Culverhole Point, near Axmouth, Devon

[SY 275 893]

Introduction

Upper Triassic strata including the Blue Anchor Formation, and the Westbury and Lilstock formations of the Penarth Group, are exposed in a 5-km-long coastal strip between Axmouth and Culverhole Point. The Penarth Group bone bed here is highly fossiliferous, and has yielded several archosaur fossils.

The area around Culverhole Point has been studied by geologists for many years. One of the first descriptions was published by Wright (1860) who studied the '*Avicula contorta* Zone' of the Westbury Formation. Subsequent studies include Woodward and Ussher (1899, 1906), Jukes-Brown (1902), Richardson (1906), Ager and Smith (1965), Stevenson and Warrington (1971), Warrington and Scrivener (1980), House (1989), and Warrington (1997a).

Description

The Triassic succession at Culverhole Point is overlain unconformably by Cretaceous sediments, including the Gault and Chalk (Sellwood *et al.,* 1970; House, 1989). Culverhole Point is a protected locality and forms a part of the Axmouth to Lyme Regis Undercliffs National Nature Reserve, and is also included in the Dorset–East Devon Coast World Heritage site, established December, 2001.

Sedimentology

The Penarth Group outcrops in several parts of the cliffs and foreshore at Culverhole Point. The western end of the section comprises the Westbury Formation and the underlying argillaceous sediments of the Blue Anchor Formation. The eastern part of the section includes the Blue Anchor Formation, Westbury Formation, Cotham Marble, and White Lias' (Richardson, 1906). The Penarth Group dips approximately 5° to the east. The following description is modified from Richardson (1906, table facing p. 406), Stevenson and Warrington (1971), and Sykes (1977):

	Thickness (m)
Penarth Group	
Lilstock Formation; Langport Member:	
Limestone, hard, grey, with an irregular upper surface	0.25
Shales, greenish-grey, thinly laminated, calcareous, darker at the base	0.13
Limestone	0.05
Rubbly, white limestone and greenish-grey, thinly laminated, calcareous shales	0.15
Limestone, hard, white, irregular top, pyritic, shelly and bored	0.28
Lilstock Formation; Cotham Member:	
Clay, dark brownish-black	0.09
'False Cotham Marble': pale greenish-grey, slightly pyritic	0.04–0.06
Shales, greenish-grey, thickly laminated, calcareous, with several hard, gritty layers	0.30
Limestone, cream coloured, earthy, shaly	0.25
Marls, pale greenish-yellow, indurated and laminated at the top; softer and darker in the middle; indurated and yellowish at the base; impersistent, pale grey, impure limestone and thin sandstone layers also occur	0.66

Dark, calcareous shales	0.13
Limestone, yellowish-grey, earthy, impersistent	0.11–0.20
Shales, indurated, dark, earthy	0.13
Westbury Formation:	
Shales, black, much selenite, upper portion dark green	0.61
Shales, brown, earthy; selenite present	0.10
Limestone, dark-grey, earthy, with a 0.01 m layer of 'beef' at the top	0.30
Shales, black, poorly laminated at the base, laminations well-defined towards the top; selenite-rich; thin sandstone layer 0.20 m from top	~1.14
'Beef'	0.03
Shales, black, laminated, earthy	0.05
Limestone, pale grey with a slight greenish tinge, nodular	0.10–0.25
Shales, black, earthy, selenite-rich	0.33
Limestone, very hard, dark grey; thin, shaly, pyritic layers near the top	0.20
Shales, black, laminated seen	0.18
Culverhole Bone Bed: black shale, indurated and gritty, infills cracks in underlying marl	0.05
[non-sequence]	
Mercia Mudstone Group	
Blue Anchor Formation:	
Greenish-grey marls, harder at the top	~2.44
Greyish-green and blackish earthy marlstones, mixed with black shale seen	1.52
Pale greyish-green marls, white in places	~2.44
Black marl, bounded top and bottom by whitish marlstones	0.61
Greyish-green marls and grey marlstones	4.11
Hard, greenish-grey marl, pink at the top and bottom	0.79
Marl, soft, greenish-grey	0.30
Grey, marlstone	0.30
Greenish marl, pinkish at bottom	0.30
Marlstone, in three beds	0.48
Series of greenish-grey, pinkish and black marls in regular units -	~3.35
Marlstones, greyish-green, massive	0.61
Greyish-green, black and pink marls and marlstones	1.42
Marlstone, hard, greyish-white, with black shale on the underside	0.25
Greenish-grey marls and marlstones	0.62
Irregular zones of red, green, and dull-red marls	0.91
Red mudstones:	
Red marls, with several well-marked greenish units	

Low in the section, reddish-coloured mudstones are overlain by the greenish-grey muds and marls of the Blue Anchor Formation, both units of the Mercia Mudstone Group. Although there is little lithological difference between these two facies, they are mapped separately because of the clear colour difference. The Blue Anchor Formation is exposed at Culverhole on broad reefs on the foreshore and in Haven Cliff to the west. Many of these beds are finely laminated, in places contain nodules of gypsum, and may show evidence of desiccation cracking (Sellwood *et al.,* 1970). Small-scale structural features in the Blue Anchor Formation sediments include microfaults in finely laminated beds, suggesting movement after the rock was consolidated, and flame structures characteristic of soft-sediment deformation. Harder beds

are occasionally folded into gentle folds with an amplitude of up to 0.30 m (Sellwood *et al.,* 1970).

The junction between the Mercia Mudstone Group and the overlying Penarth Group is marked by a clearly defined non-sequence (Richardson, 1906), probably associated with the Late Triassic transgression, and the change from dominantly terrestrial to marine conditions of deposition. The basal bed of the Westbury Formation is the bone bed, referred to by Woodward and Ussher (1911, p. 136) as the 'Axmouth Bone Bed', and termed here the 'Culverhole Bone Bed'. It is characterized by gritty sediment, including clasts of the Blue Anchor Formation, that may infill cracks and burrows in the surface of the underlying Blue Anchor Formation (Richardson, 1906; Sellwood *et al.,* 1970; (Figure 4.25)). At Culverhole Point the bone bed crops out at beach level, but is often obscured by modern beach sediments (House, 1989). The remainder of the Westbury Formation comprises laminated shales and thin limestones.

The Lilstock Formation is dominated by limestones, although the Cotham Member also includes a substantial quantity of dark and greenish shales (Richardson, 1906). Three of the Lilstock Formation beds are of special significance. The first is the Cotham Marble, represented here by the 'Crazy Cotham' variety, composed of a limestone breccia in a limestone matrix. This bed is seen at many localities over a wide area of south-western Britain, from Culverhole Point on the south coast northwards to Taunton and the Bristol district (Hamilton, 1961). The second unit, the '*Euestheria*-Bed', is also characterized by a wide geographical distribution. Richardson (1906) described several instances where these two beds have been confused, leading to the incorrect identification of the Cotham Marble. Finally, Mayall (1983) recorded the presence of the 'deformed bed', a part of the Cotham Member, which is also seen over much of south-west England, and is interpreted as possible evidence for contemporary seismic activity.

Only part of the Langport Member is seen at Culverhole Point; it is better exposed at nearby Pinhay Bay (see site report below). At Culverhole Point the Rhaetian is truncated below a major unconformity that separates the Triassic succession from the Cretaceous Chalk.

Palaeontology

Richardson (1906) described the Mercia Mudstone Group as being largely unfossiliferous, but the Blue Anchor Formation has yielded palynomorphs in this area (Stevenson and Warrington, 1971; Orbell, 1973; Warrington, 1997a).

The Culverhole Bone Bed has, since the last century, been a valuable source of vertebrate remains; a second bone-bearing bed is separated from the basal bone bed by a horizon of laminated black shales. Taxa recorded from this locality (p. 340 in Dineley and Metcalfe, 1999) include the fishes *Gyrolepis, Lepidotes,* and *Saurichthys,* as well as the sharks *Acrodus* and *Hybodus.* Most of these taxa are preserved as scales and teeth, although coprolites also occur. Rarer remains include those attributable to terrestrial vertebrates (Richardson, 1906), probably archosaurian reptiles (Benton and Spencer, 1995). Richardson (1906) recorded a reptilian coprolite from a layer of shale, and fish scales from a limestone bed some 5 m above this level, within the Cotham Member. Many of the vertebrate genera recorded at Culverhole Point are known from other Penarth Group localities.

Invertebrate body fossils are common throughout most of the Penarth Group sediments at Culverhole Point. These include bivalves such as *Pecten* and *Ostrea,* and the ostracod *Darwinula.* Trace fossils include burrows in the upper surface of the Blue Anchor Formation assigned to the ichnogenera *Diplocraterion* and *Thalassinoides* (Sellwood *et al.,* 1970), and others that have been tentatively identified as borings (Richardson, 1906).

Interpretation

The undifferentiated reddish-coloured argillaceous lithologies of the lower part of the exposed Mercia Mudstone Group have been interpreted as forming under the dominantly terrestrial conditions associated with supratidal sabkha flats or playa lakes, with localized developments of soils, infrequent floods and aeolian sedimentation. The colour change, from red to the greenish and grey sediments of the Blue Anchor Formation, indicates a change from oxidizing to reducing conditions. Cracks and burrows in the top of the Blue Anchor Formation indicate that the sediments were subaerially exposed. At Culverhole Point a well-defined non-sequence marks the boundary between the Mercia Mudstone Group and the overlying Penarth Group.

The Westbury Formation at Culverhole Point consists of alternating beds of shale and thin limestone deposited in shallow, possibly marginal marine, waters. The bone beds have been interpreted as transgressive lags of reworked older sediments and bones.

The Cotham Member was deposited in a lagoonal environment, as indicated by the sedimentary structures, and by dinoflagellate cysts from the Lyme Regis borehole (Warrington, 1997a). Of particular interest is the 'Crazy Cotham' Marble that was formed by the interaction of algae and sediment (Hamilton, 1961; Wright and Mayan, 1981) and is best described as a stromatolite horizon (Wright and Mayall, 1981). The various lamination patterns within the bed reflect the dynamic nature of the algal communities, brought about by environmental changes such as sediment input and salinity fluctuations (Wright and Mayall, 1981).

The Langport Member was deposited in warm shelf lagoons, which may have undergone phases of emergence (Hallam, 1960; Whittaker and Green, 1983).

Conclusions

The cliffs at and around Culverhole Point preserve a sequence through the uppermost beds of the red mudstones and the Blue Anchor Formation of the Mercia Mudstone Group, overlain by the Penarth Group, and capped unconformably by the Chalk. These lithologies reflect the change in palaeoenvironments that occurred over south-western Britain during the Late Triassic Epoch, from terrestrial playa-lake environments to marine conditions following the Late Triassic transgression. The famous Penarth Group bone beds at Culverhole Point have for many years been a valuable source of vertebrate remains. This is an important site for the study of Late Triassic palaeoenvironments and fossils.

References

(Figure 4.25) The basal Westbury Formation bone bed (the Culverhole Bone Bed) infilling cracks and burrows in the eroded surface of the Blue Anchor Formation at Culverhole Point. (Photo: R. J. G. Savage.)