EXCURSION

Marlstone Rock, Northampton Sand, Leicestershire and Rutland

Leader: Keith Ambrose

Sunday 15th May 2005

This day excursion was organised to look at the changes in facies displayed in Lower Jurassic Lias Group rocks of the Marlstone Rock Formation at three localities across eastern Leicestershire and Rutland and to compare it with the Northampton Sand Formation. The two formations show similar types of ooidal ironstone as well as other quite different lithologies. The trip commenced at Browns Hill Quarry, Holwell, near Melton Mowbray.

Brown's Hill Quarry, Holwell

Brown's Hill Quarry [SK741233] worked the Marlstone Rock Formation for iron ore between 1917 and 1930, with some later working in the 1950s. It is one of a number of quarries that exploited this resource between 1875 and 1962, the Holwell area having the last operating ironstone quarry in Leicestershire. The iron content of the Marlstone has been enriched by weathering, and in the Holwell area, varied between 25-40%, making it a good workable ore. As well as quarrying, the ore at Brown's Hill was also mined from three main adits, one of which can be seen in the main part of the quarry that is a RIGS site. The undermined area is still very unstable and there are signs on the road warning of possible subsidence; collapses of the workings still occur periodically in the adjacent fields.

The quarry exposes a full sequence of the Marlstone, 3.7 m thick, together with the basal part of the Whitby Mudstone Formation and the top of the Dyrham Formation. Chalky till (Oadby Till) occurs at the top of the quarry. The visible Jurassic sequence is summarised in the table below.

This sandstone of the Dyrham Formation has been given the local name *Sandrock* by past workers. It has been included in the Marlstone by others, but the recent remapping of the area by BGS has shown it to be a lenticular bed that is best equated with the Dyrham Formation. The basal bed of the Marlstone is usually a phosphatic and intraformational pebble bed, but this facies is only locally developed and is absent at Brown's Hill. Where present, the pebble bed marks a major non-sequence and forms the most appropriate level for the base of the Marlstone.

Pickwell

Two Marlstone quarries occur in the village of Pickwell [SK78411157]. They demonstrate a facies change in the formation, in that they show a sequence of interbedded ooidal ironstones as at Holwell, and ferruginous, ooidal and shelly 'limestones'. The ooidal ironstones are paler and appear to be much less ferruginous than those at Holwell, whereas the interbedded limestones appear to be more ferruginous. The quarry visited shows five ironstone-carbonate cycles, each between 0.1 and 0.9 m thick. The lowest cycle is incomplete and is of ooidal ironstone with a very shelly upper part. The ooidal ironstone is thickest component of the cycles. One bed also shows well developed cross bedding. The iron content at Pickwell is lower than at Holwell, so the Marlstone was not worked extensively as an ore. The nearest available analyses are for the nearby Somerby area, about 1 km to the south, where the iron content is around 19%.

Whitby Mudstone Formation	MUDSTONE, grey, finely laminated and fissile ('paper shales'), less fissile where fresh; scattered bivalves and ammonites, including harpoceratids and dactylioceratids; some bedding planes crowded with fossils	1.9m
	MUDSTONE, ochreous, very silty, soft; scattered harder, ?calcareous, cemented concretionary patches	0.2m
	MUDSTONE, grey to brown and ochreous; blocky, structureless; scattered bivalves; many pale grey fissures	0.3m
	MUDSTONE, ochreous and grey, generally blocky and structureless, fine lamination locally; a few bivalves; 10 mm hard, pale buff, ?calcareous layer at base	0.4m
Marlstone Rock Formation	IRONSTONE, orange-brown, fine-grained, ooidal; scattered shell detritus, locally common and sometimes abundant with local lags, commonly with abundant fine crinoid debris; cross bedding locally visible, with current directions to east and south-east. Impersistent mudstone parting near the top; uppermost 50 mm very hard and calcareous, packed with belemnites in approx.NE-SW alignment and with belemnite pavement at top; cross lamination developed in places to top commonly defined by coarse shell debris. Layer of siderite mudstone nodules at 0.7 m	2.8m
	IRONSTONE, orange-brown, fine-grained, ooidal; basal shelly lag with large shells and shell fragments and fine shell detritus – belemnites very common, plus bivalves, brachiopods; possible quartz grains. No appreciable grain size variations throughout the bed; no visible internal structures	0.9m
Dyrham Formation	SANDSTONE, orange-brown, fine-grained, calcareous, ferruginous, scattered shell debris; coarsening-up cycle at top showing more common shell debris in top 50 mm with belemnites and bivalves on upper surface; possible slight preferred orientation of belemnites E-W. Two more fining-up cycles to base of visible section; upper one scours into lower one by up to 100 mm, becomes paler and very fine-grained below 0.37 m	0.6m

Marlstone Rock Formation exposed in the Brown's Hill Quarry. (Photo: Keith Ambrose, British Geological Survey, © NERC, 2006)

Tilton Railway Cutting

This former railway cutting [SK761055] is a SSSI and exposes one of the best and most complete sequences of the Marlstone Rock Formation in Leicestershire and Rutland. A full sequence of the formation can be seen, together with adjacent beds of the overlying Whitby Mudstone and underlying Dyrham formations. The Marlstone has been worked extensively as an iron ore just to the north of the railway cutting at Tilton, and on a much smaller scale as a building stone; it can be seen in many houses and walls in the area. The ore typically yielded 25-34% iron.

Exposure 1: Foot of steps down into the cutting

This first exposure [SK76160555] represents the most complete sequence of the Marlstone, although the overlying Whitby Mudstone is not visible. The uppermost beds comprise around 2.8 m of fine-grained, ooidal ironstone, typical of the formation elsewhere in Leicestershire and Rutland. It contains abundant fossils and fossil debris, including brachiopods, bivalves, belemnites, gastropods and the ammonites *Tiltoniceras acutum* and *Dactylioceras cf. directum*. Most of the Marlstone lies within the tenuicostatum Zone of the Toarcian stage; originally, its top was thought to mark the Pliensbachian - Toarcian boundary, but this datum is now placed 2.5 m below the top of the formation. Cross bedding and cross lamination is visible in places, often with much crinoid debris. Where fresh, the Marlstone is greenish grey, due to the main constituent iron mineral being berthierine (a variety of chamosite). This weathers to the rust coloured limonite that is visible in the face.

The base of the upper ooidal ironstone is not well defined in the face. It rests on a c.2.85 m unit comprising beds of very sandy, ooidal, shell detrital ironstone with significantly fewer ooids than the overlying bed. It has been described as a sandstone by some workers but recent petrographic work by BGS showed that all samples examined were sandy grainstones/ironstones, although it may locally be a sandstone. It was sufficiently rich in iron to have been worked for ore nearby. Within the lower unit there are three beds that are rich in the brachiopods *Tetrarynchia tetrahedra* and *Lobothyris punctata.* The lower two beds are particularly prominent but the upper one less so. They are very hard and well cemented and are very fresh compared to the surrounding rocks. Lithologically and petrographically they appear similar to the immediately adjacent rocks. This lower bed of the Marlstone is entirely within the spinatum Zone. The high quartz sand content of the Marlstone is unique to the Tilton area and suggests a very localised influx of terriginous sediment probably from the nearby London-Brabant landmass.

The lowest part of the Marlstone below the 2.85 m thick sandy ironstone and immediately overlying the Dyrham Formation, comprises two distinct beds. The upper c.0.15 m is a pebble bed of rounded intra-formational clasts set in a sandy, ooidal shell-detrital ironstone matrix. This rests on a 0.05-0.12 m bed of fine-grained, ferruginous limestone with a few intraformational pebbles. The upper surface of this limestone is commonly coated in iron oxide and is intensely bored. The borings are infilled with the overlying pebbly, shell-detrital ironstone.

The lower part of the face exposes the uppermost beds of the underlying Dyrham Formation. The top bed is a 1.15 m thick grey, micaceous, well laminated muddy siltstone that is typical of the Dyrham Formation. This rests on a prominent bed of grey, fine-grained, sandy, ferruginous, shelly and shell-detrital limestone. More siltstones occur below this. Locally the Dyrham Formation is very fossiliferous, with mainly bivalves present. The section has yielded the ammonites *Amaltheus margaritatus* and *A. subnodosus* which indicate the subnodosus Subzone of the margaritatus Zone.

Exposure 2

Followed southwards along the cutting from the first exposure, the Marlstone forms a continuous outcrop on both sides of the cutting and shows some localised cross bedding in places, although it is not particularly well developed here. Also clearly visible are various seepages on the face that are marked by concentrations of iron oxide. Parts of the cutting are unstable and small landslides can be seen.

Exposure 3

Continuing southwards along the cutting, the Marlstone dips below the level of the cutting floor, and the overlying Whitby Mudstone is well exposed in a series of steps although there is no complete sequence visible. The exposures show fissile mudstones or paper shales and blocky mudstones. In parts, the mudstone contains common non-calcareous ooids and pisoids, together with thin beds of ferruginous limestone. The sequence is locally very fossiliferous with dactilioceratid and harpoceratid ammonites common, together with bivalves and belemnites.

Away from the Tilton area, other facies changes in the Marlstone are evident. Eastwards, it loses the high sand content of the lower part. Southwards, in the Stockerston-Horninghold area, the beds seen at Tilton and Pickwell are replaced by a ferruginous mudstone with thin beds of ferruginous limestone. This facies is present in only one small area and passes eastwards into mainly ooidal ironstones.

The three formations are part of the Lower Jurassic Lias Group, and were all deposited under marine conditions in a warm tropical sea that was teeming with life. The earliest strata of the Lias Group, the Blue Lias Formation and its lateral equivalent, the Scunthorpe Mudstone Foramtion, are mainly interbedded limestones and mudstones deposited in a relatively shallow sea. The mudstones of the succeeding Charmouth Mudstone Formation were deposited predominantly in deeper water punctuated by periods of shallowing. The Dyrham Formation represents a major shallowing interval with land in close proximity providing the sand and silt that typify the formation. Further shallowing induced shoaling conditions suitable for the formation of ironstones, again with a significant local influx of sand for some of the time, such as is seen at Tilton. The sea floor was agitated by southeasterly flowing currents, indicated by cross bedding that is commonly preserved. These currents were often strong, transporting coarse crinoid and other fossil debris. More gentle current activity was responsible for the formation of ooids that characterize the formation. With later deepening waters, there was a return to mudstone deposition in the overlying Whitby Mudstone Formation.

Holt Quarry, Neville Holt

The final locality [SK48142926] shows a 3 m thick exposure of the Northampton Sand Formation, which is the basal unit of the Inferior Oolite Group that overlies the Lias Group. It is in a complex of old iron ore quarries that were worked from 1862. Typically, this formation shows an interbedded sequence of ooidal ironstones that are identical to the Marlstone, as well as ferruginous sandstones. Here at Holt Quarry, only the ooidal ironstone is exposed; it is ochreous and fine-grained with some shells and shell debris. The rock is well cemented in the uppermost c.1 m and again from about 2.0-2.4 m in the face, but elsewhere it is soft and poorly cemented. It is generally poorly bedded but one outcrop shows good flaggy weathering in the upper 1 m. Iron rich laminae up to 10 mm thick can be seen in places, generally at 200-300 mm intervals; there are some more irregular veinlets and box-structure weathering in the basal 0.5 m. The Northampton Sand consists mainly of the mineral siderite, but with some berthierine. There are no published analyses for the Neville Holt area, but generally the ore contains 30-40% iron although in some areas it is as low as 18%.

The party was in agreement that there was very little difference between the ooidal ironstones of the Marlstone Rock Formation and the Northampton Sand Formation. The latter tended to be softer and more deeply weathered at the exposure visited.

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