Sandsfoot

[SY 687 788]–[SY 671 770]

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Introduction

The significance of the exposures of Corallian strata in the Sandsfoot GCR site first became apparent in the early 19th century when the locality was described briefly by Sedgwick (1826), and later by Fitton (1827). A fuller account was provided by Buckland and De la Beche (1836, pp. 23–7). Blake and Hudleston (1877), Hudleston (1889) and Woodward (1895) provided the best of the 19th-century descriptions of the site. Arkell's more detailed description of the sections (Arkell, 1936a, 1947a) best emphasizes the important role played by this site in studies of Oxfordian geology. Subsequently, the locality has figured prominently in several specialist studies concerning Oxfordian stratigraphy, sedimentology, palaeogeography and taxonomy (Morris, 1968; Wilson, 1968a; Brookfield, 1973a, 1978; Talbot, 1973a, 1974; Fürsich, 1975, 1977; Wright, 1986a, 1998).

Description

This shallowly dipping Corallian sequence lies on the southern side of the Weymouth Anticline. It comprises rock platform and low cliff exposures extending from Nothe Point to Sandsfoot Castle (Figure 2.16). The sequence is much less well exposed than formerly. Due to landscaping, building works and defences against cliff erosion, plus the inhibition of marine erosion caused by the construction of the Portland Harbour breakwater, there are 'now only intermittent exposures. The potential maximum thickness is 84 m. The sequence spans all seven Corallian ammonite zones and comprises 13 stratigraphical units, five of which, the Nothe Grit, Nothe Clay, Bencliff (Bincleaves) Grit, Sandsfoot Clay and Sandsfoot Grit, have their type localities along this stretch of coastline. (Figure 2.17) lists all the members and formations present. The zonal ranges of these are as shown in (Figure 2.7). The section was regarded by the early authors (e.g. Buckland and De la Beche, 1836) as the type locality for the Corallian Group in south Dorset. A definitive version of the stratigraphy was given by Wright (1986a). A weathering profile of the lower part of the succession is given in (Figure 2.18), and a weathering profile of the Sandsfoot Grit is given in (Figure 2.20). The revised subdivision follows Wright (in press) (see site report for Osmington, this volume). Details of the succession are as follows.

Redcliff Formation (27.5 m+)

Blake and Hudleston (1877) named the Nothe Grit Member after the '30 ft (9 m) of calcareous sandstone with hard bands of grit well exposed beneath the Nothe Fort at the end of Weymouth Pier' [SY 687 788]. At low tide the upper 5 m of the Nothe Grit is still visible. It consists of argillaceous, very fine-grained sandstone with the frequent development of calcareous concretions (beds 1, 4, (Figure 2.18)), much more so than at Red Cliff (see site report for Osmington GCR site report, this volume). A substantial bivalve and ammonite fauna is present in a bed of calcareous sandstone near the base of the succession (Wright, 1986a).

At the southern end of Nothe Point [SY 685 786], 1.8 m of the Preston Grit Member is exposed in the wave-cut platform (Figure 2.19). It comprises a massive, fine- to medium-grained, shelly sandstone with excellent infilled *Thalassinoides* burrow networks (Bed 8, (Figure 2.18)). The highest 0.45 m seen (Bed 9) consists of medium-grained, sandy limestone with a layer of *Myophorella hudlestoni* (Lycett) on the top surface (Wright, 1986a). The junction with the overlying Nothe Clay is not exposed.

At the type locality at Rodwell [SY 684 785], the lower 8 m of the Nothe Clay Member is intermittently exposed as a gently dipping succession in the rock platform. Almost 50% of the succession is limestone, there being eight distinct limestone beds, numbered NCL1 to NCL8 in (Figure 2.18), ranging in composition from shelly micrite to oomicrite, separated by layers of clay. Bored, encrusted limestone pebbles are common towards the top of the succession. The recent installation of sea defences means that the upper 5.5 m of this sequence (beds NCL5 to NCL8, (Figure 2.18)) is much less well exposed than formerly.

The Bencliff Grit Member is no longer exposed. Blake and Hudleston (1877) saw 'sandy shales and loose, foxy sands which contain towards the base huge tabular doggers of indurated, calcareous sandstone' (3.3 m).

Osmington Oolite Formation (12.5 m +)

There are excellent cliff exposures of this formation, but they are largely on land owned by the Defence Research Agency, and are not accessible to the public. Blake and Hudleston (1877) described the section. Following Arkell (1936a), beds that they included in the Bencliff Grit below and the Clavellata Formation above are now included within an enlarged Osmington Oolite Formation. The following can be pieced together from Blake and Hudleston's account (Blake and Hudleston's bed numbers in brackets; metric thicknesses have been substituted):

	Thickness (m)
Nodular Rubble Member	
7. Irregular, blue-weathering, impure limestone in hummocky masses	1.83
Shortlake Member	
6. (1) Blue, marly clay with oolitic grains	1.98
5. (2) Small-grained, sandy oolite, weathering hummocky by having a bioclastic limestone substituted towards the base	0.60
4. (3) Marly clay with doggers	1.68
3. (4) Oolite, gritty in the centre and marly below, with *Aspidoceras perarmatum* J. Sowerby)	1.82
Upton Member	
2. (5) Blue, sandy marl, partly argillaceous	1.21
1. Calcareous grit with dichotomizing branches, very hard in the upper part, passing down into soft, calcareous sands with a band of compact, argillaceous limestone at the base	3.35

It is not possible to ascertain whether there are any gaps in this succession. Bed 1 was notably fossiliferous, with several species of bivalve and gastropod, including *Cucullaea contracta* Phillips, *Chlamys qualicosta* (Etallon), *Trigonia* sp. and *Cerithium* sp.. Blake and Hudleston comment that the Shortlake Member is markedly more argillaceous here than elsewhere in south Dorset. The distinctive Nodular Rubble Member is accessible in Castle Cove (see below).

Clavellata Formation (20 m +)

South of the Defence Research Agency land, there are substantial exposures of the Clavellata Member in the Western Ledges and low cliffs of Castle Cove (Figure 2.16). This is the type section of the member as defined by Blake and Hudleston (1877). The Sandy Block and Chief Shell Beds are best seen in the base of the cliff as the reefs in the centre of the cove are covered with an almost impenetrable mass of seaweed, and more recently occupied by a large pier constructed on stilts.

At [SY 680 778], a fossil wave-cut platform in the Nodular Rubble Member of the Osmington Oolite Formation is excellently displayed, with laminated sands of the Sandy Block wrapping round bored limestone hummocks. Above the non-sequence are 0.15 m of sandy clay, and the Sandy Block succession is completed by two tiers of limestone totalling 1.42 m. Scattered *Myophorella clavellata* (Parkinson) occur in life position.

Exposures of the Chief Shell Beds (2.02 m) at [SY 677 777] consist of argillaceous, fossiliferous, oolitic limestone. Higher parts of the Clavellata Member succession are not seen at present.

The Sandsfoot Clay Member type section of Blake and Hudleston (1877) was at Castle Cove. The area is now largely vegetated and built over, and there is little beach exposure. Woodward (1895) described 11.7 m of blue, fossiliferous clay. Wright (1986a, 1998) considered that the true thickness was 15.5 m. Under favourable beach conditions the top 0.5 m of Sandsfoot Clay, consisting of very fine-grained mudstone, can be seen beneath the Sandsfoot Grit at [SY 676 775].

Sandsfoot Formation (16.8 m +)

The revised definition of the Sandsfoot Formation, including the Sandsfoot Grit, Ringstead Clay and Osmington Mills Ironstone members, follows Wright (in press).

The first accurate measured section of the Sandsfoot Grit Member as exposed in the cliff sections beneath Sandsfoot Castle [SY 676 775]–[SY 672 771] was provided by Wright (1986a) as follows (Figure 2.20):

	Thickness (m)
Unit V	
9. Tough, iron-rich, fine- to medium-grained sandstone with a red, iron-stained top surface. Scattered chamosite ooids are present. The bed is heavily bioturbated by *Thalassinoides,* and contains *Goniomya* sp. and *Liostrea* sp.	0.45
8. Massive, brown-weathering, fine- to medium-grained chamositic sandstone, very soft and argillaceous	1.38
7. Grey, fine- to medium-grained, calcareous sandstone, heavily bioturbated with the burrow infillings weathering out. Fragmentary *Chlamys midas* (Damon) are common, with *Liostrea* sp. and *Pleuromya* sp.	0.61
Unit IV	
6. Yellow-weathering, light grey, slightly sandy clay approx.	1.20
Unit III	
5. Argillaceous, iron-rich, largely fine-grained chamositic sandstone. Distinctive patches of light grey micrite are present, containing well-preserved chamosite ooids. *Ringsteadia* spp. and *Microbiplices anglicus* Arkell weather out	1.90
4. Tough, prominent, sideritic pebbly sandstone with a fine-grained or fine- to medium-grained matrix. Bioturbation is strong, but the considerable fauna is well preserved: *Ringsteadia* sp., *Pinna sandsfootensis* Arkell, *Chlamys midas, Ctenostreon* sp., *Deltoideum delta* Smith, *Isognomon* sp. and *Goniomya* sp.	0.55
3. Tough, well-bedded, fine-grained or fine- to medium-grained sandstone, iron-rich, with poorly preserved chamosite ooids. Not particularly fossiliferous, with *Pinna sandsfootensis* and *Trichites* sp.	1.80
Unit II	
2. Soft, very argillaceous, fine- to medium-grained sand with clay partings. *Deltoideum delta* is abundant, and the unit is coarse and shelly at the base approx.	2.30
Unit I	

1. Well-bedded, glauconitic sandy limestone or calcareous sandstone. *Perisphinctes* (*F.*) aff. *strumatus* (Buckman) occurs, along with numerous *Pleuromya uniformis* (J. Sowerby). The base consists of a coquina of belemnite guards, oyster fragments, etc., set in a medium quartz sand and resting with a sharp junction on Sandsfoot Clay	1.13

A weathering profile of the section is given in (Figure 2.20). Unit I contains 40% calcium carbonate and is almost a limestone. Unit II was confused with the Sandsfoot Clay by the early workers. However, it contains 50% fine quartz sand and 10% medium, and is an argillaceous sand. The clastic content of beds 3 and 4 is not markedly greater than that of Bed 2, and it is the incoming of iron — originally as iron silicate, now disseminated as siderite — that has cemented the rock (Figure 2.21). Bed 4 is markedly pebbly, with 10 mm pebbles of dark quartzite. Unit N is unique in the Sandsfoot section — a pale grey, almost insoluble clay. Unit V marks a return to the deposition of sandy ironstone, coarser than the beds in Unit III. Units I to IV are exposed in the cliffs below Sandsfoot Castle. Unit V is seen only in the low cliffs at the south end of the small bay south of the Sandsfoot cliffs, where it rests on the clay of Unit IV

There is no natural exposure of the uppermost Oxfordian Ringstead Clay Member and Osmington Mills Ironstone Member in the Sandsfoot GCR site due to the construction of a yacht storage area and small piers on the outcrop. A temporary section exposed in 1998 during construction of a car park for the 'Scuba Shack' [SY 672 772] revealed the junction of mudstone with brown siderite nodules is present as strongly cross-bedded oolite in the (Ringstead Clay) overlain by shelly, iron-oolite Rodwell Railway Cutting 1 km to the west (Blake marl (Osmington Mills Ironstone).

Interpretation

Comparison of the Sandsfoot succession with that seen at Osmington (see site report for Osmington, this volume) reveals significant differences. These are caused either by changes in facies, or by non-sequences at Osmington being much less markedly developed at Sandsfoot, giving a more complete succession.

The sands of the Nothe Grit Member are fine grained and bioturbated. Fine, offshore, silty sands pass up into well-sorted, subtidal sands laid down quite close to the beach environment.

Sedimentation in the Preston Grit Member took place after a break and minor uplift. Small pebbles of fine-grained sandy limestone imply erosion of Nothe Grit nearby. The Preston Grit is much coarser in grain size at Nothe than at Redcliff implying a shallower-water, near-beach environment in this southerly direction (Wright, 1986a), with the uppermost 0.45 m being a true sandy, shelly, bioclastic limestone.

The Nothe Clay is a comparatively shallow-water clay unit, not fully open marine. Ammonites are very infrequent in the clay facies, and there are only occasional burrowing bivalves. Shell sand was able to transgress repeatedly, presumably coming from the southwest, as these limestone beds are thicker here than at Red Cliff (see Osmington GCR site report, this volume). Each of the shelly bands marks the building out of high-energy shell sand into a comparatively shallow clay-depositing sea. The Nothe Clay at Rodwell thus contains a varied sequence of limestone beds with frequent pebbles and erosive features demonstrating the close proximity of shallow-water conditions during deposition of this unit, and again indicating a southerly shallowing, in contrast to the deeper-water sequence at Redcliff. The Bencliff Grit is remarkably similar in facies to that seen at Bran Point (see site report for Osmington, this volume), indicating that the special conditions that gave rise to its formation must have been widespread.

The basal Upton Member, a sandy limestone at Osmington, is so sandy at Sandsfoot that . Blake and Hudleston called it a calcareous grit, and grouped it with the Bencliff Grit. Though the Shortlake Member is argillaceous here, this is not an indication of deepening, for the member and Hudleston, 1877). The Nodular Rubble Member shows again the irregularly weathering bedding planes produced by diagenesis of *Thalassinoides* burrows.

Prior to the accumulation of the Clavellata Formation, a marine bench was cut into the Nodular Rubble and colonized by numerous burrowing organisms. As the basin subsided, allowing sediment to accumulate, marginal areas appear to have been uplifted, resulting in the fine quartz sand of the Sandy Block being swept into the basin. Clastic input was slight during deposition of the Chief Shell Beds and Red Beds. Wilson (1968a, b) and Talbot (1973a, 1974) point to the presence of clay and micrite as indicating accumulation in water of moderate shelf depth away from strong wave action except during storms.

Both the Sandsfoot Grit and the Sandsfoot Clay demonstrate considerable thickness increases when compared with the equivalent strata at the Osmington site (Wright, 1986a). The Sandsfoot Clay increases from 3.9 m to an estimated 15.5 m, due to much lesser erosion beneath the Sandsfoot Grit. HoWever, even at Sandsfoot there exists a non-sequence of considerable stratigraphical significance between the two members, which was thought by Wright (1986a) to represent the omission by erosion of any Serratum or Regulare Zone deposits that may at one time have existed (Figure 2.7). The omission of Sandsfoot Grit strata is again considerably less at Sandsfoot than at Black Head in the Osmington site, where an additional 4.3 m of strata has been removed by the erosion beneath the Ringstead Clay (Wright, 1986a).

The ferruginous, ooidal character of the Sandsfoot Grit at Sandsfoot is somewhat similar to that of the equivalent iron-rich oolites of the Westbury Ironstone of Wiltshire (see Westbury GCR site report, this volume), and also the early Kimmeridgian Abbotsbury Ironstone (see site report for Blind Lane, this volume). The coarse grained nature of much of the sediment implies deposition under shallow, high-energy conditions. Changes in thickness of individual units in the section at East Fleet compared with those at Sandsfoot are marked (Wright, 1998). The Sandsfoot Grit represents a barrier sand whose formation was triggered by the uplift that led to the erosion of the Sandsfoot Clay. The more argillaceous units II and W accumulated in shallow, brackish or possibly hypersaline lagoonal areas. Bed 4 has yielded a substantial bivalve fauna, and was made the type of the *Pinna* association by Fürsich (1977). This fauna of shallow-burrowing and surface-dwelling bivalves lived in or on the sandy sediment where it is found, specimens of *Pinna* frequently being found in life position or slightly disturbed but with the valves still together. Intraformational erosion has removed most of these very fossiliferous beds from the Osmington site (Wright, 1986a).

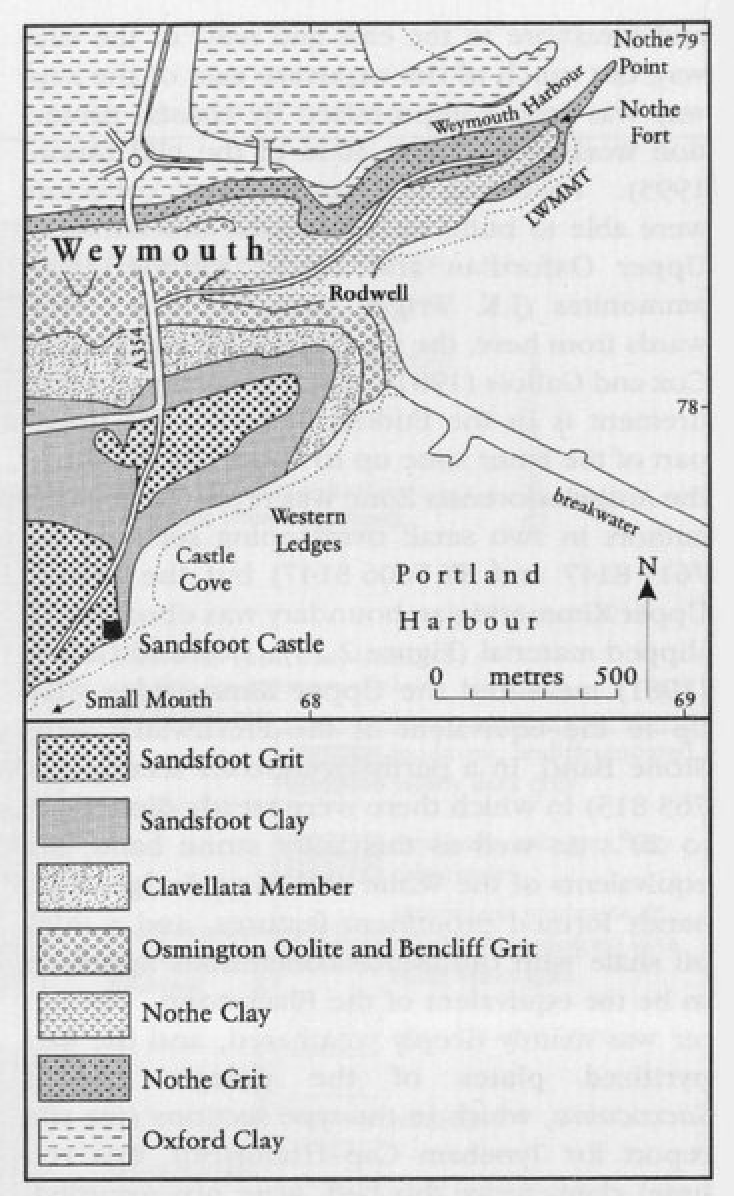
Conclusions

This is a key site in Jurassic studies. It includes the type localities of the Nothe Grit, Nothe Clay, Sandsfoot Clay (unfortunately obscured) and Sandsfoot Grit. There is a good exposure of the Preston Grit in its *Myophorella hudlestoni* shell-bed facies, exemplifying the alternative name for this unit of 'Trigonia hudlestoni Bed'.

The Osmington Oolite Formation–Clavellata Formation junction is better displayed at this locality than elsewhere. One is able to walk over a fossil Jurassic wave-cut platform and observe incursions of sandy sediment infilling burrow systems bored into the underlying Nodular Rubble. The Sandy Block also is better displayed here than elsewhere.

The Sandsfoot Grit contains a very important fauna of late Oxfordian bivalves and ammonites. Deposition of clay facies had reached most of the shelf areas of England by the late Oxfordian (Wright, 1980), and Sandsfoot is one of the few areas in Britain, and certainly the best area, where the distinctive late Oxfordian shallow-water bivalve fauna can be studied. Due to intraformational erosion, these very fossiliferous beds are not present at the Osmington site.

References

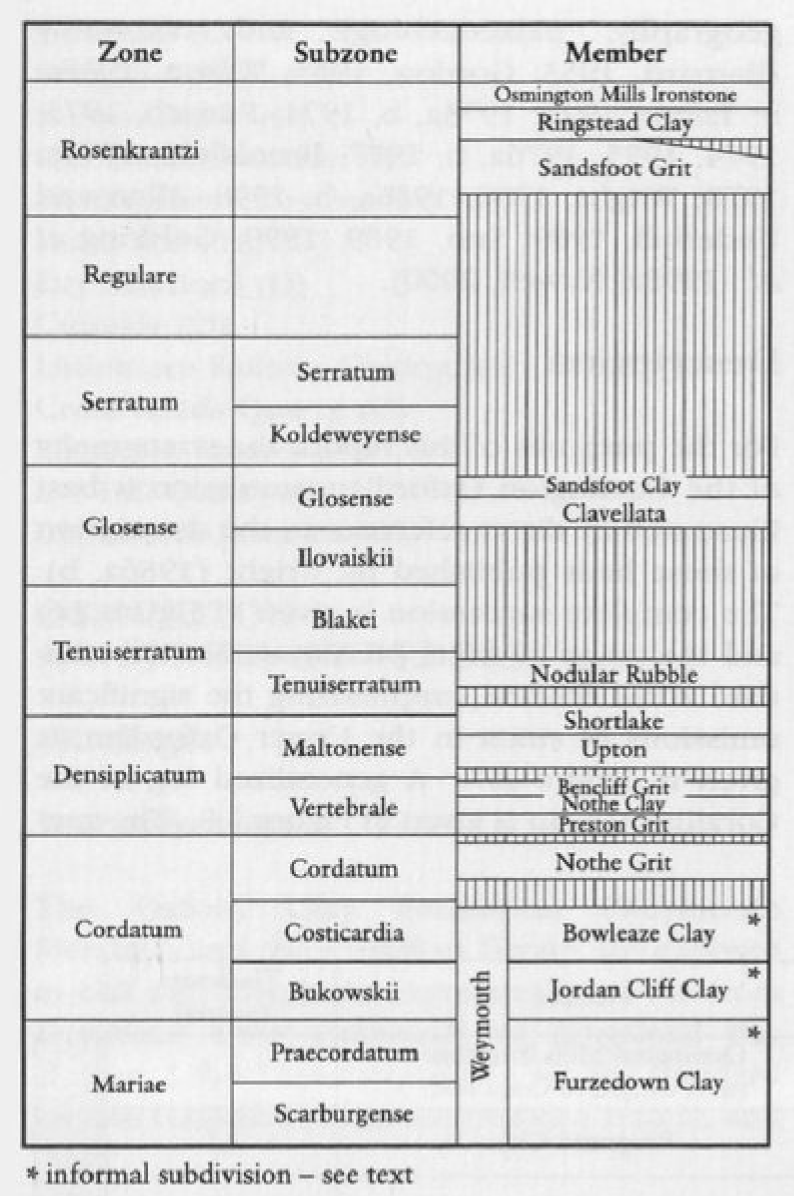


(Figure 2.16) Sketch map of the solid geology in the vicinity of the Sandsfoot GCR site.

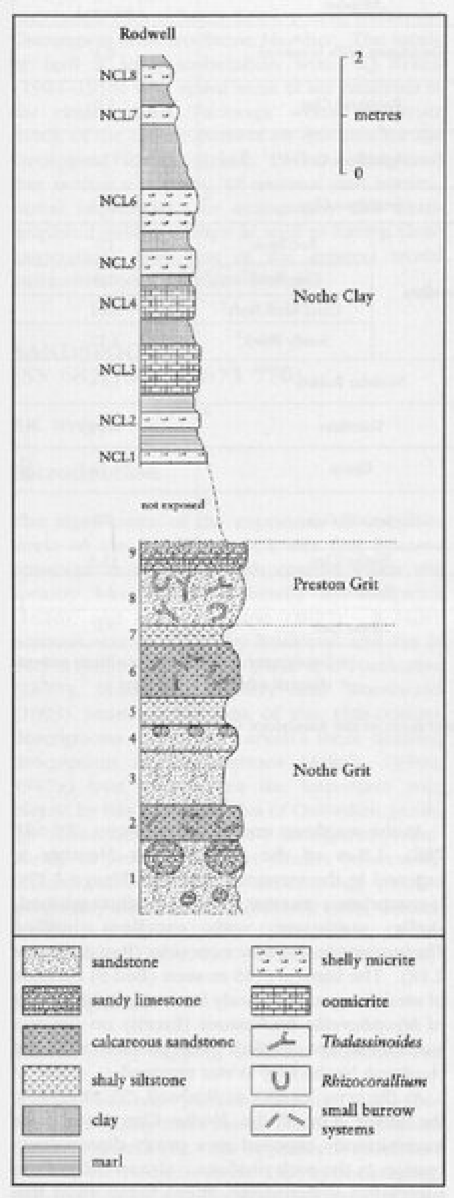
Substage	Formation	Member		Thickness (metres)
Upper Oxfordian	Sandsfoot	Osmington Mills Ironstone *		0.3
		Ringstead Clay *		5.0
		Sandsfoot Grit		11.3
	Clavellata	Sandsfoot Clay *		15.5
		Clavellata	Red Beds† *	1.5
			Clay Band† *	1.0
			Chief Shell Beds†	2.02
			Sandy Block†	1.57
Middle Oxfordian	Osmington Oolite	Nodular Rubble		1.8+
		Shortlake *		6.1+
		Upton *		4.5+
	Redcliff	Bencliff Grit *		4.0
		Nothe Clay		13.5
		Preston Grit		1.8
Lower Oxfordian		Nothe Grit		9.0

* largely not exposed or inaccessible at present
† informal subdivision – see text

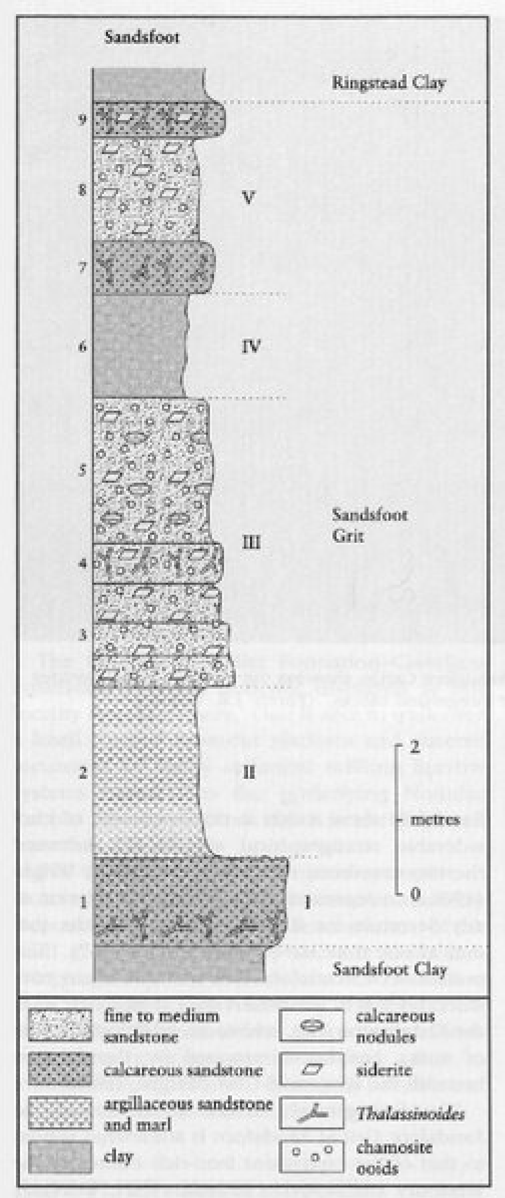
(Figure 2.17) The complete stratal succession at the Sandsfoot GCR site.



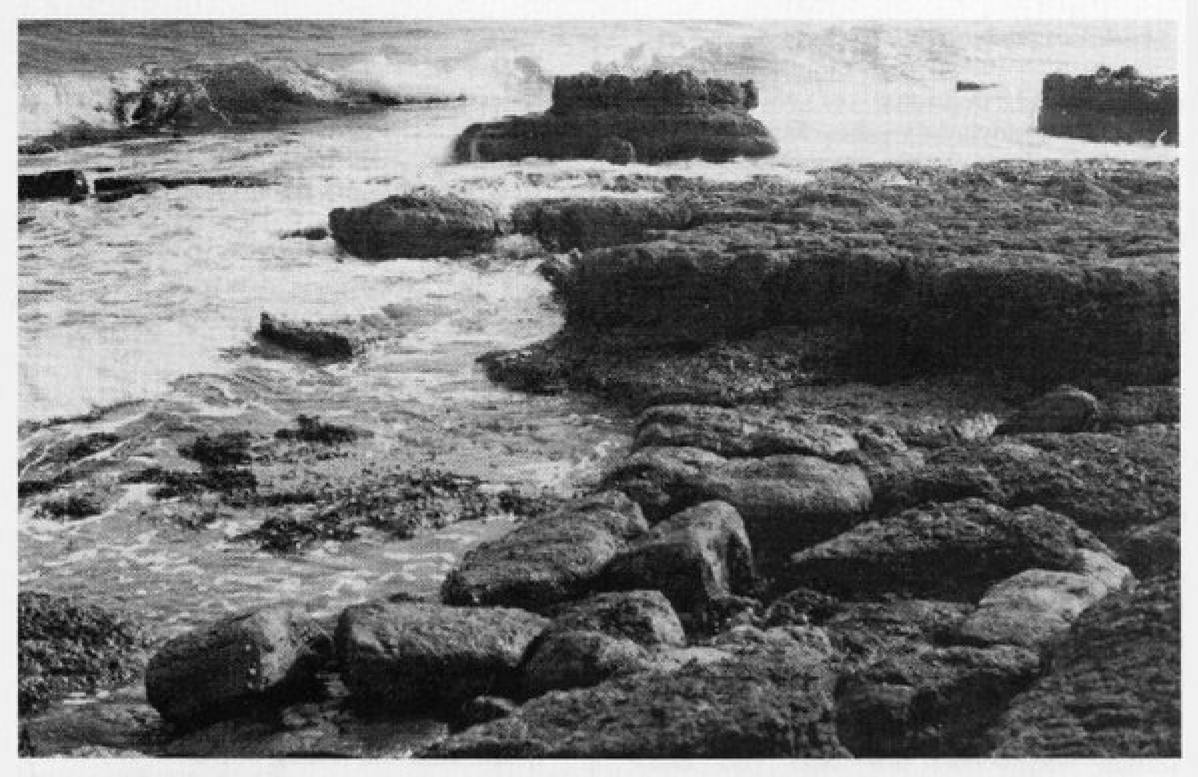
(Figure 2.7) The ammonite zones and subzones of the Oxfordian Stage showing the zonal range of the strata present at the Osmington GCR site.



(Figure 2.18) Weathering profile of the Redcliff Formation between Nothe and Rodwell (after Wright, 1986a, figs 2 and 3).



(Figure 2.20) Weathering profile of the Sandsfoot Grit in the cliff section beneath Sandsfoot Castle (after Wright, 1986a, fig. 5)



(Figure 2.19) Preston Grit exposed in the rock platform just east of Nothe Fort. (Photo: J.K. Wright.)

(Figure 2.21) Massive Sandsfoot Grit of Unit III below Sandsfoot Castle, showing the intense Thalassinoides bioturbation of the harder bands weathering out in the foreground blocks. (Photo: J.K. Wright.)