9 The Upper Carboniferous of the Halifax area

Brian Turner Durham University

Purpose

The object of this excursion is to examine the sedimentary facies and depositional environments of the upper part of the Namurian Millstone Grit and the lower part of the overlying Westphalian A Coal Measures.

Logistics

The excursion can be completed in one short day as all the localities occur within 10 km to the south and southwest of Halifax (Figure 9.1) and are easily accessible by road. Very little off-road walking is required and the distances involved at individual outcrops are less than r km, mostly over footpaths and rough tracks. Care must be excercised when visiting outcrops in quarries and road cuttings, and hard hats are recommended for safety. Private transport is an advantage but not essential, and parking facilities are available at all localities. The excursion is not suitable for large parties.

Prior permission should be sought for access to Clockface Quarry from Marshalls, Brier Lodge, Southowram, Halifax, HX3 9SY (tel. 01422 306000].

Maps

O.S. 1:50 000 Sheets 110 Sheffield & Huddersfield and 104 Leeds, Bradford & Harrogate; B.G.S. 1:50 000 Sheet 77 Huddersfield.

Geological background

Halifax lies within the central Pennines, which form a prominent topographic feature throughout northern England, comprising steep, flat-topped hills and plateaux up to 600 m above sea level, dissected by deep river valleys and cloughs. Most valleys were incised into preexisting broader, higher-level valley features during late Tertiary times. A good example of this is the River Calder, which flows eastwards through the area (Figure 9.1) in a steep-sided valley incised between prominent shoulders defining the edges of an older, high valley floor.

Geologically the Pennines consist predominantly of Carboniferous sandstones, shales and limestones folded, during the Variscan Orogeny, into an asymmetric anticline with the steeper limb in the west. In the central Pennines, late Carboniferous (Namurian and Westphalian) sediments form a low scarp on either side of the north–south trending Pennine anticlinal ridge. Apart from a few exposures along the scarp crest, most outcrops are confined to old quarries.

In early Carboniferous (Dinantian) times the structure of northern England consisted of a number of basins and blocks, initiated in response to reactivation of pre-existing lines of crustal weakness by a south-southeast–north-northwest directed extensional stress field. In the Pennine Basin, continued extension led to its further break-up into a number of small, tilted fault blocks, forming a series of half-graben basins. Thus the north Pennine Basin can be divided into the Huddersfield Basin in the east, and the Rossendale Basin in the west, separated by the Rossendale Ridge. Rapid fault controlled basin subsidence continued until late Namurian times, followed by a gradual change to a more general phase of thermal subsidence. Thicker, more argillaceous sediments accumulated within the more rapidly subsiding basins with thinner or condensed sequences over the more stable blocks.

In Namurian times the Huddersfield Basin was filled initially with sediment supplied by northerly sourced, turbidite-fronted, deep water delta systems. As the basin shallowed the deltas, now lacking turbidites, assumed a sheet-like geometry and the basin gradually evolved into a low relief alluvial plain by the beginning of the Westphalian. Deposition was characterized by a cyclic repetition of strata, each cycle being bounded by laterally persistent marine

bands related to eustatic sea level changes. In late Namurian times braided rivers flowed to the southwest, past Leeds, and to the south and southeast as far as Sheffield, located at this time on the northern margin of the Gainsborough Trough which was occupied by a standing body of fresh or brackish water characterized by low wave and tide energy.

The upper part of the Namurian Millstone Grit seen on this excursion includes the Midgley Grit and the Rough Rock unit which are equivalent in age to the middle part of the Marsdenian and the upper part of the Yeadonian Stages respectively (Figure 9.1). In the Halifax area, the Rough rock unit comprises a braided channel sheet sandbody, known as the Rough Rock, scoured into sandstones and siltstones of the underlying Rough Rock Flags. Halifax is largely built of locally quarried Rough Rock sandstone, and the River Calder on the south side of the town was cut down through these sandstones forming a deep, well-wooded valley in the underlying shales. When traced westwards into the deeper, more rapidly subsiding Rossendale Basin, the Rough Rock is underlain by the Upper and Lower Haslingden Flags, interpreted as the bar finger sands of an easterly prograding birdsfoot delta similar to the present-day Mississippi delta. In contrast, the Rough Rock Flags, which are equivalent to the Upper Haslingden Flags, are interpreted as the distal deposits of a lobate, shallow water delta prograding to the southwest.

Coal Measures conformably overly the Millstone Grit and show a similar pattern of deposition, except that sandstones are thinner and finer grained, coal seams are thicker and more abundant, non-marine bivalve bands are common, and marine bands are rare. The coals are mostly bituminous coals, underlain by seatearths comprising soft fireclay and hard ganister, some of which have been exploited commercially between Halifax and Sheffield for making firebricks and furnaces. The most prominent sandstones in the lower part of the Coal Measures, some 165 m above the base, are the locally named Elland Flags (Figure 9.1). These are still worked extensively around Halifax for flags and roofing slates.

The description of the outcrop in Greetland Quarry and the Elland Road Cutting is based on the work of Bristow (1993 and earlier work) augmented by the author's own field observations.

Excursion details

Locality 1, Clockface Quarry [SE 046 175]

The quarry is situated next to the B6114 Rochdale Road between Ringstone Edge Reservoir and the M62 Motorway and illustrates a distributary channel sandbody and interdistributary bay-fill deposits. This is a working quarry and prior permission is required for visits. The quarry provides good, two-dimensional exposures of the Namurian Midgley Grit (Figure 9.2)a, located between the Bilinguites bilinguis Marine Band and the Bilinguites metabilinguis Marine Band in the middle of the Marsdenian (R2) Stage (Figure 9.1). The base of the quarry face consists of about 2 m of incompletely exposed, burrowed and bioturbated, plant-rich, fine micaceous sandstone and siltstone containing locally rippled sandy intervals. These are sharply overlain by trough cross-stratified, coarse to very coarse, granular and pebbly sandstone containing abundant carbonaceous plant material, commonly concentrated on foresets and the base of troughs (Figure 9.3). Softish weathered, brown, iron-rich nodules and lenses occur at intervals in the sandstone. The northern end of the quarry, which has been locally affected by a northwest–southeast trending fault, reveals the presence of large-scale cross-strata dipping in opposite directions with individual foresets internally structured by trough cross-stratification, plane lamination and low angle lamination (Figure 9.2)a. These are interpreted as mid-channel or bank-attached sand bars within a major distributary channel, scoured into the abandonment, or bay-fill deposits beneath.

Locality 2, Greetland Quarry [SE 095 216]

Access to the quarry is by the steps and footpath at the top of the road behind Coronation Street, which can be reached from Clayhouse Lane off the B6113 Ripponden Road. The quarry face provides a rare example of lateral accretion surfaces within the braided river sandbody of the Rough Rock, structures which are more typical of point bars in meandering rather than braided river systems. The 6.5 m high quarry face exposes a series of 30 m long lateral accretion surfaces dipping at <15°, but decreasing in dip and flattening to the west where they appear to be overlain and draped by cross-stratified sandstone deposited by currents flowing to the west. Lateral accretion units defined by these bounding surfaces contain mainly small-scale cross-stratification, trending southwards out of the quarry face at a high angle to the

bounding surfaces. Water escape structures and undulatory laminations occur at the westernmost end of the outcrop, above a 2 m thick cross-stratified unit. The sandstone is coarse to very coarse-grained but with no systematic variation in the grain size or scale of the sedimentary structures within individual lateral accretion units, a feature which is atypical of point bars.

At the eastern end of the quarry face, the accretion surfaces steepen and are replaced by large-scale cross-stratification within a coarser-grained, more pebbly sandstone, possibly representing the nucleus around which the sandbody accumulated (Bristow, 1993), probably as a large medial bar within the Rough Rock braided distributary channel system.

Localiy 3, Elland Road Cutting [SE 103 215]

The road cutting lies on the A629 Elland bypass (Calderdale Way), some 4 km south of Halifax town centre, and illustrates a fluvially dominated prograding delta system. Because of heavy traffic, and its location on a bend in the road, care must be taken when examining the outcrop. The safest, most convenient parking is on the extensive grass verge at the southern end of the cutting. The cutting varies in height from 15 to 30 m and can be traced laterally for some 500 m. The outcrop, which is orientated north-northeast–south-southwest, approximately parallel to the local and regional palaeoflow direction, consists of three well-defined channel sandbodies overlying finer-grained rippled sandstones and siltstones forming an overall coarsening-upward sequence (Figure 9.2)b. The sandstones and siltstones are sharply overlain by medium-grained micaceous sandstones, internally structured by downcurrent-dipping bedding surfaces, defining downstream accreting beds, containing trough cross-stratification and occasional plane lamination. The sandstone and siltstone beds at the base of the outcrop were deposited in the distal part of a delta system with the overlying coarser-grained sands laid down in a more proximal (landward) mouth bar setting as the delta prograded basinwards.

The mouth bar sands are overlain by two coarse to very coarse, mainly trough cross-stratified, erosive, channel sandbodies forming concave lenses up to 7 m thick and 300 m wide, interpreted as delta distributary channel sandbodies deposited by palaeocurrents flowing to the southeast. The top of these amalgamated sandbodies is truncated by the sediments above, or conformably overlain by a locally developed thin lens of fine sandstone and siltstone indicative of channel shifting and abandonment. The upper channel sandbody differs from those below in its multistorey sheet-like geometry and internal scour surfaces, commonly strewn with wood fragments. It is an erosively based, coarse to very coarse, granular, feldspathic sandstone, internally dominated by trough and solitary planar cross-stratification, deposited by palaeocurrents flowing south. Deformed foresets occur near the top of the outcrop.

The sandstone is correlated with the Rough Rock, and is thought to have been deposited in a braided river channel characterized by low to moderate discharge fluctuations. The thickness and lateral continuity of the sediments at this locality indicate that the delta supplied by this river system was probably of the shallow water, lobate type.

Locality 4, Woodside Quarry [SE 099 209]

Easiest access to the quarry is from Woodlands Lane, off the B6112 Holywell Green Road. The Rough Rock exposed in the quarry face consists of braided river sandbodies showing tectonically induced deformation features, and occurs at about the same stratigraphic level as the outcrop in Greetland Quarry. Good views of Greetland Quarry and especially the Elland Road cut section can he seen from this locality. The outcrop exposed in the quarry face is up to 13 m high and can be traced laterally for some 150 m. The lower part of the outcrop consists of a coarse-grained, plant-rich channel sandstone with low-angle trough cross-stratification and rare solitary planar sets, deposited by palaeocurrents flowing south-southwest. The top of the sandstone is characterized by a laterally persistent 1.5 m thick zone of deformed cross-stratification (Figure 9.2)c showing local flexuring of foresets, oversteepened foresets, overturned and recumbently folded foresets, and convolute foresets. The thickness and lateral persistence of this unit suggests that deformation may be related to contemporaneous tectonic activity.

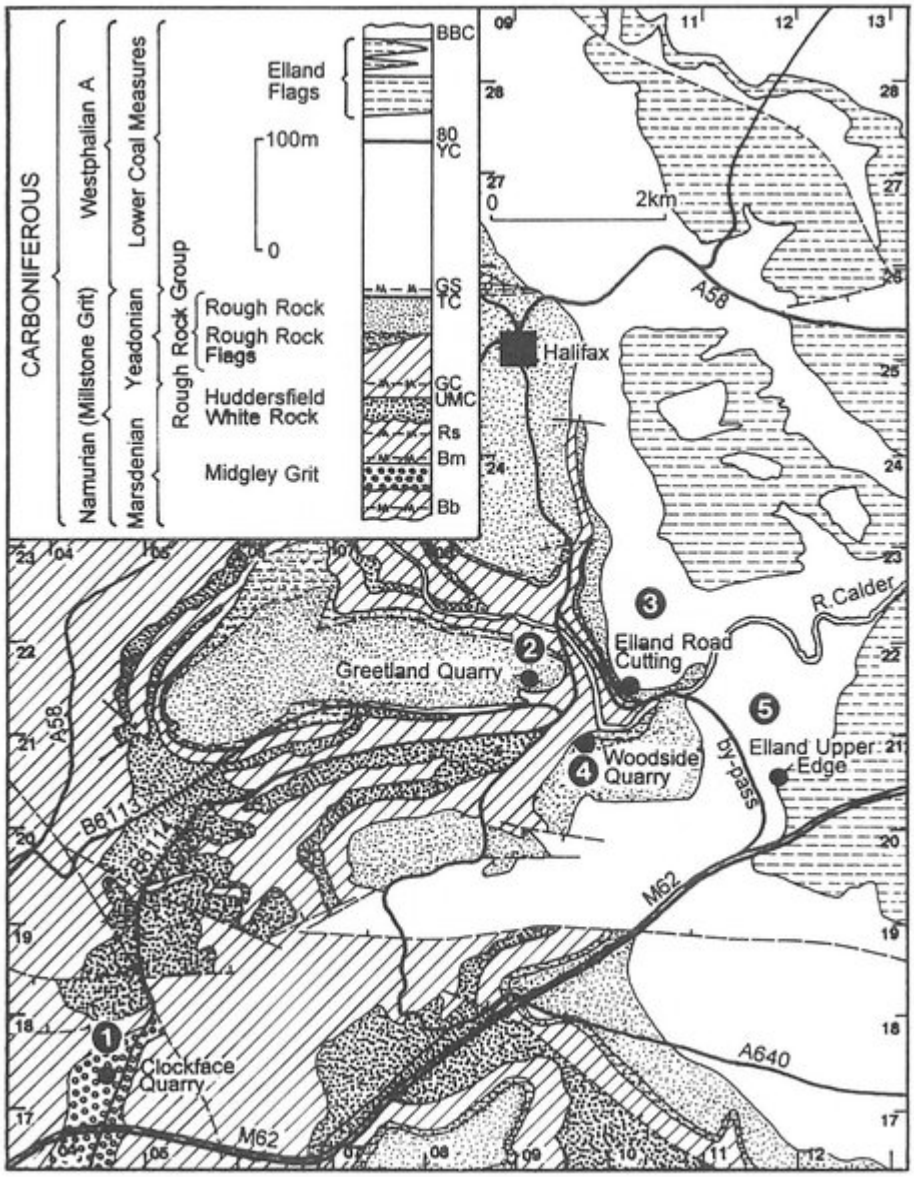
The lower sandstone is overlain by a much coarser-grained, erosively based channel sandbody downcutting to the southwest (Figure 9.2)c. Concentrated along the erosion surface are granules and small pebbles of quartz, and shale and siltstone intraclasts and lenses, together with abundant plant material including well-preserved *Calamites* stems.

Internally the sandstone is structured by trough cross-stratification, except at the southwestern end where it contains a 2 m thick bed of ripple cross-laminated fine sandstone with rare small trough cross-stratification (Figure 9.2)c.

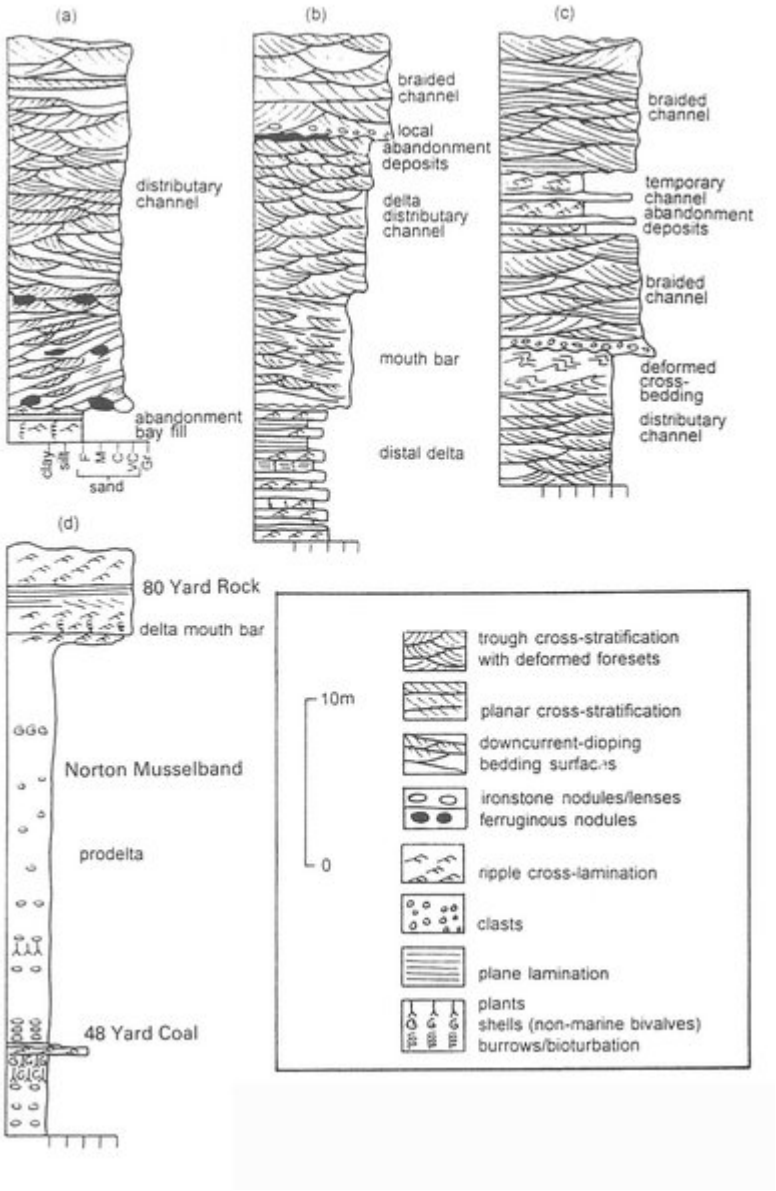
Locality 5, Upper Elland Edge [SE 118 204]

This outcrop of a prograding shallow water delta system is best accessed by the footpath leading off the B6114 Mirfield Road by the Eurogas Depot. The outcrop is orientated north-northeast–south-southwest and consists of some 15 m of black shale coarsening upwards at the top into a 30 cm thick zone of silty shale and ripple cross-laminated micaceous siltstone and fine sandstone, sharply overlain by the 80 Yard Rock (Figure 9.2)d which are only accessible at the southernmost end of the outcrop. The black shales are usually finely laminated and contain ironstone nodules and nodular layers that decrease in thickness and abundance upward through the succession, a thin coal seam, and 3 thin non-marine bivalve bands (Figure 9.2)d. The overlying 80 Yard Rock comprises fine, locally burrowed, micaceous sandstones, containing ripple cross- lamination with some plane lamination, low-angle lamination and cross-stratification deposited by currents flowing to the southwest. The sequence occurs at the top of the *Anthraconaia lenisulcata* non-marine bivalve Biozone, and is interpreted as the prodelta shales and delta front sands of a prograding shallow water delta system.

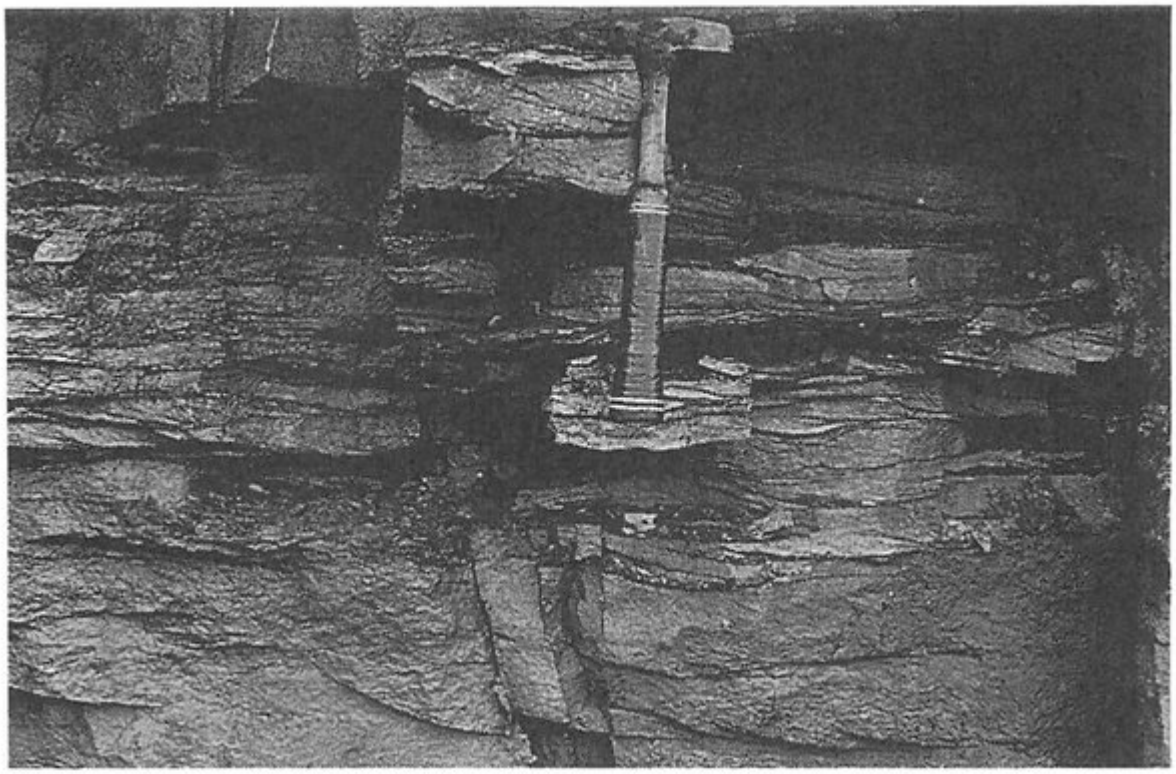
Bibliography



(Figure 9.1) Generalised geological map and vertical section of the Halifax area. Bb = Bilinguites bilinguis Marine Band; Bm = Bilinguites metabilinguis Marine Band; Gc = Gastrioceras cancellatum Marine Band; Gs = Gastrioceras subcrenatum Marine Band; UMC = Upper Meltham Coal; TC = Thin Coal; 80YC = 80 Yard Coal; BBC = Better Bed Coal.



(Figure 9.2) Generalised vertical sections through the succession exposed at: (a) Clockface Quarry [SE 046 175]; (b) Elland Road Cutting [SE 103 215]; (c) Woodside Quarry [SE 099 209]; (d) Upper Elland Edge [SE 118 204]. See (Figure 9.1) for locations.



(Figure 9.3) Small-scale trough cross-stratification with carbonaceous plant material concentrated on the foresets and base of troughs, Clockface Quarry. Photo: B. Turner