17 Lower–Middle Jurassic sequences between Whitby and Saltwick

Martin Whyte and Mike Romano University of Sheffield

Purpose

To study the succession and depositional features of the Lower Jurassic (Whitby Mudstone Formation) to Middle Jurassic (Ellerbeck Formation), the relations between the Lower and Middle Jurassic and the local exploitation of the geology. The sequence is very fossiliferous, with ammonites, belemnites, fish, bivalves, trace fossils, dinosaur footprints and plants.

Logistics

A one-day excursion which can be divided into two half-days Whitby to Saltwick Nab, and Saltwick Bay (Figure 17.1). The most convenient of several car parks within Whitby is the Abbey Car Park pay-and-display [NZ 905 110] (Figure 17.1). Descend either Church Lane or Church Steps; at the bottom go straight ahead and take one of the small closes leading from Tate Hill to the shore. On the shore turn right and proceed to the landward end of the East Pier (Locality 1). Access to the shore can also be gained down a close off Henrietta Street (turn right at the bottom of the Church Steps) or at the far end of Henrietta Street. Here an incline leads to the pier and the *slippery* ramps that connect it to the shore (take care).

To return from Saltwick Bay, ascend to the well-marked cliff-top path. The total walking distance is about 6 km.

Note: The potential dangers of this part of the coast cannot be over-exaggerated. The foreshore between Whitby and Saltwick Nab is normally only accessible for about 11/2 hours on either side of low tide. Some combinations of tide and meteorological conditions may prevent any access to the shore, or may considerably shorten the available access time. ***Tide tables must be consulted*** (times of high water are normally posted daily on the west end of the bridge in Whitby) ***and this part of the excursion must be carried out on a falling tide***. The rising tide crosses the flat rocks of The Scaur (Figure 17.1) very rapidly and it is essential that Saltwick Nab is rounded before the passage along the west side of the Nab [NZ 914 113] is blocked by the tide.

Within Saltwick Bay, access on and off the shore is possible at most states of the tide, though the lowest parts of the succession are only visible at very low tides. On a rising tide, care should be taken to avoid being cut off on slight elevations on the flat expanse of Saltwick Scar.

Fine debris is continually falling from the cliff faces and there are intermittent larger falls; thus working at or close to the base of the cliff should be avoided and *hard hats must be worn*.

Maps

O.S. 1:50 000 Sheet 94 Whitby; O.S. 1:63 360 Tourist Map of the North York Moors; B.G.S. 1:50 000 Sheet 35 & 44 Whitby and Scalby.

Geological background

At the start of the late Lower Jurassic, a eustatic change in sea level led to increased water depths within the Yorkshire Basin and initiated a prolonged phase of mud deposition. These mudrocks, the Whitby Mudstone Formation, are subdivided into a number of distinct units or members. Succeeding the basal Grey Shale Member (Excursion 16; not seen here), the Mulgrave Shale Member was deposited in anoxic bottom waters and consists of bituminous shales, which since they were not disturbed by any bottom fauna are finely laminated. The overlying Alum Shale Member formed in less oxygen-poor conditions in which the presence of a limited bottom fauna disturbed the laminae. At Ravenscar the Alum Shales can be seen to pass up into siltstones and sandstones, but in the Whitby area these and the uppermost

beds of the Alum Shale Member have been removed in a regional phase of uplift, gentle folding and erosion which took place at the end of the Lower Jurassic.

Middle Jurassic deposition started with the shallow marine Dogger Formation. The overlying Ravenscar Group is predominantly non-marine in character but is subdivided by a number of marine horizons. Only the lowest part of the Ravenscar Group — namely the Saltwick and Ellerbeck Formations — can be seen at Whitby. The Saltwick Formation is a fluviatile sequence of shales, siltstones and sandstones while the Ellerbeck Formation is a unit of marine clastics.

Excursion details

Locality 1 [NZ 902 115]

From the East Pier a good view can be had of the western end of East Cliff. The lower third of the cliff is made up of shales of the Alum Shale Member (Lower Jurassic). Resting on these is a 0.75 m ironstone (the Dogger Formation), overlain by the sandstones, shales and siltstones of the Saltwick Formation (30 in). Above these are orange-weathering marine sandstones of the Eller-beck Formation (6 m).

Between Localities i and 2, strong jointing in the Alum Shale has been exploited by marine erosion to produce small embayments and caves in the cliff. These joints strike parallel to the north–south Whitby Fault, which passes through the harbour region. Notice also the low-angle westerly-dipping joints which could easily be mistaken for bedding but which cut across bands of concretions.

Locality 2 [NZ 904 115]

Do not pass beyond this point, the last of the joint controlled headlands, unless you are confident of being able to reach Saltwick Nab, or of returning to this point, before the tide turns and rises to the base of the cliff or the exotic armour stones.

As the tide retreats wide expanses of the Alum Shale Member are exposed on the shore in front of Localities 1 to 5. This shale contains abundant specimens, preserved either crushed or in the round, of the deposit-feeding bivalve *Dacryomya* (formerly *Nuculana) ovum* (Figure 17.1). Most are articulated and some are in life position. In addition the shale contains large fossilized driftwood logs, belemnites, the bivalve *Gresslya* and the ammonites *Dactylioceras* and *Hildoceras* (Figure 17.1). The latter genus, named after the Abbess of Whitby, St Hilda (614–680), recalls the local legend, recorded by Scott in *Marmion,* that the fossil ammonites were snakes which St Hilda had turned to stone. The arms of Whitby include three snakestones in which a snake's head has been carved onto the ammonite. Except where preserved within concretions, only the elongate body chambers of the ammonites, which may extend for more than a whole whorl, are preserved uncrushed. The driftwood is often partly pyritized and pyritized burrow systems may also be found. Horizons of concretions, variously made of siderite, calcite and pyrite, have allowed a detailed stratigraphy of the shale to be established (Howarth, 1962) and show that between Localities 1 and 4 the shale is on the western limb of a shallow, southwards-plunging syncline (Figure 17.1).

Locality3 [NZ 906 114]

To the west of a prominent rockfall the Dogger, which has descended gradually towards shore level with an easterly dip, thins and is almost completely cut out by a sandstone-filled channel in the Saltwick Formation. The western margin of the channel complex is clearly marked and within the channel large coalified logs are common at the base. The eastern margin is obscure though there are siltstones and fine sandstones modified by considerable synsedimentary disturbance. In fallen blocks a variety of material from higher in the cliff can be examined and good examples of ripple marks and U-shaped burrows can be seen. In the cliff large vertical U-shaped burrows extend down from the base of the Dogger into the Alum Shale and within the latter there are large calcareous concretions with cone-in-cone structure.

Locality 4 [NZ 908 113]

The synclinal axis passes through and controls the centre of Long Bight and between here and the next headland (Locality 5), the Dogger Formation rises in an inclined bench close to the foot of the cliff. The Dogger is a coarse, sometimes pebbly, ferruginous sandstone containing berthierine (chamosite) ooids. Larger clasts within the Dogger include reworked phosphate nodules and fragments of ammonites and belemnites which have been derived from the upper part of the lower Jurassic and demonstrate the discordance between the Alum Shale Member and the Dogger Formation. At the junction between the two units large burrow systems can again be seen to pipe material from the Dogger down into the shale. The fine sandstones and siltstones above the Dogger contain an abundance of plant remains (Whitby Plant Bed) and examples of a variety of foliage types may be found on fallen blocks on the shelf of the Dogger. In places large sandstone-filled root systems extend down from the Saltwick Formation into the Dogger and even into the Alum Shale.

Locality 5 [NZ 909 114]

At the headland there is a large rockfall, and some blocks with a 0.05 m skin of reddish sideritic siltstone adhering to their base may be found. This is the Unio Bed, so called since it contains occasional specimens of the fresh-water bivalve *Unio,* which lies 6.2 m above the Dogger. Between Locality 5 and Rail Hole Bight [NZ 810 112] examination of the fallen blocks on the upper shore will reveal several which contain dinosaur footprints. *Do not damage these blocks*. The blocks come from at least two horizons within the Saltwick Formation: the Unio Bed, and a sandstone about 6 m higher in the sequence. Several types of bipedal tridactyl prints (Figure 17.2) can be found and parts of the track of a sauropod have also recently been recognised (Whyte and Romano. 1993; Romano and Whyte, 2003)

Raking tridactyl prints appear to have been made by dinosaurs which were swimming. On the flat of The Scaur, away from the cliff; shales of the Alum Shale Member with their typical fauna are still exposed, but are now on the eastern limb of the syncline, and can be followed in descending sequence.

Locality 6 [NZ 913 112]

At the base of the cliff between Jump Down Bight and Saltwick Nab (Figure 17.1) a double row of pyritic carbonate nodules and sideritic lenses marks the boundary between the Alum Shale Member and the Mulgrave Shale Member. This marker band is known as the Ovatum Band as it contains very occasional specimens of *Ovaticeras ovatum* and other ammonites. Thin (0.15 m) sideritic mudstone bands can be seen 6.3 m above and 5.6 m below the Ovatum Band.

Continue round, or through the gaps in, Saltwick Nab into Saltwick Bay.

Locality 7 [NZ 916 112]

On the flat expanses of Saltwick Scar the well-laminated bituminous shales of the Mulgrave Shale Member can be examined. The shales contain flattened and pyritized specimens of the ammonite *Harpoceras* and the epiplanktonic bivalve *Pseudomytiloides* (Figure 17.1). The belemnite *Youngibelus* also occurs in normal, bulletlike and epirostrate forms. The epirostrum is a hollow cylindrical extension of the guard and has invariably been crushed during preservation (Figure 17.1). Dark phosphatic fish fragments may also be found.

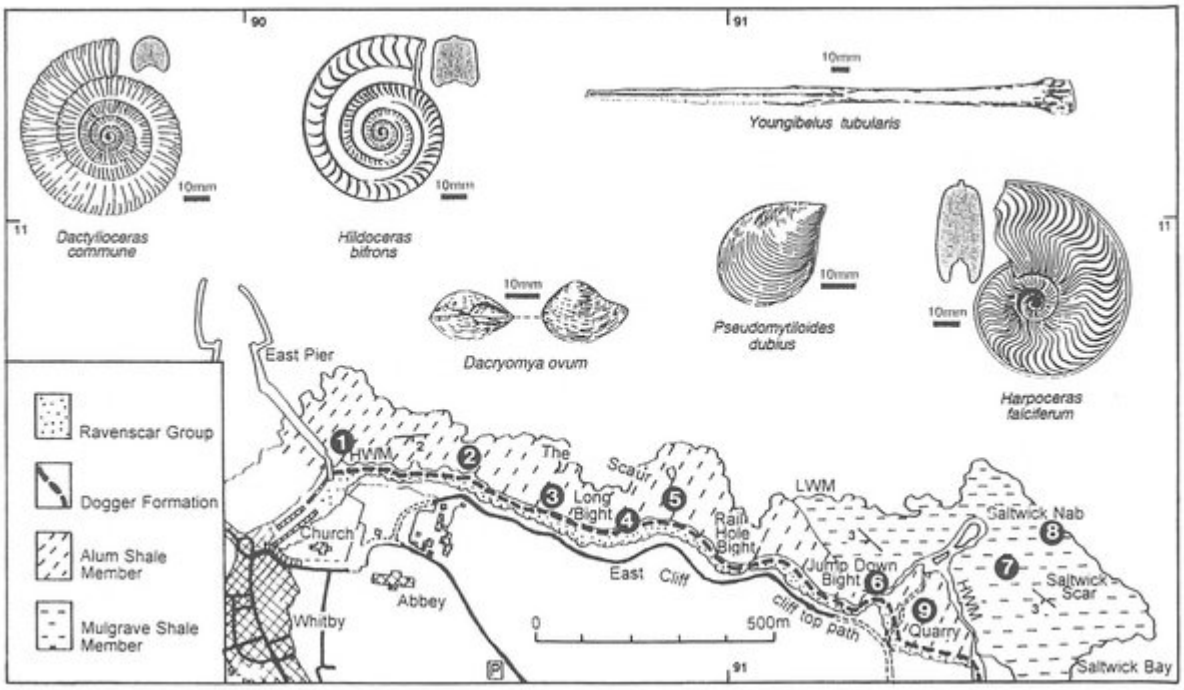
Locality 8 [NZ 915 115] to [NZ 919 112]

On the outer edge of the shore, large discoidal carbonate concretions (up to 5 m in diameter and 0.3 m thick), known as the Millstones, make a prominent upstanding feature. These preserve within them the sedimentary lamination and rest in a thinly laminated limestone (0.2 m). Beds below this can only be conveniently examined at very low waters, when just under 2 m of very bituminous shale with pyrite-skinned calcareous concretions may be seen. In the past these beds, which lie within the lower part of the Mulgrave Shale Member, were a source of jet but this is now seldom found *in situ*.

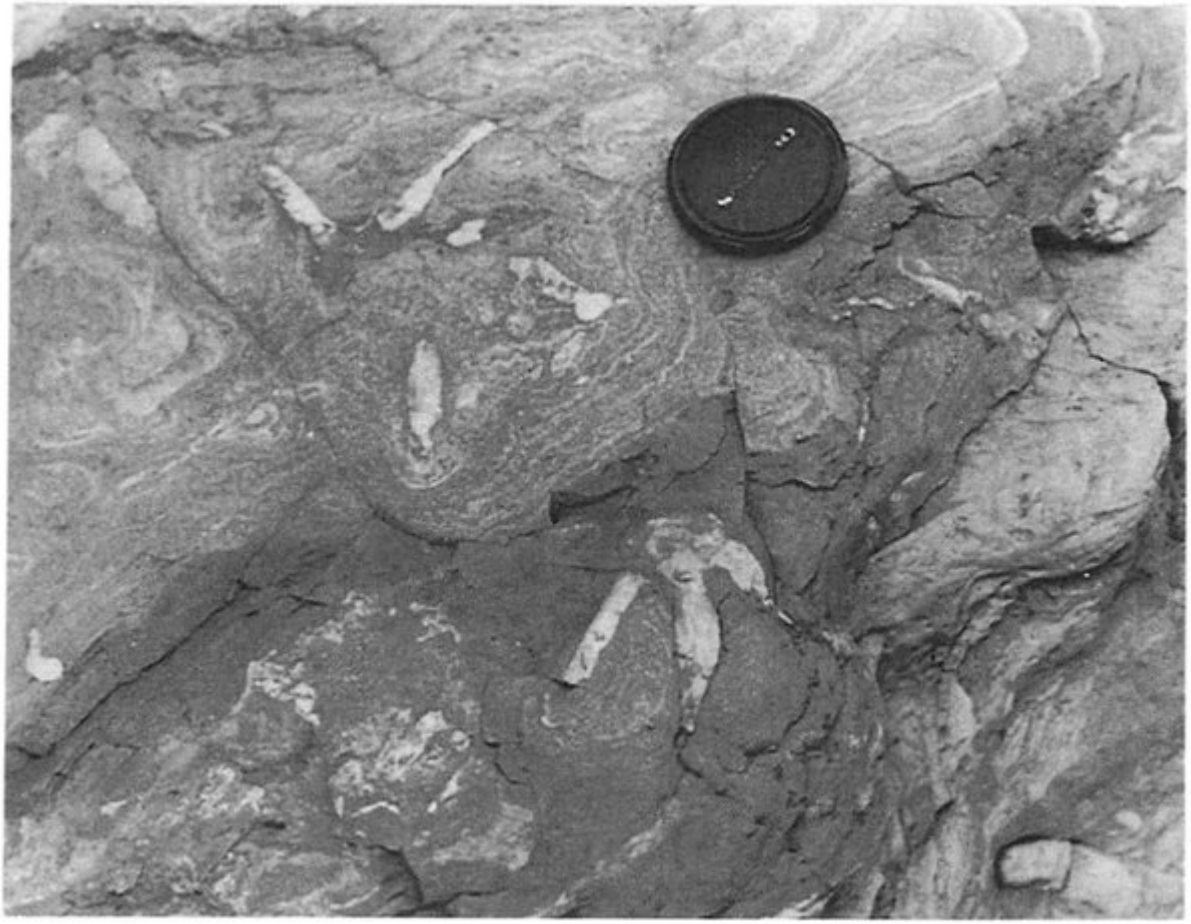
Locality 9 [NZ 914 112]

The vast amphitheatre at the back of Saltwick Bay has been created by working of the alum shale. Note the red, burnt shale which has been dumped on the top of the landward parts of Saltwick Nab. The path to the cliff-top leads through the old quarry and in its back wall [NZ 913 111] ascends over beds of the Saltwick Formation. The Unio Bed makes a small waterfall to the east of the path. At the cliff-top turn right and take the path leading back to the Abbey Plain car park. En route there are good views of the cliff and shore below. In the cliff note the channelling which can be seen in the upper part of the Saltwick Formation.

Bibliography



(Figure 17.1) Simplified geological map of the Whitby to Saltwick Nab area.



(Figure 17.2) Tridactyl dinosaur footprint, Saltwick Formation, Rail Hole Bight. The lens cap is 50 mm diameter. Photo: M. Romano.