchostracans, which mark the top of the Lonfearn Member, pass gradually up into siltstones with *Neomiodon* (Harris and Hudson, 1980).

Graphic logs of the section are given in Harris and Hudson (1980) (which forms the basis of (Figure 6.37)) Riding *et al.* (1991) and Wakefield (1994, 1995).

(C) Valtos to Mealt Falls

The spectacular but treacherous cliffs below Valtos and Dun Dearg (see (Figure 6.38)), and northwards to the Mealt Falls, expose a fine and almost continuous section through the Valtos Sandstone Formation and constitute its type locality (Harris and Hudson, 1980). The total thickness of the formation in Trotternish is about 120 m and it has been divided into three informal lithostratigraphical units: a lower sandstone-dominated unit, a middle limestone–shale-dominated unit, and an upper sandstone-dominated unit (Harris, 1992). All but the base of the lower unit and top 20–30 m of the upper unit are exposed within the GCR site. The lower unit (*c.* 48 m thick) is almost continuously exposed between Valtos and Mealt Falls. It is dominated by cross-bedded, coarsening-upwards sandstones with intervening silty shales; calcite concretions are conspicuous. Escape structures, probably made by the ubiquitous *Neomiodon,* are also evident, and winnowed valves of that bivalve also dominate a coarse sandy to granular biosparite at the top of the unit (Morton and Hudson, 1995). The middle unit (*c.* 27 m thick), comprising fine-grained sands, silty shales and grey *Neorniodon* limestones, is seen in the higher cliffs towards the northern end of the section. Exposure is intermittent but an almost complete succession can be seen intruded by numerous sills. About 15 m of the upper unit, which is lithologically similar to the lower unit, is exposed in the cliffs below Carraig Mhor [NG 511 649] and below Loch Mealt [NG 510 651]. Similar beds form the lower part of the famous 'Kilt Rock', which is seen from the viewpoint at Mealt Falls. Recent frequent rock falls along this stretch of coast have yielded dinosaur bones and footprints (J.D. Hudson, pers. comm., 1996).

Graphic logs for these sections are given by Harris (1992, fig. 6, logs 3, 4; fig. 7, log 4; fig. 8, logs 4b,4, 5) based on detailed facies analysis, but the composite log shown here in (Figure 6.39) is based on Harris and Hudson (1980).

Interpretation

According to Morton and Hudson (1995), the oldest beds exposed within the GCR site belong to the Bearreraig Sandstone Formation (below) and the Elgol Sandstone Formation (above). Both are in a coarse sandy facies with no thick argillaceous units between them; the Garantiana Clay Member and Cullaidh Shale Formation, which intervene between the two sandstone formations elsewhere, are either absent or present in sandy facies (Hudson and Morton, 1969; Harris and Hudson, 1980). However, Bradshaw (pers. comm. in Morton and Hudson, 1995) believed the absence of these argillaceous units could be explained by the fact that the base of the Elgol Sandstone Formation is erosional, cutting down into the Bearreraig Sandstone Formation. The situation is further confused by the fact that Harris (1989) has recorded the presence of the Cullaidh Shale Formation at Invertote.

The exposures of the Elgol Sandstone Formation at Invertote are almost the most northerly occurrence of that formation whose sandstones are interpreted as delta-front deposits. Here, they represent tidal currents flowing in a distributary channel with subsequent progradation of the channel mouth by deposition from dominant basinward (southerly directed) ebb-tide and fluvial currents (Harris, 1989). This sequence of events resulted in erosion of channel and mouth-bar deposits, and subsequent deposition of fining-upwards sequences from fluctuating currents in laterally migrating tidal distributary channels and channel-mouth systems. Bi-polar palaeocurrent patterns indicate tidal currents and demonstrate the exchange of water with the open sea, and the occurrence of both large- and small-scale sedimentary structures may also be characteristic of tidal-channel deposits. According to Harris (1989), the sequence of grain sizes, structures and diametrically opposed palaeocurrent directions is comparable with the tidal channel and mouth-bar deposits described from the Recent Niger Delta. The upper part of the Elgol Sandstone Formation at Invertote is dominated by wave-built sedimentary structures (wave-ripples and offshore SW-inclined swash cross-stratification). These sediments represent the reworking by waves of tidal distributary sands to form a delta shoreline–shoreface–foreshore sequence. Sand was probably supplied directly to the shoreline by the distributaries, and wave reworking may have been responsible for the sealing of channel mouths by beach sands as channel abandonment occurred. The well-sorted granule conglomerates that cap the formation probably represent storm-generated backshore beach ridges separated by pools of standing water in which dark shale intercalations could accumulate. Palaeocurrent directions in these upper beds swing round from north–south to NE–SW, probably indicating an arcuate configuration of the shoreline (Harris, 1989).

In the Lealt River section, the almost black colour of some of the shales in the Leah Shale Formation gives the mistaken impression that they are organic-rich; in fact, their blackness is due to baking by the underlying dolerite sill (Morton and Hudson, 1995). The assemblage of fossils (mainly bivalves with gastropods, ostracods and conchostracans) from this formation indicates deposition in shallow waters of low but fluctuating salinity in near-coastal lagoons (Hudson, 1983; Chen and Hudson, 1991). The Lonfearn Member of that formation was formerly called the 'Estheria Shales' after a genus of conchostracan (Anderson, 1948; Harris and Hudson, 1980). The algal stromatolite limestone, the top of which marks the base of that member, is a widespread marker bed in the Hebrides. Its regular lamination and dome-like form are more characteristic of intertidal and subtidal stromatolites than of supratidal ones; however, the occurrence of gypsum pseudo-morphs indicates hypersalinity and effectively rules out a subtidal environment (Hudson, 1970). According to Andrews and Hudson (1984), the bed in which a dinosaur footprint was discovered records a succession of peritidal environments on and around a carbonate mudflat. Horizons of desiccation cracks, such as those recorded at the top of the Lonfearn Member, indicate emergence (Hudson, 1983).

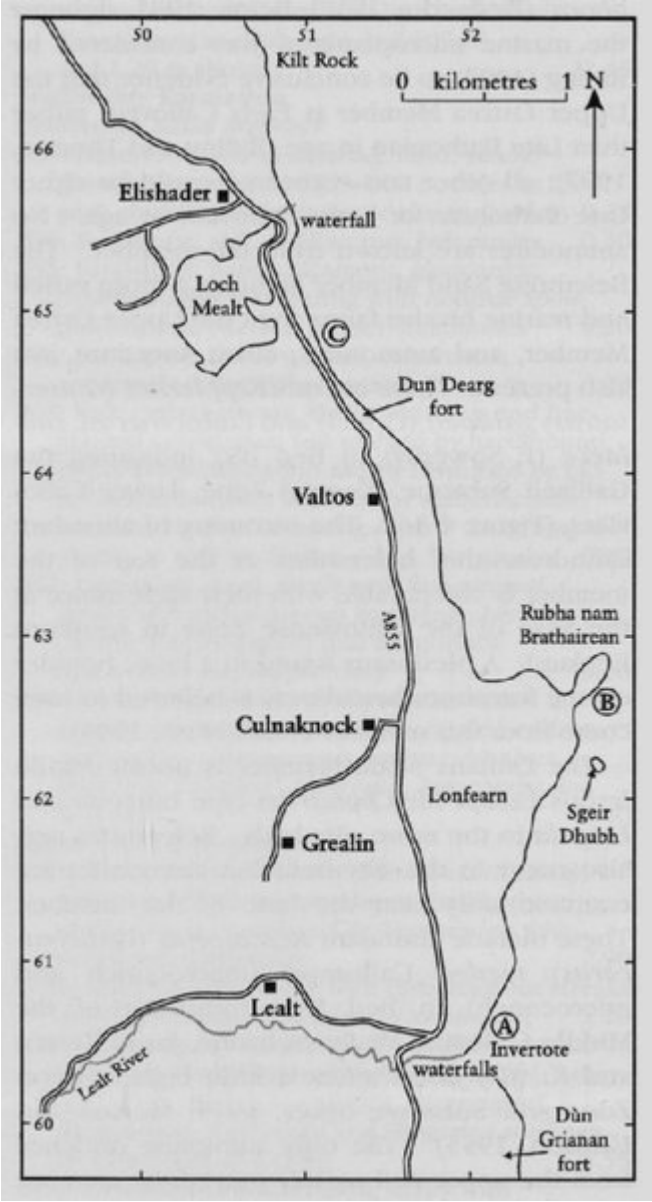
Deposition of the Valtos Sandstone Formation commenced with the inundation of the coastal mudflats, represented in the top beds of the Lealt Shale Formation, and resulted in the establishment of a shallow brackish-water lagoon in which, initially, mudstones-siltstones were deposited (Harris, 1992) with renewed influxes of sand from the Scottish Landmass, which lay to the east and north-east. The sandstones here are subfeldspathic-feldspathic with 5–26% feldspar; heavy-mineral assemblages are garnet-rich with consistent amounts of kyanite and epidote, and pebbles are predominantly vein quartz (Harris, 1992). The fauna is dominated by the bivalve *Neomiodon,* which indicates rapid and

wide salinity fluctuations probably controlled by varying rates of fluvial runoff (Harris and Hudson, 1980; Harris, 1992). This bivalve was probably highly opportunistic and colonized the shallow lagoon floor and the lagoon shorelines. It provided shell debris in rock-forming abundance (Harris, 1992), and detrital *Neomiodon* shells are the most likely nucleus for the enormous calcite concretions (2–3 m across) that characterize the formation (Wilkinson, 1992) (Figure 6.40). *Neomiodon* shells have been shown to contribute about 90% of the concretionary carbonate, and sands around the concretions, which are only lightly cemented, are now devoid of fossils (Wilkinson and Dampier, 1990). The concretions have a burial diagenetic origin and grew within pore fluids of meteoric origin at temperatures of 25–35°C. The palaeocurrent pattern in the Valtos Sandstone Formation is dominated by southerly flow directions but occasionally is northerly; according to Harris (1989), this is most probably explained by southerly fluvial and ebb currents occasionally interrupted by wind- or storm-driven currents from the north. Detailed facies analysis, based on associations of lithology, grain-size profile, sedimentary structures, trace fossils and macro-fossils, has been undertaken by Harris (1992) who deduced the depositional environment to be one of a southerly prograding lagoonal delta-system with probably only partial connection with the open sea.

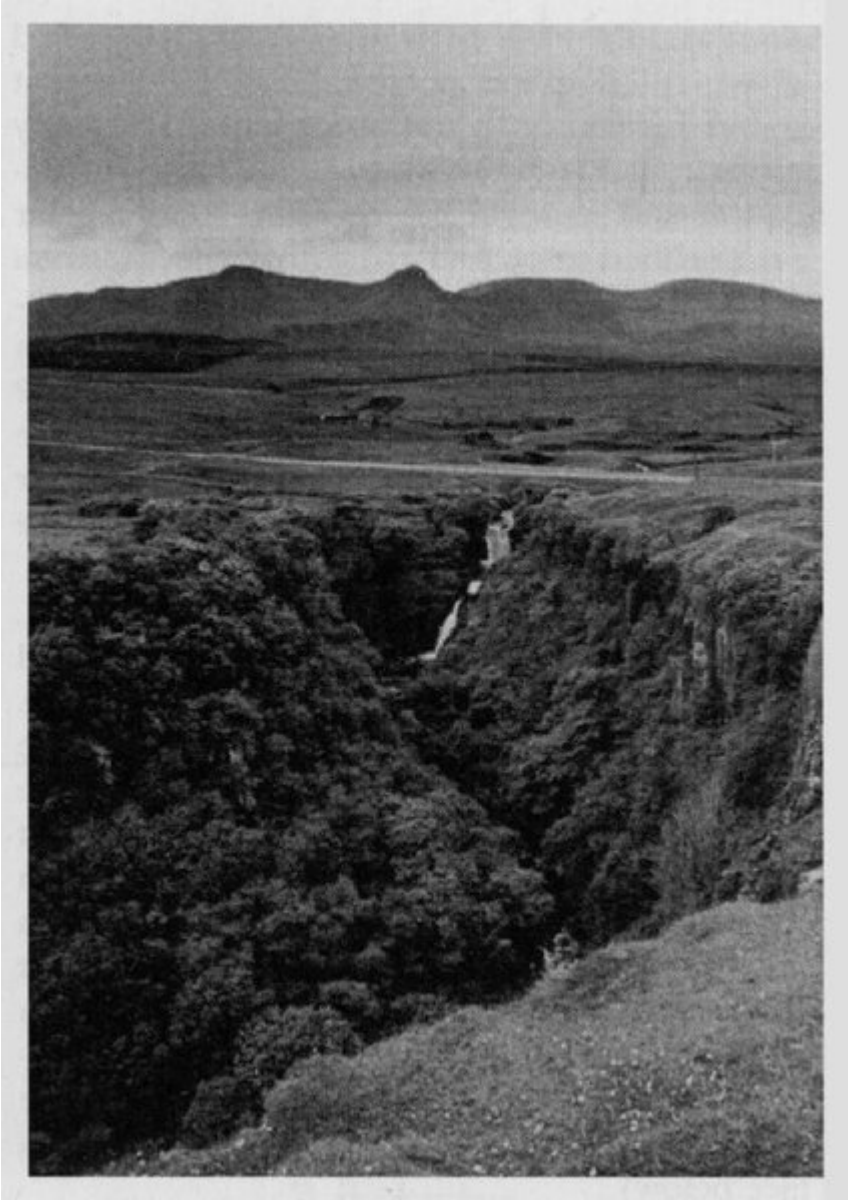
Conclusions

The Valtos GCR site includes important sections in the Elgol Sandstone Formation (its most northerly occurrence), the Lealt Shale Formation (type section as well as type section of its Lonfearn Member) and the Valtos Sandstone (type section) Formation. The Elgol Sandstone Formation represents delta-front deposits, the Lealt Shale Formation represents shallow-water near-coastal lagoon deposits, and the Valtos Sandstone Formation, a lagoonal delta-system. The site is therefore an important one for stratigraphy, sedimentology, palaeoecology and palaeogeography. It has also provided the first Scottish Jurassic dinosaur record.

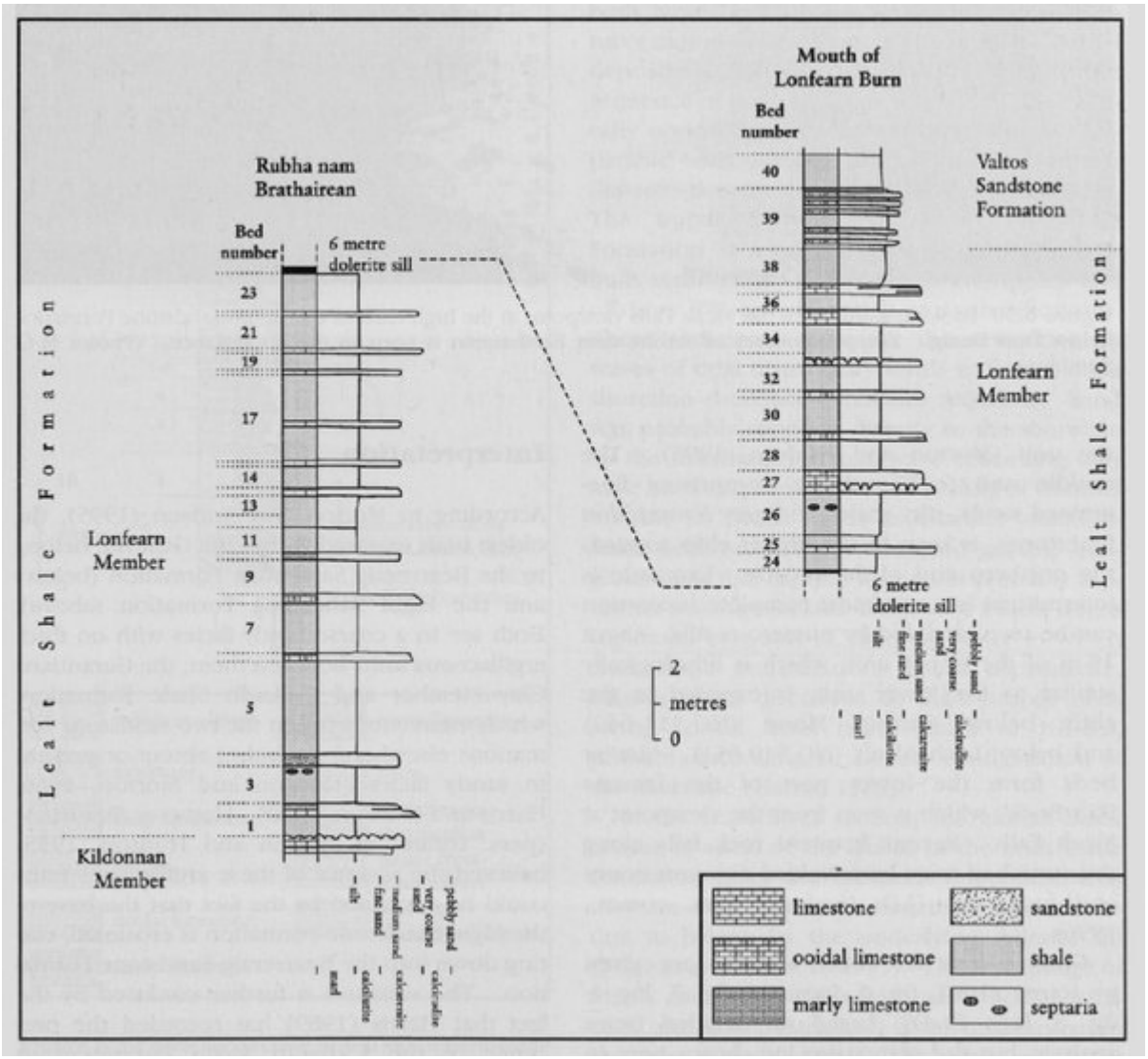
References



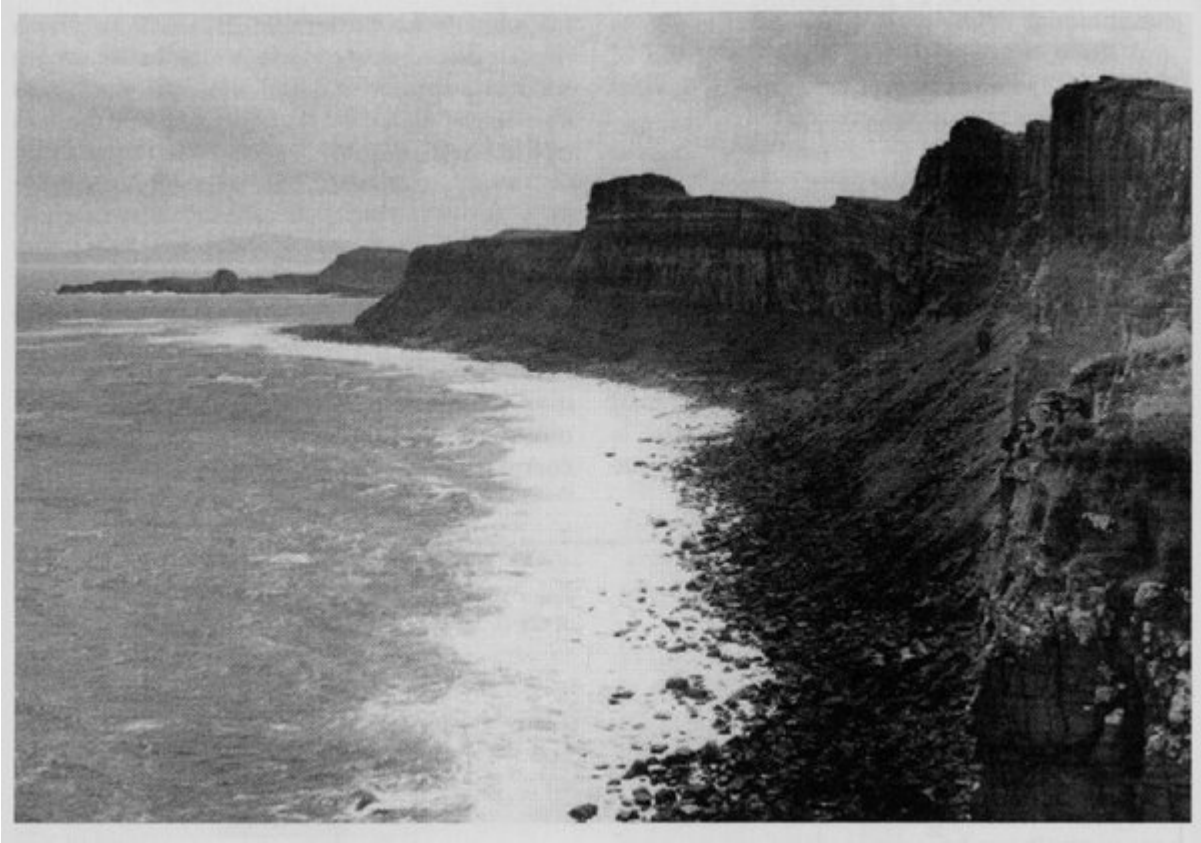
(Figure 6.35) Locality map for the Valtos GCR site which comprises three separate localities. (A) Invertote and Lealt River; (B) Rubha nam Brathairean (Sgeir Dhubh to mouth of Lonfearn Burn); (C) Valtos to Mealt Falls.)



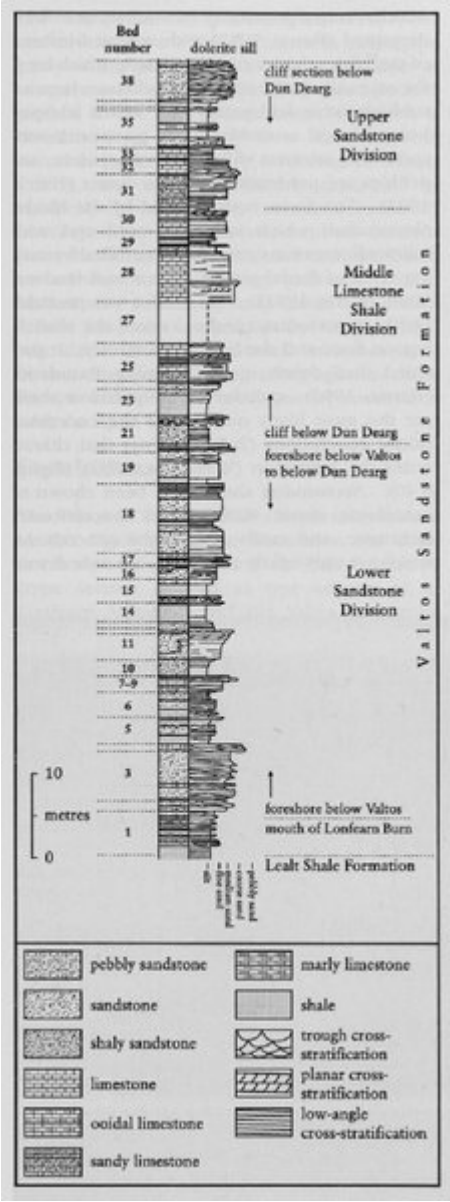
(Figure 6.36) The Leak River gorge showing the first waterfall (formed by a dolerite sill) below the road bridge. The upper part of the Leak Shale Formation is exposed above the waterfall. (Photo: M.G. Sumbler.))



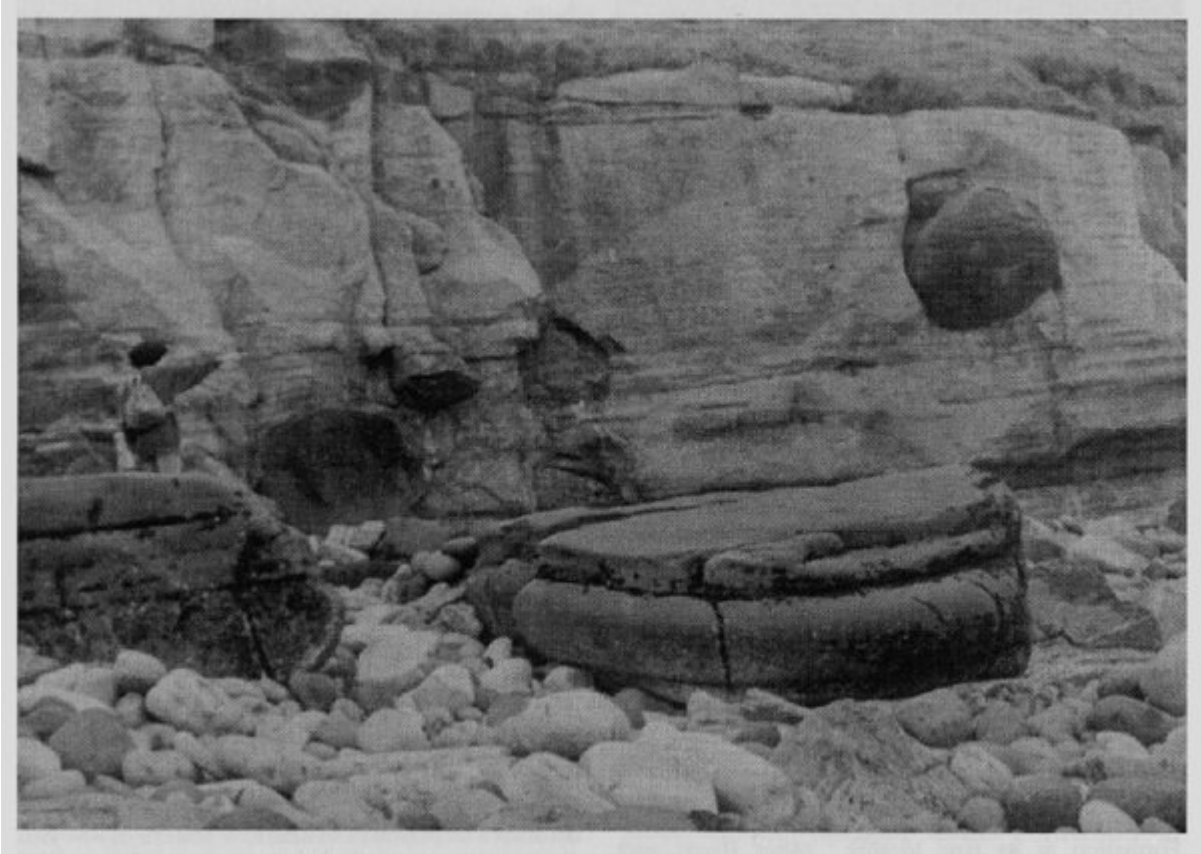
(Figure 6.37) Graphic section of the Lonfearn Member (Leak Shale Formation) at its type locality (After Harris and Hudson, 1980, fig. 6.) Bed numbers follow Harris and Hudson (1980).)



(Figure 6.38) Looking south from the Mealt Falls viewpoint at the high cliffs of the Valtos Sandstone Formation below Dun Dearg. The promontory of Rubha nam Brathairean is seen in the far distance. (Photo: M.G. Sumbler.))



(Figure 6.39) Graphic section of the Valtos Sandstone Formation at its type locality (After Harris and Hudson, 1980, fig. 7.) Bed numbers follow Harris and Hudson (1980).)



(Figure 6.40) Concretions in the type section of the Valtos Sandstone Formation (formerly known as the 'Concretionary Sandstone Series'). (Photo: J.D. Hudson.))