Ashfield Brick-Clay Pit, Conisbrough

[SK 515 981]

Highlights

This section, preserved for geological study since 1955 but nevertheless partly filled and soon to be re-excavated, vividly illustrates how much geology can be packed into one quite small rock face. In a vertical range of less than 20 m of strata, it contains Carboniferous coal measures formed in an equatorial coastal setting, an exhumed desert land surface formed by the tropical erosion and removal of more than 500 m of Carboniferous strata, a suite of water-laid desert litter and sand trapped in minor hollows in the desert surface and, in the main part of the face, evidence that the desert was then flooded by the tropical Zechstein Sea in which was formed, successively, lagoonal muds and open-sea shallow-water oolites full of the remains of a teeming marine life; scattered small reefs complete the range.

Introduction

This exposure, in the south-east outskirts of Conisbrough (Figure 4.24), spans strata high in the local Upper Coal Measures unconformably overlain by thin basal Permian deposits and the lower part of the Wetherby Member of the Cadeby Formation. The section was first described by Gilligan (1918), who recorded an unusually pebbly facies of the basal Permian deposits and an atypical 3.5 m sequence of multi-coloured 'marls' and 'limestones' at the base of the Lower Magnesian Limestone (now the Cadeby Formation). Mitchell *et al.* (1947) gave some details of the section as it was in 1930 and Downie (1967) noted that unspecified marine microfossils were present in the lower (argillaceous) beds of the Cadeby Formation. Downie also recorded reefs in the higher Magnesian Limestone beds present.

Description

The mainly late Permian sequence exposed at Ashfield Brick-clay Pit in late 1993 is shown on page 170.

	Thickness (m)
Soil and dolomite brash	0.2–0.4
Cadeby Formation, Wetherby Member (open shelf facks)	
Dolomite, cream and buff, saccharoidal (fine sand-grade), porous, in fairly even beds 0.20–0.70 m thick. Passes sharply laterally into a bryozoan boundstone patch-reef about 30 m across, with some arching of overlying strata	*c.* 4.00
Dolomite, cream and buff, saccharoidal (fine sand-grade), unevenly thin- and medium-bedded (locally merging to thick-bedded)	0.60
Dolomite, buff, saccharoidal (fine sand-grade), in one to three beds, with 0–06 m of grey and dark red mottled clayey mudstone filling hollows at the top and a 0.07–0.12 m basal group of thin wavy-bedded dolomites with several laminae of red dolomitic clay	0.45
Dolomite, cream-buff, saccharoidal (fine sand-grade), in four beds 0.12–0.55 m thick; bivalves are abundant at several levels including *c.* 0.28 and 0.75 m above base. Red friable dolomite on bedding plane *c.* 0.70 m above base	1.25

Dolomite grainstone, buff, ooidal, a single bed, with traces of large ripples and cut-and-fill structures and with very abundant casts of bivalves (mainly *Bakevellia*). The 'Bakevellia Bed'	0.90
Dolomite, grey-buff, saccharoidal (very fine sand-grade), in unevenly flaggy beds, with two discontinuous brick-red clayey 0–0.15 mm layers 0.03 m apart at the top and other red layers in the upper part. Some irregular dark red patches. A few poor casts of bivalves, especially of *Bakevellia*	0.45
Dolomite, buff-cream, dense, saccharoidal (very fine sand-grade), in two 0.15–0.20 m beds, separated by a 0.02–0.05 m irregular layer of denser finely-mottled buff and purple-red dolomite. Both main beds contain bivalve casts and the lower also contains bryozoan casts. Probably an altered ooid grainstone	0.40
Dolomite, cream, porous, soft, saccharoidal (sand-grade), in one bed, with fairly abundant bivalve casts; brick-red patches near top. Scattered U-burrows about 13–16 mm diameter. Uneven sharp base on channelled erosion surface. Probably an altered ooid grainstone	*c.* 0.55
Dolomite, cream, saccharoidal (very fine sand-grade), thin-bedded and flasery	0.18
Dolomite, buff, saccharoidal (very fine sand-grade), one bed	0.28

Underlying strata were not visible in 1993 but are expected to be re-exposed late in 1994. The following section, based mainly on information given by Gilligan (1918), lies stratigraphically directly below that now visible and is likely to differ only in detail from that to be re-exposed.

	Thickness (m)
Cadeby Formation, Wetherby Member (Lower Marl facies)	
'Marl' (mudstone), red and grey, dolomitic	0.7
'Marl' (mudstone), kaolin-rich	0.4
Interbedded thin calcitic dolomite and red and grey 'marls'	1.3
'Marl' (mudstone), grey calcitic (0.05 m) on 'marl', red, finely bedded (0.05 m)	0.1
Dolomite, buff with thin 'marl' layers	0.4
'Marl' (mudstone), brown, slightly dolomitic and calcitic	0.2
'Marl' (mudstone), dark grey, slightly dolomitic and calcitic	0.2
'Marl' (mudstone), grey grading up to dull brown-red, calcitic, with scattered casts of *Schizodus.* Sharp base	0.2
Basal Permian deposits	
Breccio-conglomerate with persistent beds of fine-grained, weakly cemented sand, red, passing into pebbly sand where thin	0.4–1.7
———— unconformity ————	
Carboniferous (Westphalian, Upper Coal Measures)	
Sandstone and silty shale, red at top	

Basal Permian deposits

Gilligan (1918) was moved to document this section by the unusual (to him) character of the basal Permian deposits and of the overlying basal beds of the Cadeby Formation (then known as the Lower Magnesian Limestone). The face measured by Gilligan has since been quarried away, but the basal Permian deposits were described as a friable fine sandy breccia or conglomerate with fairly persistent thin beds of sand. The deposits filled a hollow (?minor valley) on the old land surface (i.e. the unconformity), thinning westwards in 4.5 m from 1.7 m to 0.5 m and passing into sparingly pebbly sand-rock. Pebbles in the breccia and sand were generally less than 25 mm across and mainly comprised local Coal Measures (Westphalian) sandstone, hematite, chert and pink felspar. Polycrystalline quartz and chert were identified by Gilligan as the main constituents of the sand, the more resistant grains of which were 'exceedingly well rounded'; large flakes of muscovite were also recorded, and an extensive suite of heavy minerals was identified, the latter all potentially derived from Coal Measures rocks in the region. Gilligan noted that the sand in the deposits was in all respects except colour, like typical Basal Permian Sands, but it was left to Mitchell *et al.* (1947) to note that the colour was red. The face had retreated appreciably when Downie (1967) recorded a basal bed 0.75 m thick consisting of coarse, friable, gritty sand with layers of pebbles (mostly brown ironstone eroded from the local Coal Measures).

Cadeby Formation, Wetherby Member, ?Lower Marl facies

This unit, 3.5 m thick according to Gilligan (1918), 4.9 m thick according to Mitchell *et al.* (1947) and about 5.3 m thick according to Downie (1967), was described in detail by Gilligan (see tabulation) who included chemical analyses of each bed; these analyses showed that the unit mainly comprised red, brown and grey 'marls' (dolomitic and silici-clastic calcitic mudstone and argillaceous dolomite) with subordinate beds of calcitic dolomite. In addition to Gilligan's (1918) record of casts of *Schizodus* in the basal bed of this unit, Downie (1967) noted that the unit yielded unspecified marine microfossils. This unit is assigned to the Lower Marl facies on the basis of its bulk composition and clay mineral content but differs in several respects from its more extensive counterpart farther south.

Cadeby Formation, Wetherby Member, open shelf facies

This unit here comprises two main parts, a lower varied sub-unit mainly of shelly dolomite with several laminae and thin beds of red and grey dolomitic siliciclastic mudstone, and an upper sub-unit (4.6 m+) of relatively pure dolomite that, in its upper part, locally passes into a lenticular patch-reef at least 4 m thick.

Beds in the lower sub-unit range from thin and semi-nodular to thick and even, and several feature patchy purple-red hematite staining. At least two beds are of altered ooid grainstone but, as Mitchell *et al.* (1947) noted, other beds that superficially appear to be of porous saccharoidal dolomite also prove, on close inspection, to be of highly altered ooid grainstone. Casts of *Bakevellia* are common to abundant in some beds and reach rock-forming proportions in others; commonly they are associated with lesser numbers of other bivalves (*Liebea* and *Schizodus*). Casts of small fragments of the ramose bryozoan *Acanthocladia* are present in at least one bed.

Bedding in the upper sub-unit is less even than that in the lower sub-unit, but the rock-type is more uniform and less fossiliferous; most, if not all, is of highly altered dolomite ooid grainstone and most faunal remains comprise casts of *Bakevellia* that are abundant only at certain levels. The coarsely saccolithic boundstone reef into which the beds of this upper sub-unit sharply pass, however, is rich in the remains of frame-forming *Acanthocladia.* Arching of the youngest beds in the quarry against the flanks of the reef may be a compactional effect.

Interpretation

The sequence of Permian strata conserved at Ashfield Brick-clay Pit provides a window into the rarely-seen part of the sequence and an uncommon view of the Carboniferous–Permian unconformity. The latter, in this part of Yorkshire, is generally flat to very gently rolling, and bears a thin scattering of mainly small subangular resistant pebbles probably loosened from the old land surface by extreme temperature variations and chemical (mainly salt) weathering. It is, perhaps, not surprising that such pebbles should be concentrated in hollows like that here, swept there by occasional flash floods and typically high rates of run-off. Elsewhere, comparable hollows in the unconformity are extremely rare, perhaps the best known being those in the A l(M) road cutting [NZ 247 128] at Cleasby, near Darlington. Breccias of local rock are, of course, relatively common in places such as Knaresborough, where the desert surface had a steep local relief (Fox-Strangways, 1874); amongst GCR sites, breccias of local debris are present around a minor sandstone hill at

Newsome Bridge Quarry, near Wetherby. Such breccias differ considerably from the well-cemented rocks that are classed as Basal Permian Breccias; the latter form extensive sheets across much of the Cleveland High and comprise resistant multi-cyclic pebbles that probably accumulated as desert piedmont pavements.

Cadeby Formation, Wetherby Member, Lower Marl Facies

Rocks of this facies are uncommon in the Conisbrough area, being most widespread in the southern part of the outcrop and at depth farther east (see Smith, 1989, fig. 6 for distribution). The facies here is clearly a local variant, not connected with the main area of Lower Marl and one of a number of relatively small similar patches distributed unevenly along the outcrop from Sheffield northwards. The Lower Marl is an argillaceous facies of the Wetherby Member and it is not to be confused with the wholly older Marl Slate which does not crop out in the Yorkshire Province and is a deeper-water deposit formed under anoxic conditions.

The 'many' rocks at Ashfield are assigned to the Lower Marl on the basis of their general stratigraphical equivalence with the argillaceous rocks in the main (southern) outcrop, their marine fauna and their overall lithological character. They differ, however, in their content of red and brown beds (uncommon in the main area), in the relative rarity of shelly fossils and in the high dolomite content of most of the carbonate rocks present. Their depositional environment is uncertain, but it may be speculated that they accumulated slowly in a low-energy inshore setting such as a shallow lagoon lying landward of a minor oolite shoal or barrier bar.

Cadeby Formation, Wetherby Member, normal facies

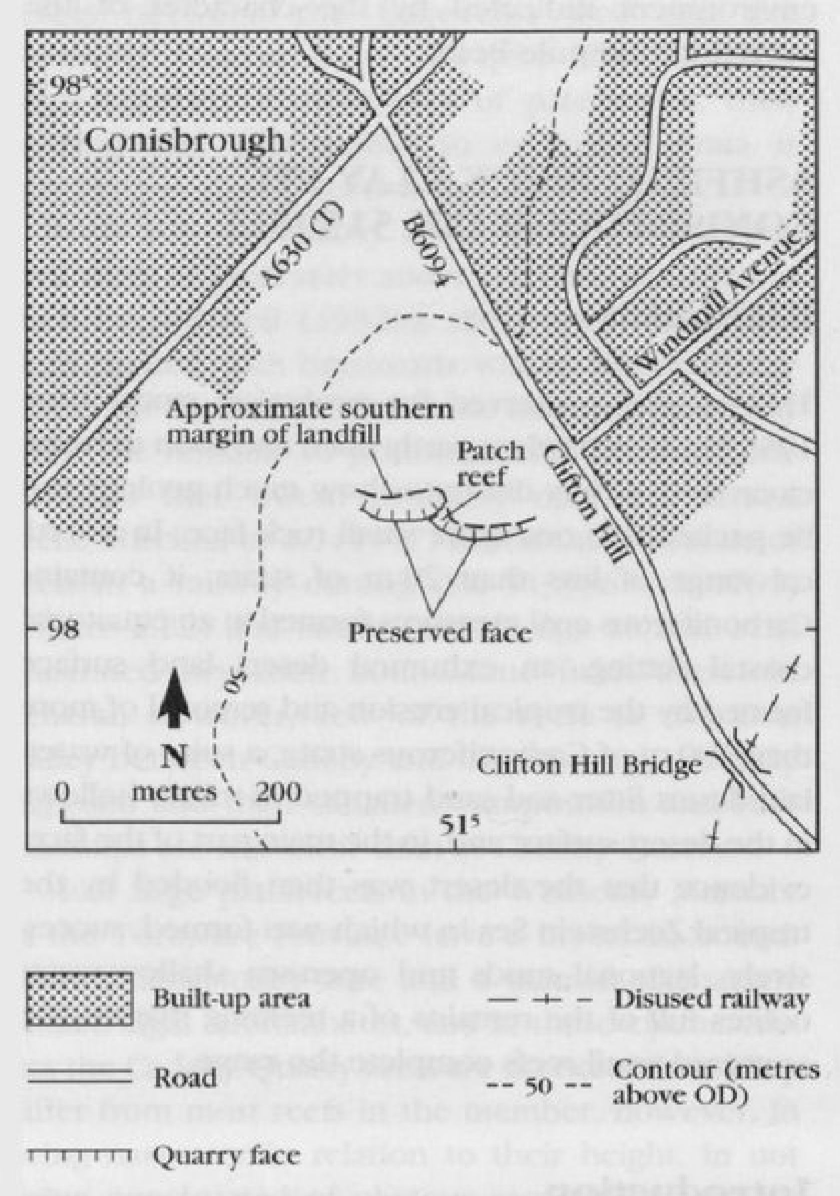
The lower sub-unit of this member at Ashfield is relatively normal for the area, though the number of dark red argillaceous layers and of red-stained patches is atypically high. The origin of this colour is not known, but it may have been derived from the strongly reddened Carboniferous clay-rocks immediately beneath and elsewhere in the area. Rocks composed mainly of ooids are widespread in this district at and near the base of the Wetherby Member, and the abundance of casts of a restricted range of bivalves is typical. The latter commonly reach rock-forming proportions (as here) in a 0.8–2.5 m bed near the base of the Magnesian Limestone sequence in many central outcrop areas; it seems likely (but cannot be proved) that this informally-named 'Bakevellia Bed' is the product of an unusually extensive single sheet coquina, and that shallow water and at least moderate energy are implied.

The upper sub-unit of the Wetherby Member at Ashfield is normal for the area. The altered ooid grainstones of which it is composed are almost entirely of dolomite and the patch-reef has a typical lithology and biota (Smith, 1981b) and is of typical size. Its base, not currently exposed, may extend below the 4 m bed at the top of the section, but no reefs have ever been reported in or below the 'Bakevellia Bed' and this reef is not likely to be an exception. As throughout the north to south belt of patch-reefs, formation on a broad, shallow, clear, open marine shelf with moderate energy is inferred (Smith, 1981b, 1989).

Conclusions

The site is an exposure of the basal Permian deposits overlain by the lowest basal part of the Wetherby Member of the Cadeby Formation. The actual unconformity is not exposed at the time of writing, but has been well-described by previous workers and is likely to be exposed by excavation planned for 1994. The basal deposits are red, and contain pebbles of derived Carboniferous ironstone and sandstone. The lower part of the Wetherby Member consists of multi-coloured ?lagoonal mudstones and argillaceous dolomites, overlain by open-shelf Shelly dolomite containing abundant bivalve remains; dolomite at the top of the exposed sequence passes into a lenticular bryozoanal patch-reef.

References



(Figure 4.24) Ashfield Brick-clay Pit, Conisbrough, and its environs, showing the location of the main features of geological interest.