Redcar Rocks, Redcar and Cleveland

[NZ 605 253]–[NZ 620 253]

K.N. Page

Introduction

The Redcar Rocks GCR site exposes the oldest Jurassic strata seen on the North Yorkshire–Cleveland coast, the Redcar Mudstone Formation, which takes its name from this locality, and the lowest part of the Staithes Sandstone Formation. Redcar Rocks and Coatham Rocks together expose the higher part of the Hettangian Stage, and much of the Lower Sinemurian and parts of the Upper Sinemurian and Lower Pliensbachian substages (Figure 6.3). The lowest part of the Hettangian succession (Planorbis Zone) is not exposed at this site, although it is known to be present inland at Eston, 8 km south-west of Redcar on the eastern outskirts of Middlesborough (Tate and Blake, 1876; Cope *et al.,* 1980a). Most of the Upper Sinemurian succession is not exposed, but there are records of loose specimens of that age that have presumably been derived from submarine or sub-beach outcrops. The outcrops expose much of the succession which occurs below the lowest exposures at Robin Hood's Bay (Normanby Stye Batts–Miller's Nab GCR site) where the oldest exposures are of Semicostatum Zone age. In addition, although only intermittantly exposed due to beach conditions, the sections yield a good sequence of stratigraphically diagnostic ammonite faunas including some of the best-preserved Semicostatum Zone faunas in Britain. This is the northernmost coastal exposure of Jurassic rocks in England.

The constant movement of beach sand at Redcar Rocks has hindered detailed recording of the sections and there are no modern published measured sections. The only detailed sections were published in Tate and Blake's (1876) classic account of the Yorkshire Lias, subsequently reproduced in Fox-Strangways (1892). Tate and Blake were remarkably thorough in their study, describing how 'our plan of collecting the fossils is to crawl along the scars, during a bright sunny day, in a position so as not to intercept the rays of sunlight — also to wash the fossiliferous shales, as is done for Foraminifera, only that which is retained by the sieve will yield the small molluscan shells'.

The site was also referred to by Wright (18781886), Barrow (1888), Blake (1891), Blake *et al.* (1891), Herries (1906a,b), Arkell (1933), and by Wilson *et al.* (1934). Gad (1966), in an unpublished thesis, measured a section across the Hettangian–Sinemurian boundary for a geochemical study, and Getty (in Cope *et al.,* 1980a) referred to the Redcar and Coatham rocks sequence based, in part, on his own unpublished records (including sections measured with D.T. Donovan). Powell (1984) established the Redcar Rocks sections as the type locality of the Redcar Mudstone Formation, but did not provide a description of the site. Chemical and gamma-ray analysis of the Hettangian and Lower Sinemurian part of the succession was undertaken by van Buchem *et al.* (1992). Correlation of the sections is reviewed here based on previous descriptions combined with some new observations, but without a newly measured section.

Description

The only detailed published description of the Redcar Rocks succession is by Tate and Blake (1876). Lord (1971) provided a sketch map of the distribution of part of the Hettangian and Lower Sinemurian succession, and van Buchem *et al.* (1992) published a simplified sketch section and gamma-ray log for essentially the same strata. Herries (1906a,b) noted that the Redcar exposures represent the western limb of a large gentle anticline, with similar strata sometimes exposed on the eastern limb in Marske Bay, some 7 km farther ESE along the coast. Exposures are entirely intertidal and discontinuous (Figure 6.4), with seasonal sand movement often obscuring parts of the succession for long periods of time. The composite section presented here is based on unpublished observations (K.N. Page) and the review of Getty (in Cope *et al.,* 1980a). The lithostratigraphical framework follows Powell (1984), although Tate and Blake's Angulata Beds and Bucklandi Beds, as adopted by Getty (in Cope *et al.*, 1980a), are retained here as informal subdivisions of uncertain status. Thicknesses are taken from Getty (in Cope *et al.,* 1980a), after Tate and Blake (1876).

PLIENSBACHIAN STAGE

Staithes Sandstone Formation

Davoei to *Margaritatus zones*

Shales and sandstones, silty, forming the outer part of Coatham Rocks (Inner Height and Outer Height) in the northern part of the site. The fauna includes bivalves (*Oxytoma, Pseudopecten, Gryphaea,* etc.), belemnites and ammonites (including *Amaltheus* indicating the Margaritatus Zone and *Aegoceras* or *Oistoceras* from the Davoei Zone in the lowest beds of the scar).

?**UPPER SINEMURIAN–LOWER PLIENSBACHIAN SUBSTAGES**

Redcar Mudstone Formation

Ironstone Shale Memberand possibly ***Pyritous Shale Member***

?Raricostatum to Davoei zones

Shales with bands of iron-rich (?sideritic) carbonate nodules exposed across West Scar, Coatham Rocks. Ammonite records by the [British] Geological Survey (Sheet 34) and by Getty (in Cope *et al.,* 1980a) suggest the presence of the Davoei, Jamesoni, and (?upper) Raricostatum zones.

SINEMURIAN STAGE

Siliceous Shale Member

including *Oxynotum Zone, Simpson! Subzone* and *Obtusum Zone* faunas

Shale, hard, sandy, calcareous, with *Oxynoticeras* and *?Eoderoceras* on High Stone. Oxynotum Zone and possibly early Raricostatum Zone, Densinodulum Subzone. Getty (in Cope *et al.,* 1980a) recorded Simpsoni Subzone and Obtusum Zone faunas based on ex-situ specimens, presumably derived from submerged exposures or these reefs.

HETTANGIAN–LOWER SINEMURIAN SUBSTAGES

Calcareous Shale Member

Liasicus to Semicostatum zones

'**Upper Bucklandi Beds**' (beds 1–18) of Tate and Blake (1876): Shale, grey, with silty bands forming low reefs exposed across Redcar Rocks with prominant *Gryphaea*-rich bands in upper part. Van Buchem *et al.* (1992) identified a shelly sandstone with ferruginous ooliths at the base of the Semicostatum Zone, capping a distinct coarsening-upward trend. Page (unpublished observations) has recorded the following sequence of faunas.

Semicostatum Zone, Sauzeanum Subzone

5: *Euagassiceras* sp.. 2

4: *Euagassiceras* sp., *Arnioceras* sp.. 2

3: *?Euagassiceras* sp., *?Pararnioceras, Arnioceras* sp.. 2

2: *Euagassiceras* sp. 1, *?Arnioceras* sp., *Nannobelus* sp..

Scipionianum Subzone

1: *?Agassiceras* sp. (large, crushed, compressed whorled ammonites).

Grey shale with some bands of calcareous nodules, with at least 3 distinguishable ammonite faunas present (= beds 6? to 10 of Tate and Blake, 1876).
3: *Agassiceras* sp. (including large crushed specimens).
2: *Arnioceras* (abundant) and *?Pararnioceras* sp..
1: *Agassiceras* sp..
These levels appear to have yielded *Agassiceras scipionianum, A. personatum, A.* cf. *decipiens* and *Arnioceras acuticarinatum* according to T.A. Getty (pers. comm.).
Total thickness for shales and mudstones with Scipionianum and Sauzeanum subzone faunas: *c.* 15
'**Lower and Middle Bucklandi Beds**'
(beds 11–19): Shales, grey, with sandy and silty bands forming a number of prominent reefs (East Scar, Stokesley Scar and Jenny Leighs Scar) and low subordinate reefs. Some of the harder silty and sandy bands are rich in *Gryphaea.* Ammonites are present at a number of levels, including:
Lyra Subzone
5: *Corniceras* cf *lyra* in the upper part of East Scar (*lyra* Biohorizon). T.A. Getty (pers. comm.) noted that the highest *Coroniceras* is present in Bed 14 of Tate and Blake (1876), with large *Paracoroniceras,* around 1.5 m higher in the succession (probably in Bed 11) — the latter may in fact be the same as the *lyra* fauna noted first.
?Bucklandi Zone, Bucklandi Subzone
4: *Arnioceras* sp. and a cf. *Arietites* sp. in Stokesley Scar. TA. Getty (pers. comm.) noted an apparently similar fauna with the addition of *Charmasseiceras,* as also recorded in Tate and Blake (1876).
Rotiforme Subzone
3: *Coroniceras* ex grp. *rotiforme* in Jenny Leighs Scar. T.A. Getty (pers. comm.) recorded similar tuberculate *Coroniceras* in beds 57 and 58 of Tate and Blake (1876).
2: *C. hyatti* common, with some *C.* cf. *rotiforme* in phosphatized nodules assigned to Bed 75 of Tate and Blake (1876) (T.A. Getty pers. comm.).
1: *Metophioceras* spp. in the lowest reef of Jenny Leighs Scar. The genus appears to range up to Bed 31 of Gad (1966) (= Bed 90 of Tate and Blake, 1876; D.T. Donovan, pers. comm.).
Total for Jenny Leighs scar to East Scar: c. 38
'**Angulata Beds**' (beds 1–29 of Tate and Blake (1876); or beds 2–31 of Wright 1878–1886): Shales, grey, with some silty bands forming very low reefs and occasional small calcareous nodules; *Gryphaea* present, also occasional levels with ammonites, including:

3: *Metophioceras* cf. grp. *brevidorsale* in topmost part of shales, in base of Jenny Leighs Scar (*Metophioceras* sp. B Biohorizon or *conybearoides* Biohorizon ?) (= Bed 17 of Gad, 1966 and Bed 1 of Tate and Blake's (1876) Angulatus Beds). According to D.T. Donovan (pers. comm.) there is only an approximate 0.3 m gap between the last Hettangian *Schlotheimia* and the first Sinemurian arietitids.

HETTANGIAN STAGE

Angulata Zone, Depressa Subzone

2: *Schlotheimia* cf. *pseudomoreana* common in a narrow band (*?pseudomoreana* Biohorizon). Specimens resembling *Schlotheimia depressa* itself may also be present close to this level (D.T. Donovan, pers. comm.) although records of *Schlotheimia angulata* (when correctly interpreted, a species of the Extranodosa Subzone) are more ambiguous and require confirmation.

Liasicus Zone, Laqueus Subzone

1: *Alsatites liasicus* figured by Wright, 1878■1886. Tate and Blake (1876) recorded '*Ammonites johnstoni*'at Redcar in Leigh Dam Scar, only accessible at low spring tides, but may have mis-identified *Waehneroceras* of the Liasicus Zone (D.T. Donovan, pers. comm., based on a re-examination of specimens in [British] Geological Survey collections).

There have been no detailed facies analyses of the succession and little documentation of the fauna since the work of Tate and Blake (1876). Wright (1878–1886) figured a specimen of *Alsatites liasicus* from here and several ammonite species were figured by Buckman (1909–1930). Spath (1925d) provided notes on the ammonite faunas of the Hettangian Stage, especially the schlotheimiids, although without any real stratigraphical control. His determinations included *Schlotheimia exeoptycha, S.* c.f. *complanata, S. cf. depressa* and 'true' *S. angulata.* Further schlotheindids are present in the Sinemurian sequence, recorded as *Charmasseiceras* both by Tate and Blake (1876) and by Spath (1925d). Tate and Blake (1876) also recorded *Microderoceras birchi* from here, indicating the Birchi Subzone.

Tate and Blake (1876) and Wright (1878–1886) gave an extensive list of fossils from the Hettangian–Sinemurian boundary beds, Including 44 nominal species of bivalve, 26 gastropods and scaphopods, 3 brachiopods, 3 corals, 4 echinoderms, 6 annelids, a nautiloid, a belemnite and occasional vertebrates, including vertebrae and teeth of ichthyosaurs, plesiosaurs and the fish *Hybodus* and *Acrodus.* The bivalve faunas typically occur in shell beds and seams: Tate and Blake (1876) noted that different bands sometimes contained different assemblages of species. Many bands are dominated by *Gryphaea,* often forming low scars, while others contain *Hippopodium ponderosum* with *Cardinia concinna,* and others have *Lucina limbata* or *Cardinia listert* with *Unicardium cardioides.* The *coral Montlivaltia guettardi* occurs with *Gryphaea* in one band in the Sinemurian succession, but is also present a little lower in the succession, within the Angulata Zone, in Tate and Blake's Coral Bed (Bed 14) where it is associated with a varied bivalve assemblage and gastropods. Tate and Blake (1876) also recorded the isastreid *Heterastraea excavata.* The Natural History Museum has several intact crowns of *Isocrinus psilonoti* from here, preserved in a dark-grey, micaceous siltstone (Simms, 1989); Tate and Blake (1876) also recorded echinoids which probably can be referred to *Moltlivoltia lobatum* and *Diademopsis* spp.. Amongst the microfauna, ostracods are recorded from Redcar with 16 species described in Tate and Blake (1876), including *Bairdia redcarensis* and *Cytbere redcarensis,* and 13 species in Lord (1971). Tate and Blake (1876) also cited the occurrence of foraminifera and abundant microgastropods in some samples.

Interpretation

Despite the apparently meticulous investigation by Tate and Blake (1876), their description of the section has proved difficult to correlate with that now seen (Lord, 1971). The sequence of ammonite faunas present indicates a remarkably

complete Hettangian to Lower Sinemurian succession. Key features include what is probably the best Hettangian–Sinemurian boundary section in northern Britain. The material recorded by Spath (1925d), if correctly determined, suggests that a complete Angulata Zone is present, with evidence of the Extranodosa, Complanata and Depressa subzones. The site also incorporates a virtually unique Scipionianum to Sauzeanum subzone sequence which, once fully documented, will have great potential as a stratigraphical reference section since these two subzones rarely yield well-preserved faunas elsewhere in Britain.

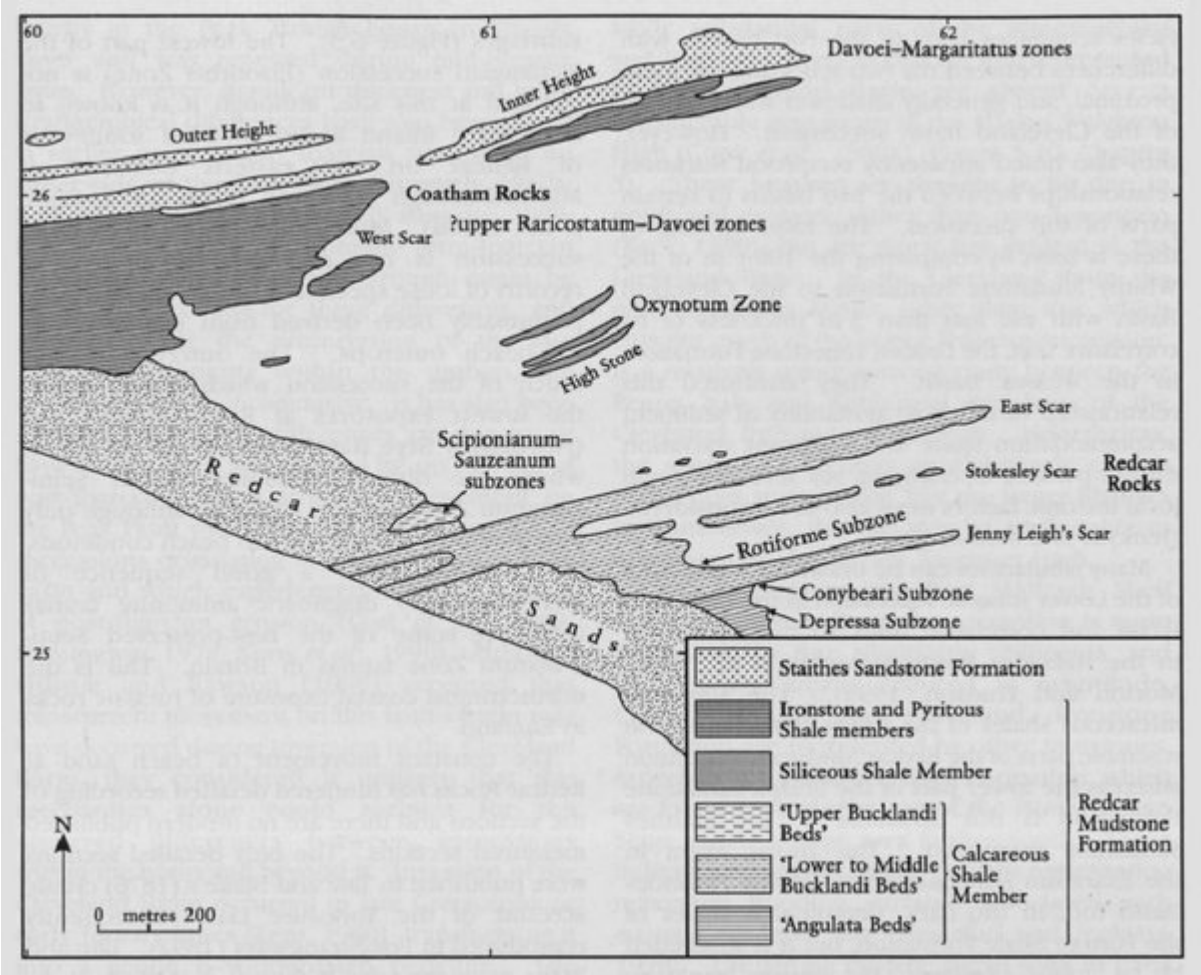
Although higher parts of the succession here are closely similar to those exposed farther south, around Robin Hood's Bay (Normanby Stye Batts–Miller's Nab GCR site), precise lithostratigraphical correlation is impossible due to the poor and discontinuous exposures at Redcar Rocks. The lower (mid-Hettangian to Lower Sinemurian) parts of the succession are not seen at Robin Hood's Bay or are exposed only on very low tides, although facies at the two sites would appear, overall, to be broadly similar and dominated by silty mudstones with few limestones. As such this part of the succession at Redcar Rocks, comprising the Redcar Mudstone Formation, contrasts strikingly with correlative sections in basins to the south, such as the exposures of the Blue Lias Formation in Dorset and around the Bristol Channel, and to the north in the Hebrides Basin where a similar Blue Lias Formation facies is developed at this level. However, the presence of ferruginous ooliths near the base of the Semicostatum Zone invites comparison with the succession at the Conesby Quarry GCR site, to the south of the Market Weighton High on the East Midlands Shelf. There the Semicostatum Zone coincides with the onset of large-scale oolitic ironstone deposition, in the form of the Frodingham Ironstone Member. The poor development of facies typical of the Blue Lias Formation and the Frodingham Ironstone Member at Redcar Rocks and Robin Hood's Bay, suggests high levels of terrigenous runoff into the Cleveland Basin during Hettangian and Lower Sinemurian times, by comparison with these other basins. This effectively swamped any climatic, tectonic and/or eustatic signal represented by the ironstone and mudstone–limestone facies of the Frodingham Ironstone Member and Blue Lias Formation respectively.

Little detailed interpretation of the benthic fauna is possible in the absence of any precise documentation. Although the bivalve faunas at Redcar Rocks appear typical of day-rich facies in the early part of the Lower Lias, the relative abundance and diversity of some other elements of the fauna, notably the gastropods and serpulids, is unusual and may reflect factors associated with the atypical facies. The distribution of many taxa, notably the bivalves, indicate significant palaeoecological or taphonomic control on fossil assemblages, but contemporary detailed study is lacking at Redcar Rocks. The presence of intact crinoid material here indicates preservation by obrution and is reminiscent of similar occurrences in the Sinemurian succession at Robin Hood's Bay, while the presence of corals, including isastreids, suggests periods of very low sedimentation and depths well within the photic zone. The abundant microgastropods in some of the samples analysed by Lord (1971) was taken as a tenative indication of a brackish-water influence associated with the proximity of a landmass to the west. However, microgastropods are a common, though poorly documented, element of Lower Jurassic faunas at many sites and there is no evidence here, or elsewhere, that the majority of these microgastropod assemblages are anything other than fully marine.

Conclusions

The mid-Hettangian to Lower Sinemurian succession at Redcar Rocks is remarkably complete and has great potential for further research. Its predominantly fine clastic facies contrasts strikingly with correlative successions in southern Britain and in the Hebrides Basin, where Blue Lias Formation facies of alternating limestone and mudstone are typical. Once fully documented, Redcar Rocks has potential as a key Hettangian–Sinemurian sequence and complements the better-known Robin Hood's Bay succession where the basal Sinemurian and Hettangian stages are not exposed. The Semicostatum Zone sequence, in particular, is one of the best developed anywhere within the North-west European Province.

References



(Figure 6.3) Sketch map of Redcar Rocks and Coatham Rocks, showing the location of the named scars and significant ammonite faunas.

(Figure 6.4) Redcar foreshore after storms have washed away the beach sand, exposing mudrocks of the Redcar Mudstone Formation, Calcareous Shale Member. This area exposes part of the 'Upper Bucklandi Beds' of Tate and Blake (1876), of Scipionianum Subzone to Sauzeanum Subzone age. (Photo: K.N. Page.)