High Moorsley Quarry

[NZ 334 455]

Highlights

High Moorsley Quarry (box 12 in (Figure 3.2)) is typical of many exposures in the much-quarried Magnesian Limestone (Permian) escarpment and exposes a representative section of the lower part of the Raisby Formation (formerly the Lower Magnesian Limestone). In addition, it contains a spectacular submarine debris flow, other evidence of contemporaneous, mass downslope sediment movement and a coarse, mineralized breccia.

Secondary features in the quarry include evidence of markedly widened major joints, the opening of which probably resulted from cambering and/or mining subsidence.

Introduction

High Moorsley Quarry is cut into the west-facing Permian escarpment a short distance south-west of High Moorsley village and exposes about 17 m of the lower part of the Raisby Formation. The rocks exposed are typical of this formation in north-east England, and include an inferred slide-breccia and a debris flow; secondary calcite-marcasite mineralization is a feature of the northern part of the quarry. The general section and the mineralization at High Moorsley Quarry were noted by Francis (1964) and in Smith and Francis (1967, p. 109), and details of the debris flow and slide-breccia were given by Smith (1970c). Lee (1990) presented isotopic analyses of several rock types froth the quarry and discussed their diagenetic history.

Description

The position of High Moorsley Quarry is shown in (Figure 3.44); the main exposures of the Raisby Formation are in the high, east face of the quarry, but the breccias and debris flow are best exposed in the north of the quarry.

The generalized section in the quarry (from the top) is given below.

Bed		Thickness (m)
7	Dolomite mudstone, coarsely mottled buff and grey-buff, mainly in uneven to lenticular nodular wavy beds 0.15–0.30 m thick in lowest 1.6 m where patchily bioturbated, 0.15–0.20 m beds above; some auto-brecciation	c. 5.1
6	Dolomite mudstone, buff with grey-buff patches, in even to wavy beds mainly 0.05–0.15 m thick but becoming thick-bedded in places, partly finely nodular; some beds bioturbated; sharp planar base	c. 1.4
5	Dolomite mudstone, finely mottled buff and grey-buff, partly unevenly laminated, strongly bioturbated, one bed, planar base	0.1

4	Dolomite mudstone/wackestone, buff and grey-buff, thick-bedded in the north but mainly in varied uneven to lenticular beds 0.10–0.20 m thick with some boudin-like structures; some beds dip at up to 7° in large cross-sets; ripple-like linen-fold fluting (WSW–ENE, relief 0.10 m, wavelength 0.50–0.80 m) 0.60–0.80 m above base	c. 2.3
3	Breccio-conglomerate, buff and grey-buff, comprising ill-sorted sub-rounded to tabular dolomite mudstone clasts up to 0.15 m across (some WSW–ENE imbrication) in a varied matrix of skeletal dolomite mudstone, wackestone and packstone; locally clast-free in uppermost 0.05–0.25 m. Discontinuous, forming at least three discrete 5–10 m-wide lenses (?lobes) in about 60 m along the north-east face of the quarry	0–0.6
2	Dolomite mudstone, buff and grey-buff, mainly in very uneven to lenticular beds 0.05–0.15 m thick, with linen-fold fluting (?nearly symmetrical ripples, relief 0.05–0.10 m) *c.* 0.30 and 0.80 m beneath the scoured top, several to many penecontemporaneous sub-concordant glide-planes, and with scattered large penecontemporaneously folded and brecciated patches (more in north than south).	*c.* 4.0
1	Calcite mudstone, mottled in shades of grey, mainly in finely augen-nodular beds 0.01–0.06 m thick with sub-stylolitic contacts; scattered poorly-preserved molluscan debris; partly broken-up by penecontemporaneous brecciation. Normal top not exposed	1.5+

Judging from small exposures at the north and south ends of the designated area, and from topographical features, the floor of the quarry lies less than 5 m above the base of the Raisby Formation.

All the dolomite rocks in the quarry contain scattered to abundant, irregular to ovoid, calcite-lined cavities after replacive anhydrite, and small calcite laths after anhydrite are also present; manganese dioxide speckles and dendrites are widespread. Most beds are lithologically varied when traced laterally. Beds 1 and 2 are slightly to severely broken-up into irregular blocks, slices and lenses up to 10 m across and 3 m thick, and are interpreted (Smith, 1970c) as comprising a slump- or slide-breccia caused by downslope movement of a mass of fairly-well lithified strata; crumpling and slight truncation of bedding in otherwise apparently undisturbed parts of this disrupted sequence (Figure 3.45) show that some bedding-plane sliding was on an unusually large scale. Heavy calcite–marcasite mineralization of parts of the breccia implies that many inter-block cavities remained at least partly empty of sediment after movement ceased, but M.R. Lee (in letter 1990) believes that the association is coincidental and that the mineralization may be related to later tectonic brecciation. Limestone from bed 1 was analysed for its isotopic composition and strontium content by Lee (1990), who reported lower carbon and oxygen values than is normal for dolomite rocks in this formation, but a higher strontium content. Bed 3 was interpreted as a proximal turbidite (= debris flow) (Smith, 1970c), overlain by a fall-out tail from a suspension cloud. The breccia ranges from clast-supported to matrix-supported and is very variable in thickness; it appears to thin out southwards in the east face. Two clasts from this bed were interpreted by Lee (1990) to have been at one time composed of replacive anhydrite, but their isotopic composition was found to be almost the same as that of normal dolomite rocks in the quarry.

Conspicuously wide, sub-vertical joints in the north and south faces of the quarry are probably a response to massive cambering along the escarpment, but may have been further widened by differential mining subsidence; they cause inherent instability in parts of the east face. Other widened joints trend WSW–ENE in the east face.

Interpretation

High Moorsley Quarry is important because it provides a representative section of the Raisby Formation in this part of County Durham; both the lithology and scanty biota are typical of those in many abandoned quarries in the escarpment, and the debris flow and slide-breccia are characteristic of a disturbed sequence commonly found 3–7 m above the base of the formation. Together they throw much light on the depositional environment of the Raisby Formation.

The Raisby Formation is the first major carbonate unit of the English Zechstein sequence in the Durham Province, and is up to about 73 m thick in some eastern parts of County Durham. Generally, however, it is considerably thinner, and is unlikely to have been more than 50 m thick at High Moorsley. At outcrop in eastern Durham and adjoining areas it is almost everywhere a carbonate mud rock, and is mainly dolomitized. Judging from the distribution of similar rocks in Yorkshire (Smith, 1974b, 1989, fig. 6), it accumulated mainly on the gentle marginal slopes of the Zechstein Sea and passed westwards into a belt of shallow water dolomitized packstones/grainstones formed on a progradational carbonate shelf. Such shelf rocks have since been eroded from the Durham Province, but may, by selective storm winnowing, have been the source of some or most of the hemipelagic carbonate muds deposited on the slopes (i.e. now the Raisby Formation).

The evidence of sediment instability forms another part of the argument favouring a slope location for the deposition of the Raisby Formation at outcrop in northern Durham and Tyne and Wear, and was summarized by Smith (1970c, 1985); both the debris flow and the slide-breccia are textbook examples of their kind, though the exposure of the latter could be improved by the clearance of debris.

The exposures at High Moorsley Quarry are representative of disturbed strata at about this stratigraphic level for more than 40 km between offshore boreholes east of Blyth [NZ 82 31] and the village of Ludworth [NZ 358 413] and it seems likely that most of the disturbance was caused by an external stimulus such as an earthquake shock or a closely spaced group of shocks; instability through natural over-steepening seems to be excluded by the limited stratigraphic range and absence of widespread turbidites such as characterize the Concretionary Limestone Formation in, for example, Marsden Bay (Trow Point to Whitburn Bay GCR site). The abundance of bioclasts in the matrix of the debris flow has been attributed to rapid burial and consequent escape from predation.

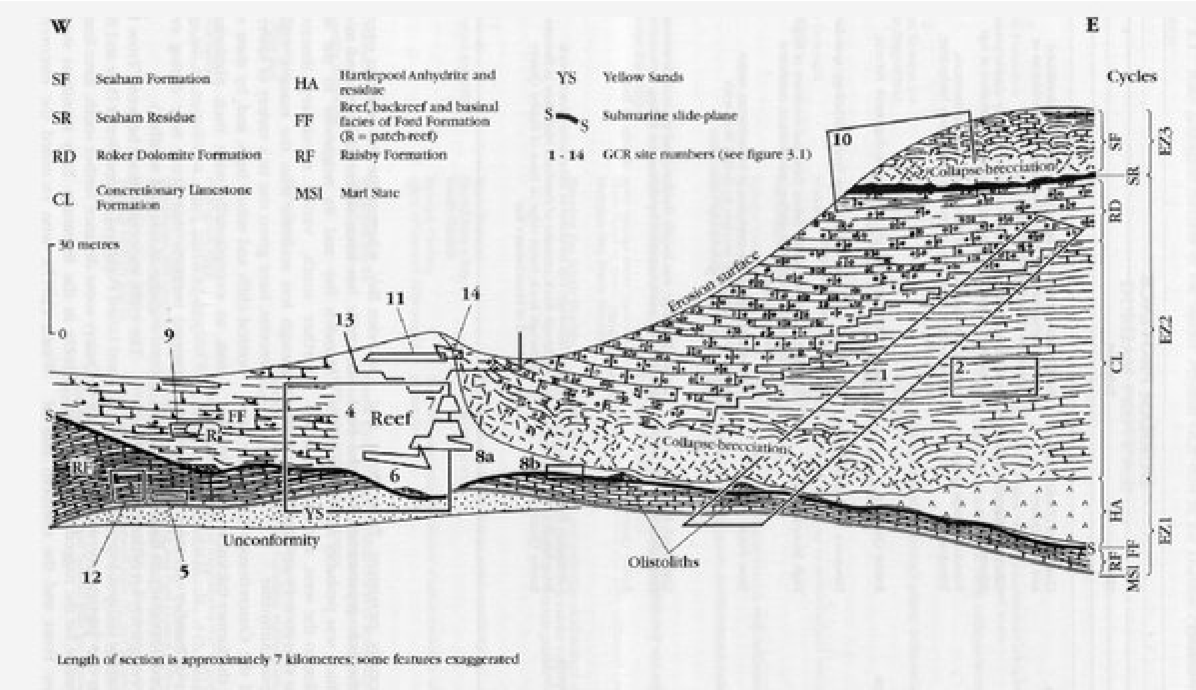
Future research

The sedimentology and diagenesis of the complex rocks of the Raisby Formation at High Moorsley Quarry have recently been investigated by Lee (1990) and there is little immediate scope for further research on these aspects.

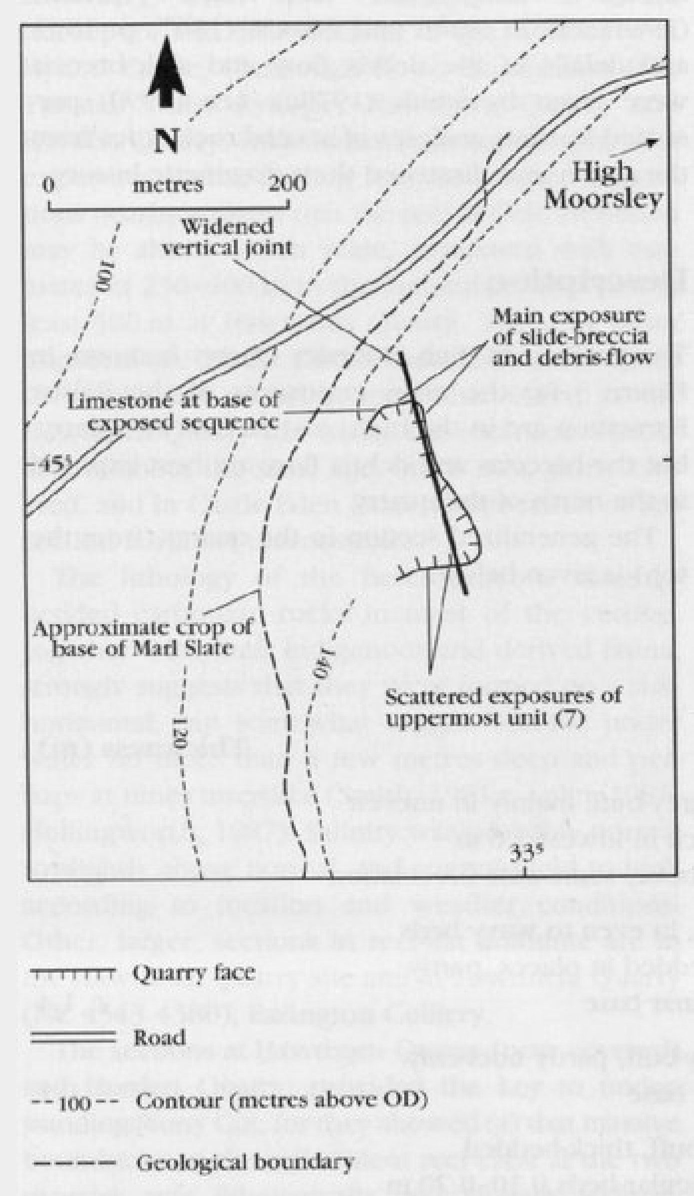
Conclusions

The site is notable for the exposure of the lower part of the Raisby Formation, comprising dolomites and limestone typical of the sequence found in Durham, together with well-exposed interbedded slide-breccia and debris-flow units, a characteristic feature of strata close to the base of the formation. These are indicative of the movement of sediment down an inclined depositional surface as a result of instability, perhaps triggered by earthquake shocks. This site, together with Dawson's Plantation Quarry, is one of the best exposures of evidence of downslope sediment slumping and ~Hding low in the Raisby Forn1alion, and needs to be preserved for this reason.

[References](#)



(Figure 3.2) Approximate stratigraphical position of GCR marine Permian sites in the northern part of the Durham Province of north-east England (diagrammatic). Some sites in the southern part of the Durham Province cannot be accommodated on this line of section and have been omitted. The Hartlepool Anhydrite would not normally be present so close to the present coastline but is included for the sake of completeness.



(Figure 3.44) High Moorsley Quarry and its immediate surroundings, showing the main features of geological interest.

(Figure 3.45) Crumpled bedding in the lower beds of the Raisby Formation near the north end of the east face of High Moorsley Quarry, with evidence of contemporaneous truncation at the top of the disrupted beds. Hammer (middle top): 0.33 m. (Photo: D.B. Smith.)