Horden Quarry

[NZ 435 417]

Highlights

This small and very old quarry (box 14 in (Figure 3.2)) at Borden is now the best of the exposures in north-east England where a one-time crest of the shelf-edge reef of the Ford Formation may be seen and examined. The east side of the quarry also contains indifferent exposures of collapse-breccia (probably mainly of the Roker Dolomite Formation), showing that the Hartlepool Anhydrite, now dissolved, once lay against the steep reef-face here.

Introduction

This excavation, which formerly contained a concrete reservoir, lies near the foot of a steep slope on the west side of Horden township; it should not be confused with Yoden Quarry, which lies on the hill 400 m farther west. The slope into which the quarry is cut roughly marks the position of the seaward margin of the shelf-edge reef of the Ford formation (Cycle EZ1b).

The quarry reveals two exposures of dolomite boundstone and bindstone at a one-time crest of the Ford Formation reef, and an adjoining collapse-breccia probably composed mainly of fragments of the Roker Dolomite Formation. The locality was probably that mentioned by Trechmann (1925) who reported *Epithyris* (*Dielasma*) and several bivalve and gastropod genera from his reef-limestone 'C' from a 'knoll behind Horden Colliery', and brief descriptions and illustrations were given by Smith (in Smith and Francis, 1967, p. 139 and Smith, 1973b, 1981a). The petrography of the reef dolomite at this exposure was considered by Aplin (1985) and the fauna of the rock here was used by Hollingworth (1987, fig. 6.18, reproduced in Hollingworth and Tucker, 1986, fig. 7) as the basis for his graphic reconstruction of a reef crest faunal community. There is some confusion regarding the local source of bivalves collected by Logan (1967), for he appears to have believed that they came from the same locality as those recorded by Trechmann (1925). He attributed them to 'Yoden Quarry (Horden Colliery)'.

Description

The location and outlines of the old quarry at Horden are shown in (Figure 3.50), which also shows the position of the main points of geological interest. (Figure 3.51) shows the section in the main surviving face in the west of the quarry, but similar features are also displayed in the south face.

The main geological interest at Horden is a onetin1e reef crest of the Ford Formation, exposed in two places on opposite sides of the quarry, and the presence of a collapse-breccia of later strata lying against the ultimate steeply-inclined reef-face in the north of the quarry.

Ford Formation, reef crest

The configuration of the reef crest at the old quarry at Horden, as it was towards the end of reef growth, is shown in (Figure 3.52). This crest comprises a sharp transition from almost horizontally, fairly thin-bedded, dolomite boundstone of the reef-flat sub-facies to much thicker bedded, steeply dipping boundstone and bindstone of the uppermost reef slope sub-facies. Exposures near the floor of the western and southern part of the quarry show that the primary dip of the reef slope steepens there to 75° to 85°. The bindstone forms sinuous laminar sheets 0.1–0.3 m thick between exceptionally thick (1–3 m) boundstone beds, but appears to die out or become much thinner, at or just below the crest.

The dolomitized reef boundstone at Horden is a buff-coloured rock with an abundant fauna of low diversity. Lists by Trechmann (1925) and Pattison (in Smith and Francis, 1967) included ramose bryozoans (*Acanthocladia anceps*) and a small number of brachiopod, bivalve, gastropod, foraminifera and ostracod genera. These lists are confirmed by more

detailed collecting by Hollingworth (1987), who quantified the relative proportions of the genera present; his observations showed that the bryozoans *Acanthocladia* (32%) and *Dyscritella* (18%) together make up half of the faunal elements present and that the remainder was dominated by *Dielasma* (18%) *, Bakevellia* (16%) and *Pseudomonotis* (12%). In his reconstruction of the reef crest community, Hollingworth also showed that most of the shelly organisms occupied (and presumably lived in) spaces in the tangled masses of *Acanthocladia zoaria,* and that most of the latter were heavily encrusted with ?algal laminae. Hollingworth (1987) found that almost all the *Dielasma* present in his sample died before reaching maturity, but only about 5% of the *Pseudomonotis speluncaria* collected by Logan (1967) were juveniles.

The laminar bindstone sheets between the massive boundstone beds are buff-cream in colour and are composed of finely crystalline, slightly calcitic dolomite. They are mainly lacking in skeletal fossils, but patches of densely crowded *Dielasma* and bivalves, and scattered fragments of bryozoans, occur parallel with the lamination of some of the sheets (Smith, 1981a). Presumably these organisms were all firmly attached to the seaward face of the reef. Bioclasts were also recorded by Aplin (1985, p. 92) in the algal-laminated lining of vertical tension fissures in reef-flat boundstone just landward (i.e. west) of the reef crest here, where fissures were bridged by reef-flat boundstone.

Roker Dolomite Formation, collapse breccia

Hard grey limestone (dedolomite) collapse breccia, with some residual cream dolomite, is poorly exposed in the eastern part of a low rock eminence in the north of the quarry. The rock comprises angular fragments, up to a few centimetres across, of finely crystalline limestone in a grey to brown dense calcite matrix; few traces of its original lithology remain. Because of the poor quality of the exposure, the sub-vertical contact with the reef slope is somewhat obscure, but its approximate position and trend are shown in (Figure 3.50).

Interpretation

Horden Quarry is of major importance, firstly in being the only good and readily accessible exposure of rocks formed at the crest of the shelf-edge reef of the Ford Formation, and secondly, because it illustrates the juxtaposition of the steep Cycle EZ1 reef slope and the Cycle EZ2 collapse-breccia. The exposures are thus vital links in the chain of evidence leading to present understanding of the reef profile, its communities and the mutual relationships of the reef and the Hartlepool Anhydrite.

Ford Formation, reef crest

The ultimate reef crest (i.e. that formed just before the reef ceased to grow) has been eroded off at the Horden exposure but, by comparison with former exposures at Hawthorn Quarry site (Figure 3.47) and at an old quarry [NZ 436 437] at Easington Colliery (Figure 3.53), was probably only a few metres above present ground level. Elsewhere, the ultimate reef crest is exposed inaccessibly high in the north face of the working quarry [NZ 476 344] near Hart, and earlier reef crests are indifferently exposed at Ford Quarry SSSI and in the Stony Cut site [NZ 418 473], Cold Hesledon. As at Hawthorn Quarry, the relative thickness of the reef-flat and equivalent reef slope rocks at Horden and Easington Colliery show that the reef crest pro-graded basinward three to six times faster than it grew upward, perhaps because its upward growth was limited by an approach to sea level. There are, indeed, hints at all three quarries that, at times, the reef crest prograded without any corresponding build-up of its surface or even with reef-top erosion during phases of slightly lowered sea level.

The exposure of the ultimate reef-face in the old quarry (now filled) at Easington Colliery was uniquely important in that the youngest of the steeply-dipping laminar bindstone sheets was characterized by two short courses of unmistakable columnar stromatolites (Smith, 1981a, fig. 22). This showed that at least the last of the laminar sheets was a reef-face coating, perhaps implying a similar origin for the other steeply-dipping laminar sheets; probable stromatolitic laminite with domes up to 0.3 m across also coats the seaward face of the reef in the quarry at Hart, where the ultimate upper reef slope has a primary dip of 75–85° throughout its exposed height of about 13 m. The presence of a double layer of short columnar stromatolites on the outermost steep reef slope in the quarry at Easington Colliery invites comparison with parts of the Trow Point Bed (Smith, 1986; also this volume), which, in places, similarly comprises two short courses of

columnar stromatolites and similarly lies immediately below the dissolution residue of the Hartlepool Anhydrite.

The faunal assemblage of the reef crest is of considerable interest in that it comprises only genera that could withstand high energy conditions and maintain their position on a near-vertical slope. The dominance of sessile flexible and robust bryozoans is predictable and, except for small gastropods, most of the shelly animals were adherent or encrusting forms. The smoothly even curvature of the crest, as compared with the sharply ragged angularity of some modern counterparts, presumably results from the smaller size of the late Permian reef frame builders and the abundance of laminar ?algal sheets.

From the known position of the reef crest and of two former quarries on top of the hill immediately west of the Horden exposure, the shelf-edge reef of the Ford Formation is shown to be at least 400 m wide between Peterlee and Horden. Its clear topographical expression here, at Easington Mill Hill and in Easington Colliery township, implies that a major reef re-entrant may be present between Horden and Easington Colliery, with the reef crest stepping back some 1.2–1.5 km to the west of its main position. It is not known whether the reef was continuous around this inferred reentrant or whether, as is equally possible, it was discontinuous and present in sub-parallel stretches separated by open sea or large surge-channels. There is similar uncertainty over comparable re-entrants near Seaham and between Blackhalls Rocks and Hartlepool (see (Figure 3.1)).

?Roker Dolomite Formation, collapse-breccia

The juxtaposition of the reef slope and collapse-brecciated Roker Dolomite at Hawthorn Quarry, Easington Colliery and Horden indicates that here the Hartlepool Anhydrite must, before its dissolution, have lain against the steep reef slope and been at least as thick (?80–110 m) as the height of that slope. Foundering of the Roker Dolomite and higher strata in each place must have been by a similar amount, less a proportion resulting from a lower packing density, and was probably episodic. As at Hawthorn Quarry and in the nearby coastal cliffs, the foundering at Horden probably also involved the Hesleden Dene Stromatolite Biostrome that formerly overlay the reef, and must have affected all strata above the Roker Dolomite Formation. As elsewhere in the area to the south of Ryhope, reaction of the reef dolomite with brines rich in calcium sulphate from the dissolving anhydrite is assumed to have caused the dedolomitization in the collapse-breccia, but very little of the adjoining reef-rock at Horden has been dedolomitized.

Future research

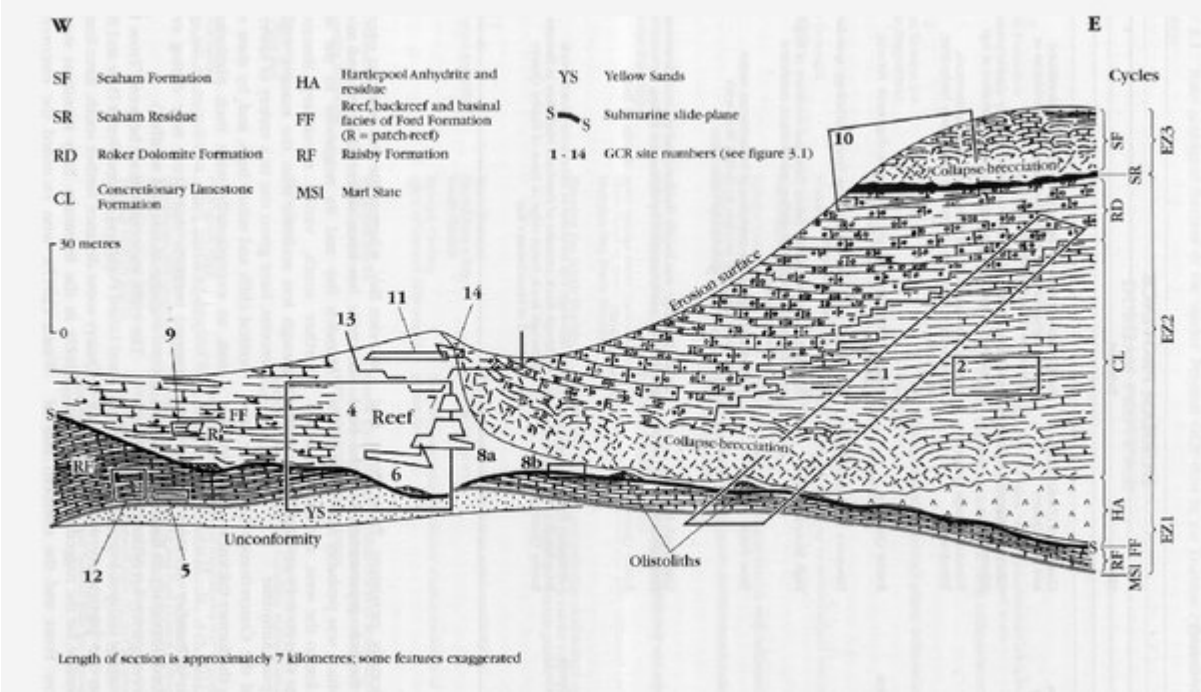
The stratigraphy, palaeontology and petrology of this small but important exposure have all been investigated in considerable detail since 1980, and there is probably little immediate scope for further research on most aspects of the rocks exposed. Possible exceptions to this are a more detailed analysis of differences and similarities of faunal communities behind and in front of the reef crest and further research on the laminar sheets to determine if, like the youngest sheets at the Easington Colliery exposure, they are indeed stromatolitic in origin and at one time draped the seaward face of the reef.

Conclusions

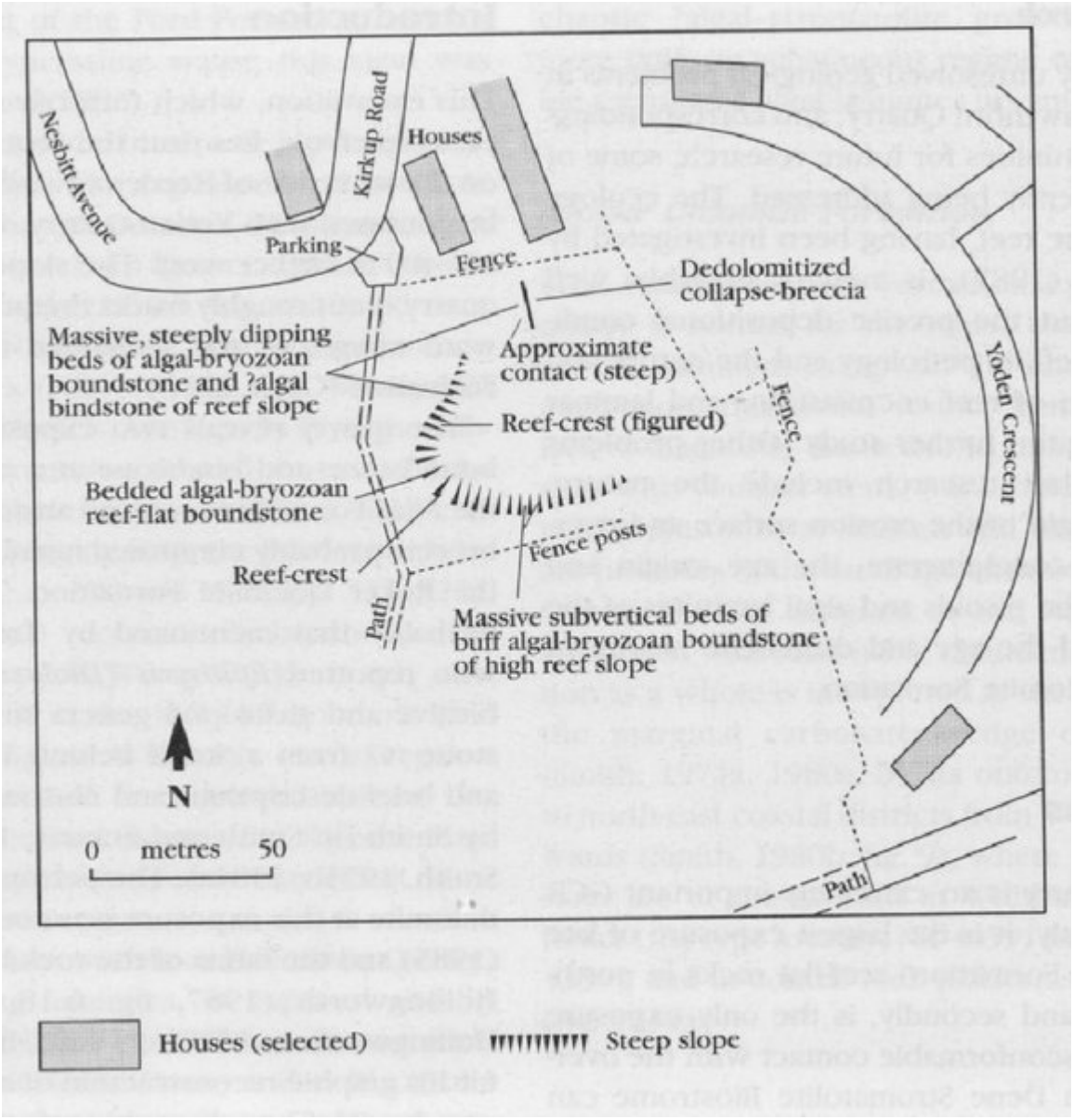
This is the only GCR site where the one-time crest of the shelf-edge reef of the Ford Formation can still be seen in juxtaposition with collapse-breccias of the Roker Dolomite Formation. The reef crest is characterized by a sharp change from gently-dipping, mainly thin-bedded dolomite of the reef-flat to thicker bedded, steeply-dipping dolomite of the uppermost reef slope. The reef contains frame-building bryozoans and shelly fossils, the former encrusted with ?algal laminae.

The breccias comprise angular rock fragments with little evidence of the original lithology. The close juxtaposition of reef slope rocks and the breccias suggest that the Hartlepool Anhydrite must have lain against the reef slope before its dissolution. Both the exposure of the reef crest and the opportunity to relate the position of the reef to the anhydrite to the east, mark this site as being extremely important for the study of the stratigraphy and sedimentology of the late Permian marine rocks in Durham.

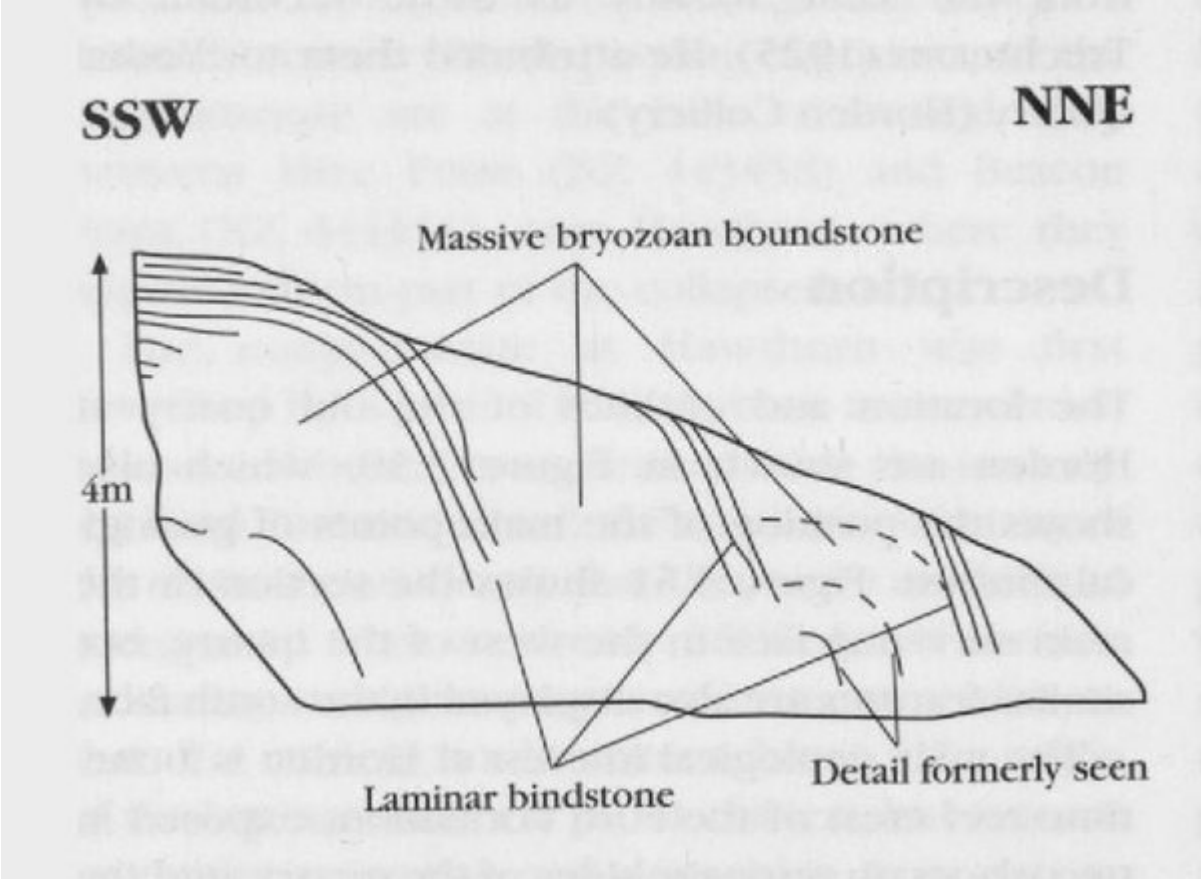
References



(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.

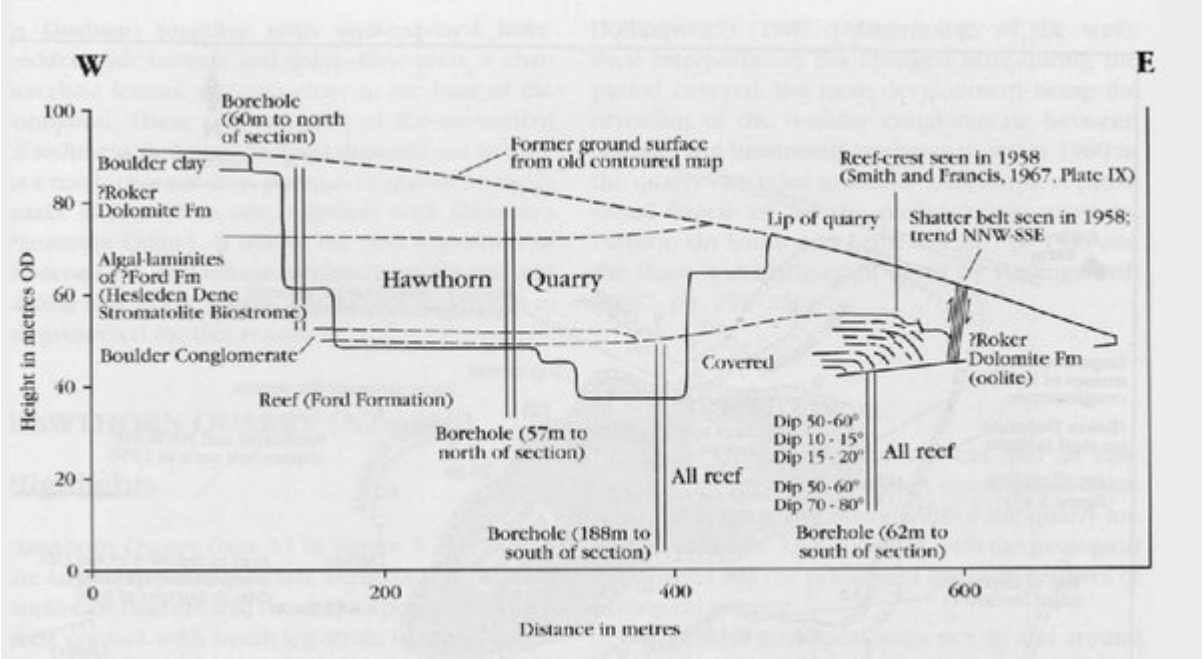


(Figure 3.50) Location of Horden Quarry and the main features of geological interest.

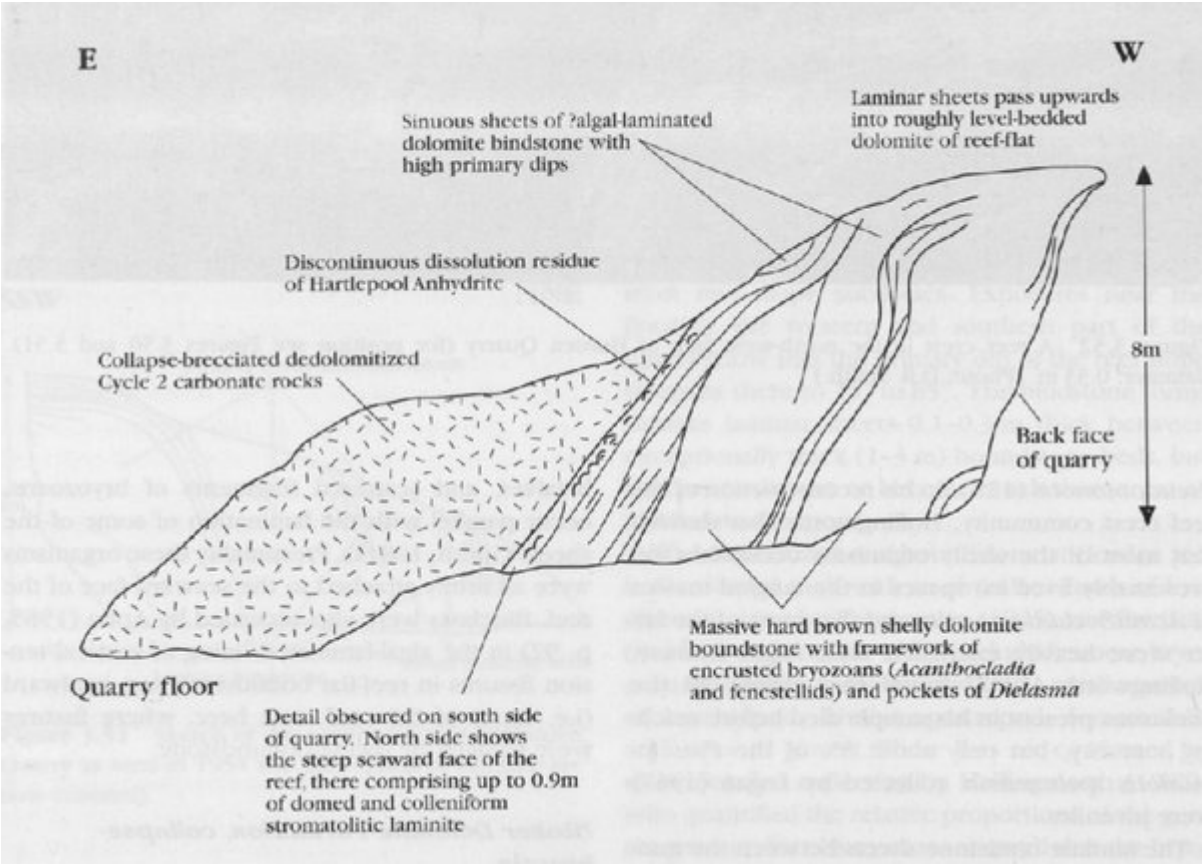


(Figure 3.51) Sketch of the north-west face of Horden Quarry as seen in 1954 and later (parts of the face are now covered).

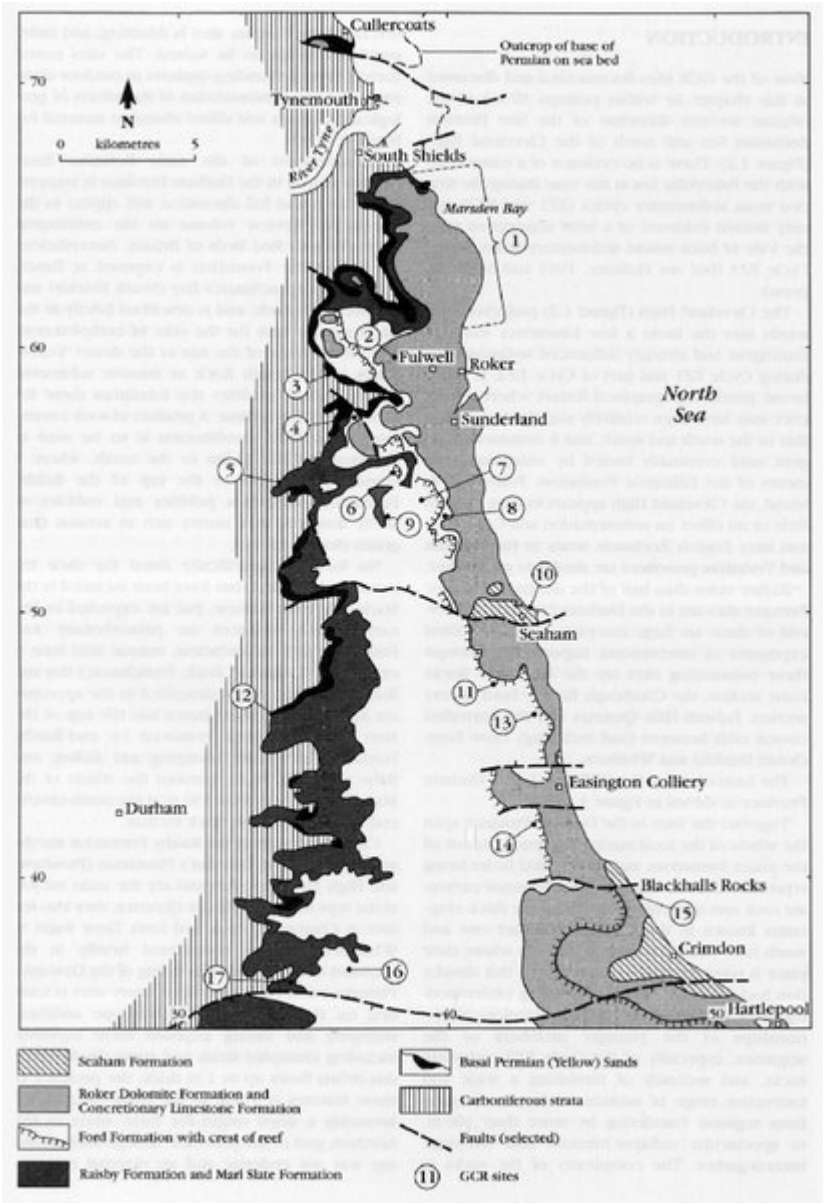
(Figure 3.52) A reef crest in the north-west face of Borden Quarry (for position see (Figure 3.50) and (Figure 3.51)). Hammer: 0.33 m. (Photo: D.B. Smith.)



(Figure 3.47) Section across Hawthorn Quarry, showing the relationships of the main geological features. The line of section is shown in Figure 3.46.



(Figure 3.53) South side of old quarry (now filled) on the east side of Townfield Hill, Easington Colliery, showing the crest and stromatolitic seaward face of the shelf-edge reef, and succeeding residue and collapse-breccias. This quarry was recommended for SSSI designation but was filled before action could be taken; it is included here for the purposes of comparison.



(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).