Hayes Point to Bendrick Rock, South Glamorgan

[ST 129 668]–[ST 144 677]

Introduction

This section provides excellent exposure of the marginal facies assigned to the Mercia Mudstone Group. Fine-grained sediments deposited on the margins of a large hypersaline water body are interbedded with coarse-grained fluviatile sediments. The finer-grained sediments include siltstones with nodular evaporites, wave-rippled siltstones and fine sandstones, and thin, graded sandstones of sheetflood origin. The coarse fluvial sediments include a limestone conglomerate up to 2 m thick, together with occasional thin, matrix-supported conglomerates, interpreted as the products of debris flows. Sediment transport was towards the east and south-west. This is a key locality for the interpretation of the environments of Triassic marginal depositional areas.

The Triassic succession between Bendrick Rock and Hayes Point has been described in detail by Tucker (1974, 1977), Tucker and Burchette (1977), and Lockley *et al.* (1996), and reviewed by Ivimey-Cook (1974) and Waters and Lawrence (1987).

Description

Sedimentology

The coastal section between Bendrick Rock and Hayes Point preserves sediments of the marginal facies, or 'Dolomitic Conglomerate', of the Upper Triassic Series. The sequence is dominated by arenaceous sediments, with some argillaceous lithologies. Of these it is the thin graded sandstones and silty mudstones that are especially well exposed at this locality.

The lower part of the section (Figure 3.64) consists of a sequence of dolomite beds, the nodular limestones described by Tucker and Burchette (1977). These comprise nodules of calcite and dolomite with a vertical fabric or polygonal ribs enclosed in fine-grained marl and rest unconformably on the Carboniferous Limestone, which is seen especially well at Hayes Point.

The overlying sediments (Figure 3.64) consist of a series of sandstones and conglomerates, separated by marls (Tucker, 1977). The bases of the sandstones and conglomerates generally rest on erosion surfaces that show evidence of scouring. The conglomerates occur as discrete beds that show well-developed cross-bedding, and bedding planes may preserve lunate megaripples or dunes. The conglomerates are composed of well-rounded and well-sorted pebbles in a sandy matrix (locally the matrix may be absent), and bed thickness varies, with a maximum of 2 m. The lowest sandstone is approximately 0.5 m thick, with evidence of trough cross-bedding in the lower parts of the bed. A thicker unit of cross-bedded sandstone follows, above an argillaceous bed, and is succeeded by more marl, then a substantial conglomeratic horizon.

Immediately overlying this conglomerate is a series of thin sandstones (Figure 3.64), which often show evidence of graded bedding; at the bases of the individual beds are scour surfaces overlain by gravel lags, which fine upwards through coarse- to fine-grained sandstone. The beds include trough cross-laminations. In places the upper surfaces of the beds bear current ripples (Tucker, 1977; Tucker and Burchette, 1977). The sandstones consist mainly of sand-sized fragments of Carboniferous Limestone.

The siltstones and marls that separate the arenaceous and rudaceous units are generally thin-bedded. Ripples with bifurcating crests are common, and may be associated with desiccation cracks and rain drop imprints (Tucker and Burchette, 1977). Flakes of siltstone and marl (produced during desiccation) are found in the overlying units.

In a study of the limestone pebbles in the conglomerates at Hayes Point [ST 143 673], Tucker (1974) described evidence for exfoliation, or onion-skin weathering. Many of the limestone clasts on the surface of the conglomerate unit show either concentric spheres of rock separated by very narrow cracks, or have been shattered into sharp angular fragments. Often, the cracks between the pieces of rock have been infilled with red silt and sandstone, while the cracks that extend below the palaeoland surface are generally infilled with calcite. Similar features have been recorded at Bendrick Rock [ST 131 668]. Here, the upper 0.3 m of the Carboniferous Limestone has been split into thin sheets of rock that run parallel to the former land surface.

Palaeontology

The Hayes Rock to Bendrick Point succession is especially famous for its dinosaur footprints (Tucker and Burchette, 1977; Lockley *et al.,* 1996), and it is has been selected for the GCR, independently of its stratigraphy, for its fossil reptiles, for its tracks (Benton and Spencer, 1995). The footprints occur over wide areas in the finer-grained sandstones, and many individual trackways may be identified on single bedding planes (Figure 3.65) and (Figure 3.66). The footprints have two morphologies, one tridactyl and rather slender, and the second larger, tridactyl and with heavier digits. Both forms were initially assigned to the ichnotaxon *Anchisauripus* (Tucker and Burchette, 1977; Benton and Spencer, 1995), but, in a more detailed study, Lockley *et al.* (1996) concluded that the tracks should be assigned to five ichnogenera: *Grallator, Anchisauripus, Chirotherium* or *Tetrasauropus, Pseudotetrasauropus,* and *Otozoum.* The first two were made by theropod dinosaurs, small and large respectively. The last three might have been made by prosauropod dinosaurs of differing sizes, or they may be attributable to a variety of unknown basal archosaurs.

Interpretation

The sedimentary rocks between Bendrick Rock and Hayes Point have been interpreted as deposits of a marginal environment (Ricker, 1977). The region was low-lying and was dominated by a hypersaline water body fed by many ephemeral streams and rivers. The Triassic sediments were initially deposited against knolls of Carboniferous Limestone, which, as sedimentation continued, were gradually buried.

The basal dolomites in red marls and siltstones have been interpreted as replaced evaporite minerals, probably gypsum and/or calcite (Tucker, 1974; Tucker and Burchette, 1977). The dolomitization is probably a post-Triassic diagenetic feature. Such lithologies represent a period of emergence, when the water levels were relatively low, and must have required high levels of evaporation, little precipitation, and low rates of sedimentation. The associated marls and silts indicate deposition on a floodplain or in a playa basin (Waters and Lawrence, 1987; Talbot *et al.,* 1994), and may have been deposited either in shallow muddy ponds formed after floods, or on the floodplains bordering the ephemeral rivers, or they may have an aeolian origin.

Despite this picture of an arid climate, there is evidence for periodic, probably heavy, rainfall. The thin, laterally extensive graded sandstones are typical of sediments deposited during flash floods or sheet flows (Tucker and Burchette, 1977). The presence of symmetrical ripples in some of the sandstones suggests that the water formed pools, because the ripples reflect small waves.

The coarse conglomeratic units have been interpreted as stream-flood deposits (Tucker, 1977; Tucker and Burchette, 1977). A number of river forms may have been present: lenticular pebble beds are characteristic of braided channels subject to downstream migration of bars (as indicated by the cross-bedding), while other sedimentary structures suggest ephemeral streams and stream-flood events.

Combining the sedimentary information and the above interpretation, it is possible to produce a picture of the changing environmental conditions that affected South Wales during the Late Triassic Epoch. The fine-grained lithologies were deposited in a large hypersaline water body in open connection with the sea, similar to a modern sabkha or playa basin. These are interbedded with coarser-grained facies deposited during periodic flooding events that occurred when the water level was low. During periods of low water level, stream floods cut channels into the playa plain, and deposited the conglomeratic units. During times of low rainfall, and therefore low water level and reduced sheet and stream flooding, soils could form on the playa sediments (Tucker, 1977). Palaeocurrent directions measured from sedimentary structures indicate that material was transported to the area from the west and north-west.

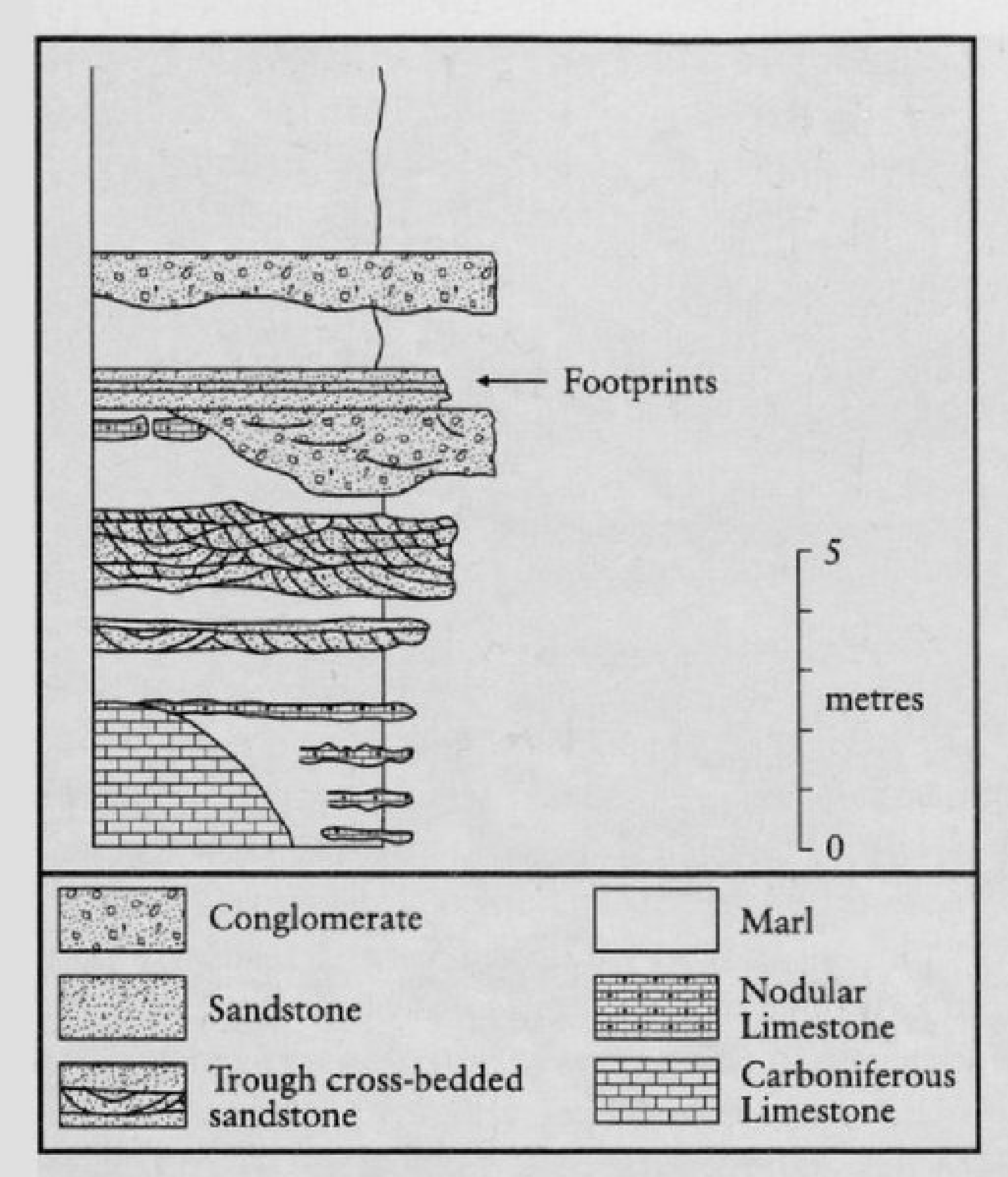
The sheeting of the Carboniferous Limestones at Bendrick Rock is typical of surface weathering (insolation) of exposed rocks in arid and semiarid environments (Ricker, 1974). Thin layers of rock peel away from the outcrop surface as a result of processes such as diurnal temperature changes, the growth of salt crystals, and chemical weathering. The low latitude of this region during the Triassic Period probably discounts freeze-thaw activity, but the close proximity to the Triassic hypersaline lakes makes the growth of salt crystals a viable alternative. The onionskin weathering and shattered pebbles at Hayes Point are also thought to have formed under arid conditions; these features are commonly observed in modern deserts. The conglomerate was deposited rapidly during a flood. There then followed a prolonged period of weathering that produced the exfoliated and shattered pebbles.

The dinosaur and other archosaur footprints indicate that appropriate habitats existed in the vicinity, although these are not preserved. The footprints indicate a range of dinosaurs, including herbivores and carnivores. The assemblage compares with ichnofaunas from Colorado and Utah, and a late Norian to Rhaetian age is inferred (Lockley *et al.,* 1996).

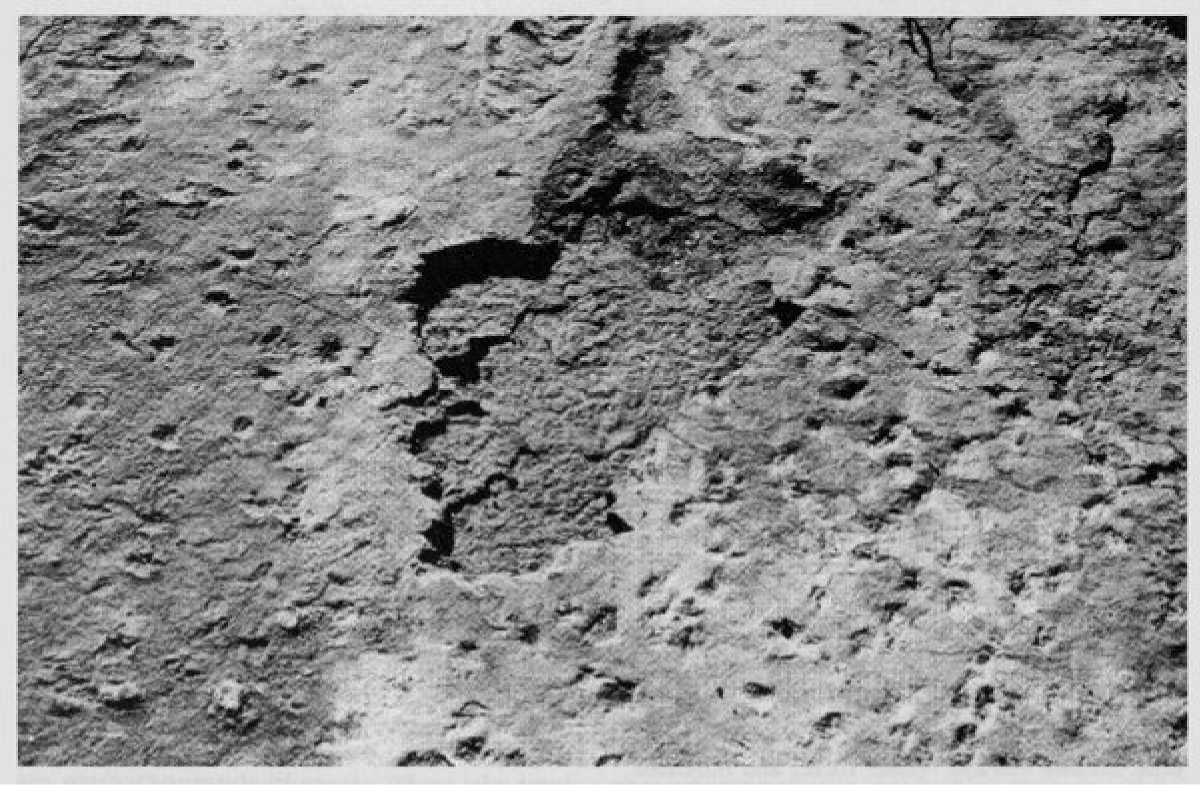
Conclusions

The coastal section between Bendrick Rock and Hayes Point preserves one of the best examples of the finer-grained lithologies of the marginal Triassic strata in Britain. These late Triassic sediments record a fluvial-marginal environment that was inhabited by dinosaurs and other reptiles. Weathering products, such as exfoliated pebbles and sheeting, are rarely seen in the geological record, although they are commonly recorded in modern deserts. They confirm that the climate of South Wales during the Late Triassic Epoch was arid. This is an internationally important site for the evidence it provides on Late Triassic palaeoclimates, depositional palaeoenvironments, palaeogeography, and faunal associations.

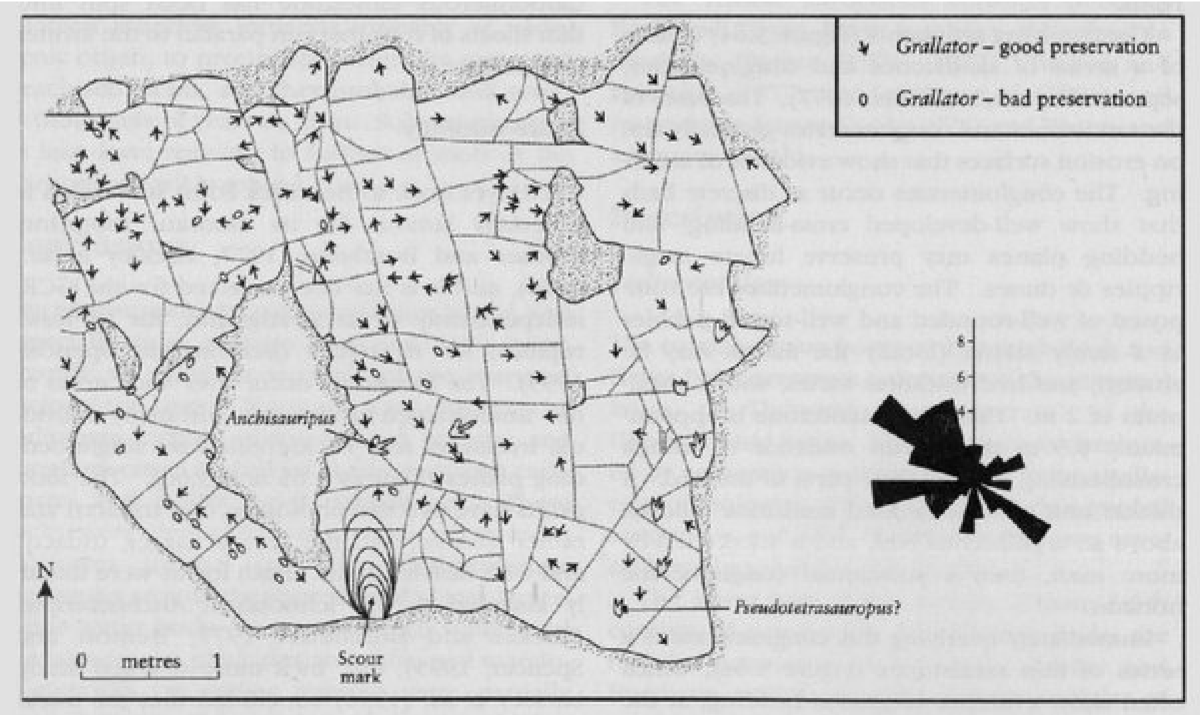
References



(Figure 3.64) Sedimentary log through the Late Triassic succession at Bendrick Rock, with the footprint horizon marked. (After Tucker and Burchette, 1977.)



(Figure 3.65) A bedding plane on the foreshore at Bendrick, covered with three-toed dinosaur footprints, probably Anthisauripus and Grallator. Each small depression is a footprint. Width of the field of view is about 5 m. (Photo: M. J. Benton.)



(Figure 3.66) Map of the track-bearing surface collected near Bendrick Rock, and currently on display in the National Museum of Wales. The rose diagram (inset) shows the predominant orientation of Grallator tracks. (After Lockley et al., 1996.)