Barrowmouth Beach Section, Saltom Bay

[NX 9573 1572]–[NX 9594 1603]

Highlights

This coastal section is the best exposure of late Permian marine strata in Cumbria and is also one of the best exposures of early Permian continental breccias (brockram) and of the underlying Carboniferous–Permian unconformity; the strata exposed lie at the base of the local Permian sequence, higher parts of which are not exposed, but are known from many local exploratory boreholes.

The marine strata are represented by about 4.6 m of varied shallow-water shelly dolomite that was formed near the eastern margin of the Bakevellia Sea, and the underlying breccia is thought to have been a water-laid desert sheet gravel and which may have become stabilized so as to form a desert pavement.

Introduction

The classic Barrowmouth Beach section lies at the southern end of Saltom Bay, Whitehaven, Cumbria and comprises a rugged marine rock platform up to about 25 m wide backed by a near-vertical sea-cliff a few metres high. About 7.0 m of Permian strata dip south-westwards at about 5 degrees and are exposed for about 150 m.

The section was first mentioned by Sedgwick (1836), and was later discussed by Binney (1855), Murchison and Harkness (1864), Goodchild (1893) and Eastwood *et al.* (1931); more recently it was recorded by Arthurton and Hemingway (1972), who nominated it as the type locality of the Saltom Dolomite, and by Macchi (1990) who presented a graphic section. All these authors agree on the Permian age and basin-marginal significance of the 'Magnesian Limestone' that forms the main part of the exposure, but they differ in detail in their recording of the section.

Description

The position of the site and its boundaries is shown on (Figure 2.1). The Permian strata display appreciable lateral variation which probably accounts for some of the differences in recording; the following section is based on observations by the writer in 1983 and 1991.

	Average thickness (m)
7 Clay/mudstone, ?dolomitic, variegated in shades of yellow, buff, grey and pale purple, flaky	0.15+
6 Dolomite, calcitic, or dolomitic limestone, mainly olive-buff and grey-buff, finely crystalline, in four to six uneven thin beds; some thin ?argillaceous layers; 0–40 mm nodular bed at top	*c.* 0.52
5 Dolomite, argillaceous or dolomitic mudstone, buff and buff-grey, soft, shaly to flasery, with scattered poorly-preserved plant remains; 40–70 mm bed of buff and grey, microporous, finely crystalline dolomitic limestone, 0.40–0.50 m above base	*c.* 0.75
4 Dolomite, dark buff, calcitic, finely saccharoidal, in uneven thin beds with wavy partings of shaly dolomite; slightly uneven top with thin discontinuous layer of blue-black hematitic dolomite	*c.* 0.50
3 Dolomite, buff, calcitic, finely saccharoidal, unevenly thin- to medium-bedded, partly plane-laminated	*c.* 0.45

2 Dolomite, buff, calcitic, finely saccharoidal, thin- to thick-bedded with flasery olive partings towards top; partly cavernous, with few to abundant bioclast moulds; many purple-stained angular rock fragments in lowest 0.25–0.30 m; slight onlap at sharp base (relief *c.* 0.15 m)	*c.* 3.10
1 Breccio-conglomerate of purple and red-stained, angular to subrounded pebbles, cobbles and small boulders; mainly crudely-bedded; tough matrix of dolomite-cemented sandstone	*c.* 1.60

Unconformity, sharp, local relief 0.3 m, with polygonal neptunian sandstone dykes extending up to 0.9 m into underlying reddened (purple) Whitehaven Sandstone (Upper Carboniferous).

In this section, bed 1 is the Brockram of B. Smith (1924), Lower Brockram of Hollingworth (1942) and Basal Breccia of Arthurton and Hemingway (1972); in parts of the designated area it thins to as little as 0.2 m. Details of this continental deposit are beyond the scope of this volume but were given by, amongst others, B. Smith (1924), Eastwood *et al*. (1931), Arthurton and Hemingway (1972) and Macchi (1990). Higher beds in the section (Figure 2.2) and (Figure 2.3) all form part of the St Bees Evaporites as defined by Arthurton and Hemingway and beds 2 to 6 inclusive comprise their Saltom Dolomite (formerly the Magnesian Limestone).

All the carbonate rocks in the Saltom Bay section contain scattered, mainly small cavities (now calcite-lined) after former sulphates, and in some beds small concordantly-elongated cavities are so numerous as to give the rock a 'birciseye' (fenestral)-like fabric. No true fenestral fabric was seen by the writer, however, who was also unable to identify with certainty the algal lamination recorded high in the section by some authors. Dedolomitization of parts of the carbonate rocks was inferred by Arthurton and Hemingway (1972), and presumably accompanied the dissolution of the former sulphate during Tertiary or later uplift. Although a number of the thin argillaceous layers in the section resemble dissolution residues from bedded evaporites, none is associated with evidence of collapse-brecciation and an origin as residues after substantial thicknesses of evaporite is therefore unlikely. The dark grey to black layer at the top of bed 4 may be a mineralized crust or hardground.

The abundant fossils in bed 2 belong to a few species of bivalves and gastropods and were listed by Eastwood *et al.* (1931, p. 217) and Pattison (1970). Pattison noted that the bivalves *Bakevellia* (*B.*) *binneyi* and *Permophorus costatus* are the commonest fossils in this bed here, at nearby surface exposures and in borehole cores from the vicinity; he figured *Permophorus* from Saltom Bay (1970, plate 21, fig. 9). The foraminifer *Agathammina pusilla* is also present (Pattison, 1969).

The steep unstable slope backing the designated area is overgrown and has a confused hummocky surface caused by tipping, hill-creep, landslips and mudflows. Few exposures are of rocks *in situ,* but earlier records (e.g. Sedgwick, 1836; Binney, 1855; Eastwood *et al.,* 1931) show that the slope is composed mainly of thinly interbedded and interlaminated dark brick-red mudstone and siltstone of the St Bees Shales (?60 m) which overlie the St Bees Evaporites (*c.* 20 m) of which the Saltom Dolomite is here the basal unit. A 7.6 m gypsum/anhydrite noted low in the sequence by Binney (1855) was formerly worked in galleries up to 9 m high at the nearby Barrowmouth Alabaster Mine which closed in 1908 when the workings encountered an unprofitably high proportion of anhydrite; Binney's view on the low position of the gypsum/anhydrite bed was disputed by B. Smith (in Eastwood *et al.,* 1931) who suggested that it was separated from the limestone by 'a considerable thickness of shale'. It is likely to be either the Sandwith Anhydrite of Arthurton and Hemingway (1972) or a combination of the Sandwith Anhydrite and the Fleswick Anhydrite.

Interpretation

The low cliff overlooking Barrowmouth Beach is by far the largest and best exposure of the 'Magnesian Limestone' of West Cumbria and the wave-swept rock platform affords an unrivalled view of the underlying 'Brockram' and of the unconformity between Permian strata and the eroded and deeply reddened Upper Carboniferous Whitehaven Sandstone; the hiatus represented by the unconformity probably spans at least 60 million years. The section is doubly important in that it is also the best exposure of marginal strata of the Bakevellia Sea Basin; it lies close to, or on, the Ramsey–Whitehaven Ridge and thus throws light on Permian sedimentation near the margins of both the Solway Firth and East Irish Sea sub-basins.

Permian continental breccias and 'Magnesian Limestone' are, or have been, exposed in a number of small quarries and natural exposures in the Whitehaven area and were recorded by Eastwood *et al.* (1931); some of the quarries have now been filled and most of the other sections are overgrown. The surface exposures, however, afford only a small part of the available information on the local Permian sequence, most of which comes from numerous coal, iron ore and gypsum/ anhydrite exploration boreholes (Eastwood *et al., 1931;* Taylor, 1961; Meyer, 1965; Arthurton and Hemingway, 1972). Analysis of the borehole information by Arthurton and Hemingway revealed that the basal marine units are sharply varied in thickness, up to a maximum of about 15 m, and comprise a diverse mosaic of facies types indicative of a range of nearshore depositional environments; the lower part of the basal carbonate rocks passes south-eastwards into dolomitic siliciclastic siltstone, the Saltom Siltstone, which is thought to be absent at the Barrowmouth section unless it is represented by bed 5.

If Arthurton and Hemingway were correct in assigning beds 2–6 inclusive to the Saltom Dolomite, the carbonate rocks at Barrowmouth would be the whole of the carbonate member of the incomplete first or Saltom Cycle (= Cycle BS1 of Jackson *et al.,* 1987) ((Table 1.1). It is possible, however, that the dark grey to black hematitic layer at the top of bed 4 is correlative with the zone of 'intense haematitic staining' at the top of the Saltom Dolomite in Borehole S9 (about 1.5 km SSW of the Barrowmouth Beach section) and if this were so, then the section would include parts or all of the carbonate members of both the Saltom and Sandwith (BS2) cycles.

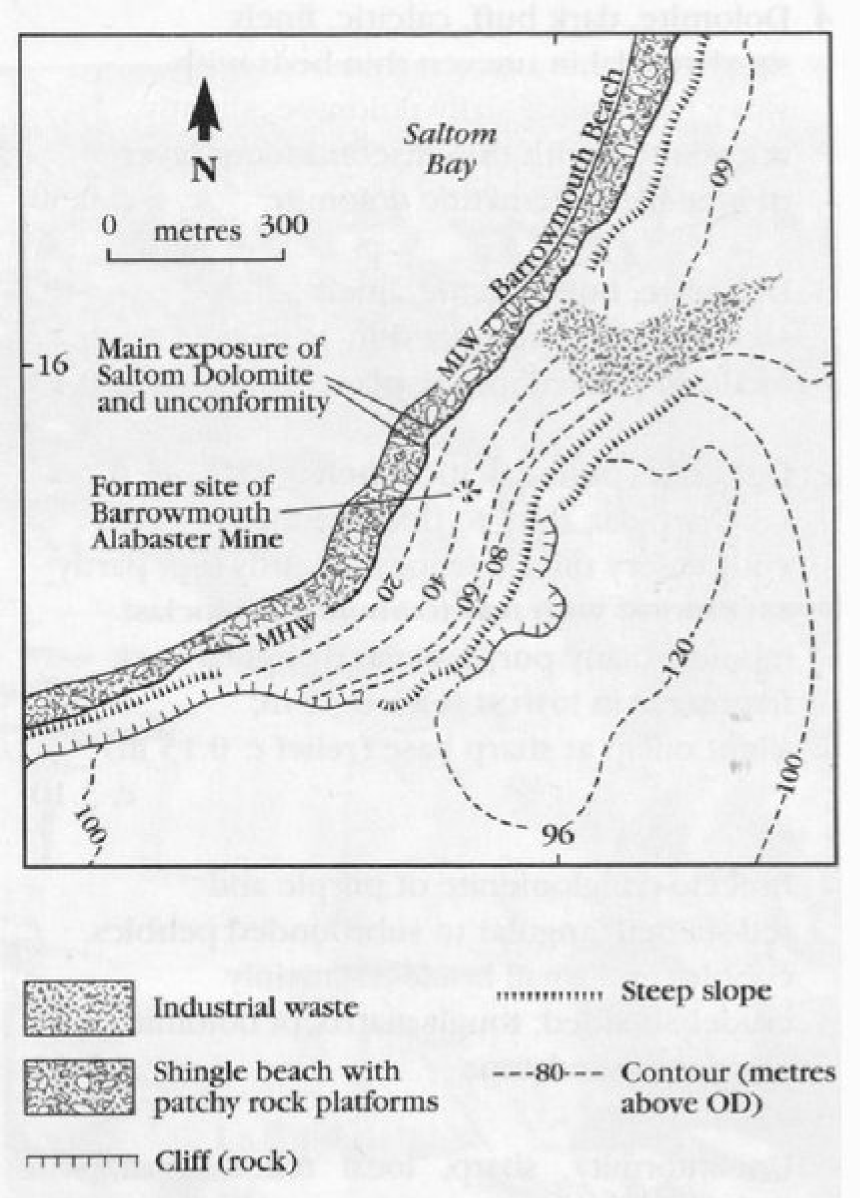
Future research

Full understanding of the significance of the Barrowmouth Beach section is severely hampered by an almost complete lack of detailed knowledge of the petrography, geochemistry and sedimentology of the rocks exposed. These aspects ought to be addressed in the light of further detailed analysis of cores from nearby boreholes.

Conclusions

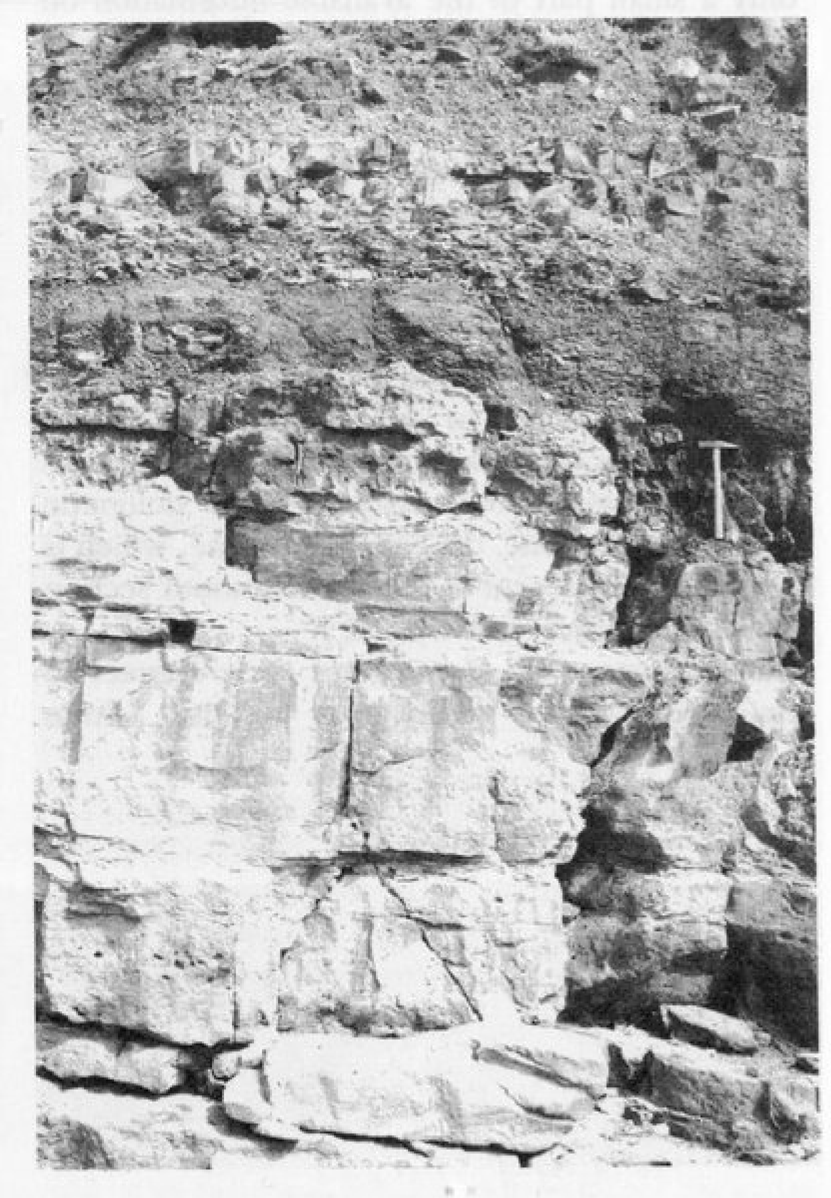
The cliff section backing Barrowmouth Beach is the only GCR she in marine Permian strata near the eastern margin of the Bakevellia Sea basin. It is the best coastal exposure of Permian sedimentary rocks and of the underlying Carboniferous–Permian unconformity in Cumbria. The cliff exhibits a sequence of early Permian continental breccias (brockram), the products of erosion of the early Permian uplands, overlain by late Permian shallow marine dolomitized limestones that contain fossil-rich layers. The site has considerable potential for future study and research, particularly into the petrological, geochemical and sedimentological aspects of the sequence, together with the relationships of this site to sequences revealed by detailed analysis of cores from nearby boreholes.

References



(Figure 2.1) The Barrowmouth Beach GCR site, Saltom Bay, Whitehaven, showing the position of the main features of geological interest.

(Figure 2.2) Lower beds of the Permian sequence at the south-west end of the Barrowmouth Beach (Saltom Bay) section, showing Saltom Dolomite resting on the slightly uneven surface of the Brockram or Basal Breccia. Hammer: 0.33 m. (Photo: D.B. Smith.)



(Figure 2.3) Higher beds of the Permian sequence in Barrowmouth Bay, a few metres southwest of the view in (Figure 2.2). The line of small cavities in dolomite near the base of this photograph is also visible near the top of the section in Figure 2.2. Most or all of the beds here form part of the Saltom Dolomite, but it is possible that bed 6 may be part or all of the Fleswick Dolomite. Hammer: 0.33 m. (Photo: D.B. Smith.)

Cycles	Manx-Furness Basin (Central area)	South Cumbria	West Cumbria	Vale of Eden
	St Bees Evaporites and Shales	St Bees Shales (with Brockram)	St Bees Shales (with Brockram) / St Bees Evaporites	Eden Shales (with Brockram)
BS4	Anhydrite			Blocky Facies
	Anhydrite		Blocky Facies	D-Bed
	Dolomite			Belah Dolomite
BS3	Halite	Roosecote Anhydrite	Fleswick Anhydrite	C-Bed
		Roosecote Dolomite	Fleswick Dolomite	
BS2		Haverigg Haws Anhydrite		
	Anhydrite		Sandwith Anhydrite	B-Bed
	Dolomite	Gleaston Dolomite ('Magnesian Limestone') 'Grey Beds'	Sandwith Dolomite	A-Bed and Hilton Plant Beds
BS1	Dolomite, anhydrite, mudstone, etc.		Saltom Dolomite	
			Saltom Siltstone	

(Table 1.1) Classification and correlation of Permian marine and associated strata in north-west England and adjoining areas, showing the main depositional cycles. The Manchester Marl of south Lancashire and north Cheshire is a general correlative of the St Bees Evaporites but precise correlation is uncertain. Based on Smith (1992, table 9.2). Cycles after Jackson et al. (1987).