Sully Island, South Glamorgan

[ST 167 670]

Introduction

The sea-cliff exposures of Sully Island provide excellent sections in the marginal facies of the Triassic Mercia Mudstone Group. These rocks include a series of breccias and sands, interpreted as deposited at the margin of a large hypersaline water body, overlain by nodular evaporites and carbonates. They rest unconformably upon a terraced surface of Carboniferous Limestone. This site, therefore, demonstrates the regionally significant unconformity between Carboniferous and Triassic rocks, as well as a range of sediments that illustrate graphically the brackish-water and evaporitic conditions of the Late Triassic playas of the South Wales region.

Many accounts of the geology of Sully Island have been published, including Strahan and Cantrill (1904), Anderson (1960), Cope (1971), Ivimey-Cook (1974), Tucker (1977, 1978), Waters and Lawrence (1987), and Leslie *et al.* (1992, 1993).

Description

Sully Island is located to the south of the village of Swanbridge. At high tide the island is cut off from the mainland, although at low tide it is possible to walk across the rocks exposed in Sully Sound. The island is roughly oval in outline, and measures about 0.5 km from west to east, and 0.2 km from north to south. The north shore of the island faces the mainland and for the most part has low relief, especially where it faces Swanbridge Bay. The rest of the island is bounded by substantial cliffs, and at low tide a rocky foreshore is exposed. The Triassic sections are best seen at the south-east corner of the island (Figure 3.67).

The Upper Triassic sediments at Sully Island consist of a wedge of breccias that pass upwards into sandstones and siltstones, which are in turn overlain by dolomites and limestones (Figure 3.68). Sedimentary structures including ripples are preserved within the clastic sediments, which show graded bedding. As is often the case with sediments deposited under terrestrial conditions, there is a high degree of lateral variation. These sediments have been grouped together as the 'Marginal Triassic', also known as the 'Littoral Triassic' or 'Dolomitic Conglomerate' (Strahan and Cantrill, 1904; Ivimey-Cook, 1974), and are laterally equivalent to the red mudstones that are more characteristic of the Mercia Mudstone Group.

Tucker (1978, p. 207) identified three lithofacies at Sully Island: (1) lacustrine shore-zone clastics, (2) lacustrine evaporites, and (3) lacus-trine carbonates, all showing rapid lateral variation and overlain by red mudstone. The following simplified sedimentary section is adapted from information in Tucker (1977, 1978) and Leslie *et al.* (1992, 1993):

	Thickness (m)
Mercia Mudstone Group; Marginal Triassic	
Limestones and dolomites	6–9
Nodular dolomite	0.3
Sandstones and siltstones	max. 5
Breccia and coarse sandstone	3–5
Carboniferous Limestone	

The Carboniferous Limestone dips about 50° to the east. The contact with the overlying Upper Triassic lithologies is a sharp, clearly defined, angular unconformity at an angle of between 5° and 10° to the bedding in the Triassic sediments that dip gently to the north. Many of the Triassic arenaceous beds show clear evidence of later deformation including contorted bedding, recumbent folds, and symmetrical anticlinal folds (Tucker, 1978, p. 210).

The basal Upper Triassic beds consist of a wedge of well-sorted breccias that grade into a thick sequence of sandstones and siltstones (Figure 3.68); Tucker, 1977, 1978). Grain size varies across the wedge; the thickest section contains fine-grained arenaceous sediments and these pass eastwards into coarse-grained well-sorted conglomerates and breccias that are interbedded with pebbly sandstones. In places, the coarse-grained lithologies have been dolomitized, and may include low breccia ridges. The breccia beds are characterized by grain-supported fabrics, and may occur as lenses with low-angle planar cross-stratification and imbricated pebbles, the bed boundaries are at least locally gradational.

The finer-grained parts of the sedimentary wedge comprise red pebbly sandstones, sandstones and siltstones, and are classified as calcilithites (Tucker, 1977, 1978). These sediments display wave ripples (straight-crested with rounded and sharp profiles), lenses with cross-laminations, continuous beds with well-developed cross-laminations, impersistent graded bedding, and dewatering structures such as folds and disturbed bedding. In places, for example by the side of the natural causeway to the mainland, spectacular tepee structures are seen.

The thickest part of the clastic wedge is overlain by a series of nodular dolomites that contain scattered quartz nodules (Tucker, 1977, 1978; Leslie *et al.,* 1992, 1993). Dolomite also occurs associated with limestones, and consists of calcarenites and cryptalgal limestones with interbedded calcretes. The calcarenites typically comprise laminated and rippled fenestral intrapelsparites, which may show evidence for desiccation. The cryptalgal limestones consist of stromatolite mounds and algal mats (Figure 3.69). The main limestone unit contains many cavities, which may be aligned parallel to bedding. Laterally the dolomitized limestones are replaced by a haematite-rich dolomite that rests directly on the Carboniferous Limestone.

Large (5–6 in diameter and up to 1 m thick) patches and mounds of travertine occur interbedded with the laminated and stromatolitic limestones. The travertine takes many forms, including sheets of flowstone that preserve the shape of the underlying topography, small columnar structures composed of fibrous calcite, pisoids, and floe calcite (aragonite; Leslie *et al.,* 1992, 1993).

The red mudstones and siltstones of the Mercia Mudstone Group are seen on the causeway between Sully Island and the mainland and in the cliffs towards the western edge of the island (Anderson, 1960). Recently, a series of vertebrate tracks from the foreshore of the mainland close to Sully Island have been assigned to the ichnotaxa *Grallator, Tetrasauropus,* and *Pseudotetrasauropus* (Lockley *et al.,* 1996).

Interpretation

The thick sequences of elastic sediments at Sully Island have been interpreted as forming on the shore of a hypersaline water body that was probably a permanent feature in the Late Triassic landscape. Rapid lateral changes in lithology, reflect deposition on a narrow beach in an environment with some wave action (Tucker 1977, 1978).

The coarse-grained breccias, seen at the thin end of the clastic wedge, are typical of lacustrine beach gravels: the clasts are generally angular, reflecting the limited amount of wave-induced abrasion. The breccia ridges and associated cross-bedding are thought to have developed on the planar erosion surface as berms on the shores during periods of intense wave activity (Tucker, 1978).

The sandstones and silts, lateral equivalents to the breccias, were formed in the shallow waters at the edge of the water body. Water depth probably never exceeded more than a few metres, but was probably subject to marked fluctuations. During periods of low water level, the sediments were affected by wave activity in the form of breakers and swash and backwash action, as shown by wave-current ripples, cross-laminations, and wave-formed oscillation ripples (Tucker, 1978).

The fine-grained sandstones and siltstones were probably deposited in deeper water, well below average wave-base (Tucker, 1977, 1978). This sediment would have been carried into the water body by rivers, with the fines slowly falling out of suspension. Coarser sediments originated in the areas of shallower water, and were transported into the deeper water by storms. The soft-sediment deformation and dewatering structures were caused by mass movement of the unconsolidated sediments, probably triggered by local tectonic activity. Tepee structures in this unit are rare, but graphic, indicators of dewatering and intense evaporation.

The thin limestones are interpreted as deposits of a shore-zone mud flat. The haematite-rich replacement of the limestone is characteristic of a palaeosol, possibly a ferricrete. The nodular dolomites are typical of evaporitic environments such as sabkha plains, where concentrations of evaporitic minerals often accumulate. The nodules were formed as replacements after anhydrite (Tucker, 1977, 1978), and represent several phases of precipitation of sulphate evaporites associated with regression–transgression cycles. The overlying thin limestones and dolomites contain a variety of sedimentary features characteristic of deposition in shallow lakes and mudflats, for example fenestral intrapelsparites, stromatolites, ripples, and laminated sediments. Cavities in the limestones were created by solution by meteoric (vadose) waters; the resultant cavities were later infilled with calcite and sediment (Leslie *et al.,* 1992, 1993). From this evidence, the local environment of deposition has been interpreted as a series of low-lying mudflats that were periodically flooded.

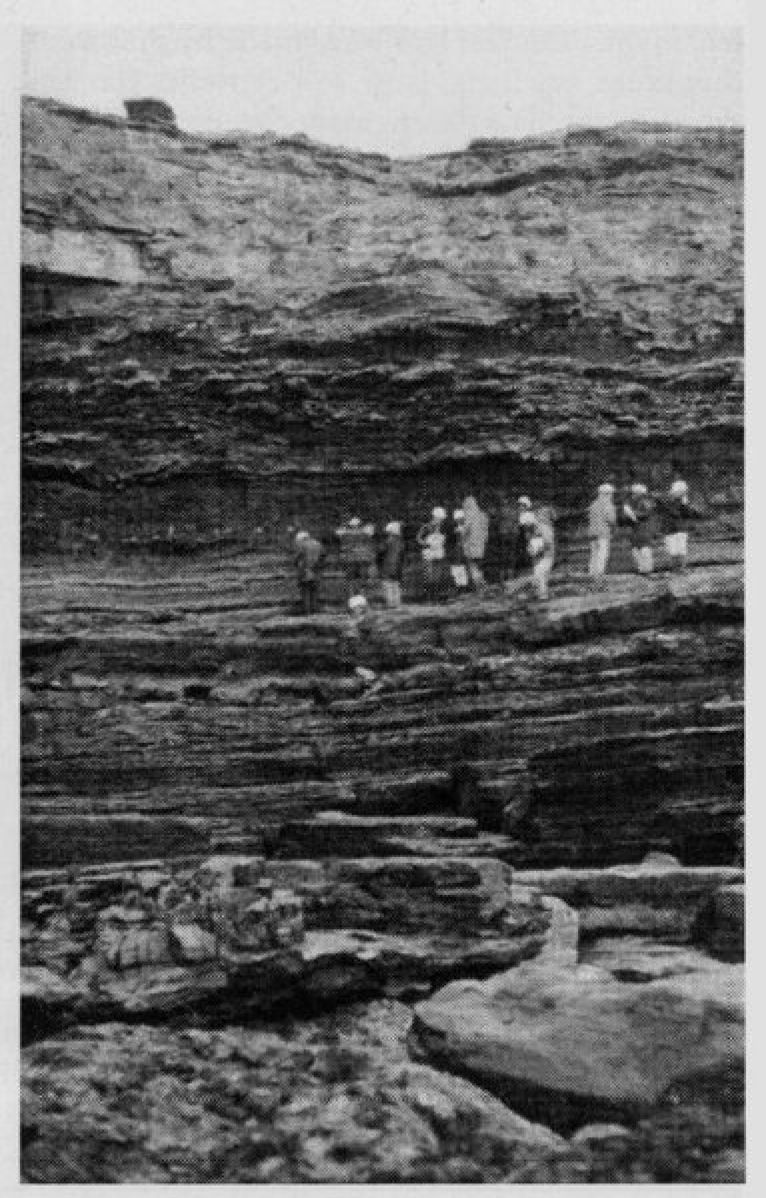
The travertines associated with these sediments indicate ephemeral (interbedded sheets) and semi-permanent springs (mounds), although their formation is not thought to have been linked with the deposition of the limestones. The springs were formed by ground-waters upwelling from the Carboniferous Limestone basement (Leslie *et al.,* 1992, 1993).

The red dolomitic mudstones and siltstones were deposited under arid and hypersaline conditions in areas around the margins of the water body (Leslie *et al.,* 1992, 1993), that were subject to periodic flooding.

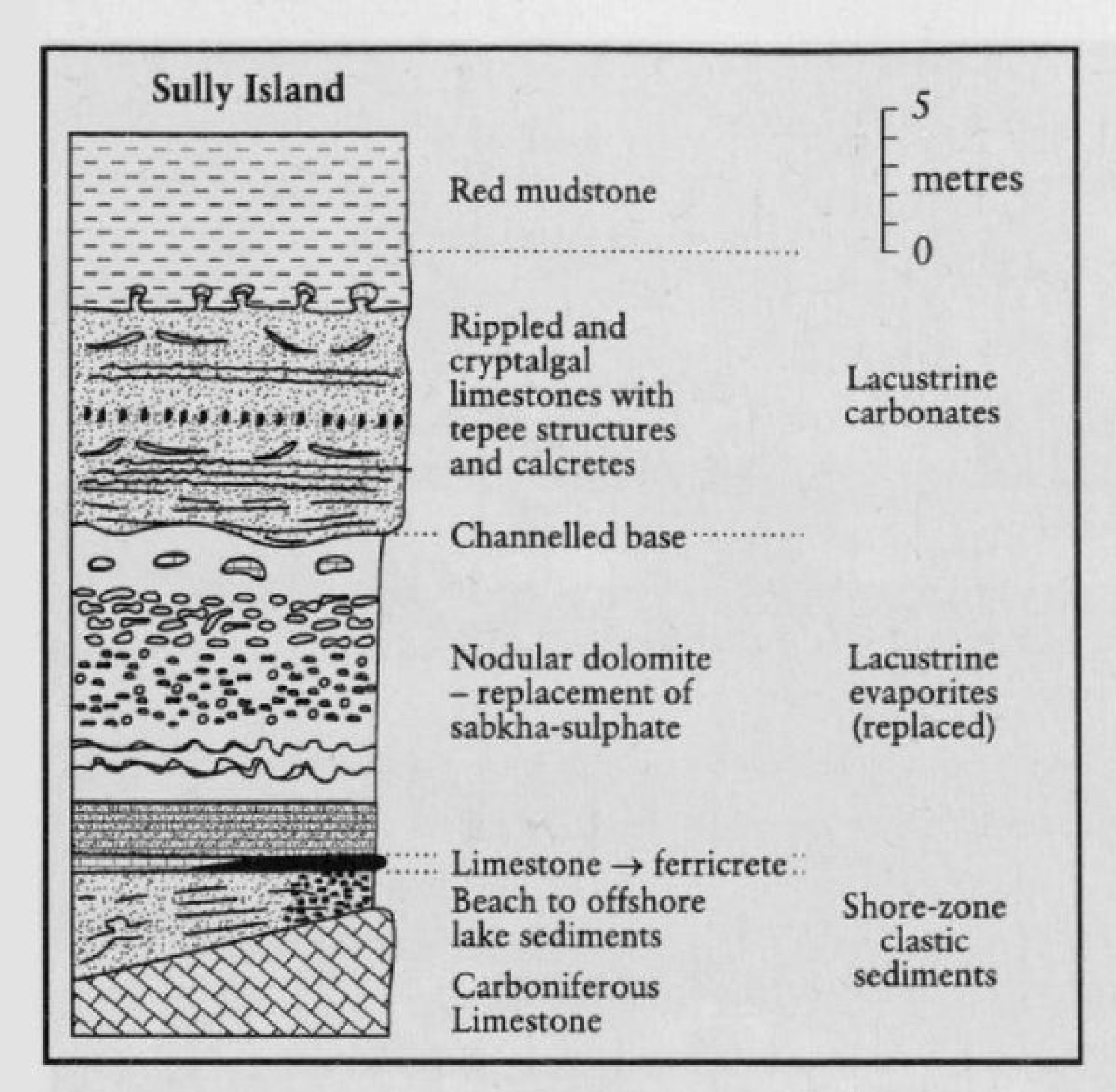
Conclusions

Sully Island preserves an excellent section of Upper Triassic marginal and intertidal rocks. It is especially important for the evidence of hypersaline conditions (algal beds, evaporites) and desiccation (mud cracks, tepee structures). These facies are unusual in the sedimentary rock record, and are shown exceptionally well here. The site is critically important for understanding the nature of the arid playa margins in Late Triassic South Wales, a setting unique in the British Triassic succession.

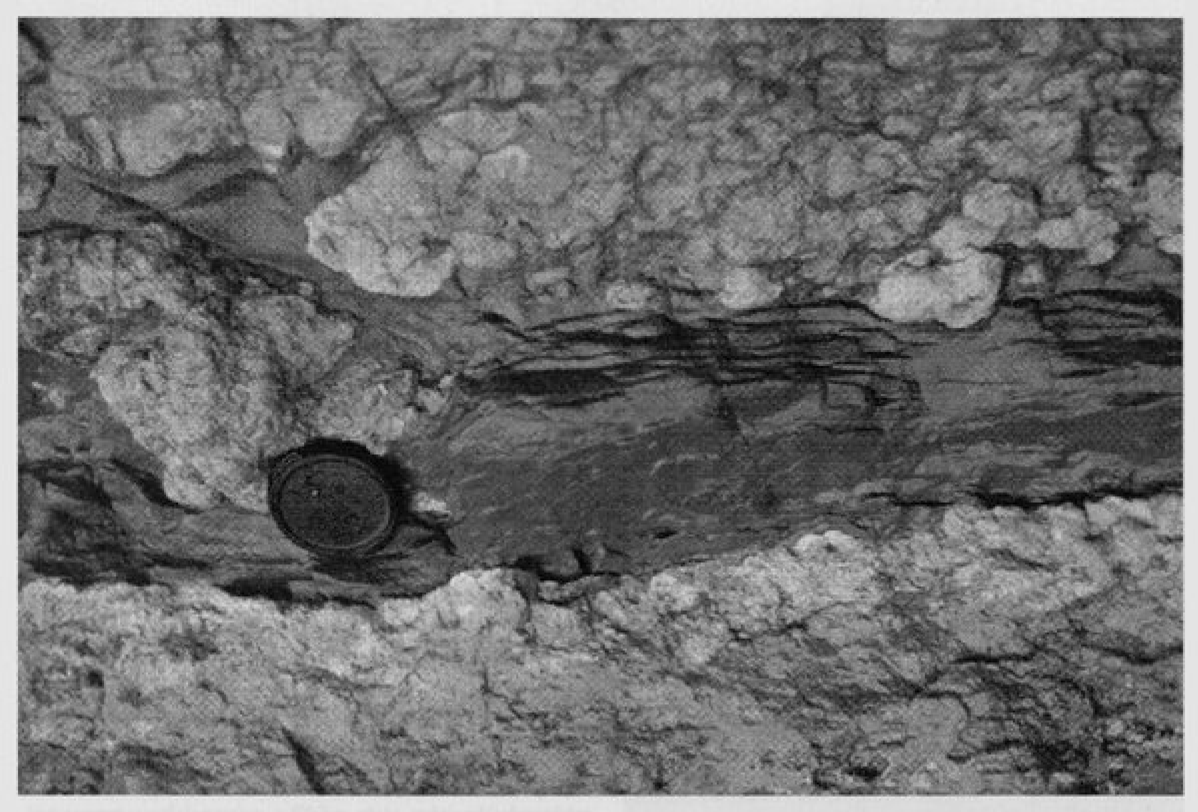
References



(Figure 3.67) The marginal Triassic sediments at Sully Island, showing the Carboniferous Limestone overlain unconformably by shore-zone clastic deposits, then replaced evaporites, and finally carbonates (see Figure 3.68). (Photo: M. J. Benton.)



(Figure 3.68) Section at Sully Island, showing the main marginal playa facies (see Figure 3.67). (After Tucker, 1978.)



(Figure 3.69) Thinly laminated cryptalgal limestones with nodular dolomites in the Sully Island succession. (Photo: M. J. Benton.)