Bude Coast

Highlights

Bude Coast is the best available site for the Bude Formation, providing excellent sedimentological and biostratigraphical data. The formation marks the last stages of the infill of the Culm Trough.

Introduction

This is the stretch of coast between Marsland Cliff and Bude Haven, Devon [SS 203 068]–[SS 208 170]. Beds of the Bude Formation are folded here into a series of complex anticlinoria (Figure 3.11). The geology is best described by Freshney *et al.* (1979).

Description

Lithostratigraphy

The Bude Formation here is about 1290 m thick, a summary log of which is shown in (Figure 3.12). The most distinctive facies are impersistent beds of sandstone, up to 20 m thick, showing a variety of sedimentary structures. These include sand volcanoes, indicating the rapid dewatering of the sediment (Burne, 1970), and hummocky cross-stratification, thought to be generated by storm waves in shallow water conditions (Harms *et al.,* 1975; Higgs, 1984). Merriman *in* Freshney *et al.* (1979) provides details of the petrography of these sandstones. mudstones (in ascending order), the Longpeak, Tom's Cove, Saturday's Pit, Sandy Mouth, and Warren Gutter Shales.

The depositional environment of the Bude Formation has been the matter of some dispute. Higgs (1984) has argued that they were probably formed in a non-tidal, lacustrine setting, probably between storm-wave base and fair-weather wave base. This requires the existence of a large, relatively deep lake, in which fresh to brackish conditions prevailed, but interrupted periodically by marine incursions. In contrast, Melvin (1986) suggested that they represent turbidites deposited in a submarine fan setting, although there remain difficulties with this model, such as the restricted distribution of marine fossils to certain distinctive mudstone horizons.

At several points through the sequence, there is evidence of soft sediment deformation, in particular slumped bedding. Freshney *et al.* (1979) interpret this as due to seismic activity.

These sandstones occur against a background of mainly shale and mudstone deposits. Mostly, they are grey and more or less silty, but there are also occasional bands of black, sulphurous mudstones. The latter have proved laterally persistent (King, 1966, 1967; Freshney and Taylor, 1972) and often contain a variety of fossils, including ammonoids preserved in calcareous concretions, and fish bones and coprolites. In view of their stratigraphical usefulness, King named the most important black

Biostratigraphy

Fossils here are mainly restricted to the five black sulphurous mudstones. The lower three mudstones have yielded mainly bivalves, ammonoid spat and fish. The latter are of palaeontological interest, especially those from the Saturday's Pit Shale, which include *Acanthodes wardi* (Egerton), *Cornuboniscus budensis* White and *Elonichthys aitkeni* Traquair (Owen, 1950). However, they are of little biostratigraphical significance. Edmonds *in* Ramsbottom *et al.* (1978) suggested that the Tom's Cove Shale might be a correlative of the Vanderbeckei Marine Band of South Wales, but there is no biostratigraphical evidence to confirm (or refute) this idea.

The lowest level with well preserved ammonoids is the Sandy Mouth Shale. Ramsbottom (1970) described from here the holotype of *Anthracoceratoides cornubiensis* Ramsbpttom, one of the most characteristic ammonoids of the Langsettian

Culm. Ramsbottom argued that this indicated a correlation between the Sandy Mouth Shale and the Meadow Farm Marine Band in South Wales. Edmonds *in* Ramsbottom *et al.* (1978), based on the relative thicknesses in the Bude Formation and the South Wales Coal Measures, instead argued that the Sandy Mouth Shale correlated with the Aegiranum Marine Band, but this now seems unlikely in view of evidence now available from the Warren Gutter Shale (see below).

The Warren Gutter Shale has yielded a diverse assemblage, including the ammonoids *Donetzoceras aegiranum* (Schmidt) and *Gastrioceras depressum* Delepine, together with the bivalves *Dunbarella macgregori* (Currie) and *Caneyella* sp., an orthocone nautiloid and a variety of fish fragments (Freshney *et al.,* 1979). Edmonds *in* Ramsbottom *et al.* (1978) had originally argued that the Warren Gutter Shale could be correlated with the Cambriense Marine Band, but now concedes that the biostratigraphical evidence clearly points to it being a correlative of the Aegiranum Marine Band (N.J. Riley, pers. comm.).

Interpretation

This is by far the best available exposure of the Bude Formation (Figure 3.13). There are other coastal exposures, such as near Hartland Point (e.g. Shipload Bay) and between Clovelly and Greencliff (Edmonds *et al.,* 1979). There are also some inland exposures, such as near Okehampton (Edmonds *et al.,* 1968). However, the coast near Bude is the only place to show the full sequence of Bude Formation, with at least some biostratigraphical control. Since it also provided the name for the formation, it seems reasonable to take it as the stratotype section.

It is also one of the best sections for analysing the sedimentology of the formation. Early work here suggested that the deposits were turbidites (Ashwin, 1958; Reading, 1963; Lovell, 1965), but the discovery of xiphosurid trails (King, 1965) called this into question. Freshney *et* al. (1979) instead suggested that they were deltaic deposits formed in shallow, brackish water. The recognition of 'hummocky bedding' by Higgs (1984) appears to confirm this view.

The Bude Formation represents the last stages in the process of infilling the Culm Trough. Continued subsidence of the trough allowed a considerable thickness of sediment to be deposited, with only minor phases of emergence occurring (e.g. the smutty coals or 'culm' beds found in the Bude Formation near Bideford).

The turbidites that generated part of the underlying Crackington Formation may have been caused by tectonic activity disturbing unconsolidated sediments on submarine slopes (Edmonds *et al.,* 1975). A continuation of this activity appears to be reflected by the existence of beds in the Bude Formation showing soft-sediment deformation. These movements were presumably linked with early Variscan earth-movements.

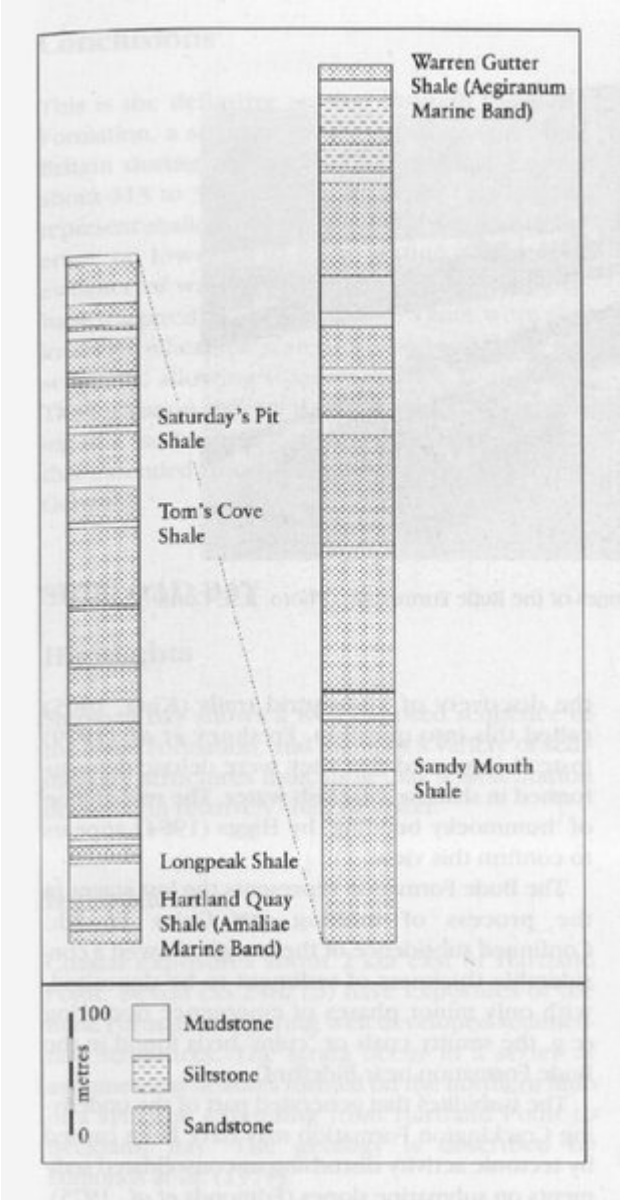
The distance between the Listed and Aegiranum marine bands in the Bude sequence is 1261 m when the biostratigraphical position of the Hartland Quay and Warren Gutter shales is considered. This is about three times as thick as the equivalent interval in the central part of the South Wales Coalfield; in Britain, only the Lancashire and North Staffordshire coalfields, in the middle of the Pennine Basin, develop comparable thicknesses of strata.

Conclusions

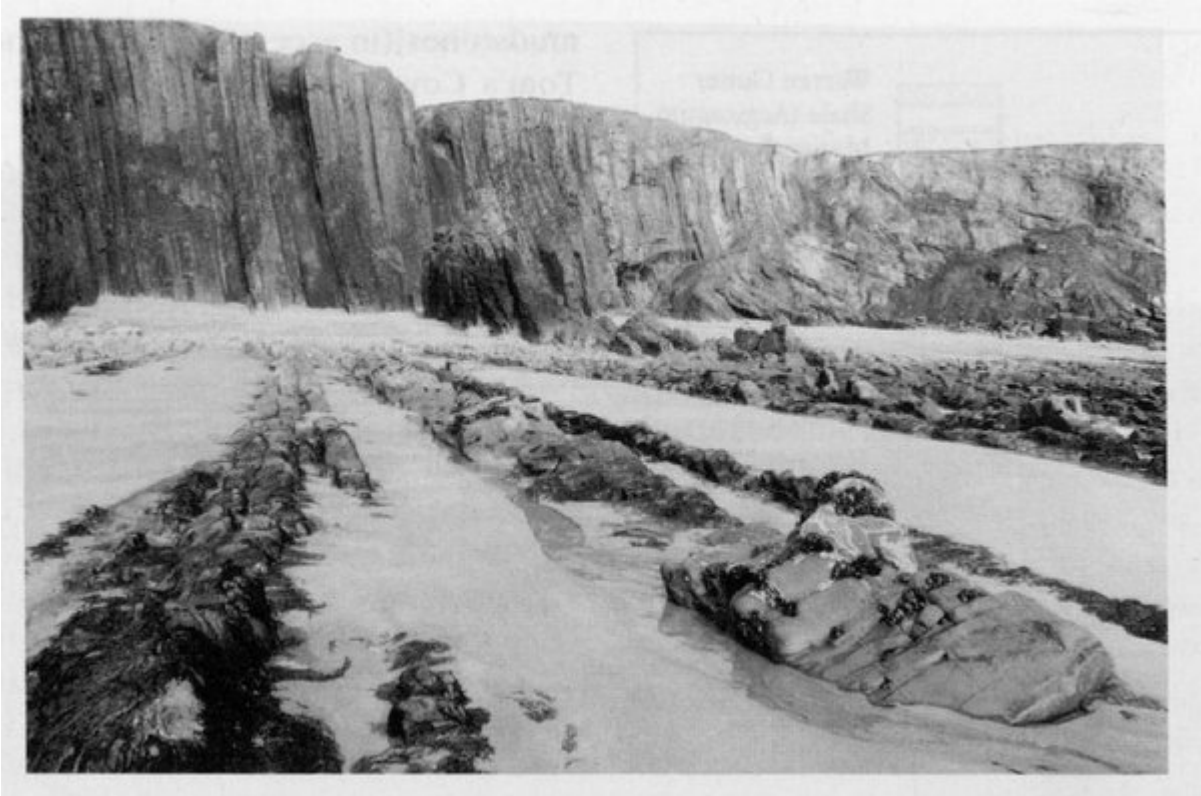
This is the definitive section through the Bude Formation, a series of rocks formed in southwest Britain during the middle Westphalian Epoch, about 313 to 308 million years ago. They mainly represent shallow-water deposits formed in an estuarine or lower delta-plain setting, and show evidence of wave action, and some slumping perhaps triggered by seismic action. There were also intervals when the water-level fell exposing the sediment, allowing some vegetation to develop. The formation reflects the last phases of the infilling of a marine basin known as the Culm Trough, that extended from southwest Britain to northern Germany.

References

(Figure 3.11) Maer Cliff, near Bude, Bude Coast GCR site. Reproduced by permission of the Director, British Geological Survey: NERC copyright reserved (A5901).



(Figure 3.12) Stratigraphical log of the Bude Formation at Bude Coast GCR site, based on Freshney et al. (1979, fig. 3).



(Figure 3.13) Bude Coast GCR site. Typical thick sandstones of the Bude Formation. (Photo: R.A. Cottle.)