Humbledon Hill Quarry

[NZ 381 552]

Highlights

Humbledon (formerly Humbleton) Hill Quarry (box 6 in (Figure 3.2)) is cut into the lower part of the core of the late Permian shelf-edge reef and is world famous as one of the most prolific sources of English Zechstein reef faunas; this locality has yielded more than 40 marine Permian invertebrate type, figured and cited specimens including the brachiopod *Stenoscisma humbletonensis* (Howse) which has been recorded at only one other locality in the region, and the cyclostome bryozoan *Stomatopora voigtiana* (King, 1850) which is thought to be unique world-wide. The quarry contains the best exposure of the contact between the reef and underlying bedded dolomite and, in conjunction with newer roadside sections on the north side of the hill, it provides a transect about 200 m long through the lower part of the reef.

Introduction

Humbledon Hill is a well-known local landmark in the south-western inner suburbs of Sunderland; it is smoothly rounded, roughly circular in plan and 250–300 m across. The hill forms a prominent link in a chain of grassy knolls that mark the position of the shelf-edge reef of the Ford Formation, and the quarry is cut into the steep ENE-facing slope of the hill, not far from the presumed seaward face of the reef; it exposes a thickness of about 15 m of rock in the main excavation and scattered smaller excavations below and above increase the exposed thickness to more than 25 m. Most of the exposed rock is reef dolomite, but the lowest few metres are of sparingly fossiliferous dolomite of uncertain stratigraphical affinity; an apparent erosion surface separates the two main rock units.

Humbledon Hill Quarry has existed for more than 160 years, though the total amount of rock removed is not great and working must have been limited and perhaps intermittent; it was mentioned as a fossiliferous exposure by Sedgwick (1829) part of his 'Shell-Limestone' — and yielded large numbers of fossils to those great rivals and most dedicated of collectors Richard Howse (1848, 1858) and William King (1848, 1850). Kirkby (1857, 1858) reported on the ostracod fauna from the quarry and Logan (1967) described several of the bivalves.

No additional genera have been found here since the days of Howse, King and Kirkby, but the lithology and fauna were described briefly by Trechmann (1945) and more fully by Hollingworth (1987).

This account is based mainly on the writer's observations of the quarry since 1953 and includes data on parts of the quarry now overgrown, filled or otherwise inaccessible.

Description

The main face of Humbledon Hill Quarry is about 90 m long and more than 15 m high; it, and a little of the adjoining hillslope, comprise the site. The location of the main features of geological interest are shown in (Figure 3.28). Parts of the quarry face and much of the hillslope are obscured by vegetation and most of the former quarry floor has been enclosed in private gardens.

The geological sequence in and around the quarry is shown below.

Thickness	(m)
Ford Formation, reef-facies	25+
?Erosion surface	
Ford or Raisby Formation, in south of quarry	2+
Gap	?4–10

Magnesian Limestone (probably mainly Raisby Formation) with Marl Slate at base. Proved beneath drift in nearby well and borehole (two differing records)	82 or 87
Yellow Sands (proved in borehole)	3+

The disposition of the lithological units exposed in the southern part of the main quarry face is shown in (Figure 3.29).

Ford or Raisby Formation

The oldest rocks in Humbledon Hill Quarry are exposed in the south-east of the main face and underlie the supposed erosion surface. They comprise about 2 m of evenly level-bedded saccha-roidal cream-buff porous dolomite (possibly an altered oolite) with scattered to abundant shell debris; a bed near the middle of the exposed sequence is extremely shelly. Trechmann (1945, p. 341) recorded seven invertebrate genera apparently from this exposure (though his wording is slightly ambiguous), including a bryozoan, brachiopods, a gastropod and two species of bivalves.

The ?erosion surface

This undulate surface has a visible relief of about 0.5 m (Figure 3.29); no erosion products were noted on the surface, but overlying dipping rubbly shelly dolomite displays strong onlap. A former 2 m cutting in the quarry floor revealed no bedded dolomite, indicating that the erosion surface in the quarry as a whole has a minimum relief of 2 m.

Ford Formation, reef-facies

Details of the reef-rock in the quarry are somewhat obscured by vegetation and quarry waste, but two main rock types are present: (a) massive hard dolomitized autochthonous bryozoan boundstone (framestone/bafflestone) in ovoid bodies up to several metres across, and (b) tongues, sheets and pockets of crudely bedded dolomitized shelly rubble. The two rock types appear to be randomly distributed relative to each other and both contain scattered cavities after former secondary sulphates.

The biota for which this quarry is renowned is divided unequally between the boundstone and the shelly rubble. Work by Pattison (unpublished British Geological Survey report; Pattison, 1978) on fossils from the adjoining road cutting to the north-west showed that comparable boundstone bodies there contain a relatively low-diversity fauna dominated by *in situ* pinnate bryozoans and small pedunculate brachiopods (Figure 3.30), and Hollingworth (1987, pp. 211–213) broadly confirmed this from smaller collections made in the quarry. In contrast, Pattison showed that the enveloping rubble exposed in the cutting contains a highly diverse assemblage of bryozoans, brachiopods, bivalves, crinoids and gastropods. Hollingworth (1987, pp. 212, 216) recorded a similar biota in reef rubble in the quarry, and noted that none of the bryozoan colonies in the rubble were in life position. He inferred that many organisms clearly lived here and were not originally inhabitants of the boundstone bodies. Trechmann (1945) recorded large rolled productids in 'mushy and porous' rock (i.e. rubble) near the base of the reef, and noted that the overall biota remained roughly constant throughout the main face, but became considerably less diverse in small exposures towards the top of the hill behind and above the quarry.

Interpretation

Humbledon Hill Quarry is especially important (a) as the prime source of more than 40 late Permian type, figured and cited marine invertebrate fossils and (b) as one of the best exposures of lower reef-core rocks in the shelf-edge reef of the Ford Formation. Because of the current restrictions on access, the historical aspect is the more important, but the record of the reef-core has assumed additional significance following the unique light thrown on the reef structure by exposures created during the widening of the adjoining road to the north-west in 1973 (see below).

The erosion surface and underlying strata

The significance of the inferred erosion surface beneath the reef at Humbledon Hill Quarry is unknown, and its assessment is complicated by the uncertain stratigraphical age of the underlying bedded dolomite. Similarly uneven inferred erosion surfaces separate reef and underlying beds at an exposure [NZ 3805 5489] some 370 m south of the quarry and also at the Gilleylaw Plantation Quarry site, Silksworth, at both of which the surface has a local relief of about 2 m. Truncation surfaces, indeed, underly reef-rocks at most places where the base of the reef is exposed; in several such exposures the truncation has been ascribed to massive pre-reef submarine slumping (Smith, 1970c), but the thickness of underlying Zechstein strata in these exposures is much less than that at Humbledon Hill and Silksworth and this explanation may not be appropriate.

The uncertainty regarding the age of the strata immediately beneath the reef in Humbledon Hill Quarry precludes complete understanding of the local stratigraphy and geological history and needs to be resolved; Kirkby (1870) and Woolacott (1912) attributed these beds to the 'Compact Limestone' and 'Lower Limestone' (both now Raisby Formation), respectively, but Trechmann (1945) clearly considered them to be part of the reef; Smith (1969a, 1971b, 1994) tentatively classes them as pre-reef Ford Formation. The argument for a Raisby Formation age presumably was based on their superficial lithological similarity to known Raisby Formation strata beneath the reef at Down Hill, Hylton Castle (not the SSSI) and Claxheugh Rock, but a high content of shell debris is very unusual in upper parts of the Raisby Formation; the faunal list given by Trechmann has little bearing on the problem because of the high species overlap between the Raisby and Ford formations. The argument for a Ford Formation age is based mainly on the height of these strata above the base of the Marl Slate; this is shown by the well and borehole at the adjoining Humbledon Hill Pumping Station to be about 82 or 87 m (two differing records), which greatly exceeds the maximum proved thickness of about 50 m of undoubted Raisby Formation strata in the environs of Sunderland and is comfortably thicker than the maximum exposed thickness of about 45 m of Raisby strata in the general area. Though arguments based on thickness alone are unlikely to be conclusive in a sequence so demonstrably variable as the Magnesian Limestone, the author believes that the thickness and faunal abundance evidence together support a Ford Formation age for the sub-reef strata at Humbledon Hill Quarry. The thickness of these strata is not known, but they exceed 5 m at their main exposure in the sides of Newport Dene [NZ 385 542], 1.2 km SSE of Humbledon Hill; they may have been more than 50 m thick in parts of the Sunderland area (Smith, 1994). Farther south, the reef overlies at least 20 m of lagoon-type dolomite in Castle Eden Dene [NZ 43 39].

Ford Formation, reef-facies

The importance of the collections of fossils from Humbledon Hill cannot be over-emphasized; they formed a disproportionately large part of King's (1848, 1850) source material and are now housed at University College, Galway, where they provide an invaluable reference set. The collection was fully curated and catalogued by Pattison (1977). None of the genera named by King was unique to Humbledon Hill, though Howse (1848) erected the species *Terebratula humbletonensis* (later referred to *Camarophoria* by Howse (1858) and now *Stenoscisma humbletonensis* by more recent authors), which at that time had not been recorded elsewhere, but which was later reported from Tynemouth by King (1850). Humbledon Hill (presumably the quarry) was listed by Howse (1848, 1858) as a source (though not the only source) of almost 40 genera of Permian marine invertebrates and Trechmann (1945) listed 46 genera from there. Ostracods from Humbledon Hill were described and figured by Kirkby (1857, 1858) and the quarry supplied material to the Kirkby Collection of other Magnesian Limestone fossils, housed at the Hancock Museum, Newcastle upon Tyne. Many specimens of bivalves from Humbledon Hill, including some from both the King and Kirkby Collection (Hancock Museum), were cited and illustrated by Logan (1967). More recently, the quarry was cited as the only source in the world of the bryozoan *Stomatopora voigtiana* (King, 1850) by Taylor (1980) and as one of the sources of the crinoid *Cyathocrinites ramosus* (Schlotheim) described by Donovan *et al.* (1986). The precise source within the quarry of the type, figured and cited specimens is not clear from the literature, but it is probable that most were collected from the rubbly parts of the main face.

The variability of the reef-rock at Humbledon Hill Quarry was first noted by Howse (1848), who mentioned 'hard somewhat crystalline' and 'earthy and rubbly' varieties; Trechmann (1945) referred to both massive and mushy varieties. Presumably these equate with the autochthonus boundstone and shelly rubble mentioned earlier. The widening of the adjoining road exposed a 125 m transect through the reef a short distance west (i.e. landward in a palaeoenvironmental sense) of the quarry (Smith, 1981a, 1994; Hollingworth, 1987) and revealed that the boundstone there forms discrete to grouped ovoid masses up to several metres across (but generally 1–2 m) that are embedded randomly in the shelly rubble; they increase in proportion towards the ENE (i.e. towards the quarry and reef crest). This key exposure, taken in conjunction with that of the quarry, shows that this part of the reef, when formed, comprised patchily distributed bryozoan thickets or compound colonies, each with a low-diversity specialized associated biota and a relief of a few decimetres, lying on and in (and subsequently covered by) a variable mosaic of bioclastic debris derived from and supporting a highly diverse invertebrate community.

Many of the bryozoans in the boundstone masses are thickly invested with lamellar encrustations, which doubtless contributed bulk and stiffening (and possibly cement), but no evidence of contemporaneous cementation of the shelly rubble has been recorded. Some of the boundstone masses are themselves coarsely concentrically layered, presumably as a result of intermittent growth.

The fauna of the reef-rock at Humbledon Hill Quarry is typical of that of the lower and middle parts of the reef-mass, and was assigned by Hollingworth (1987) to the lower reef-core; the Humbledon Hill exposures, together with that at Hylton Castle site, provide the basis for his portrayal of a typical lower reef-core community (Hollingworth, 1987, fig. 6.12; Hollingworth and Pettigrew, 1988, fig. 8). The reef-base coquina, commonly found elsewhere beneath the reef, is absent at Humbledon Hill, and Trechmann's (1945) record of faunal impoverishment at the top of the hill suggests that high reef-core rock is present and may imply that the reef is unusually thin (and perhaps condensed) here. The lack of evidence of strong contemporaneous erosion in the reef and fossils at Humbledon Hill and similar exposures, and of sedimentary structures in the rubble, points to accumulation in relatively low-energy conditions below wave base (Smith, 1981a; Hollingworth, 1987) and is consistent with Hollingworth's assessment of the living conditions of the faunal community.

Neither the biota nor the structure of the reef dolomite in the quarry provide evidence of proximity to the reef slope, which therefore probably lay at least 30 m east of the main exposure.

The isolation of Humbledon Hill from other known areas of late Permian reef-rock, coupled with its rounded outlines, invited speculation that it might be a link in a chain of reef knolls (Trechmann, 1913, 1925, 1945); the newly-exposed reef-rock along the north side of the hill shows no evidence of lateral passage into bedded rocks or of an approach to a reef margin, however, and it now seems more likely that the knoll-like form of the hill is an erosional feature in an otherwise relatively continuous shelf-edge reef. Similar doubts regarding two rounded hills of reef-rock between West Boldon and Hylton Castle were resolved in 1959 when temporary excavations in the floor of the intervening valley revealed almost continuous reef-rock. The reef is known to form an east-facing NNW/SSE belt extending from West Boldon to Hartlepool, and may once have extended farther; it marks the seaward margin of the carbonate rocks of Sub-cycle 2 of English Zechstein Cycle 1 (Figure 1.4), (Figure 3.1) and (Figure 3.2). Other GCR sites in rocks of the shelf-edge reef are at Hylton Castle Cutting (Sunderland), Ford Quarry, Cutting and Claxheugh Rock (Sunderland), Tunstall Hills (Sunderland), Stony Cut, Hawthorn Quarry and Horden Quarry; each reveals aspects and parts of the reef that are different from those seen at Humbledon Hill, though the fauna at Humbledon Hill and Tunstall Hills have much in common.

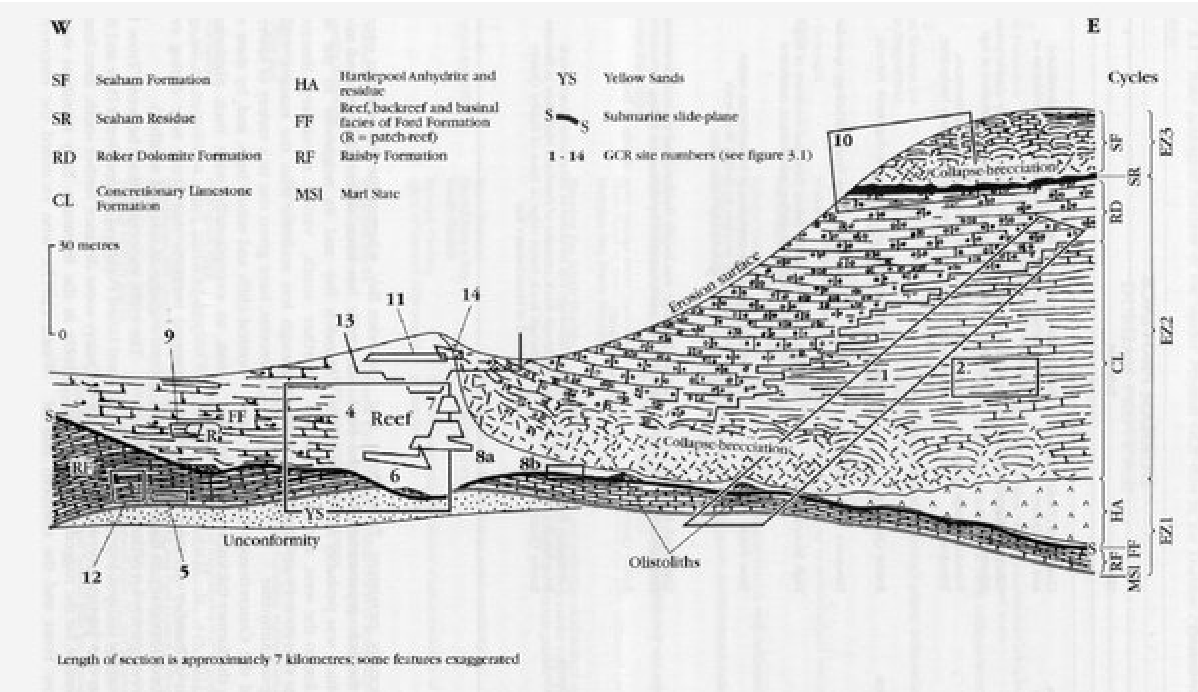
Future research

Restrictions on access now hinder research on all aspects of the reef-rocks in Humbledon Hill Quarry, though many features formerly seen in the quarry may still be seen and investigated in the adjoining road cutting. Opportunities for fossil collecting are now severely limited, but large numbers of fossil specimens from the quarry are available for study at the British Museum of Natural History, the Hancock Museum (Newcastle upon Tyne), Sunderland Museum, University College (Galway) and the British Geological Survey, Keyworth.

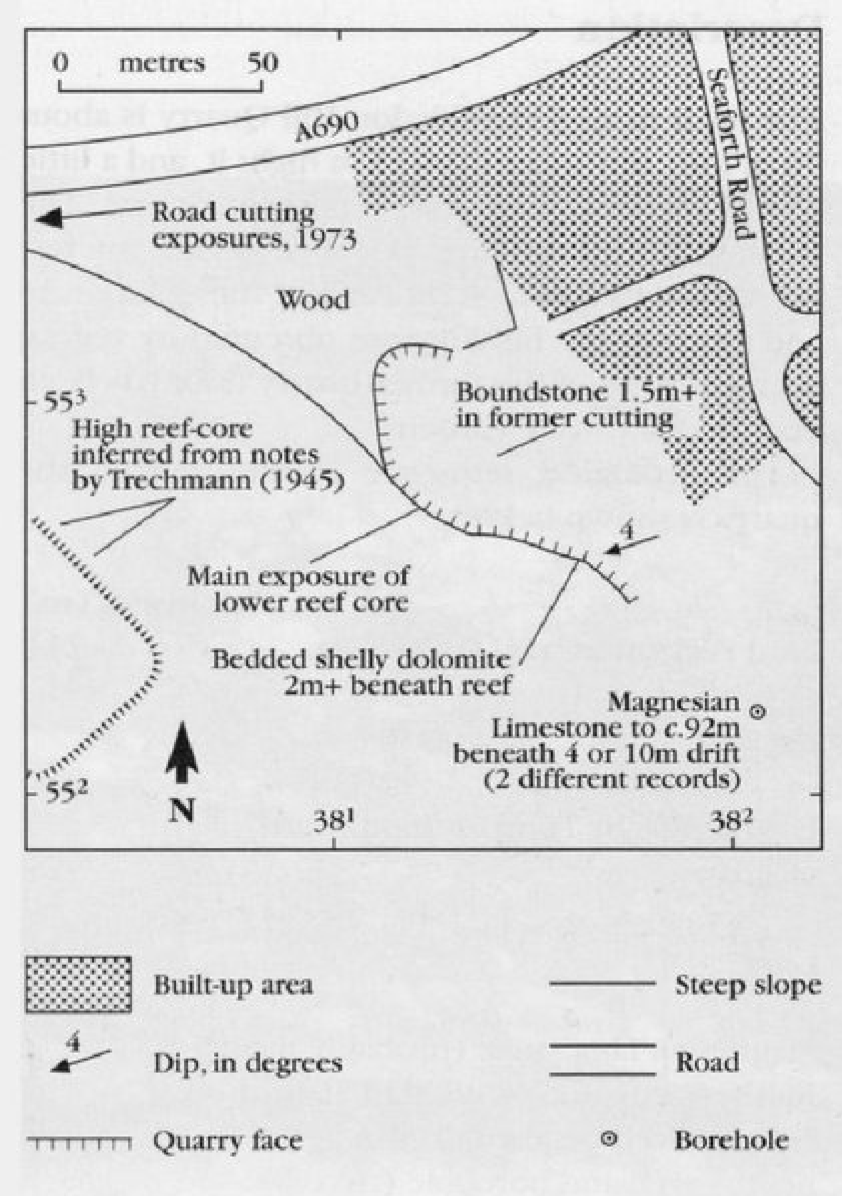
Conclusions

The site is internationally famous for its fauna. It has yielded a rich variety of invertebrate fossils characteristic of the English Zechstein reef; in particular, the bryozoan *Stomatopora voigtiana* (King, 1850) is considered to be unique worldwide. The site was formerly one of the best exposures of lower reef-core rocks in the Ford Formation and of the erosion surface immediately beneath the reef. Although access to the site is now restricted, it remains one of major importance for the study of late Permian reef faunas in the Durham Province.

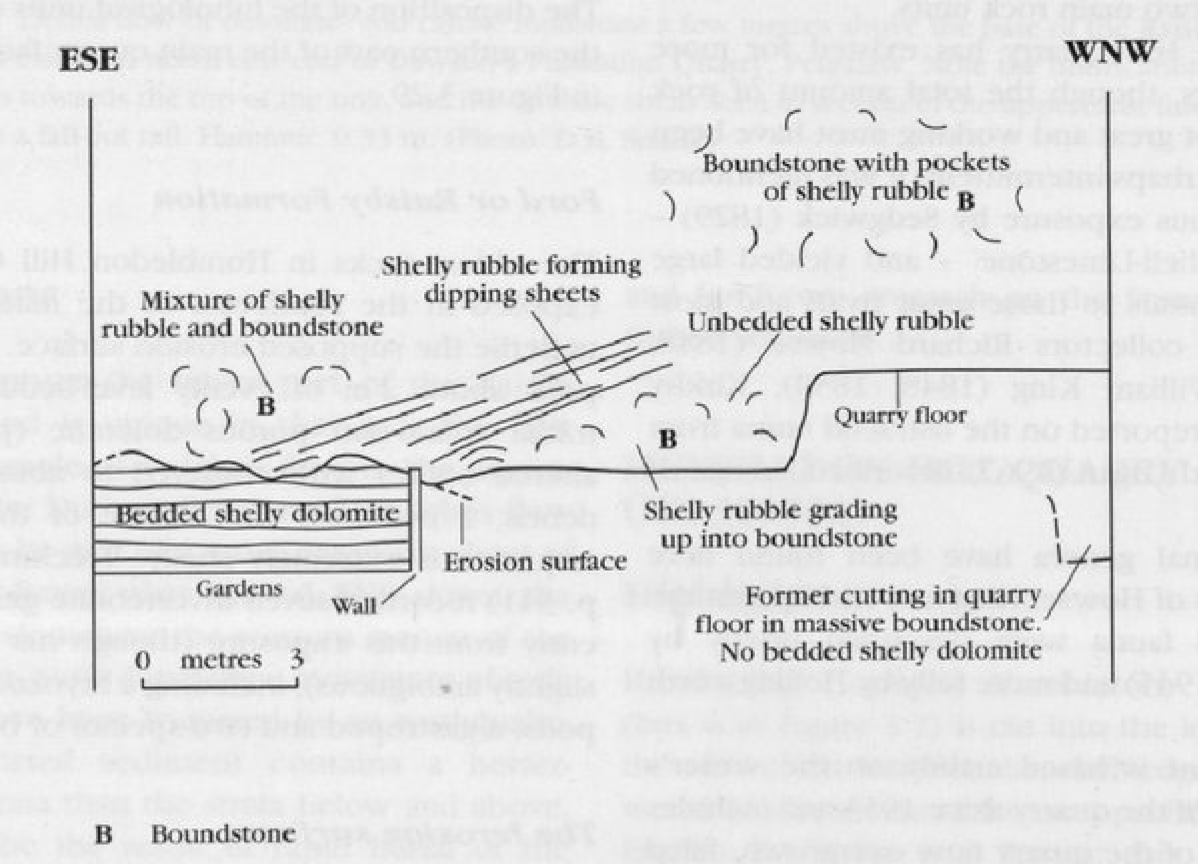
References



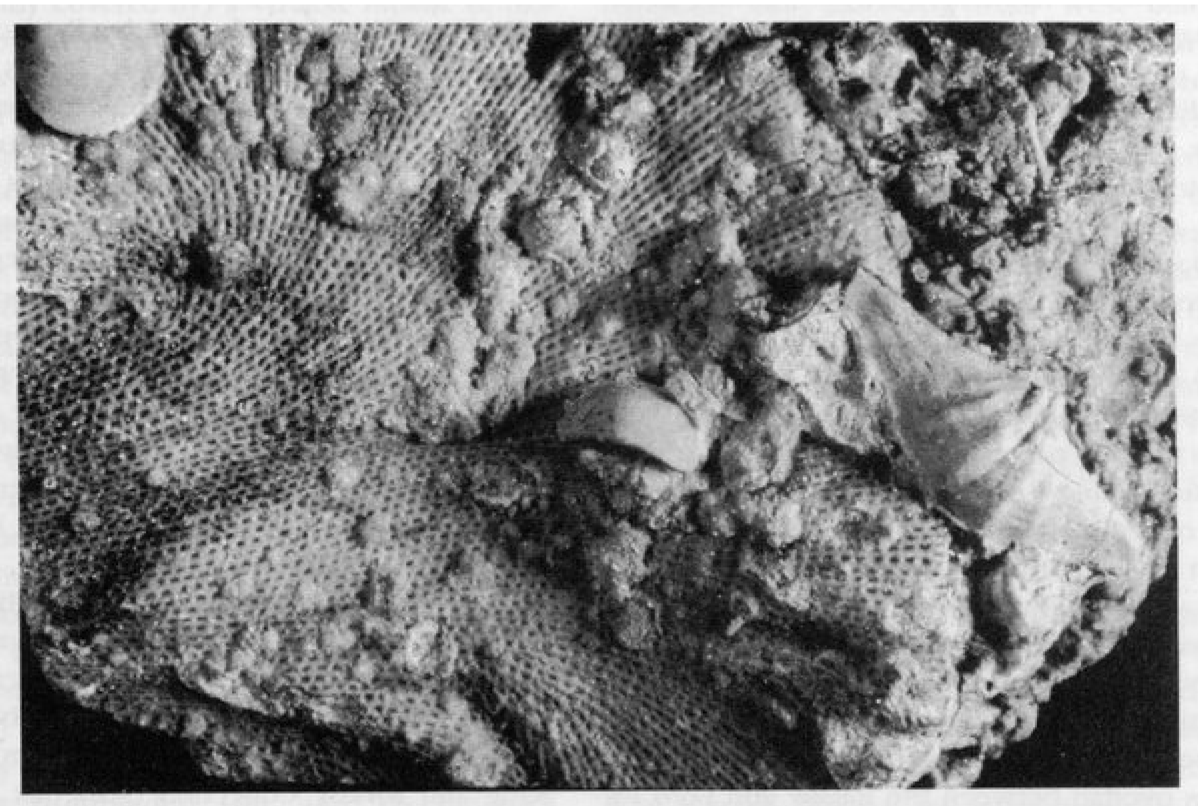
(Figure 3.2) Approximate stratigraphical position of GCR marine Permian sites in the northern part of the Durham Province of north-east England (diagrammatic). Some sites in the southern part of the Durham Province cannot be accommodated on this line of section and have been omitted. The Hartlepool Anhydrite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



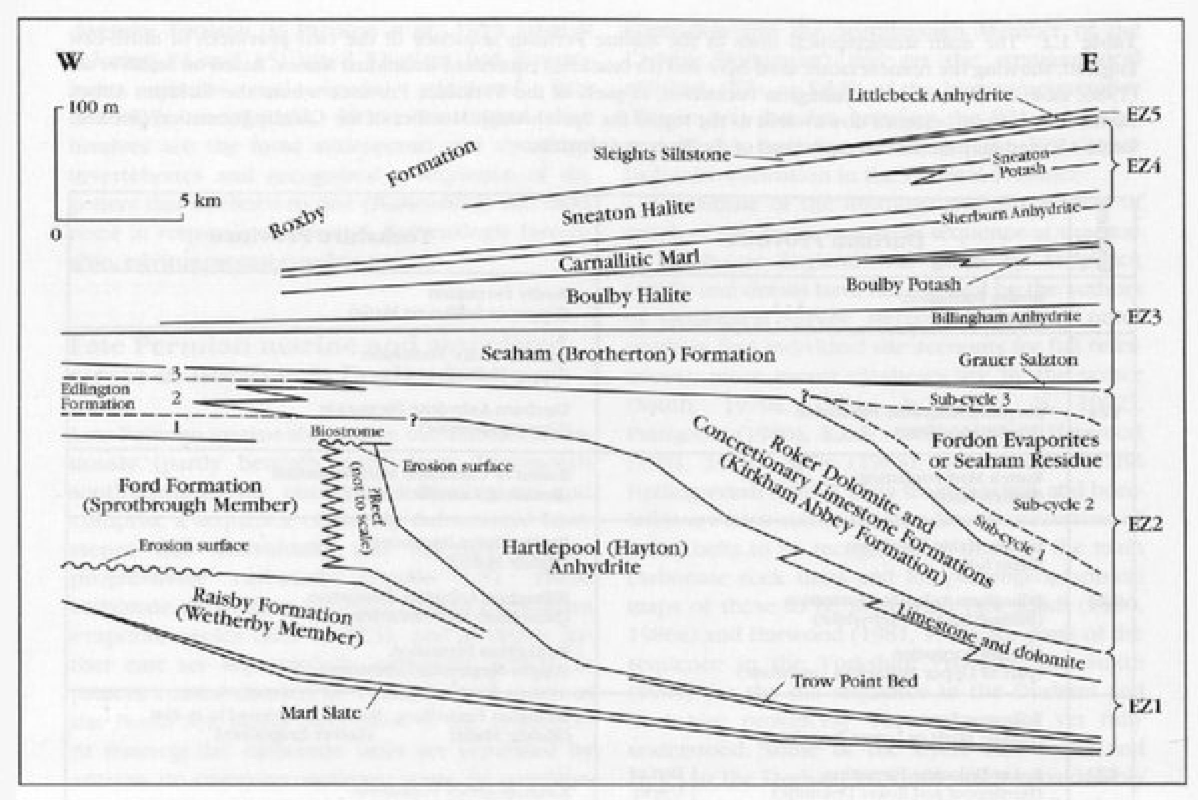
(Figure 3.28) Humbledon Hill Quarry and its immediate surroundings, showing the position of the GCR site and the main features of geological interest.



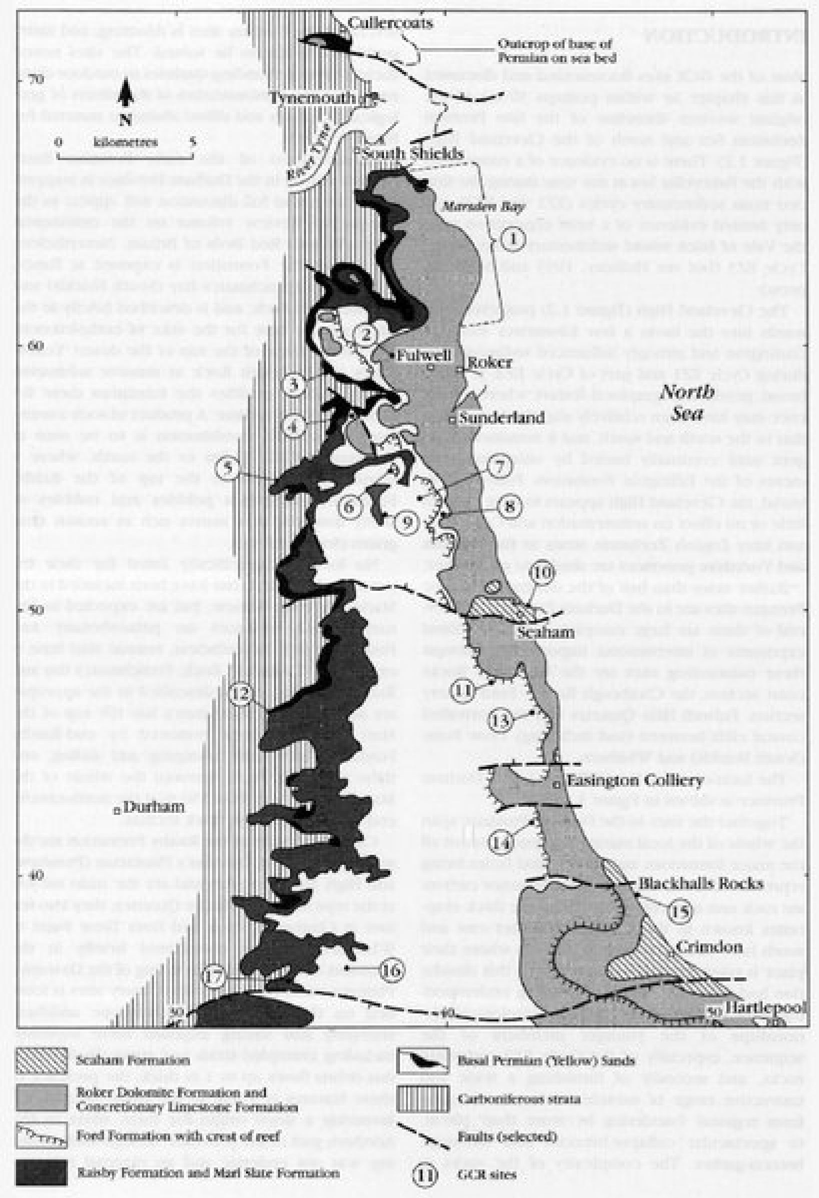
(Figure 3.29) Sketch of the stratal relationships in the southern part of the main face of Humbledon Hill Quarry, based on an unpublished drawing made by the writer in 1953.



(Figure 3.30) Typical elements of the fauna of the boundstone bodies in reef dolomite in Humbledon Hill Quarry, comprising the pinnate bryozoan Fenestella retiformis and the pedunculate brachiopods Dielasma elongatum and Pterospirifer alatus. Field of view about 67 x 100 mm. (Photo: N.T.J. Hollingworth.)



(Figure 1.4) Late Permian (Zechstein) lithostratigraphical units in north-east England; names as in the Durham Province with Yorkshire Province names (where different) in brackets. In Yorkshire, the Wetherby Member and Sprotbrough Member together comprise the Cadeby Formation. The erosion surface shown between the Wetherby and Sprotbrough members is the Hampole Discontinuity which lies up to 3 m below the top of the Wetherby Member; it has not been recorded in the Durham Province. Slightly modified from Smith (1989, fig. 1).



(Figure 3.1) The distribution of Permian marine rocks in the Durham Province, showing the location of Permian marine GCR sites: 1, Trow Point to Whitburn Bay; 2, Fulwell Hills Quarries; 3, Hylton Castle Cutting; 4, Claxheugh Rock, Cutting and Ford Quarry; 5, Dawson's Plantation Quarry, Penshaw; 6, Humbledon Hill Quarry; 7, Tunstall Hills (north); 8, Tunstall Hills (south) and Ryhope Cutting; 9, Gilleylaw Plantation Quarry; 10, Seaham; 11, Stony Cut, Cold Hesledon; 12, High Moorsley Quarry; 13, Hawthorn Quarry; 14, Horden Quarry; 15, Blackhalls Rocks; 16, Trimdon Grange Quarry; 17, Raisby Quarries. The map is based on Smith (1980b, fig. 9).