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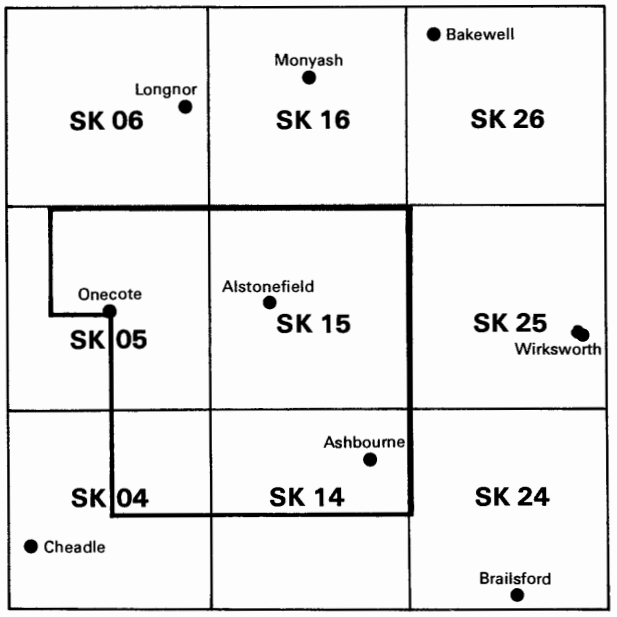


# The limestone and dolomite resources of the country north and west of Ashbourne, Derbyshire

## Description of 1:25 000 sheet SK 15 and parts of 04, 05 and 14

D. McC. Bridge and D. S. Kneebone



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The first twelve reports on the assessment of British sand and gravel resources appeared in the report series of the Institute of Geological Sciences as a subseries. Report 13 and subsequent reports, which include a number of limestone resource studies, appear as Mineral Assessment Reports of the Institute.

Details of the published reports appear at the end of this report.

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*The asterisk on the cover indicates that parts of sheets adjacent to the one cited are described in this report.*

**PREFACE**

National resources of many industrial minerals may seem so large that stocktaking appears unnecessary, but the demand for minerals and for land for all purposes is intensifying and it has become increasingly clear in recent years that regional assessments of resources of these minerals should be undertaken. The publication of information about the quantity and quality of deposits over large areas is intended to provide a comprehensive factual background against which planning decisions can be made.

The interdepartmental Mineral Resources Consultative Committee recommended that limestone should be investigated, and following a feasibility study initiated in 1970 by the Institute and funded by the Department of Education and Science, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys in 1972. The work was subsequently financed by the Department of the Environment and was undertaken with the co-operation of members of the British Quarrying and Slag Federation.

This report describes the limestone and dolomite resources of some 150 $km^2$ of country to the north and west of Ashbourne, Derbyshire, shown on the accompanying 1:25 000 resource map.

The assessment was based on a geological survey at the 1:10 560 scale carried out between 1969 and 1977 by Dr N. Aitkenhead and Messrs J. I. Chisholm, I. P. Stevenson, T. J. Charsley and D. Price. Dr Aitkenhead and Mr Chisholm compiled a number of the figures contained in this report and provided much useful advice.

Chemical analyses were carried out by Mr. A. E. Davis and Mr A. N. Morigi of the Institute's Analytical Chemistry Unit.

Mr C. L. Reeves (land agent) was responsible for negotiating access to land for drilling. The ready co-operation of landowners, tenants and quarrying companies in the work is gratefully acknowledged.

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# The limestone and dolomite resources of the country north and west of Ashbourne, Derbyshire

Description of 1:25 000 sheet SK 15 and parts of 04, 05 and 14

D. McC. Bridge and D. S. Kneebone


## SUMMARY

The study of samples from 25 cored boreholes, 56 major sections and a large number of small exposures, together with information from the records and geological maps of the Institute, form the basis of the assessment of limestone and dolomite resources in the country lying to the north and west of Ashbourne, Derbyshire.

The limestones have been classified on the basis of their calcium carbonate content, and the accompanying 1:25 000 resource map shows the distribution of the recognised categories of limestone at or near to the surface. Horizontal sections constructed from the borehole data and from knowledge of the regional geology indicate the categories likely to be encountered at depth.

Three resource blocks have been outlined and for each, the geology, the categories of limestone and the occurrences of other rocks are described. The results of investigations of chemical and mechanical properties are presented with outline borehole logs and the data are statistically analysed for the stratigraphical units described.



**Bibliographical reference**

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## INTRODUCTION

In recent years concern for environmental planning has made it clear that more detailed and comprehensive information on limestone resources is required. This information is needed to facilitate land-use and mineral planning by central and local government and to assist in the formulation of national policies to ensure continuing supplies to all industries for which limestone is an essential raw material. Ideally the information should relate to all the uses of this commodity ranging, for example, from crushing strength which relates to its use as aggregate, to trace-element composition, important in more specialised uses, for example, glass and steel manufacture. The provision of information on limestone resources is particularly important in regions such as Derbyshire and north Staffordshire which contribute significantly to the country's production of raw materials and are noted also for their high scenic and amenity value. In 1979 the two counties produced 17.7 million tonnes of limestone from the Lower Carboniferous outcrop, representing 21 per cent of national production (Institute of Geological Sciences, 1981a); the cement, steel and chemical industries accounted for 39 per cent of the tonnage, the remainder being used for constructional purposes. This report describes the resources along the southern margin of the limestone crop and is one of a series of reports covering the region.

The material for study has been obtained from cored boreholes, natural sections and quarries. The petrology, chemistry and certain physical properties of the samples have been determined in the laboratory and the rocks have been classified in terms of their calcium carbonate ($CaCO_3$) content so that the relation between limestone purity and possible end-use may be deduced. Detailed results are set out in the report and its appendices and geological resource information is summarised on the accompanying map. A glossary is appended.

## DESCRIPTION OF THE DISTRICT*

### General

The area covered by this report lies mainly within the Peak District National Park and encompasses parts of West Derbyshire, Staffordshire Moorlands and East Staffordshire (Figures 1 and 2). Although relatively sparsely populated, the district lies within easy striking distance of the main conurbations of the English Midlands. Ashbourne, with a population of about 5500, is the largest town in the district and serves as a commercial centre for the villages and farmsteads in the outlying areas. Agriculture is one of the mainstays of the local economy but mineral extraction and tourism are also important.

Limestones underlie the northern and central parts of the district and give rise to a gently rolling plateau, most of which is pastoral farmland characterised by small fields enclosed by dry stone walls. The plateau is deeply dissected by the steep-sided and wooded valleys of the River Dove and its two main tributaries, the Manifold and the Hamps; there are also numerous

* The term 'district', as used here, refers to the area covered by the assessment report.

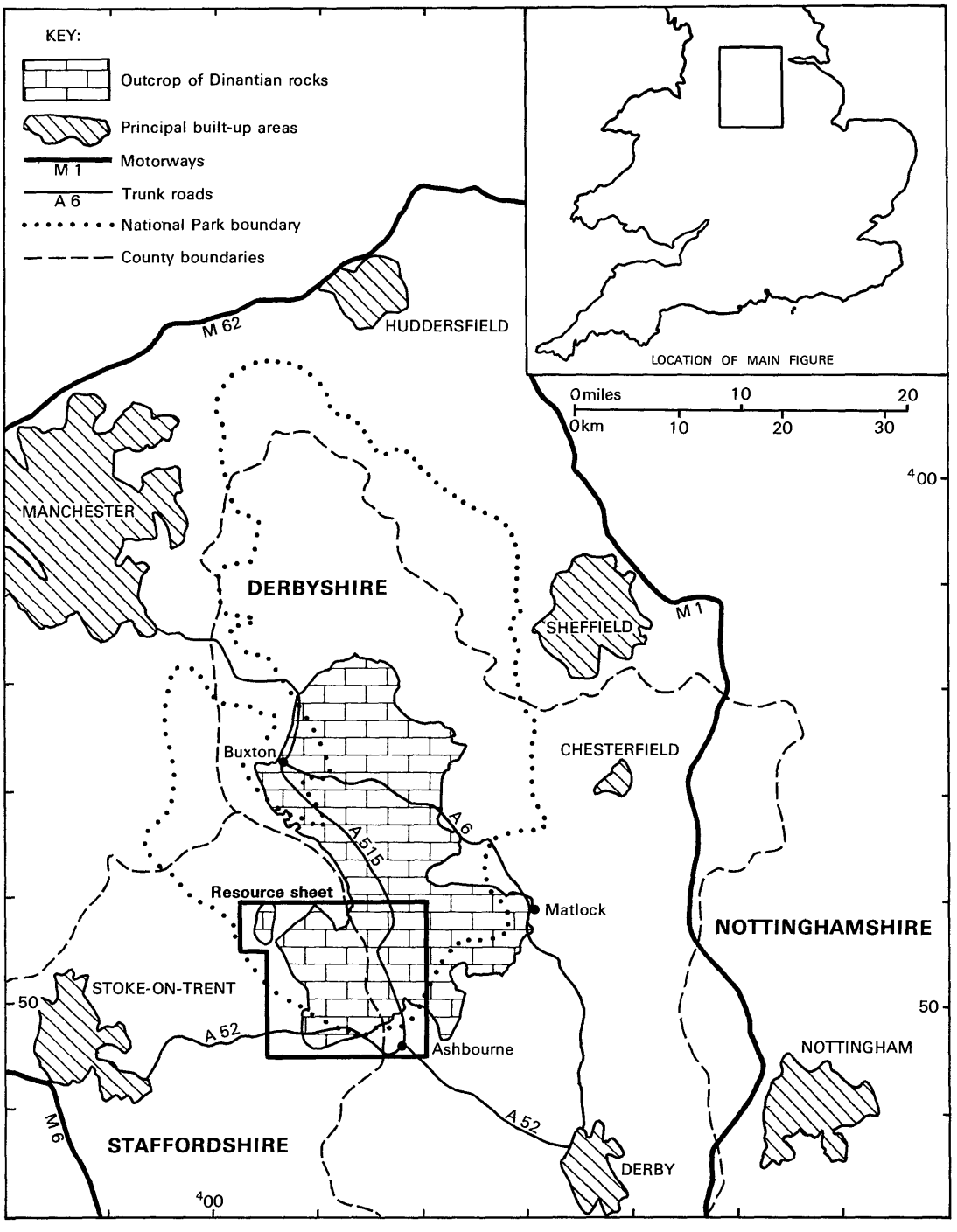



**Figure 1** Location of the resource sheet area.

smaller dry valleys. In Dovedale and along the Manifold valley, near Wetton, the rivers cut through upstanding limestone reefs and provide some of the most impressive scenery in the region. In the south-west, beyond the National Park boundary, the ground rises towards a north-west- to south-east-trending escarpment known as the Weaver Hills; it is here that most of the working quarries are located. Away from the main limestone crop the character of the landscape alters; extensive tracts of moorland rising to over 450 m above sea level are developed on the sandstones and shales which underlie the north-west of the district, while in the lowland areas in the south-east similar rocks produce more fertile pasture enclosed by hedgerows rather than by dry stone walls.

Surface drainage is well-developed on the shales but on the limestone crop both the River Manifold and the River Hamps disappear underground in periods of low flow.

The district is crossed by two east-west primary roads through Ashbourne (the A52 and the A523) and there is also a north-westerly link (the A515) to Buxton and the Manchester conurbation. A mineral line joins Caldon Low Quarry [078 487] with the mainline rail network.

## Geological setting

The Lower Carboniferous (Dinantian) Series is essentially a marine sequence composed mainly of limestones but also containing some shales and sandstone units. During late Dinantian times shallow well-oxygenated seas were established in the north of the district (The Derbyshire shelf) and also, on a smaller scale, in the south-west (the Staffordshire shelf) while a tract of generally deeper

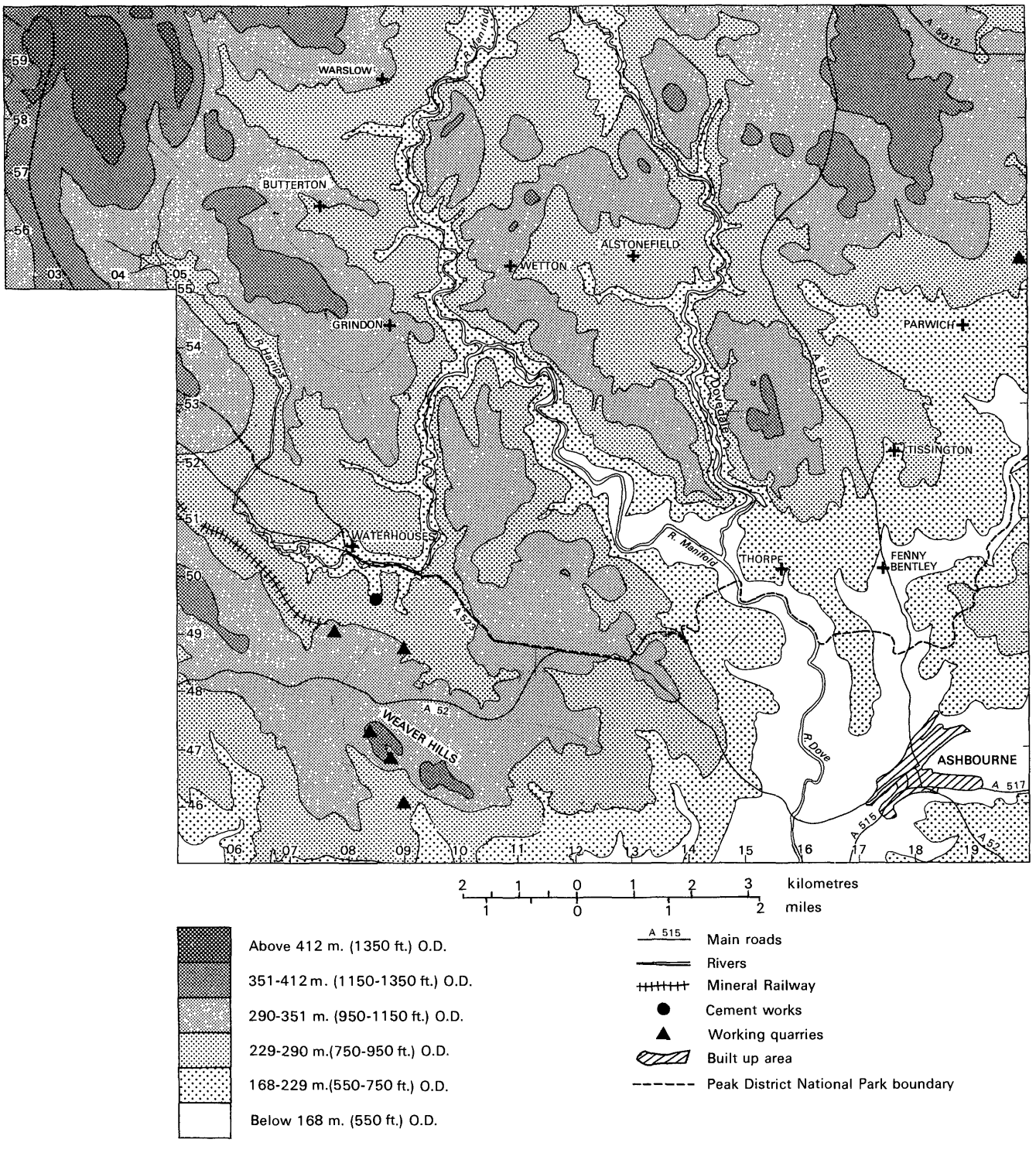



**Figure 2** Topography.

water with local shoals covered the intervening 'off-shelf' area (Aitkenhead and Chisholm, 1982). During the early Dinantian, carbonates were probably deposited throughout the district but shelf and off-shelf provinces cannot be distinguished. On the late Dinantian shelves carbonate sedimentation proceeded in clear seas free from terrigenous material and the resulting limestones are distinctive for their paleness and lithological uniformity over wide areas. In the early Dinantian, and in the late Dinantian off-shelf province, a much more varied sequence was laid down. Initially carbonate sedimentation predominated; knoll-reefs and associated inter-reef limestones formed in the central part of the district while, simultaneously, well-bedded limestones of more uniform lithology accumulated in the south-west around Caldon Low. In the late Dinantian, however, clastic sedimentation became more important, resulting eventually in the widespread deposition of sandstone-shale and limestone-shale turbidites between the shelf areas.

Volcanic activity never reached the intensity seen in other parts of Derbyshire (Cox and Harrison, 1981) but during the closing stages of the Dinantian a series of submarine volcanic eruptions occurred in the south-east of the district, spreading tuff and fragmented lava over several square kilometres.

Carbonate deposition diminished towards the end of the Dinantian and was largely succeeded by that of mudstones and sandstones of Upper Carboniferous (Namurian) age, the outcrop of which now surrounds that of the Dinantian rock.

The main phase of deformation took place at the end

of the Carboniferous period although some folding and faulting of the strata may have occurred contemporaneously with deposition. The effect of the earth movements on the shelf limestones was relatively minor but those of the intervening area were arched-up into a series of major north- or north-north-westerly-trending anticlines and synclines (see diagram on resource sheet).

Local alteration of the limestones to dolomite occurred probably during Permian times, when magnesium-bearing solutions could have been introduced down joints from a hypersaline sea which it is thought may have covered the region during this period. Some of the magnesium may also have been introduced during the episodic mineralisation which took place from late Carboniferous through to Jurassic times, when fissures in the limestone were infilled with gangue minerals, mainly calcite with some baryte, locally containing copper, lead, zinc and hematite ores.

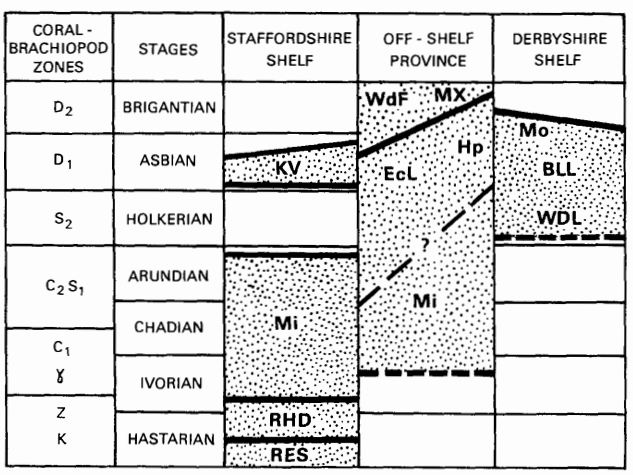
Renewed uplift during the Tertiary led to the removal of the post-Dinantian cover rocks and the deposition on the limestone surface of clays, sands and gravels of fluvial origin. These deposits are now only preserved in steep-sided solution hollows and are collectively termed Pocket Deposits.

Boulder clay dating from the Quaternary Ice Age is the most widespread superficial deposit, forming sheets up to a few metres in thickness; there are also patches of head in hollows, and strips of alluvium in the floors of the main valleys.

**Stratigraphical nomenclature**

The geology of parts of the district has been described in pioneering works by Parkinson (1950), Prentice (1951) and Ludford (1951); more recent useful summaries include those of Parkinson and Ludford (1964) and Ludford (1970). The stratigraphical nomenclature adopted on the Institute's 1:50 000 geological maps of the district (Sheets 111 and 124) has been defined by Aitkenhead and Chisholm (1982) and their paper is the source of much of the stratigraphical information contained in this report. The formations that have been distinguished in each of the three resource blocks are listed in Table 1, together with a summary of the stratigraphical relations as they are at present understood. The formations have been defined mainly on the basis of lithology but also on the evidence of contained fossils. More detailed stratigraphical information is presented in the section 'Resource Block Descriptions'.

**Table 1** Nomenclature and age relations of the Dinantian formations (based on Aitkenhead and Chisholm, 1982)




| | | | |
|---|---|---|---|
| **KV** | Kevin Limestones | **Hp** | Hopedale Limestones |
| **Mi** | Milldale Limestones | **EcL** | Ecton Limestones |
| **RHD** | Rue Hill Dolomites | **Mo** | Monsal Dale Limestones |
| **RES** | Redhouse Sandstones | **BLL** | Bee Low Limestones |
| **WdF** | Widmerpool Formation | **WDL** | Woo Dale Limestones |
| **MX** | Mixon Limestone-Shales | | |

**Mineral extraction**

Quarrying is concentrated in a small area of the Weaver Hills, except for one operation located within the National Park (Figure 2). Three of the quarries (Kevin, Wredon and Ballidon) are sited in shelf limestones and produce mineral of high chemical purity; the remainder produce stone of slightly more variable quality. Limestone from Cauldon Quarry is mixed with Namurian shales to provide the raw materials for the local cement works. The stone from the other quarries is used primarily for aggregate but the higher quality grades also go for agricultural and non-constructional uses (sugar processing, rubber, plastics and animal feedstuffs). Caldon Low Quarry is the only site with a link to the mainline rail network. Production levels range between 0.5 and 1 million tonnes per year, except for the quarry at Wredon which has only been re-opened in recent years and is a much smaller operation. The locations of all the active quarries are shown on the resource map.

## ASSESSMENT PROCEDURES

Following a desk study, a field survey was mounted and representative rocks were sampled for processing in the laboratory.

**Field survey**

As modern 1:10 560-scale geological maps were available, the first phase of the fieldwork involved examining the extensive natural exposures and quarries in the district and collecting representative material at 1 m intervals from some of them. Sampling of chert was generally avoided but, when present in the rock, its percentage was estimated by direct measurement on the rock-face. To provide additional data in areas where information was scanty, 24 boreholes were drilled to depths ranging from 60 to 140 m and continuous cores of 47 mm diameter were obtained. Material was also made available from a deep borehole drilled near Caldon Low in 1977 for the Land Survey Division.

**Laboratory programme**

All core and section material was sawn in half, acid-etched and then lithologically logged.

The colour of the acid-etched stone was determined using an EEL reflectance spectrophotometer (Cox and others, 1977, p 7) and the values recorded were used to classify the material as 'pale grey', 'mid-grey' or 'dark grey' in colour. The limiting percentage reflectances selected to define these colour bands are listed in Table 2.

The colour of the rock powder is important if the material is to be used as a whitening agent, or, in an end-use where the colour of the manufactured product is critical. Hence reflectance measurements were also taken on pressed discs prepared from finely powdered samples (<63 micrometres particles size) of the high and very high purity limestones in each formation.

The purity of the carbonate rocks was determined systematically by measuring the amount of the acid-insoluble residue (Molinia, 1974) in successive 1 m samples. Additionally, chemical analyses were performed on selected samples. Major elements (Ca, Mg, Si, Al, Na, K, S, P, F, Fe) were determined by direct electron excitation X-ray spectrometry, trace elements (Cu, Pb, Zn, Mn, Fe (if less than 0.1 per cent)) by atomic absorption and As by colorimetry (Roberts and Davis, 1977).

In order to assess the likely performance of the rock as an aggregate, samples of borehole core and section

**Table 2** Rock colours defined by limiting reflectance percentages with reference to three filters and a $MgCO_3$ standard

| Colour | Limiting reflectance percentages | | |
|---|---|---|---|
| | 660 nm | 520 nm | 470 nm |
| Pale grey | >35 | >26 | >24 |
| Mid-grey | 35 to 15 | 26 to 12 | 24 to 11 |
| Dark grey | <15 | <12 | <11 |

material were subjected to the Aggregate Impact Value (AIV) test of B.S. 812 (British Standards Institution, 1975). Samples were prepared from the borehole core by crushing successive 10 m lengths of halved core in a laboratory jaw-crusher; in the case of section material it was found that about 4 kg of uncrushed stone were required to provide sufficient material for one test. Material collected during the early stages of the survey was tested with the rig mounted on a solid wooden base, following the work of Ramsay (1965). Although the results were internally consistent, they were difficult to relate directly to those obtained when using the machine in accordance with the British Standard procedure which states that the rig must be mounted on a concrete block. Consequently, for the latter part of the project, the procedure recommended in B.S. 812 was adopted and in this report all the 'wood-based' results have been converted to equivalent British Standard values (see Cox and Harrison, 1981, p 134-136 for details of conversion scheme).

Aggregate abrasion values were also determined for a limited number of samples.

**Classification**

Two classifications of limestones have been used in this report, one based on petrology and the other on calcium carbonate ($CaCO_3$) content. The former is used to describe the rocks in lithological terms and the latter is preferred for demonstrating the variation in purity of the resources. The relationship between the five purity categories adopted, their $CaCO_3$ contents and possible end-uses are shown in Table 3.

## THE RESOURCE MAP

The limestone and dolomite resource map is folded into the pocket at the end of this report. The base map is the Ordnance Survey 1:25 000 Outline Edition on which resource information is shown in shades of blue, grey and green.

Geological data Geological boundary lines, shown in green, are taken from recent 1:10 560 scale geological maps prepared by the Institute's N. W. England Field Unit. Faults, mineral veins and other structural data likely to have a bearing on the extraction of the limestone and dolomite are shown in red, and drift-covered areas in yellow.

Carbonate resource information Shades of blue are used in each of the three designated resource blocks to indicate the distribution of high calcium limestone ($CaCO_3$ ≥93.5 per cent) at or near the surface. The same colour scheme is used to show the variation in purity of the resources at sample sites. In areas shaded pale grey or brown, the limestones are commonly of lower purity, or the purity is too variable to be predicted with certainty. In these areas resource information is presented on a formational basis and at a more generalised level. Areas of dolomite or dolomitised limestone, where mapped, are indicated in green.

IMAU site data At the site of each borehole, the lithostratigraphical sequence is summarised in a tablet and the purity of the limestone is indicated. Purity values were determined as follows: the measurements of insoluble residue (that is, the non-carbonate fraction) were grouped into successive 10 m sets. For each group, the mean, standard deviation and confidence limits were calculated at the 95 per cent probability level, assuming the student's 't' distribution. The mean and positive confidence limit were summed to give a value which, when subtracted from 100, gave a conservative (worst) estimate of the calcium carbonate percentage for each thickness increment. This value then determined the category of limestone according to the classification in Table 3.

At natural section and quarry sites, the approximate thickness and overall purity of the sampled sequence is indicated using a simple box format. The elevation recorded is that of the highest stratigraphical horizon collected.

Horizontal sections These have been drawn to show the relationship of the various limestone categories at depth. The sections are based directly upon borehole information, the structure as determined from field evidence, and the relationship of the various categories of limestone to the known stratigraphical sequence. They represent, therefore, an interpretation based upon all the

**Table 3** Classification of limestones by purity with some possible industrial uses

| Category | Percentages | | Possible uses |
|---|---|---|---|
| | $CaCO_3$ | Equivalent CaO | |
| 1 Very high purity | ≥98.5 | >55.2 | Steel, glass, rubber, plastics, paint, whiting |
| 2 High purity | ≥97.0 to <98.5 | ≥54.3 to <55.2 | Iron, ceramics, Portland cement, sugar |
| 3 Medium purity | ≥93.5 to <97.0 | ≥52.4 to <54.3 | Paper, animal feeding stuffs, agriculture |
| 4 Low purity | ≥85.0 to <93.5 | ≥47.6 to <52.4 | Aggregates |
| 5 Impure | <85.0 | <47.6 | Natural cement, mineral wool |

Note $CaCO_3$ content is only one of several chemical specifications governing end-use; for example, silica, iron, sulphur and certain trace elements may be as important in some applications.

available data and should be treated only as a guide to the likely distribution of purity at depth. Zig-zag lines have been used diagrammatically to indicate the approximate position of a change in limestone category.

## RESOURCE BLOCK DESCRIPTIONS

For convenience, the limestone is divided into three resource blocks: Block A includes the limestones of the Derbyshire shelf, Block B includes those of the Staffordshire shelf and Block C encompasses the intervening area.

### BLOCK A

This block is located at the southern end of an extensive shelf province which in late Dinantian times stretched northwards for some 25 km to the present position of Castleton. The terrain ranges in elevation from about 290 m to a maximum of 388 m on Wolfscote Hill and consists of a rolling plateau deeply dissected in the west by the valleys of Wolfscote Dale and Biggin Dale. Discontinuous apron-reefs mark the shelf margin and give rise to well-defined escarpments overlooking Parwich in the east and Beresford Dale in the west.

Stratigraphy and petrology The **Woo Dale Limestones** crop out along the River Dove between Coldeaton Bridge and Wolfscote Dale and have an exposed thickness of about 160 m. The formation consists of a lower division (the Iron Tors Limestones) comprising thickly bedded bioclastic limestones and an upper thinner bedded division in which sparsely fossiliferous calcite mudstones (micrites) alternate with spar-cemented peloidal limestones (Figure 3). The calcite mudstones are generally mid-grey in colour with a porcellaneous texture and commonly contain spar-filled cavities known as bird's-eye structures (Plate 7); the peloidal limestones are usually paler coloured and contain much micritised bioclastic debris which is sometimes current-sorted. Apart from scattered brachiopod shells and algally bound lithoclasts (Plate 7), coarse debris is rare. The formation passes laterally into the Milldale Limestones.

The Woo Dale Limestones are succeeded upwards by the **Bee Low Limestones**, the junction between the two formations being drawn normally at the top of the highest calcite mudstone band (see, for example, borehole SK 15 NE 6). The formation reaches a maximum thickness of 189 m around Wolfscote Hill [137 583] and consists of thickly bedded bioclastic limestones of very homogeneous character (Plate 7). It contains few distinctive marker horizons apart from sporadic coral-brachiopod shell beds such as the *Davidsonina septosa* bands which can be traced around Wolfscote Hill and Alsop Moor [163 567]. In places, around the margins of the shelf, the Bee Low Limestones pass laterally into discontinous, outward-dipping apron-reefs.

Interbedded clays (or 'clay wayboards' as they are known locally) mark obvious discontinuities in the limestone succession and range in thickness from a few millimetres to over 0.5 m (Figure 3). The clays commonly rest on undulating surfaces which Walkden (1974) has shown to be of karstic origin. The clays are not always preserved in borehole cores and are often obscured in natural sections but evidence from quarries on the shelf area farther to the north suggests that the wayboards occur most frequently in the middle and upper parts of the formation. The interval between the wayboards ranges from several metres to several tens of metres.

A close inspection of core and section material from the Bee Low Limestones has revealed the presence in the rock of wispy bands characterised by brown pigmentation (Plate 7). The bands are seldom more than a few millimetres thick but in some, fine spar-filled tubes can be seen. Similar structures have been described from other parts of Derbyshire (Walkden, 1974; Adams 1980) and have been interpreted as caliche (pedogenic) crusts which formed under subaerial weathering conditions. The brown pigmentation is found commonly in the upper few centimetres of limestone immediately underlying the clay wayboards but also occurs within the body of the rock (Figure 3). Between the crusts there is often a gradational sequence developed which, when complete, consists of three main lithologies: a basal fine-grained micritic limestone, a bioclastic limestone in which the skeletal fragments are in grain-to-grain contact and in which micritisation and oncolitic structures are common, and, at the top, a well-washed spar-cemented assemblage containing a high proportion of peloids. The cycle is not always fully developed, particularly where the pedogenic horizons are closely spaced; in these cases, well-washed biopelsparites predominate. The repetition of cycles, of the type described, is well-illustrated in the sequences proved by boreholes at Wolfscote Hill (15 NW 8) and Twodale Barn (15 NE 7). The significance of the cycles from the point of view of exploration lies possibly in their use as a correlation tool in detailed investigations at the quarry reserve level.

Apart from the clay wayboards, which are presumed to be of volcanic origin, the only evidence for volcanic activity during the deposition of the Bee Low Limestones is the occurrence of a thin tuffaceous limestone band seen in a section on the Tissington Trail (15 NE 2S). The band, which is less than a metre thick, occurs approximately 35-50 m below the top of the formation and is heavily iron-stained.

The **Monsal Dale Limestones** crop out on the high plateau in the central part of the block and in a smaller area around Pikehall, in the north-east. Erosion has removed the higher beds from much of the outcrop, so that the maximum thickness, estimated to be about 95 m, is only attained in the down-faulted block dissected by Gratton Dale [194 596]. On the main crop the thickness is generally less than 50 m though sequences of this order of thickness are likely on the hills north of Hawks Low [170 570] and east of Mount Pleasant Farm [170 585]. The base of the formation is marked by a band of darker coloured, rubbly weathering limestone between 5 and 15 m thick (Figure 3). This band contains shells with thick algal encrustations *(Girvanella)* and *Saccamminopsis*, and can be recognised over most of the outcrop; best exposures are seen at the upper end of Biggin Dale [147 588] where the band is developed sufficiently to be mapped out. The overlying limestones contain sporadic thin dark-coloured bands (see, for example, borehole 15 NE 3) but mid-grey shades predominate. The low percentage of pale coloured limestones, the widespread development of mottling and the occurrence of much coarse crinoid and brachiopod debris distinguish this formation from the underlying Bee Low Limestones. The Monsal Dale Limestones also seem to contain fewer pedogenic horizons.

Structure The shelf limestones are characterised by gentle folding and low dips. The Biggin Syncline, a broad structure of approximate north-west to south-east trend is the main fold structure in the block and produces dips on the limbs of the order of 5 to 10°. A series of faults trending between north-west and west is developed in the west of the block.

Dolomitisation and mineralisation The areas on the ground where the rocks have been thoroughly dolomitised are indicated on the resource sheet. No attempt has been made to classify the dolomites, either lithologically or chemically, because the deposits are impersistent, both vertically and laterally. Boreholes (15 NE 3, 15 NE 6 and 15 NE 7) drilled close to the main affected areas proved no thick deposits of dolomite at depth and it is likely therefore, that the junctions between the altered and unaltered rock are approximately vertical.

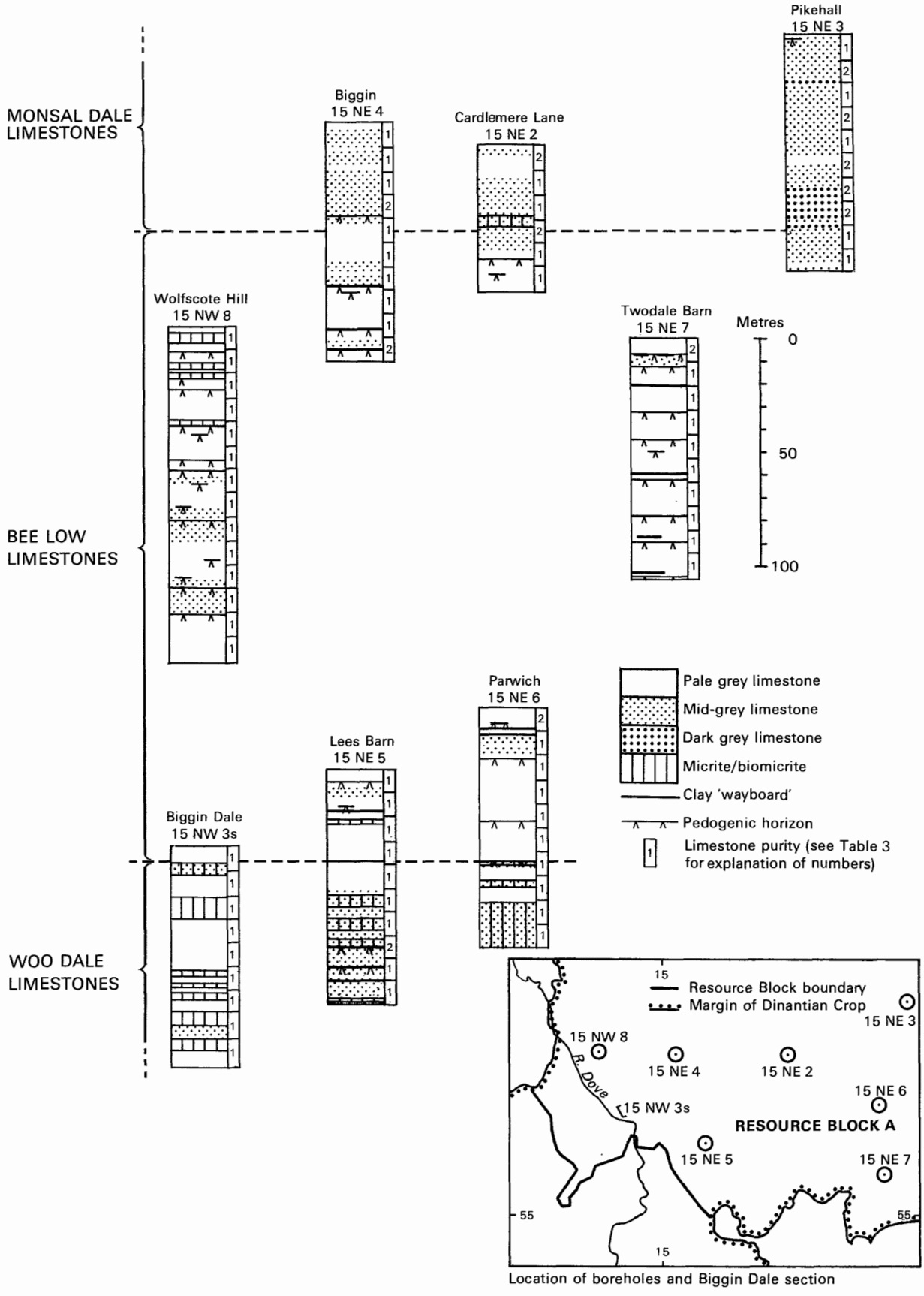



**Figure 3** Various sections of parts of Resource Block A.

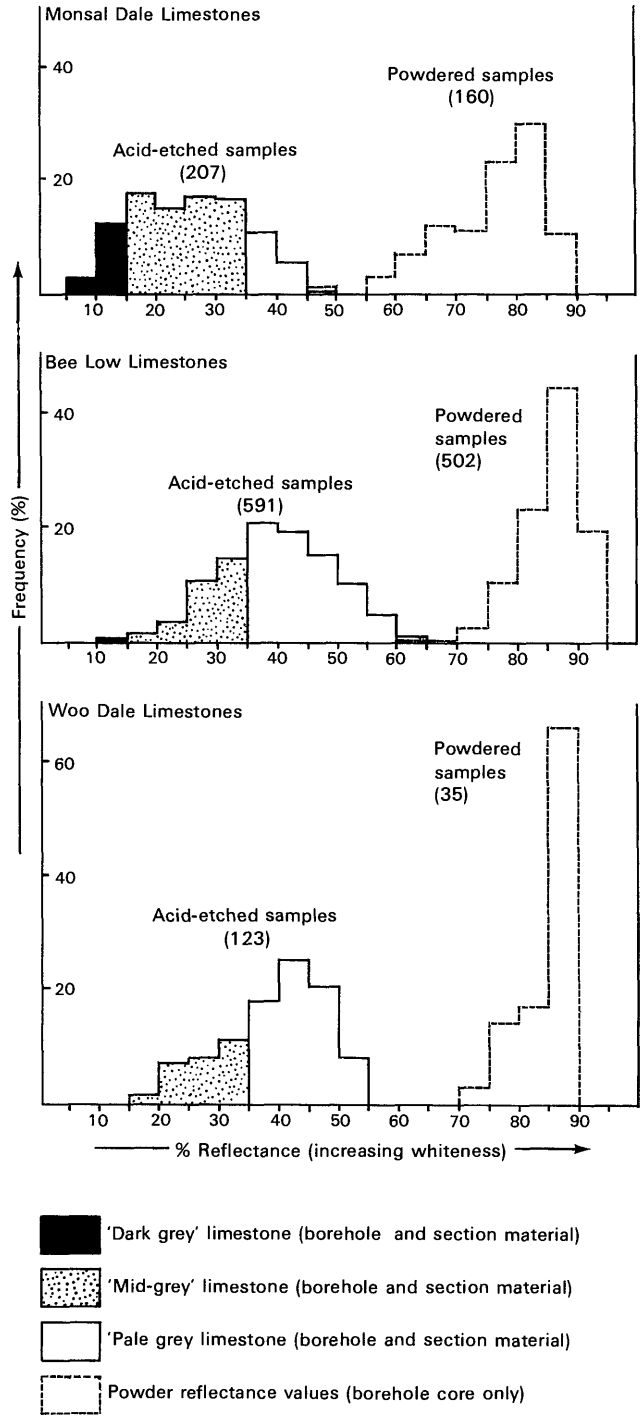



**Figure 4** Colour variation within limestones of Resource Block A.

Incipient dolomitisation associated with joints, faults and mineral veins has been recorded at a number of localities but the intensity of the dolomitisation is very low, and the zones affected are very restricted.

The block lies on the fringe of the Derbyshire Orefield and though there is evidence of old mineral workings on the plateau south-east of Biggin and underground in Gratton Dale, the block is not extensively mineralised.

Colour Colour variation at sample sites is detailed in Appendix C and a summary of the results is given in Figure 4. Measurements taken on sawn and etched surfaces of core and section material indicate that the **Bee Low** and **Woo Dale** limestones are the palest and most uniformly coloured deposits on the shelf. Both formations contain a high proportion of algally-degraded debris and it is this which gives the highest reflectance results. Where zones of mottling or porcellanous bands occur, the response is generally more subdued and mid-grey shades predominate. In the **Monsal Dale** Limestones colour variation is more marked. The basal dark grey band is distinctive, particularly in the west of the district, but at some localities in the east of the block (see, for example, borehole 15 NE 2) only a slight darkening of the sequence is recorded at this horizon. Discolouration of the limestones is common adjacent to masterjoints or veins and close to clay wayboards where hematite is often a contaminant.

The whiteness of the limestones in powdered form was assessed by measuring the reflectivity of specially prepared powder discs. The results, summarised in Figure 4, indicate that where the whiteness of the powdered stone is important, then the Bee Low and Woo Dale limestones ought to be worked in preference to the Monsal Dale Limestones. The two older formations not only give more consistent results but the brightness of the powders is generally higher (85 to 90 per cent mode compared with 80 to 85 per cent for the Monsal Dale Limestones). The Wolfscote Hill borehole (15 NW 8) produced the best results of all the material tested, yielding a mean of 90.5 per cent with a standard deviation of 2.7.

Rock chemistry and non-carbonate mineralogy The **Bee Low** and **Woo Dale** limestones are very high purity deposits with $CaCO_3$ levels consistently greater than 99 per cent (Figure 5, Table 4). The summary statistics quoted in Table 4 indicate the mean composition of these formations but make no allowance for clay wayboard or fissure-fill material which may be a contaminant but can be separated from the crushed stone by screening or washing processes. Silica is the main non-carbonate in these deposits and occurs chiefly as disseminated euhedral quartz crystals. Other minor elements are combined to form clay minerals, dolomite and iron-ores. Kaolinite, illite and mixed-lattice clays form thin coatings along stylolites and are disseminated in trace amounts throughout the rock. Iron occurs as the sulphide (pyrite) and as the oxide (hematite or limonite) but also substitutes in the dolomite lattice to form ferroan dolomite. Anomalously high iron levels are recorded adjacent to wayboards and close to joint surfaces or mineral veins but throughout most of the Bee Low and Woo Dale limestones, total iron is generally less than 0.05 per cent. Trace element concentrations approximate to background levels but traces of copper, lead and zinc mineralisation have been recorded in some of the borehole cores (see, for example, 15 NE 4, 15 NE 5).

The **Monsal Dale Limestones** are more variable chemically and somewhat less pure overall than the underlying formations (see Figure 5). Shell debris is often silicified and the percentage of clay minerals is higher, particularly within the dark lithofacies which marks the base of the formation.

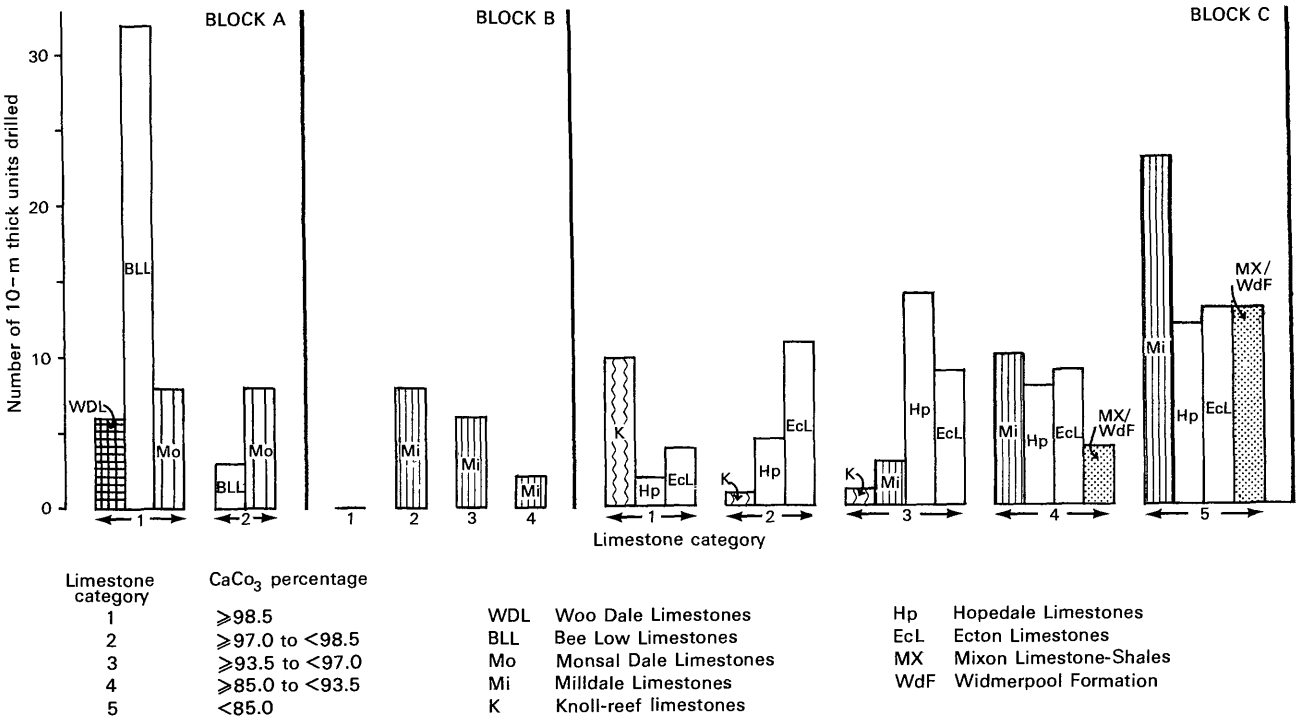
There are no analyses of the dolomitic rocks but MgO values are slightly enhanced in limestones adjacent to the main dolomite outcrop in the east of the block.

Mechanical properties Although B.S. 812 specifies a series of tests for evaluating various aspects of aggregate strength, a full test programme was beyond the scope of this report. However, a large number of aggregate impact value (AIV) tests were carried out and these provide some insight into the variability of the stone. The results, identified by formation in Figure 6, demonstrate that even within apparently homogeneous formations, such as the Bee Low Limestones, a wide range of values can be anticipated. Borehole 15 NW 18, in which the AIV range is from 18 to 24, illustrates this point well. The correlation between AIV and lithology can be demonstrated at some sites; for example, the value of 18

**Table 4** Summary of the chemistry of the main lithostratigraphical divisions

| | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050° C | $Fe_2O_3$ | MnO | Cu | Pb | Zn | As |
| **Monsal Dale Limestones** (16:3)* **Block A** | | | | | | | | | | | | | | | | |
| Mean | 54.25 | 0.21 | 0.02 | 0.01 | 1.31 | 0.61 | 0.35 | 0.07 | 0.04 | 42.90 | 2625 | 363 | [ 5 | <3 | 10 | -]‡ |
| ± † | 1.21 | 0.06 | 0.01 | 0.01 | 1.18 | 0.53 | 0.35 | 0.04 | 0.02 | 0.69 | 2979 | 185 | - | - | - | - |
| max. | 55.90 | 0.51 | 0.09 | 0.05 | 8.90 | 4.33 | 2.75 | 0.36 | 0.15 | 43.84 | 18600 | 1200 | 20 | 110 | 230 | 3 |
| **Bee Low Limestones** (61:3) **Block A** | | | | | | | | | | | | | | | | |
| mean | 55.40 | 0.15 | 0.01 | 0.01 | 0.20 | 0.19 | 0.08 | 0.03 | 0.01 | 43.46 | 489 | 223 | [<3 | <3 | 10 | -] |
| ± † | 0.10 | 0.02 | 0.00 | 0.00 | 0.07 | 0.01 | 0.02 | 0.00 | 0.00 | 0.09 | 324 | 65 | - | - | - | - |
| max. | 56.10 | 0.32 | 0.10 | 0.05 | 2.11 | 0.34 | 0.48 | 0.05 | 0.06 | 44.00 | 10000 | 2060 | 10 | 70 | 80 | 3 |
| **Woo Dale Limestones** (6:1) **Block A** | | | | | | | | | | | | | | | | |
| Mean | 55.53 | 0.14 | 0.00 | 0.00 | 0.04 | 0.25 | 0.05 | 0.03 | 0.02 | 43.48 | 283 | 183 | - | - | - | - |
| ± † | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Max. | 55.70 | 0.16 | 0.00 | 0.00 | 0.12 | 0.35 | 0.09 | 0.04 | 0.02 | 43.58 | 400 | 240 | 5 | 0 | 20 | 3 |
| **Kevin Limestones** (26:0) **Block B** | | | | | | | | | | | | | | | | |
| mean | 55.46 | 0.02 | 0.01 | 0.00 | 0.11 | 0.26 | 0.12 | 0.03 | 0.01 | 43.82 | 277 | 222 | [ 5 | 20 | 20 | -] |
| ± † | 0.07 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | 0.01 | 0.00 | 0.00 | 0.04 | 43 | 21 | - | - | - | - |
| max. | 55.80 | 0.04 | 0.01 | 0.03 | 0.33 | 0.41 | 0.24 | 0.05 | 0.03 | 43.98 | 600 | 350 | 15 | 30 | 30 | - |
| **Milldale Limestones** (31:2) **Block B** | | | | | | | | | | | | | | | | |
| mean | 53.52 | 0.20 | 0.02 | 0.01 | 2.10 | 0.59 | 0.41 | 0.10 | 0.02 | 42.52 | 3361 | 270 | [<3 | <3 | 20 | - |
| ± † | 0.56 | 0.05 | 0.00 | 0.01 | 0.87 | 0.05 | 0.11 | 0.02 | 0.01 | 0.49 | 1873 | 41 | - | - | - | - |
| max. | 55.30 | 0.60 | 0.03 | 0.05 | 12.68 | 1.05 | 1.09 | 0.25 | 0.10 | 43.80 | 21800 | 560 | 15 | 60 | 400 | 2 |
| **Knoll-reef and apron-reef limestones** (19:1) **Block C** | | | | | | | | | | | | | | | | |
| mean | 55.03 | 0.27 | 0.01 | 0.01 | 0.28 | 0.50 | 0.14 | 0.04 | 0.11 | 43.64 | 1342 | 268 | [<3 | <3 | 10 | -] |
| ± † | 0.21 | 0.24 | 0.00 | 0.01 | 0.14 | 0.03 | 0.02 | 0.01 | 0.03 | 0.30 | 1491 | 77 | - | - | - | - |
| max. | 56.00 | 2.30 | 0.02 | 0.05 | 1.33 | 0.62 | 0.24 | 0.07 | 0.30 | 44.08 | 13500 | 730 | 5 | 40 | 70 | 3 |
| **Milldale Limestones (excluding reef lithofacies)** (51:1) **Block C** | | | | | | | | | | | | | | | | |
| mean | 48.34 | 0.37 | 0.03 | 0.06 | 10.19 | 0.86 | 1.07 | 0.25 | 0.05 | 38.57 | 5204 | 769 | [<3 | <3 | 10 | -] |
| ± † | 1.13 | 0.14 | 0.01 | 0.02 | 1.82 | 0.11 | 0.04 | 0.04 | 0.02 | 0.93 | 766 | 223 | - | - | - | - |
| max. | 53.42 | 3.07 | 0.14 | 0.49 | 27.00 | 2.56 | 0.71 | 0.71 | 0.55 | 42.86 | 11500 | 3950 | 120 | 90 | 1000 | 1 |
| **Ecton Limestones** (51.:1) **Block C** | | | | | | | | | | | | | | | | |
| mean | 49.01 | 0.25 | 0.02 | 0.03 | 5.88 | 2.76 | 0.57 | 0.13 | 0.04 | 40.99 | 5810 | 1217 | [<3 | <3 | 10 | -] |
| ± † | 1.63 | 0.10 | 0.01 | 0.01 | 1.83 | 0.93 | 0.23 | 0.05 | 0.01 | 0.98 | 1176 | 337 | - | - | - | - |
| max. | 55.20 | 1.46 | 0.16 | 0.10 | 33.00 | 15.02 | 5.37 | 1.10 | 0.22 | 43.85 | 15500 | 4000 | 20 | 40 | 1200 | 1 |
| **Hopedale Limestones (excluding reef lithofacies)** (51:2)* **Block C** | | | | | | | | | | | | | | | | |
| mean | 49.83 | 0.36 | 0.02 | 0.06 | 4.67 | 2.39 | 0.68 | 0.14 | 0.08 | 41.36 | 6316 | 1034 | [ 5 | 10 | <5 | -] |
| ± † | 1.26 | 0.08 | 0.00 | 0.03 | 1.28 | 0.92 | 0.20 | 0.04 | 0.02 | 0.77 | 1374 | 255 | - | - | - | - |
| max | 55.70 | 1.02 | 0.06 | 0.84 | 18.00 | 13.17 | 2.82 | 0.58 | 0.41 | 45.92 | 21600 | 3700 | 100 | 600 | 1750 | 3 |
| **Widmerpool Formation/Mixon Limestone Shales** (20:1) **Block C** | | | | | | | | | | | | | | | | |
| mean | 49.83 | 0.47 | 0.02 | 0.06 | 7.84 | 0.83 | 1.01 | 0.19 | 0.14 | 39.38 | 6835 | 668 | [ 5 | 10 | <5 | -] |
| ± † | 2.52 | 0.29 | 0.01 | 0.02 | 3.68 | 0.14 | 0.40 | 0.08 | 0.03 | 2.36 | 2017 | 168 | - | - | - | - |
| max. | 54.90 | 2.73 | 0.06 | 0.14 | 35.00 | 1.39 | 3.21 | 0.65 | 0.30 | 43.59 | 23000 | 1700 | 15 | 40 | 190 | 3 |

* The first figure denotes the number of samples analysed for all constituents other than As; the second figure denotes the number of samples analysed for As.
† Confidence limits at the 95 % probability level.
‡ Figures within square brackets represent background levels.




| Limestone category | $CaCo_3$ percentage |
|---|---|
| 1 | ⩾98.5 |
| 2 | ⩾97.0 to <98.5 |
| 3 | ⩾93.5 to <97.0 |
| 4 | ⩾85.0 to <93.5 |
| 5 | <85.0 |

| | | | |
|---|---|---|---|
| WDL | Woo Dale Limestones | Hp | Hopedale Limestones |
| BLL | Bee Low Limestones | EcL | Ecton Limestones |
| Mo | Monsal Dale Limestones | MX | Mixon Limestone-Shales |
| Mi | Milldale Limestones | WdF | Widmerpool Formation |
| K | Knoll-reef limestones | | |

**Figure 5** Summary of the purity of each formation based on insoluble residue determinations carried out on borehole core

for the dark fine-grained limestone encountered at a depth of about 70 m in borehole 15 NE 3 is indicative of a rock significantly harder than the beds either above or below. In most cases, however, the AIV is not predictable to within 3 or 4 points without a very much more detailed study of the geological variables such as grain-size, texture and structure. In all the histograms, the results given by section material show a bias towards the top end of the scale and though it is possible that the material was weathered and, therefore, inherently weaker, it is more likely that in crushing the assymetrical blocks prior to testing, the percentage of weak flaky particles generated was higher than would normally be the case when crushing borehole core.

A single aggregate abrasion value determination on material from the Bee Low Limestones yielded a value of 16.8 per cent.

*Other factors affecting mineral working*

Overburden There is virtually no drift cover on the plateau top apart from a few thin patches of head. However, the area is known to contain Pocket Deposits which, if encountered in an open-pit working, would cause problems; several large pits that have exploited these deposits in the past are indicated on the resource map, though most have now been partially or completely backfilled.

Water table According to Edmunds (1971), the permanent groundwater level lies between 213 m (700 ft) and 244 m (800 ft) A.O.D. (Figure 7). Consequently, since most of the block is at an elevation of at least 305 m (1000 ft), groundwater seepage is unlikely to pose a serious problem in any open-pit operation on the plateau top.

BLOCK B

The Weaver Hills form part of a high plateau trending north-west to south-east and tilted towards the north-east. The highest point in the area is 'The Walk' at 371 m (1217 ft) above O.D. Southwards, the ground falls away abruptly towards the Churnet valley, while to the north the plateau slopes more gently down to the River Hamps. There is no surface drainage on the limestone crop and most of the plateau top is open grassland.

Stratigraphy and petrology The oldest rocks in the area are the **Milldale Limestones** which are worked extensively at Caldon Low, Cauldon and Wardlow quarries. The total thickness of the formation is about 470 m, of which only the uppermost 180 m is exposed. Sections in the main quarries reveal a gently dipping sequence consisting, mainly, of medium and thickly bedded fine- and medium-grained calcarenites (Plate 3). The limestones are typically mid-grey in colour but darker thinner bedded bands are evident in some of the working faces at Cauldon and Caldon Low. Lenses of coarse crinoid debris, dispersed brachiopods and onkolitic nodules occur throughout the sequence but, in general, there is a rather sparse macrofauna and marker horizons are rare. Under the microscope, the chief constituents of the limestone are seen to be compacted peloids, foraminifera and ostracods, with much finely comminuted indeterminate skeletal debris.

Chert nodules occur in some of the darker beds but are not widely distributed: 11 m of cherty limestones are exposed in the quarry floor at the northern end of the Caldon Low workings [079 488] and scattered nodules are present in a face at the western end of Cauldon quarry. The distribution of the chert nodules appears to be irregular, but the sequence is disrupted by faulting and a series of exploratory drill-holes would be required to identify the position and full extent of the cherty horizons. Black and purple-stained shaly partings and seams, up to about 5 cm in thickness, occur sporadically throughout the sequence but do not constitute a major waste problem in the existing workings. The seams appear to become more numerous towards the top of the succession, which is seen in the old quarry at Caldon Low [082 487]. The lower part of the formation is known only from the Caldon Low Borehole [080 482]. This penetrated 190.75 m of mainly fine-grained thickly bedded limestones and dolomites. Sandstones of possible Devonian age were encountered at a depth of 365.07 m below the

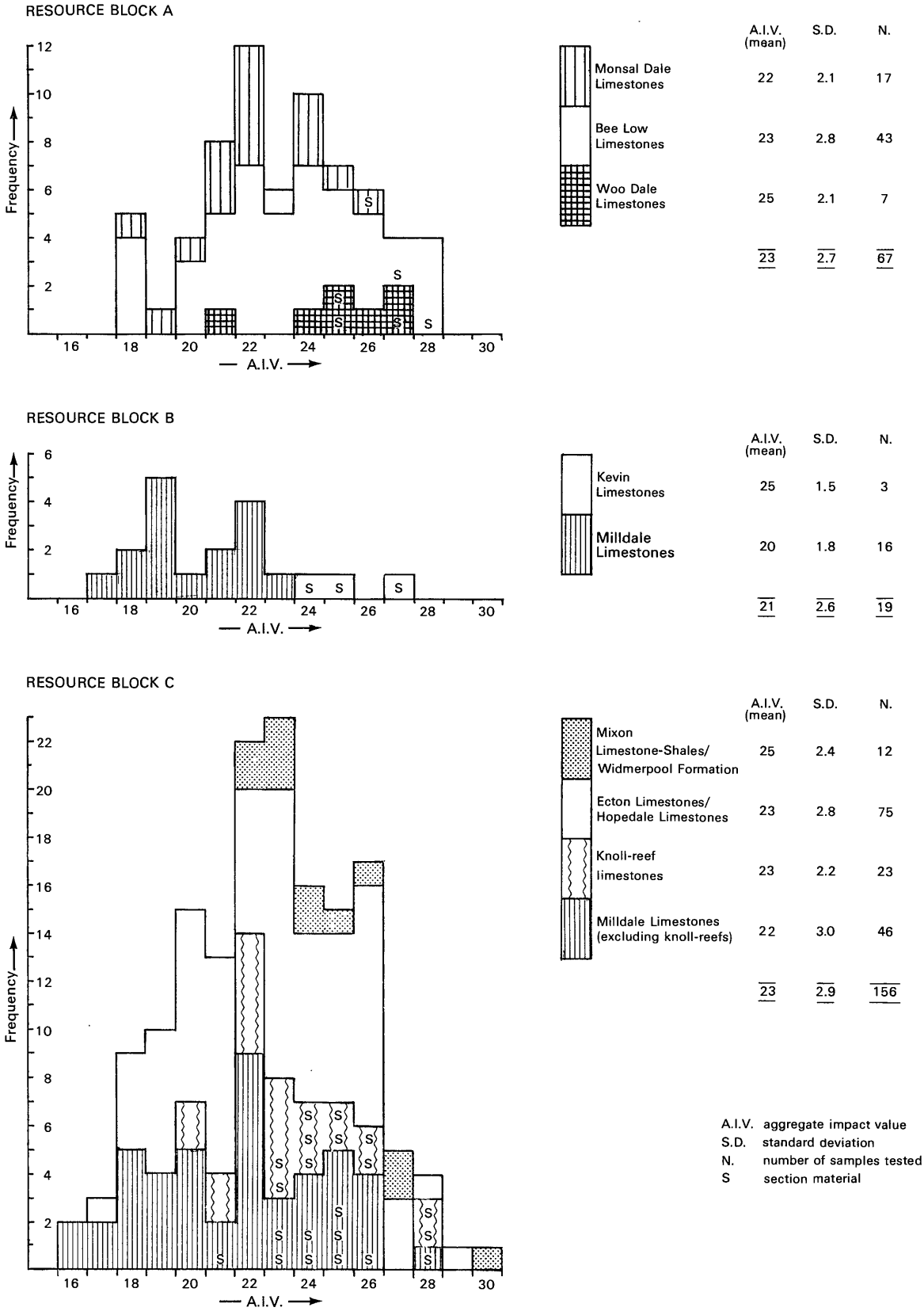



**Figure 6** Aggregate impact value results for each of the designated resource blocks.

**Plate 3** The Milldale Limestones at Caldon Low Quarry: thin to thickly bedded mid- and dark grey calcarenites (section 04 NE 1S).

**Plate 4** The Milldale Limestones at Brownend Quarry, Waterhouses: steeply dipping mainly thinly bedded limestones with shale intercalations (section 05 SE 3S).

**Plate 5.** Apes Tor Quarries (500 m north-east of Ecton): syncline - anticline pair in the central part of the Ecton Anticline in the Ecton Limestones (section 05 NE 4S).

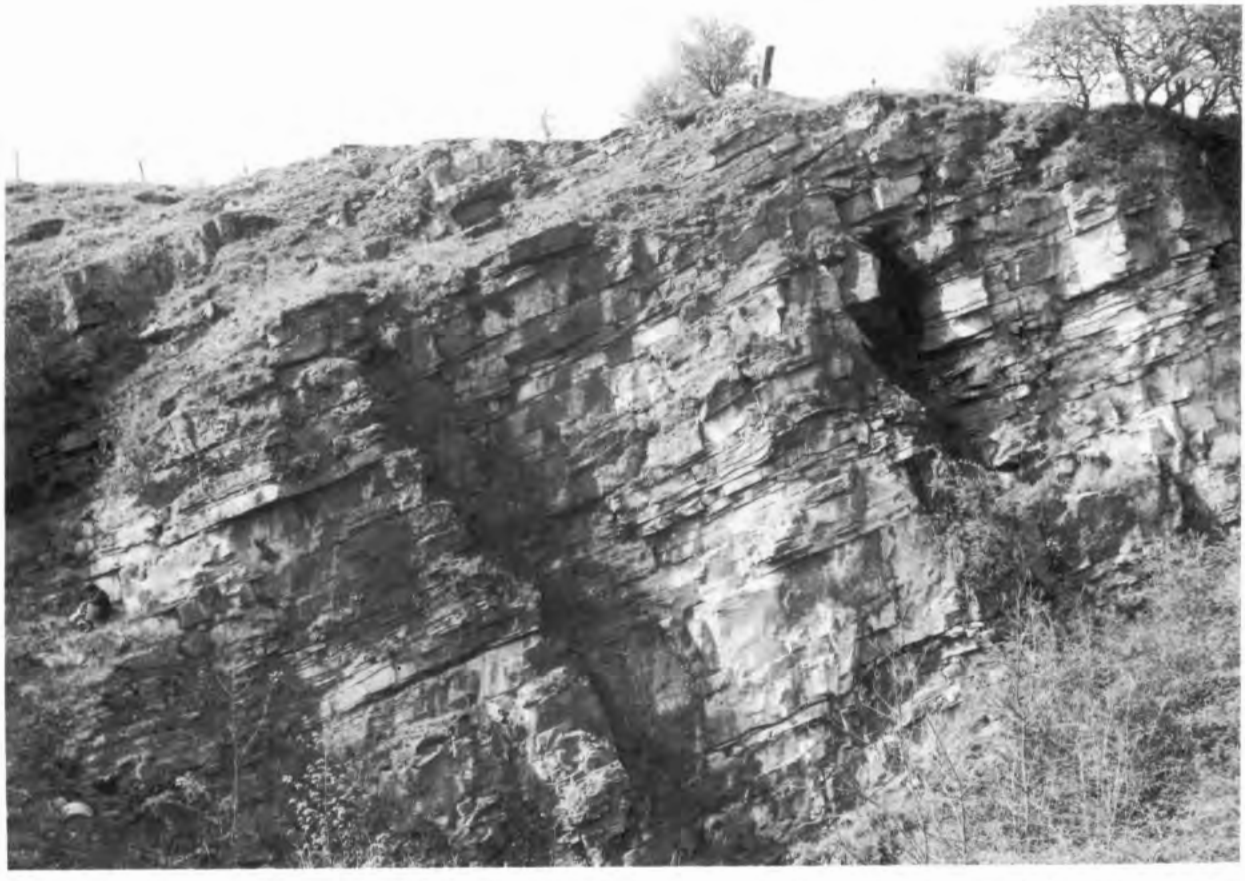


**Plate 6.** Hopedale Limestones: easternmost of two old quarries in Waterhouses: interbedded coarsely bioclastic and finely peloidal limestones with shale partings (section 05 SE 4S).

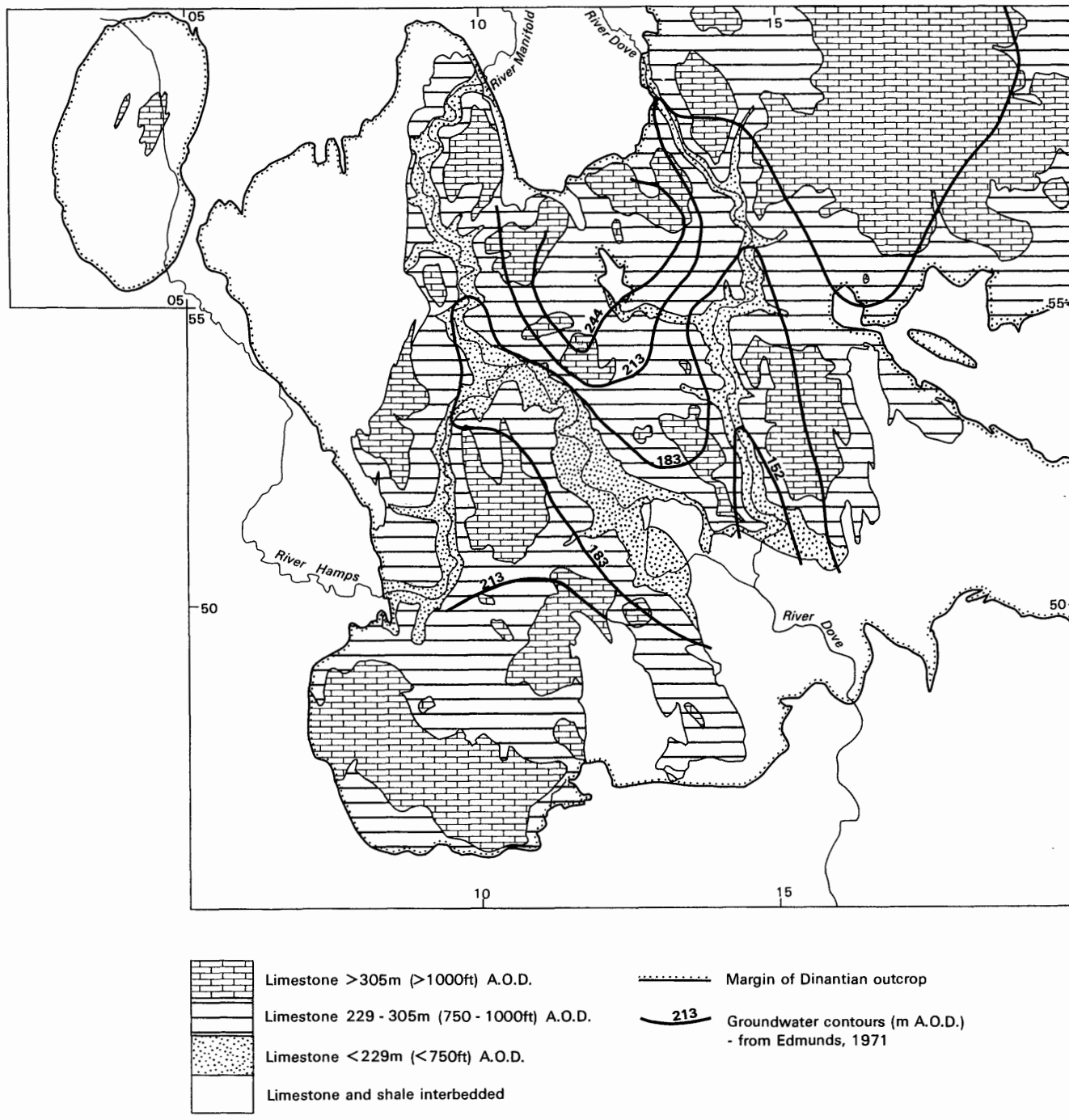



**Figure 7** Relationship between topography and groundwater levels.

surface (Institute of Geological Sciences, 1978, p.11).

The Milldale Limestones in this area appear to have accumulated in fairly shallow water, free from major influences of argillaceous material. A zone of north-eastward transition into a much more argillaceous lithofacies is indicated diagrammatically on the resource map by a zig-zag line.

The succeeding **Hopedale Limestones** have a restricted outcrop around the north-west margin of the block and are largely concealed by drift. The 'Cauldon Low Conglomerate', which marks the base of the formation, has almost been destroyed by quarrying operations but is preserved in a number of small exposures near the railway sidings [for example, at location 077 491]. The conglomerate is composed of quartz pebbles and grains ranging in size from a few centimetres to a few millimetres diameter, together with rounded and sub-angular limestone fragments. Southwards, the Hopedale Limestones pass into laterally equivalent shelf limestones, termed the **Kevin Limestones.** The base of the latter formation is conglomeratic where it is seen in Wardlow Quarry but the best exposures are found at the type locality, which is Kevin Quarry itself (Plate 1). Here, a continuous section (04 NE 7S) shows 131 m of pale thickly bedded limestones separated by prominent bedding planes, some with reddish or yellowish clays as partings or pockets up to 5 cm thick. The limestones resemble the Bee Low Limestones lithologically and contain an abundance of well-washed spar-cemented calcarenites capped by pedogenic crusts. Thin beds of calcite mudstone, notable for their flinty fracture, occur in the upper, middle and lower parts of the section and serve as useful marker horizons. The top of the section also contains a shell band with *D. septosa*. It is estimated that the formation is over 180 m thick in the type area but that a thinning occurs northwards towards Hoften's Cross [072 481]. At the latter locality and also at the southern end of the Weaver Hills, the shelf limestones

pass into apron-reef deposits consisting of more massive rubbly limestone with contorted spar-filled cavities.

Structure Broad folding and flexuring can be seen in the quarries at Cauldon and Caldon Low but dips are generally low (10° to 20°) and rapid dip reversals are rare except adjacent to faults. The regional dip in the Milldale Limestones has a strong northward component, but around the margins of the limestone outcrop the predominant directions are west and south. Well-developed steeply-inclined joint-sets and minor faulting are prominent features of all the working quarries.

Dolomitisation and mineralisation The limestones are dolomitised locally adjacent to veins and fractures but wholesale alteration of the rock is rare. Of the various vein-minerals recorded, calcite is the most common, and hematite is also widely developed. The latter is the most deleterious in so far as it affects both the colour and chemistry of the stone. The hematite sometimes forms quite rich deposits, especially along faults, when it can be removed by selective digging, but, more often, it occurs disseminated through the rock as blebs and infilling microveinlets. There are also recorded occurrences of copper, lead and zinc ores. The Ribden Mine, located about 2 km south of Caldon Low Quarry is well documented (Robey and Porter, 1971) though the surface workings have now largely been obscured by refractory clay diggings. There are also a number of old workings on the hillside to the south-east about which little is known.

Colour Reflectance values for the limestones of Block B are summarised in Figure 8. The histograms for the etched rock surface data show clearly the contrasting colours of the younger and older deposits: in the **Kevin Limestones** pale grey colours predominate whereas in the **Milldale Limestones** mid-grey and dark grey shades are more common.

In finely powdered form, samples from the Kevin Limestones produce high reflectance results (Figure 8) comparable with those obtained from the Bee Low and Woo Dale limestones of Block A. Measurements carried out on selected high purity and very high purity samples from the Milldale Limestones are appreciably less reflective and whiteness levels are significantly lower.

Rock chemistry and non-carbonate mineralogy The purest limestones in the block are the **Kevin Limestones.** These are very high purity deposits ($CaCO_3$ ≥98.5 per cent) similar in composition to the Bee Low Limestones. No assessment boreholes were sunk in this formation but results from surface samples collected in Kevin Quarry indicate a mean insoluble residue content for the exposed sequence of only 0.7 per cent. The insoluble fraction is composed chiefly of quartz and clay minerals with subordinate iron oxides. The latter commonly occur with pyrolusite ($MnO_2$) as coatings on joint surfaces. The formation is notable for its chemical uniformity but some variation in purity has been recorded, especially adjacent to clay wayboards and in pedogenic zones where residue values ranging from 1 to 3 per cent have been measured. Wayboard clays occur as thin widely spaced seams but can be removed by washing and screening and are not considered a major contaminant.

The **Milldale Limestones** are more variable in composition and are less pure than the Kevin Limestones. In the area of the quarry workings where most of the sampling was carried out, the deposits are mainly of high purity (≥97.0 to <98.5 per cent $CaCO_3$) but substantial thicknesses of medium purity (≥93.5 to <97.0 per cent $CaCO_3$) mineral also occur. At the scale of the assessment survey, it was found impracticable to separate the two categories and the formation is therefore shown as undivided high and medium purity mineral on the resource map. The chief impurity in the Milldale Limestones is silica, which occurs as

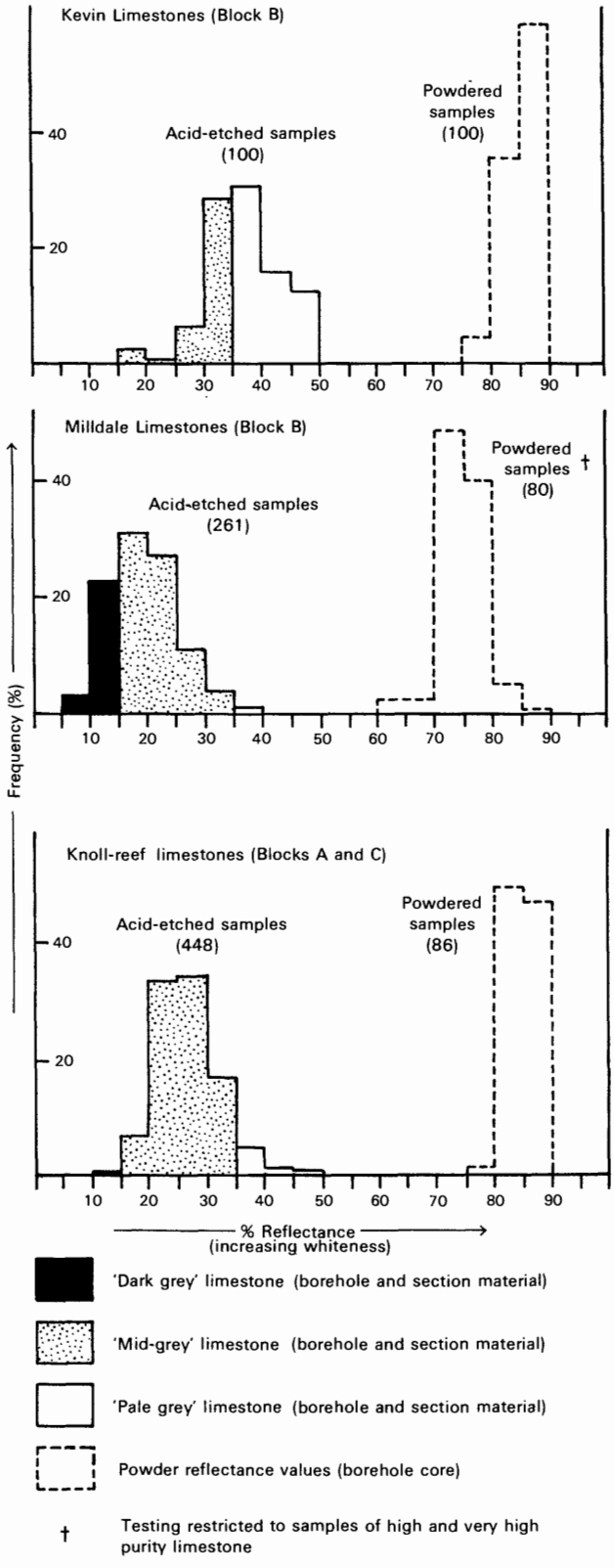



**Figure 8** Colour variation within the limestones of the Weaver Hills (Block B) and within knoll-reef deposits (Blocks A and C).

disseminated authigenic crystals, as chalcedonic replacements of fossil debris and as chert; in an 11 m section in Caldon Low Quarry nodular chert constitutes between 5 and 10 per cent by volume of the rock. The limestones also contain disseminated clay and discrete shaly wisps and partings which vary from red to black in colour. The highest concentrations of silica and clay minerals are likely to be found in the limestones cropping out around

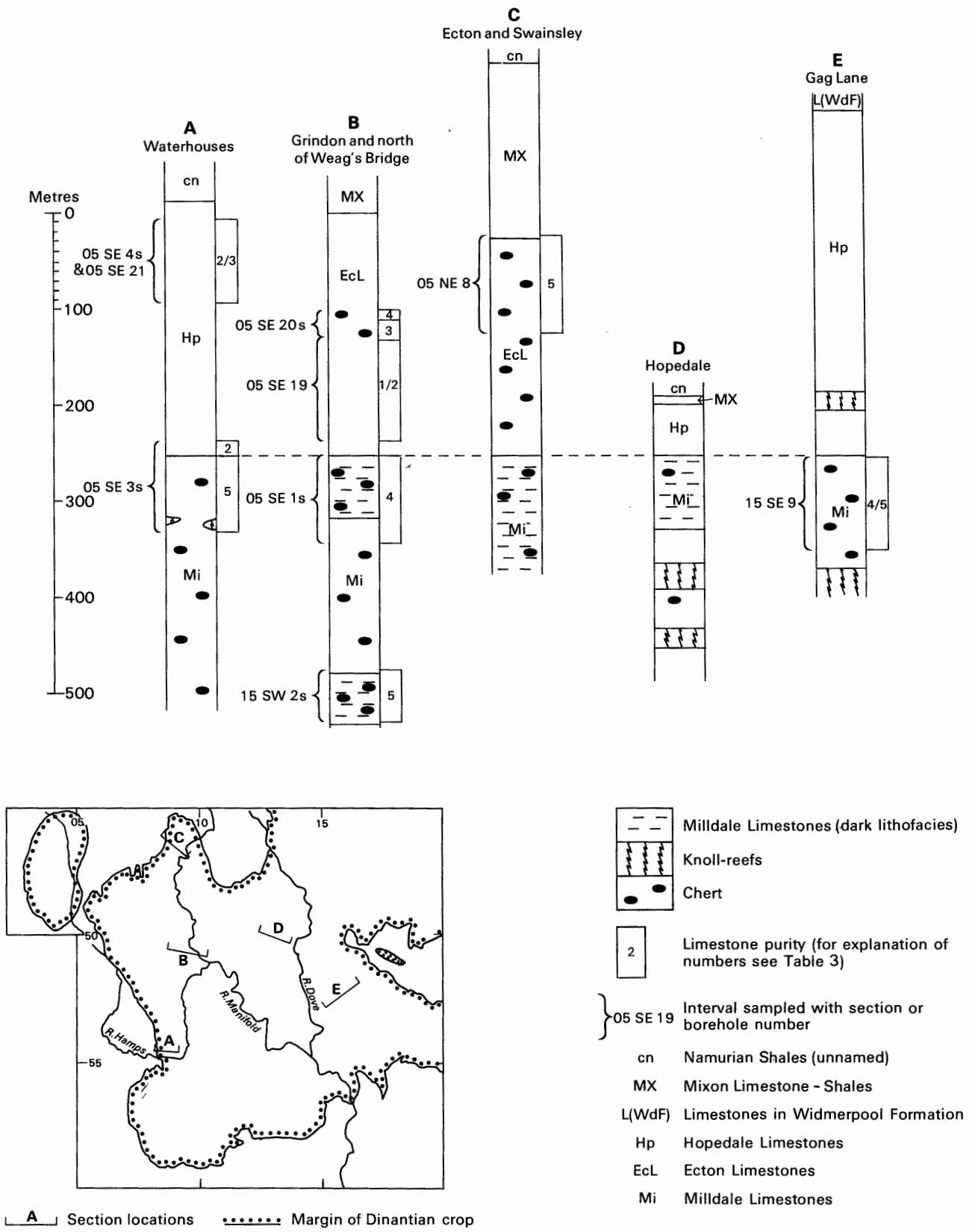



**Figure 9** Generalised vertical sections in Resource Block C.

the north-east margin of the block. The most striking feature of the Milldale Limestones when viewed in quarry sections is their red colouration; hematite is widely distributed throughout the rock along joints and vein networks, and in some of the whole rock analyses reported in Appendix D upwards of 2 per cent $Fe_2O_3$ is recorded.

The trace element distribution shows no major anomalies but boreholes at Rue Hill (04 NE 10) and Caldon Low (04 NE 36) both penetrated heavily veined sequences which yielded levels of lead and zinc above the regional background.

Mechanical properties A limited number of AIV determinations have been carried out, the results of which are recorded in Figure 6. On the evidence available, the Milldale Limestones would appear to be slightly more resistant to impact fracturing than the Kevin Lime-

stones. A single aggregate abrasion value determination on material from the Kevin Limestones produced a value of 11.9 per cent.

*Other factors affecting mineral working*

Overburden The limestones are largely free of drift although patches of head and boulder clay occur in dips in the plateau top and on the hillsides around the margins of the crop. Pocket Deposits, consisting of sands and clays, fill fissures and solution hollows in the limestone and are a source of local contamination. Many of the larger deposits have been worked and their position is indicated on the resource sheet but it is clearly impracticable to map out all the smaller deposits, many of which have no surface expression.

Water table Information from Edumunds (1971) and from various mining reports indicates that the permanent water table is at a level ranging from 213 m (700 ft) to 244 m (800 ft) A.O.D. throughout the block. Since most of the plateau is over 305 m (1000 ft) above sea level, then there are substantial areas of mineral which can be worked without recourse to pumping. The only locality where the water table is close to the surface is on the low ground in the vicinity of Kevin Quarry (Figure 7).

BLOCK C

This block encompasses a deeply dissected sparsely populated plateau, much of which is over 305 m (1000 ft) above sea level. Through the plateau, the rivers Dove, Hamps and Manifold have cut deep gorges which provide good sections through the geological succession. On the plateau top exposures are more limited but there are many small quarries where the limestone was once worked for walling-stone or lime burning, and these provide useful additional information. Included in the block is the large inlier at Mixon in the west and a series of small inliers near Parwich in the east. Access through the centre of the area is difficult as the roads are narrow and often steeply graded. At the present time, the block does not support any active quarring operations.

Stratigraphy and petrography The stratigraphical succession is summarised in the margin of the resource sheet and the age relations of the various formations are shown in Table 1. The deposits are highly variable in thickness and lithological character, and each formation consists of a number of separate lithofacies. Representative sections illustrating the lithofacies encountered in different parts of the block are given in Figure 9.

The main outcrops of the **Milldale Limestones** are in the axial zones of the Dovedale and Ecton anticlines. Limestones of knoll-reef facies form laterally extensive deposits at least 180 m thick in Dovedale (Plate 2); the facies is also widely developed between Ecton and Weag's Bridge in the Manifold Valley. The limestones consist typically of unbedded, sparsely fossiliferous micrite with numerous spar-filled cavities, and subordinate bands containing shell, crinoid and bryozoan debris. The knoll-like form of the deposits is well-displayed in the hills of Thorpe Cloud and Bunster, located at the southern entrance to Dovedale. The knoll-reefs pass laterally and vertically into inter-reef deposits of very variable character. A facies comprising thin to thickly bedded crinoidal and peloidal limestones with scattered chert nodules is well-exposed in Milldale (15 SW 3S) and in the crags overlooking Coldeaton Bridge (15 NW 6S). In the same area a dark lithofacies has been mapped out consisting of thinly bedded cherty limestone with shaly intercalations. The latter facies is more widely developed in the Manifold valley and good exposures are found in the river section between Wetton Mill [097 561] and Thor's Cave [098 549] and in cuttings along the old Manifold Railway track.

Towards the south-west of the block the reef masses become smaller and form single isolated bodies rather than complex knolls. In Browend Quarry (05 SE 3S), where the uppermost 80 m of the formation is exposed, the sequence is one of thinly-bedded fine-grained argillaceous calcarenites with shale intercalations and scattered chert nodules (Plate 4); two small reef lenses are seen in the lower part of the section. Similar lithologies crop out in the hillsides west of the Hamps (05 SE 8S, 05 SE 9S). Coarser grained detrital limestones containing less chert and forming thicker-bedded units crop out lower in the sequence and underlie the ground between Soles Coppice [102 537] and Throwley Moor [098 525]. This part of the succession is estimated to be about 150 m thick.

Detrital limestones containing variable amounts of chert and interbedded argillaceous units are also represented in the Weaver Hills ((14 NW 4S to 7S). In the more easterly outcrops, seen in Rushley Wood and Musden Wood, over 200 m of thinly bedded fine calcarenitic limestone containing chert nodules and shale partings are exposed. Assessment boreholes 14 NW 5, 15 SW 8 and 15 SW 9, which penetrated the upper parts of the formation, serve to highlight the variability of the sequence. A fine lamination seen in much of the cored material is distinctive but does not appear to be diagnostic of any particular horizon; graded bedding is another feature observed in some boreholes, notably 15 SE 9 (Plate 8). The conglomeratic bands proved in boreholes at Calton Moor (14 NW 5) and Slade House (15 SW 8) have not been traced on the ground, though beds of similar lithology are exposed in a quarry east-south-east of Huddale Farm (14 NW 3S).

The Milldale Limestones are overlain by the **Hopedale Limestones** and the laterally equivalent Ecton Limestones. The former range in thickness from about 60 m at the type locality to a maximum of about 360 m around Gag Lane, north-east of Thorpe. The sequence is characterised by a high proportion of sharp-based conglomeratic units in which crinoid debris, shells and intraclasts of micritic material are all important constituents. The limestones are thin to thickly bedded and range in colour from mid-grey to dark grey; a fine-grained dark lithofacies has also been noted in places in the more easterly outcrops. Chert nodules occur locally but are absent, apparently, from the Gag Lane sequence. The top of the formation is marked by the incoming of dark mudstones and shales of the Mixon Limestone - Shales and the Widmerpool Formation. Disused quarries north-west of Wetton (15 NW 4S) and near Waterhouses (05 SE 4S; Plate 6) display typical sections. Large knoll-reefs, similar to those found in the Milldale Limestones are developed north of Wetton, while smaller widely dispersed reef masses occur elsewhere in the crop.

The **Ecton Limestones** are similar lithologically to parts of the Hopedale Limestones but they contain a much higher proportion of graded beds which are interpreted as turbidites. The formation varies in thickness and is estimated to be 225 m around Ecton, 258 m around Grindon and 150 m at Blore with Swinscoe. As in the Hopedale Limestones, conglomeratic beds are common, especially near the base and towards the top of the sequence. Some of the best turbidite examples come from the lower parts of the sequence proved in the Calton Moor borehole (14 NW 5). The beds are sharp-based and each has a thin coarsely bioclastic basal part (3 to 5 cm thick) and a thicker, bioturbated more argillaceous upper part (10 to 20 cm thick); interturbidite mudstones commonly separate the limestone beds. A darker, more argillaceous and finer grained facies containing 'striped beds' is developed locally in the middle and upper parts of the exposed sequence and is seen south-east of Swainsley Farm (093 575). Chert in nodular and tabular form is ubiquitous in the section

exposed along the old Manifold Railway (05 NE 2S) but has not been found in boreholes or sections in the area between Grindon and Waterfall Low.

The Ecton and Hopedale limestones pass upwards into formations containing a substantial clastic content. In the west, the formation is the **Mixon Limestone-Shales.** This consists of thinly bedded limestones and silty mudstones forming sharp-based graded units. Sandstones and sandy limestones predominate in the upper part of the succession and comprise the Onecote Sandstones member. The formation is about 183 m thick in the Mixon inlier, but thins towards the north-east and is only about 24 m near Gateham Grange [115 569]. The New Mixon Hay No. 2 borehole [039 5713] indicated a limestone to mudstone ratio for the lower and middle parts of the sequence of about 2:1.

Laterally equivalent beds in the south and east of the block are assigned to the **Widmerpool Formation.** This, too, contains mudstone-limestone-sandstone turbidites but the sandstones are developed throughout the sequence rather than being confined just to the upper part of the succession. The formation is known mainly from an IMAU borehole drilled in Pike House Quarry (15 SE 10) and from a Land Survey Division borehole sunk at Lees Farm [1818 5016] (Institute of Geological Sciences, 1981b) where 238.79 m were penetrated without the base being proved.

A sequence of dark cherty limestones with subordinate mudstones is developed locally towards the base of the formation and crops out in a belt which extends southwards from Newton Grange, through Tissington, to the southern margin of the Dovedale reef-complex; the facies is shown separately on the resource sheet and is designated by the symbol L (WdF).

Cropping out east of the village of Tissington, there are fairly extensive volcanic and volcaniclastic deposits, comprising tuffs, lavas and hyaloclastites. The deposits are not well-exposed but they have been encountered in a number of boreholes; one drilled at Lees Farm [182 502] penetrated some 30 m of volcanic breccia, which is the thickest development of these rocks that has so far been proved. Evidence that the volcanic activity continued spasmodically for a period following the main eruptive phase is indicated by the presence of tuffaceous fragments in the limestones overlying the volcanics (see for example borehole 15 SE 8 and section 15 SE 4S).

Structure The limestones are folded into north-south- and north-north-west to south-south-east-trending anticlines, with the axes of the main structures. coincident with the lines of the main knoll-reefs. The reef masses themselves appear to have undergone little deformation but in the thinly bedded limestone and limestone-shale sequence that envelop the reefs minor folds are numerous. The intensity of the folding is most pronounced in the north-west of the block and is revealed rather spectacularly in the quarries at Ape's Tor (05 NE 4S; Plate 5). Similar tight fold structures are also seen at the south-east of the Weaver Hills, in the core of the Mixon-Morridge anticline and in the Swinscoe region (14 NW 9S). Dips throughout the block commonly exceed 30° and are often much higher. Clearly the development of quarries with stable working faces could pose problems in these intensely folded area.

The major faults trend north-south, parallel to the fold axes. The Manifold valley fault system stretching from Ecton to Throwley Moor has an estimated displacement of about 600 m along parts of its length and is the most important fracture line. A subordinate set of north-westerly-trending faults has been mapped in the Dove valley north of Milldale.

Dolomitisation and mineralisation The limestones all contain some disseminated dolomite but the Hopedale and Ecton limestones seem to have been most affected, especially the coarser grained conglomeratic facies (Plate 8). Areas where the limestones have been completely altered to dolomite rocks are shown on the resource sheet. In the case of the deposits near Ilam Tops [130 520], nothing is known about the depth of alteration; around Tissington, however, the dolomitisation seems to be related spatially to the outcrop of the Tissington Volcanics and the zone of alteration is quite extensive.

Mining activity in the 18th and 19th centuries has left its mark on the ground and there are a number of sites that are either undermined or where there are extensive spoil heaps at the surface. The Ecton Copper Mine, the mines of the Mixon area, the Bincliff Lead Mines [117 540] and the Thorswood Mine in the Weaver Hills [112 470] were all thriving operations which are well documented in the literature. There are also a series of old vein workings in the Newton Grange area about which little is known.

Colour The predominant colours in the limestones are mid-grey and dark grey, though the presence of hematite in many of the rocks results in their also having a pinkish tinge. In the **Hopedale** and **Milldale** limestones, there is sufficient contrast between the mid-grey and the darker lithofacies for the latter to be separately distinguished in places. Anomalously high reflectance results are given by dolomitic rocks and by fine-grained lithologies in the Milldale Limestones where there is often a high percentage of clay grade silica present.

Throughout the block the knoll-reefs are the only deposits that are pure enough to provide a powdered product comparable in whiteness with that of the Derbyshire and Staffordshire shelf deposits (see Figure 8).

Rock chemistry and non-carbonate mineralogy The purest deposit in the resource block are the **knoll-reefs.** Insoluble residue determinations indicate that most are composed of very high purity limestone ($CaCO_3$ $\geq$ 98.5 per cent), though the analytical evidence suggests that locally the purity is slightly lower (mean CaO = 55.03 per cent: equivalent to 98.2 per cent $CaCO_3$). The facies is characterised by comparatively high $P_2O_5$ values, a feature common to all the reef build-ups in the Derbyshire/Staffordshire region. The limestones are stained red by iron oxides, and Triassic (?) sandstone has been recorded infilling fissures in the structures at depths up to 85 m below the present day ground surface (see borehole 15 NW 10 and Plate 8). **Apron-reefs** fringing the shelf area have a similar composition.

In contrast, the **Milldale Limestones** are the least pure of the carbonate formations. The various inter-reef facies contain a high percentage of non-carbonate material and the deposits are mainly impure or are of low purity (<93.5 per cent $CaCO_3$). Chert is widely distributed but is particularly common in the dark bituminous facies designated Mi/dk on the resource sheet. Finely disseminated silica is abundant in the more argillaceous lithologies and when present in large quantities (>10 per cent) it appears on the surface of the etched rock as a white residue totally masking the fabric of the rock (see, for example boreholes 15 SW 8 and 15 SW 9); silica also occurs replacing shell debris. Shaly horizons, ranging from a few millimetres to several centimetres in thickness, occur throughout much of the sequence and contribute to the high $Al_2O_3$ values shown in Table 4.

A number of localities have been identified where the Milldale Limestones are of substantially higher purity: in the Coldeaton Bridge area (15 NW 6S) the crags overlooking the River Dove consist of high purity, chert-free peloidal limestones; similar lithologies are exposed in cliff sections alongside the road near Milldale (15 SW 3S). About 12 m of very high purity mineral are exposed in a small quarry south-east of Huddale Farm

and diggings on Throwley Moor (05 SW 11S) provide evidence that this area too is underlain by relatively pure, chert-free mineral.

The formation contains some disseminated dolomite and this is reflected in the slightly increased MgO values; the highest recorded value (2.56 per cent) represents approximately 12 per cent of dolomite mineral. Anomalously high $P_2O_5$ values (0.55 per cent in borehole 14 NW 5) correlate with conglomeratic beds containing clasts of knoll-reef limestone.

Trace element concentrations above the background level have been detected in a borehole at Caltonmoor House (14 NW 5) and in another at Stanshope (15 SW 9). In the former, traces of lead/zinc mineralisation were observed in the core, and in the latter, which was sited close to the Bincliff Mines, copper, lead and zinc levels are slightly elevated.

The **Hopedale** and **Ecton** limestones are laterally equivalent formations with broadly similar chemical compositions (Figure 5, Table 4). Both formations contain thick cherty sequences of low purity and impure grade mineral and in this respect they resemble the Milldale Limestones. However medium and high purity resources of considerable thickness have also been identified; a borehole east of Grindon (05 SE 19) proved 100 m of high and very high purity mineral in the lower part of the Ecton Limestones. Field evidence suggests that the deposits extend southwards along the strike for at least 2 km. Farther to the south, beds higher in the sequence referred to the Hopedale Limestones, have been worked in the past at quarries near Waterhouses (05 SW 4S). The beds are chert-free but are slightly less pure than those near Grindon. The second main area where higher purity mineral is likely to be encountered is in the Gag Lane sequence within the Hopedale Limestones in the east of the block [158 529]. Although no boreholes have been sunk in this immediate vicinity, field evidence and information from nearby boreholes (15 SE 8, 15 SE 10) indicate a strong likelihood that chert-free mineral underlies this area. The patchy dolomitisation that typifies the Ecton and Hopedale limestones is especially prevalent in the central and eastern parts of the block and it is likely that the Gag Lane sequence is at least partly affected. In the Blore with Swinscoe area, there is borehole evidence for high purity mineral (14 NW 4) but its subsurface extent and its relationship to the nearby cherty limestones is unknown.

The non-carbonate constituents in both formations are similar to those found in the Milldale Limestones; in addition many of the rocks contain a bituminous residue or show traces of oil. Hematite and pyrite are fairly ubiquitous contaminants throughout the Hopedale and Ecton limestones.

The trace element data show a number of small anomalies; the Rusheycliff Barn borehole (15 SE 8) located within a few hundred metres of old vein workings produced maximum copper, lead and zinc values of 100, 600 and 1750 ppm respectively from 5 m aggregated samples. A small lead/zinc anomaly was also detected in Pike House borehole (15 SE 10).

The **Mixon Limestone-Shales** and the **Widmerpool Formation** have not been widely sampled though they cover large areas in the western and southern part of the district. Their high clastic content precludes their development as a source of aggregate but they may have some potential as a source rock for the cement manufacturing industry. The limestone member that occurs within the Widmerpool Formation is poorly exposed but, where sampled, it is of low or impure grade.

Mechanical properties Aggregate impact values for the limestones of Resource Block C are detailed in Appendix C and summarised in Figure 6. Some of the weakest material tested included dolomitic limestones (boreholes 14 NW 6 and 15 SE 8), samples containing large amounts of vein-calcite and highly argillaceous samples from the Mixon Limestone-Shales; all gave values in excess of 26. A single determination carried out on a sample of tuff from the Tissington Volcanics produced a value of over 30. In the more resistant rocks, aggregate impact values vary considerably but the overall distribution is similar to the found for the shelf limestones of resource blocks A and B. Crushed core from a borehole drilled into the Ecton Limestones near Grindon (05 SE 19) provided the most consistently low aggregate impact values (mean 18, standard deviation 5.2).

*Other geological constraints affecting mineral working*

Overburden Spreads of boulder clay are preserved on the outcrops of the Widmerpool Formation and on the Mixon Limestone-Shales. There are also deposits of alluvium, together with smaller patches of head and scree in the main valleys. Around Ecton in the Manifold Valley, there are more extensive deposits of cemented scree. As the screes are composed essentially of 'mineral', they are not separately distinguished on the resource sheet from the underlying consolidated deposits.

Water table The permanent water table only approaches the surface along the main river valleys (Figure 7). However, workings at higher levels may be affected by perched groundwater developed on the shaly horizons which are particularly common in the Milldale Limestones.

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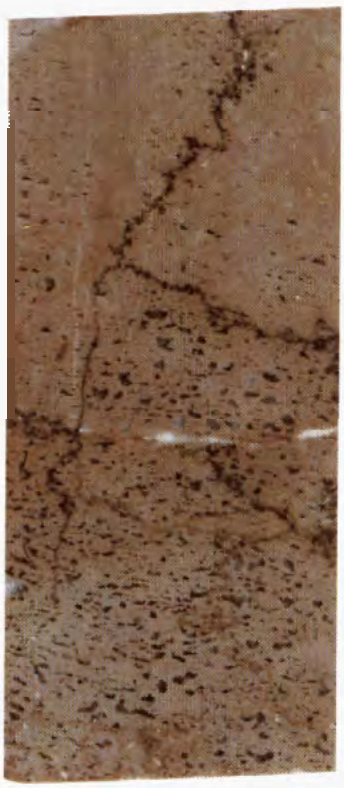

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4

**Plate 7** Core samples of very high purity limestone (all natural size).

1 Woo Dale Limestones (SK 15 NE 5): mid-grey bioclastic limestone with intraclasts composed of micritised foraminifera and peloids.

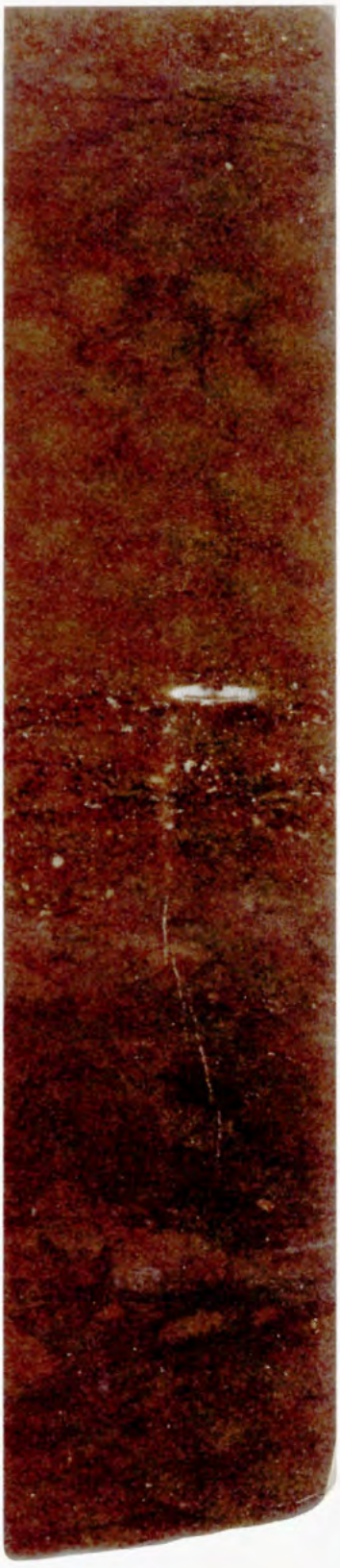
2 Woo Dale Limestones (SK 15 NE 5): mid-grey micritic limestone showing bird's-eye texture.

3 Bee Low Limestones (SK 15 NE 7): pale grey bioclastic limestone.

4 Bee Low Limestones (SK 15 NE 7): pedogenic structures picked out by brown pigmentation.

5 Milldale Limestones (knoll-reef facies (SK 15 NW 10): micritic limestone containing cavities lined with radiaxial calcite and infilled with sparry calcite/sediment; some discolouration by iron oxides is evident.

MLD 14745



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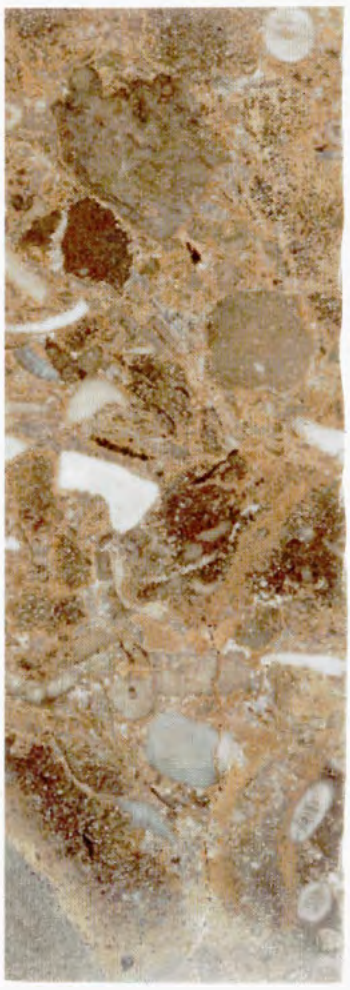

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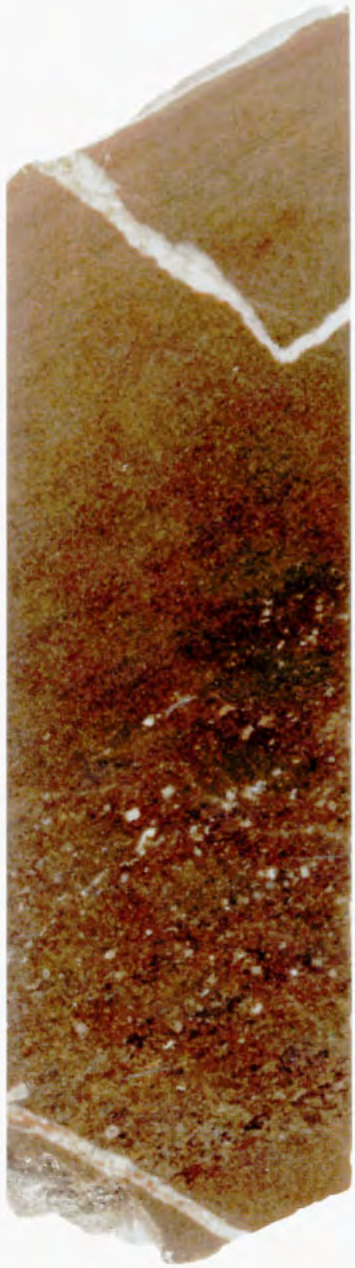

4

**Plate 8** Core samples from the Milldale and Hopedale Limestones (all natural size).

1 Milldale Limestones (SK 15 SE 9): dark grey sharp-based turbidites showing graded bedding and bioturbation structures.

2 Milldale Limestones (SK 15 NW 10): quartz sand (Triassic?) infilling subsurface fissure in knoll-reef.

3 Hopedale Limestones (SK 15 NE 5): dolomitic limestone with unaltered crinoid fragments and micrite intraclasts.

4 Milldale Limestones (SK 15 SW 8): dark grey sharp-based turbidite with fine lamination in the upper part picked out by concentrations of clay-grade silica. MLD 14746

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## APPENDIX A

## CLASSIFICATION AND GLOSSARY

### Classification

The petrographic classification of limestones proposed by Folk (1959, 1962) is widely accepted and is used in the descriptive logs (Appendix C). The classification is summarised in Table 5.

Clastic limestones consist of two basic components, namely allochem grains and matrix. The former are discrete bodies which have been subjected to some degree of transport; they include fossils and fossil fragments, oolites (ooids), intraclasts and pellets (peloids). The matrix is subdivided on grain size into: microcrystalline ooze (less than 4 micrometres) termed micrite, a slightly coarser crystalline fabric (4 to 16 micrometres) termed microspar and crystalline calcite cement or spar (greater than 16 micrometres).

Limestones are also classified by reference to the mean grain size of the allochems into calcirudites (greater than 1 mm), calcarenites (1 to 0.062 mm) and calcilutites (less than 0.062 mm). A grain size term may be incorporated into the main rock name as a suffix, for example, biosparrudite. If a rock contains diagnostic allochems which are not mentioned in the main rock name, these are used to qualify the rock name, for example, crinoidal biosparrudite.

The pure mineral dolomite ($CaMg(CO_3)_2$) contains 21.9 per cent MgO and 30.4 per cent CaO (or 54.3 per cent $CaCO_3$). Rocks containing dolomite are classified as follows:

| | |
|---|---|
| 10 to 50 per cent | Dolomitic limestone |
| 50 to 90 per cent | Calcitic dolomite |
| greater than 90 per cent | Dolomite rock (usually referred to as simply 'dolomite') |

In the first category, the use of Folk terminology is not precluded, for example, dolomitic biosparite.

Limestones containing 10 to 50 per cent detrital clay are classified as argillaceous limestones.

### Glossary

**Anticline** An arch fold, the core of which contains the stratigraphically older rocks.

**Anticlinorium** A composite arch fold consisting of several subsidiary folds.

**Authigenic** Refers to those constituents that came into existence with or after the formation of the host rock.

**Bioclast** A fossil fragment.

**Bioturbation** The churning and stirring of a sediment by organisms.

**Bird's-eye structure** Patches of finely crystalline calcite in carbonates indicating supratidal environmental conditions.

**Caliche** Any material formed by the cementation or replacement of a pre-existing soil by predominantly $CaCO_3$.

**Clastic** Refers to a rock or sediment composed principally of particles of either fragmental or chemical origin that have been transported individually for some distance from their places of origin.

**Encrinite** A limestone in which crinoidal limestones constitute more than 50 per cent of the bulk.

**Euhedral** A term used to describe crystals which have well developed crystal boundaries or faces.

**Facies** The sum of all the primary lithological and palaeontological characteristics exhibited by a sedimentary rock and from which its origin and environment of formation may be inferred.

**Fenestra** A void in a rock framework larger than any pore and partly filled with secondarily introduced sediment or cement.

**Formation** Any sedimentary bed or consecutive series of beds sufficiently homogeneous to be regarded as a unit.

**Hyaloclastite** A deposit formed by the intrusion of lava into water and its consequent granulation into small angular fragments.

**Inlier** A limited area of older rocks completely surrounded by younger rocks.

**Intraclast** Material created by penecontemporaneous erosion within a basin of deposition.

**Karst** A type of topography that is formed in limestone by dissolution and that is characterised by sink-holes, caves and underground drainage.

**Knoll-reef** A fossil reef now represented by a small prominent hill more or less circular in ground plan.

**Lithofacies** The group of sedimentary features of a rock type which characterise a particular environment of deposition.

**Lithoclast** A mechanically formed and deposited fragment of carbonate rock derived from an older lithified limestone within, adjacent to, or outside the depositional site.

**Micritisation** Decrease in size of sedimentary carbonate particles, possibly due to boring algae.

**Oncolite** A small concentrically laminated sedimentary structure formed by the accretion of hemispheroidal algae laminae around a mud-flake or shell fragment.

**Pedogenic** Pertaining to soil formation.

**Peloid** An allochem composed of micrite, irrespective of size or origin.

**Stylolite** An irregular suture-like boundary developed in some limestones.

**Syncline** A trough fold, the core of which contains stratigraphically younger rocks.

**Tuff** A general term for all consolidated pyroclastic rocks.

**Turbidite** A sediment or rock deposited from a turbidity current. It is charaacterised by graded bedding, moderate sorting and well developed primary structures, such as current lamination.

**Volcaniclastic** Any deposit rich in fragments or grains of volcanic rocks formed by volcanism, weathering and erosion of volcanic products.

**Wayboard** An old mining term used commonly in Derbyshire to describe a discrete and deleterious thin rock bed, usually of clay.

**Table 5** Classification of limestones (based on Folk, 1959).

| | | | | LIMESTONES | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | > 10% Allochems Allochemical Rocks | | < 10% Allochems Microcrystalline Rocks | | |
| | | | | Sparry calcite cement > microcrystalline ooze | Microcrystalline ooze > sparry calcite cement | 1-10% allochems | | < 1% allochems |
| Volumetric allochem composition | > 25% Intraclasts | | | Intrasparite | Intramicrite (rare) | Most abundant allochem | Intraclasts: Intraclastic micrite (rare) | Micrite |
| | < 25% Intraclasts | > 25% Oolites | | Oosparite | Oomicrite (rare) | | Oolites: Oolitic micrite (rare) | |
| | | < 25% Oolites | Volume Ratio of Fossils: Pellets > 3:1 | Biosparite | Biomicrite | | Fossils: Fossiliferous Micrite | |
| | | | Volume Ratio of Fossils: Pellets 3:1 to 1:3 | Biopelsparite | Biopelmicrite | | Pellets: Pelletiferous Micrite | |
| | | | Volume Ratio of Fossils: Pellets < 1:3 | Pelsparite | Pelmicrite | | | |

## APPENDIX B

## EXPLANATION OF FORMAT FOR BOREHOLE AND SECTION LOGS

The following list is arranged in the same order as data in the records. The numbered paragraphs below also correspond with the annotations on the first record (Appendix C).

1 The Registration Number
This consists of two statements.

a The number of the 1:25 000 sheet on which the borehole or section lies, for example, SK 15.

b The quarter of the 1:25 000 sheet on which the borehole lies and its number in a series for that quarter, for example, NW 10.

Thus the full Registration Number is SK 15 NW 10. This is abbreviated to 15 NW 10 in the text.

Collected sections are registered in a similar manner using a separate series of numbers, suffixed by letter S, for example, SK 15 NW 1S.

2 The National Grid reference
All National Grid references in this publication lie within the 100 km square SK. Grid references for borehole sites and section limits are given to eight figures (that is, accurate to within 10 m). In the text, six-figure grid references are used for more approximate locations.

3 Location

Borehole and section locations are referred to the nearest named locality on the 1:25 000 base map.

4 Surface level

The surface level at the borehole site is given in metres above Ordnance Datum. Some of the sites have been accurately levelled but, in many cases, the elevation has been estimated from the 1:25 000 topographical base map. For collected sections surface level is taken to be the top of the sampled sequence. When groundwater has been recorded, the depth at which seepage occurred is give.

5 Date of drilling

6 Descriptive borehole log

The major rock types are listed and each is subdivided, where possible, using the rock classification and nomenclature explained in Appendix A, and followed by a brief description.

7 Depth

The figures given relate to depths of the base of the lithologies described in the log.

8 Major rock types are represented on a graphical log and diagnostic lithologies are shown using an ornamental overprint. A complete list of symbols is given in Figure 10.

9 Colour (Rock)

The limestones are classified as pale grey, mid-grey or dark grey depending on the percentage reflectance of red light (peak wavelength of 660 nm) from the flat, acid-etched rock surface. A white magnesium carbonate standard with a reflectance value of 100 per cent was used to calibrate the spectrophotometer.

10 Colour (Powder)

The percentage reflectances of red light (peak wavelength of 660 nm) from specially prepared powder discs of high and very high purity mineral are shown graphically.

11 Texture

The shaded intervals highlight carbonate lithologies which are spar-cemented and which exhibit textural and compositional properties characteristic of moderate to strongly agitated water conditions at the time of deposition.

The darker triangular-shaped symbol denotes units showing graded-bedding.

12 Alteration/mineralisation

The presence of disseminated dolomite or dolomitic limestone is recorded and the extent and nature of any mineralisation is shown.

13 Mechanical properties

For most boreholes (and a few sections) the results of the Aggregate Impact Value test (British Standards Institution, 1975) are reported for each 10 m of core or section material.

14 Insoluble residue data

Residue values are expressed as weight percentages and, where appropriate, the mineralogy is summarised.

15 Classification into categories by purity

The overall purity of a limestone, averaged over consecutive 10 m intervals of depth, is stated using the following system:

| | | Percentage $CaCO_3$ |
|---|---|---|
| 1 | Very high purity | $\geq$ 98.5 |
| 2 | High purity | $\geq$ 97 to <98.5 |
| 3 | Medium purity | $\geq$ 93.5 to <97 |
| 4 | Low purity | $\geq$ 85 to <93.5 |
| 5 | Impure | <85 |

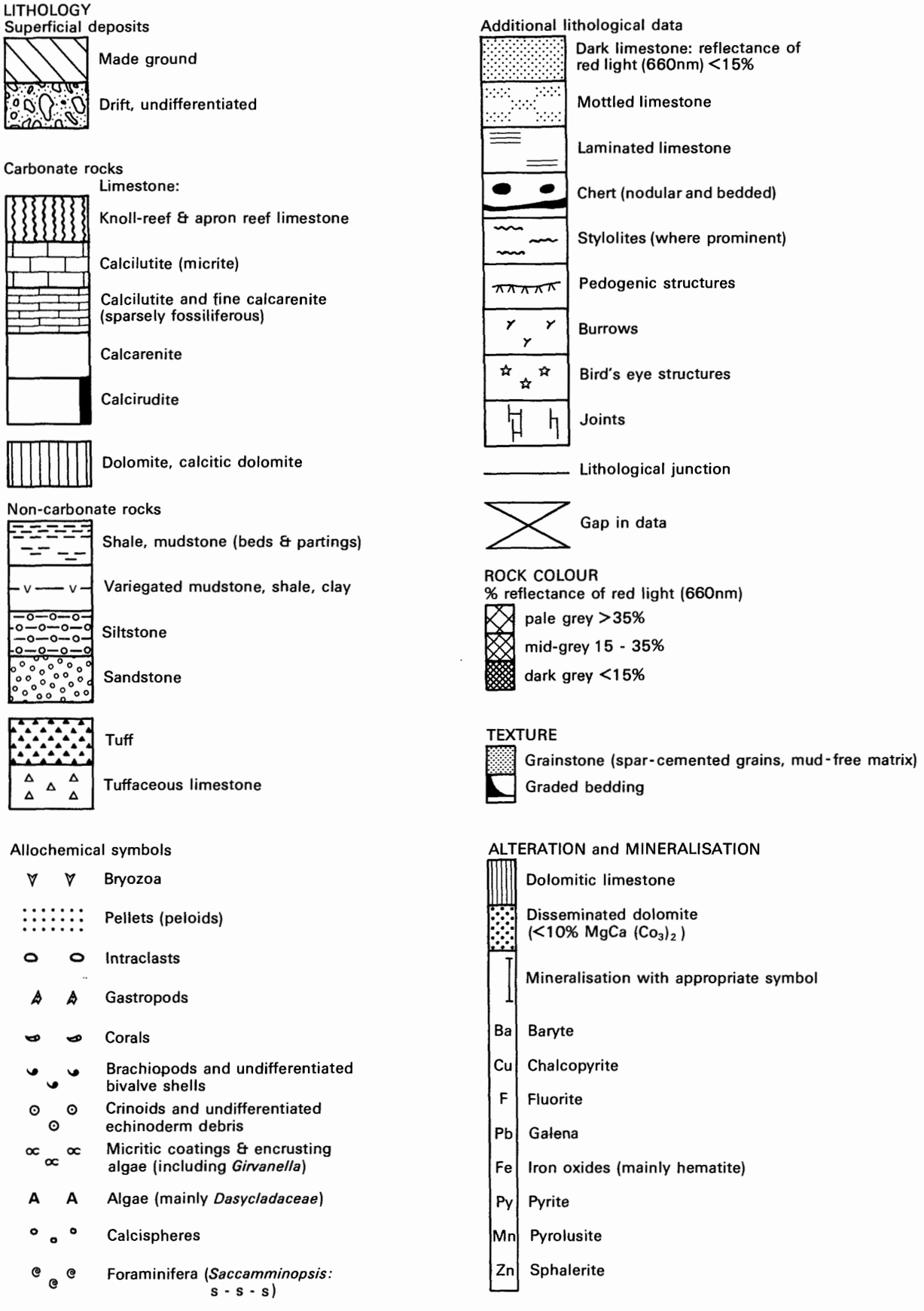



**Figure 10** Explanation of symbols used on graphical logs.

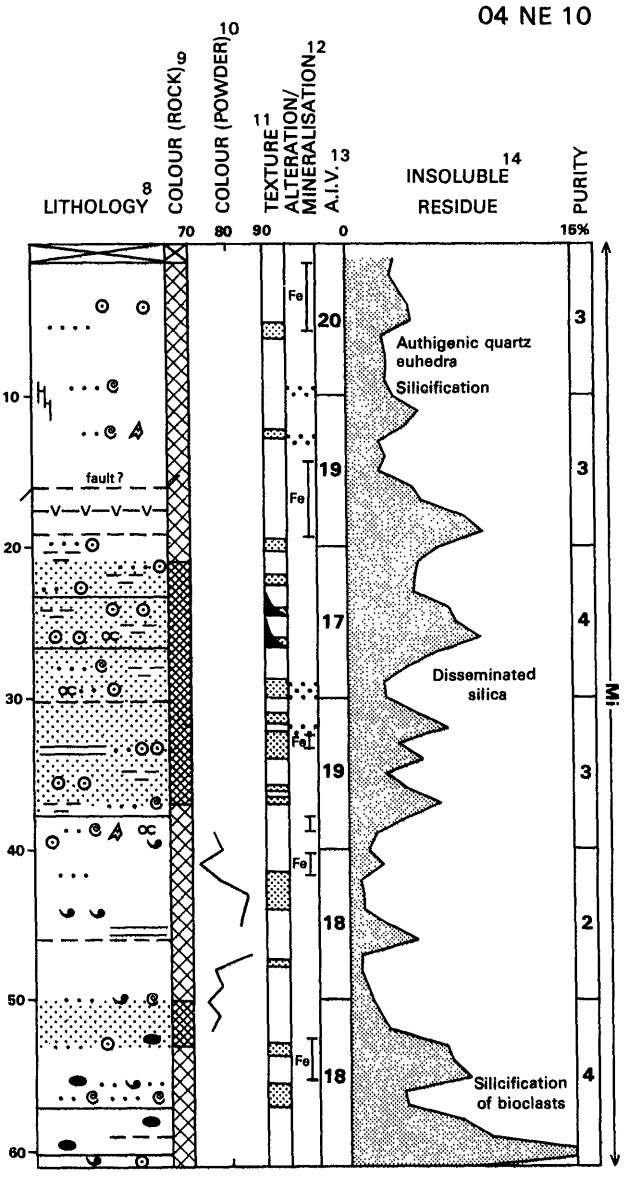
APPENDIX C

RECORDS OF BOREHOLES AND SECTIONS

**SK 04 NE 10**[1] **0888 4778**[2] **Rue Hill, Wardlow**[3]
Surface level +325.6 m[4]
February 1971[5]

| [6] | Thickness m | Depth[7] m |
|---|---|---|
| Openhole | 1.10 | 1.10 |
| **Milldale Limestones** | | |
| Limestone, mid-grey, medium and fine calcarenites with dispersed shells; coarse crinoid debris at 4.25 m; bioclasts slightly silicified throughout. Much brecciation and calcite veining at top of unit | | |
| **Passage** | 3.40 | 4.50 |
| Limestone, mid-grey, mainly fine calcarenite but with local coarse calcarenite lenses; spar-cemented assemblages, consisting of peloids, foraminifera, gastropods and crinoid ossicles developed beneath major stylolitic junctions; some associated brown staining. Distinctive marker horizons absent. Calcite-veined with associated secondary silica and dolomite. Silica also occurs as discrete authigenic crystals and as bioclast replacements. Variable hematite staining. Breccia (fault?) at 14.45 m. Sheared red mudstone at 16.00 m | 11.60 | 16.10 |
| Limestone, mid-grey, locally reddened, medium and fine calcarenite; thin wayboard clay at 17.60 m; sheared black shale at 19.10 m. Beds steeply dipping (fault zone ?) | 3.00 | 19.10 |
| Limestone, dark grey, fine calcarenite, commonly peloidal, thin shaly partings and stringers | 4.30 | 23.40 |
| Limestone, dark grey, sharp-based graded crinoidal units up to 0.50 m thick, interbedded with fine-grained argillaceous calcarenites. Some thin shale intercalations | | |
| **Passage** | 3.20 | 26.60 |
| Limestone, dark grey, predominantly fine calcarenite but with lenses of coarse crinoid debris (ungraded), finer lithologies are spar-cemented with foraminifera, peloids, gastropods and indeterminate skeletal fragments. Thin shaly intercalations. Disseminated dolomite and silica | 11.20 | 37.80 |
| Limestone, mid-grey with some darker bands, lenses and dispersed fragments of crinoid debris common throughout, finer lithologies are peloidal with subordinate foraminifera and algal fragments, current laminated. Sporadic chert nodules towards base. Veining and bioclast silicification throughout | 19.26 | 57.06 |

BLOCK B
04 NE 10



| | | |
|---|---|---|
| Limestone, dark pinkish grey, fine calcarenite, scattered cherts, some current lamination and slumping; pink shale intercalations | 3.20 | 60.26 |
| Limestone, mid- to dark grey, crinoidal | 0.75 | 61.01 |

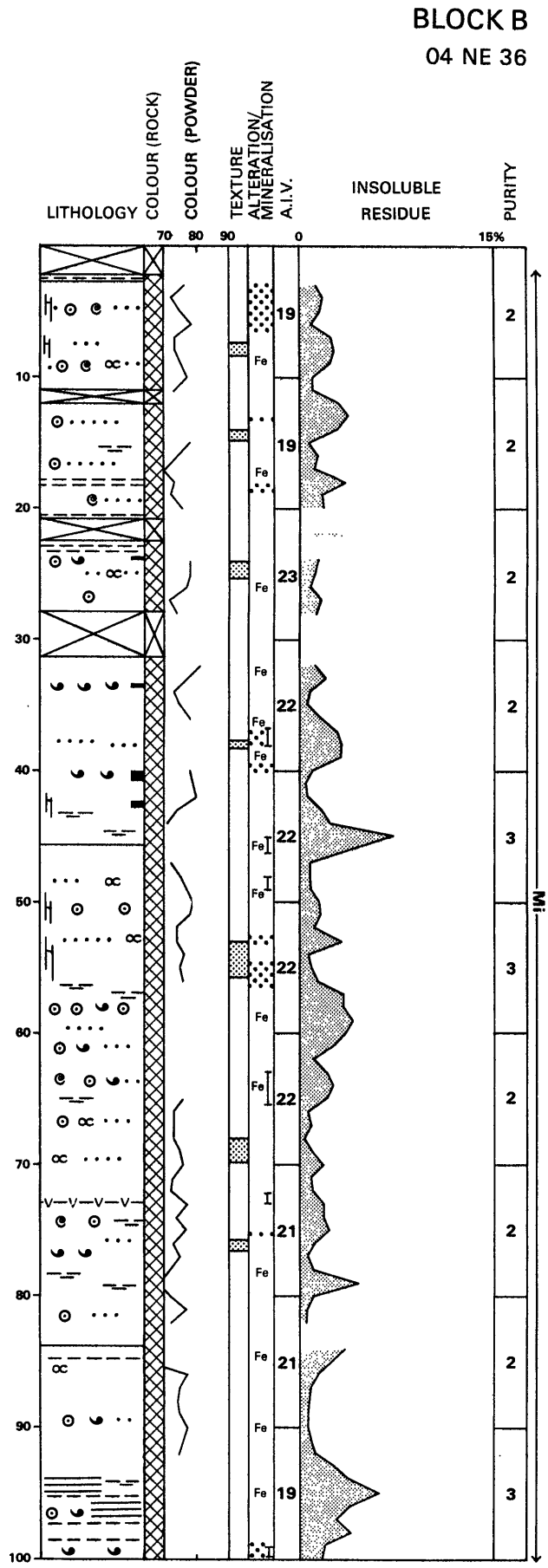
Borehole completed at 61.01 m

*The annotations are explained in Appendix B*

**SK 04 NE 36 0804 4822 Little Rue Hill Quarry: Caldon Low Borehole**

Surface level c. +335 m
1977

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 2.15 | 2.15 |
| **Milldale Limestones** | | |
| Clay, red-brown with limestone fragments (fissure-fill) | 0.44 | 2.59 |
| Limestone (biopelsparite), fine to medium calcarenite, with dispersed crinoid debris, isolated brachiopods, abundant foraminifera. Core fractured and veined with some cavities at base; patchy dolomitisation; hematite and limonite staining | 9.41 | 12.00 |
| Limestone, mid-grey, fine to coarse calcarenite; abundant peloidal grains with micritised rims to 14.09 m, scattered crinoid debris and dispersed brachiopod shells; wispy shale partings. Calcite veining, hematite and limonite staining. [Dip 41° at 12.70 m] | 5.85 | 17.85 |
| Limestone, mid-grey, fine to medium calcarenite; coarser grained and more bioclastic from 23.56 to 23.88 m. Thin calcite veins throughout; associated dolomitisation at 18.60 m, hematite staining common; much fissure-filling clay. Incomplete core recovery | 13.44 | 31.29 |
| Limestone (biosparite), mid-grey, fine to medium calcarenite, with brachiopod bands at 33.30 m (20 cm) and 40.33 m (40 cm); biopelsparite bed from 37.85 to 38.38 m; wispy shale partings between 43.05 and 45.26 m. Irregular calcite veins throughout; hematitic patches common; rare euhedral quartz crystals | 14.30 | 45.59 |
| Limestone, mid-grey, brown-stained adjacent to joints, fine to medium calcarenite, with dispersed crinoid debris and a 4-cm coarse crinoidal band at 58.16 m; a few scattered brachiopods; peloid grains common, particularly in the lower part of the unit; purple-stained shale partings at intervals, especially from 57.54 to 57.56 m. Many steeply-inclined calcite veins; calcite-limestone breccia from 49.17 to 49.64 m with associated hematite and limonite staining; disseminated | | |



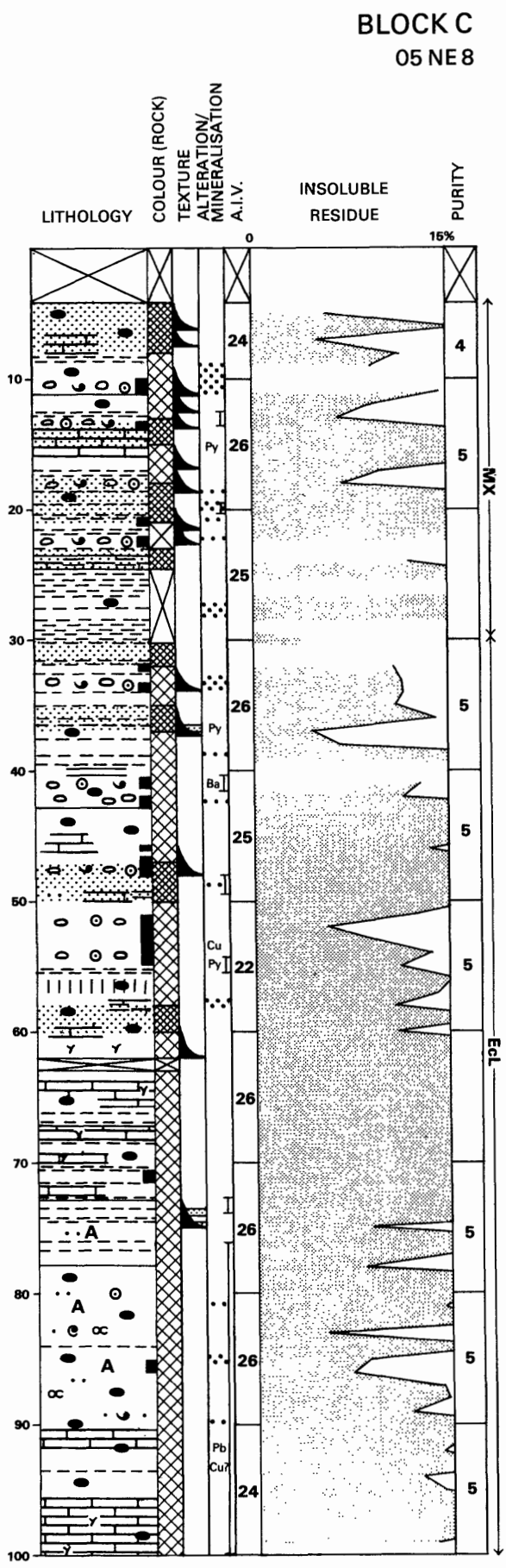
| | | |
|---|---|---|
| and patchy dolomite, trace silicification. [Dip variable: 6° at 57.66 m, 33° at 64.80 m] | 26.86 | 72.45 |
| Clay, dark reddish purple and pale greenish grey | 0.01 | 72.46 |
| Limestone, mid-grey, fine to medium calcarenite, interbedded biosparites and biopelsparites with dispersed crinoid debris and isolated brachiopods; 3-cm shell band at 76.80 m. Several red-stained clay and shale partings between 72.78 and 75.73 m and below 78.45 m. Calcite veining with associated hematite staining common | 11.30 | 83.76 |
| Breccia, laminated shaly limestone with calcite matrix | 0.02 | 83.78 |
| Limestone, mid-grey, with shale partings | 0.72 | 84.50 |
| Clay and mudstone, reddish purple. [Dip 3° at 84.60 m] | 0.10 | 84.60 |
| Limestone, mid-grey, becoming darker from 97.26 to 97.69 m, fine to medium calcarenite, some peloidal bands, scattered fine crinoid and shell debris, sometimes concentrated in thin bands; oncolitic nodules up to 5 cm in diameter from 84.87 to 85.52 m; fine current lamination from 93.88 to 96.24 m. Shale and shaly limestone partings, especially from 93.30 to 95.13 m. Mudstone, greenish-grey (2 cm), at 95.39 m; local hematite staining. [Dip 4° at 95.39 m] | 15.80 | 100.40 |

Borehole completed at 535.37 m

**SK 05 NE 8** **0942 5928** **Old Quarry, Warslow Hall**

Surface level c. +250 m
February 1977

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 4.54 | 4.54 |
| **Mixon Limestone - Shales** | | |
| Limestone, mainly dark grey, beds 0.08 to 0.40 m thick, graded with sharp bases and finely laminated tops; abundant shell debris, subordinate crinoids and dasycladacean algae; dispersed intraclasts, mud-supported; scattered chert nodules; bioclasts highly silicified; disseminated pyrite. Clay residue on etched rock surface | 3.71 | 8.25 |
| Calcareous mudstone | 0.75 | 9.00 |
| Limestone, mid-grey, graded, conglomeratic in basal 83 cm with subrounded intraclasts, disseminated dolomite, patchy silicification | 2.08 | 11.08 |
| Limestone, dark grey, graded in units 0.10 m thick, laminated in part with alternating dark carbonaceous and paler calcareous layers | 1.42 | 12.50 |
| Mudstone | 0.41 | 12.91 |
| Limestone, mid-grey, three graded units | 0.91 | 13.82 |

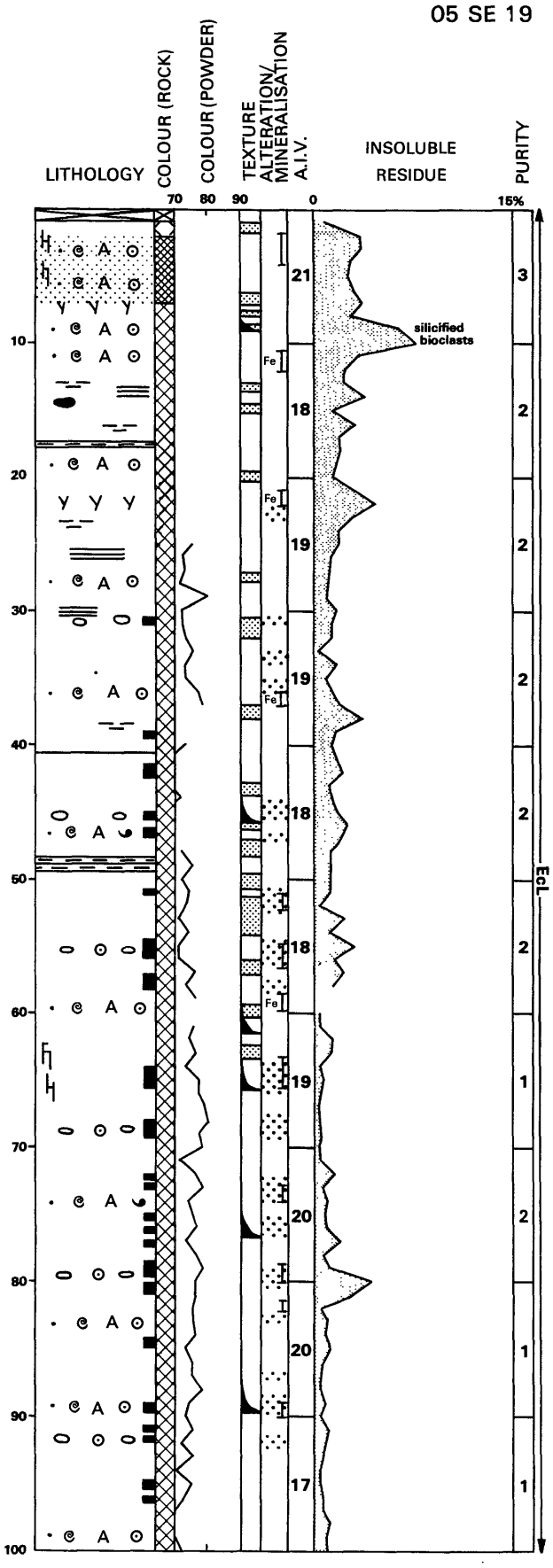


| | | |
|---|---|---|
| Limestone, mainly dark grey, graded turbidites up to 1.20 m thick, all coarsely conglomeratic at base and usually laminated at top. Intercalations of shale and/or argillaceous limestone; latter is banded and sparsely fossiliferous. Disseminated dolomite, calcite veining, especially in interval 19.55 to 20.00 m. | 10.50 | 24.32 |
| Mudstone with a few bivalves | 1.81 | 26.13 |
| Limestone with mudstone intercalations | 1.77 | 27.90 |
| Mudstone, black with goniatite fauna; subordinate limestone units | 1.93 | 29.83 |
| **Ecton Limestones** | | |
| Limestone, mid- to dark grey, conglomeratic beds (7) ranging from 0.20 to 3.53 m thick, containing intraclasts of fine-grained limestone up to 10 cm diameter, grading less apparent, especially below 42 m. Interbedded shales and thin limestones (interturbidites); latter are colour-banded due to alternation of calcareous and carbonaceous layers. Sporadic chert and pervasive silicification, disseminated dolomite, veining with baryte at 40.80 m, sulphide mineralisation at 52.40 m | 32.19 | 62.02 |
| Gap | 0.86 | 62.86 |
| Limestone, dark grey, (white silica residue on etched rock surface), thinly bedded, very fine calcarenite with intercalations of shale (limestone:shale 4:1); coarser graded units up to 30 cm thick at 71.20 and 72.53 m, bioturbation common; scattered chert nodules, veining at 70.80 m | 9.96 | 72.82 |
| Limestone, mid-grey, fine and coarse calcarenites, locally graded, mainly algal biopelsparites, some showing current lamination; rare rudite debris (notably from 85.90 to 87.46 m); no silica residue but sporadic chert and disseminated dolomite. Minor intercalations of sheared shale. Extensively veined below 77.50 m | 17.68 | 90.50 |
| Limestone, mid-grey, argillaceous, very fine calcarenite. Local chert; some mudstone partings | 1.63 | 92.13 |
| Limestone (biopelsparite), mid-grey, fine calcarenite, laminated, veined with sulphide mineralisation. A few thin mudstones | 3.65 | 95.78 |
| Limestone, dark grey, argillaceous, bioturbated, some mudstone partings | 4.03 | 99.81 |
| Borehole completed at 99.81 m | | |

**SK 05 SE 19** **0933 5410** **Grindon**
Surface level c. +290 m

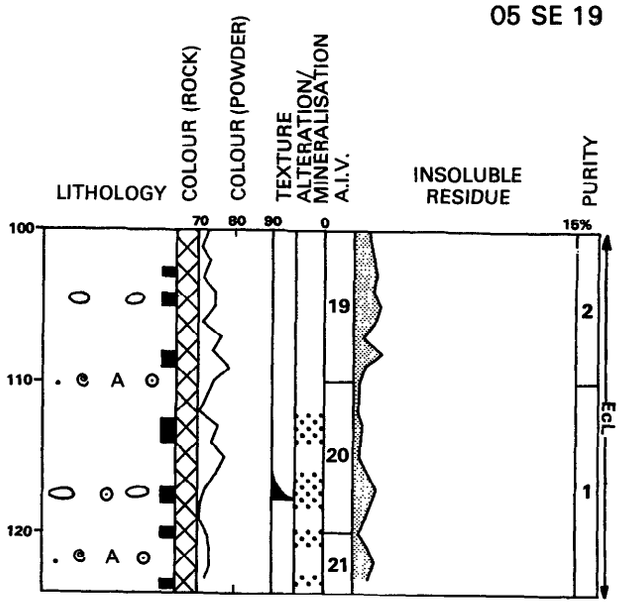
| | Thickness m | Depth m |
|---|---|---|
| Openhole | 0.90 | 0.90 |
| **Ecton Limestones** | | |
| Limestone, mid- to dark grey, fine to medium calcarenite, beds 20 to 30 cm thick containing well-sorted crinoids, dasycladacean algae, foraminifera and peloids; inter-bedded fine-grained bioturbated limestone (distinctive white clay-grade silica residue on etched surface); local grading; some beds separated by reddish grey shale partings; bioclasts are silicified; some disseminated dolomite; abundant dendritic hematite associated with veining | 11.50 | 12.40 |
| Limestone, mid-grey, generally finely bioclastic (biopelsparite), but with several bands of coarser debris (15.70 m, 27.70 m, 30.60-30.90 m, 32.00-32.50 m, 38.79 m). Beds range from 30 cm to over 1 m thick; grading not often seen but strong current lamination at 13.50 m, 25.50 m and 30.50 m. Bioclasts generally as in unit above but also include dispersed intraclasts up to 4 cm diameter; coarse spar cement where bioclasts are loosely packed, some bioturbation in finer lithologies at 22 m but not common generally. Beds separated locally by thin, red, shaly partings. Variable disseminated hematite and dolomite associated with veining. Fissure-filling clays common. [Dip 23° at 13.42 m] | 28.16 | 40.56 |
| Limestone, mid-grey, alternating biosparrudites and biopelsparites; coarser beds commonly contain irregular intraclasts up to 10 cm diameter and crinoid stems up to 1 cm diameter; subordinate brachiopods. Grading is rare but is seen in beds at 61.40 and 77.30 m; parallel lamination is common; beds range from 0.20 to 1.5 m thick. Coarser lithologies are dolomitised preferentially; abundant hematite in matrix and also associated with veining. Brown plastic clays (48.43-48.72 m, 48.80 -49.41 m) may be joint infillings or wayboards. [Dip 24° at 51.66 m, 25° at 92.54 m] | 83.44 | 124.00 |

Borehole completed at 124.00 m



# BLOCK C

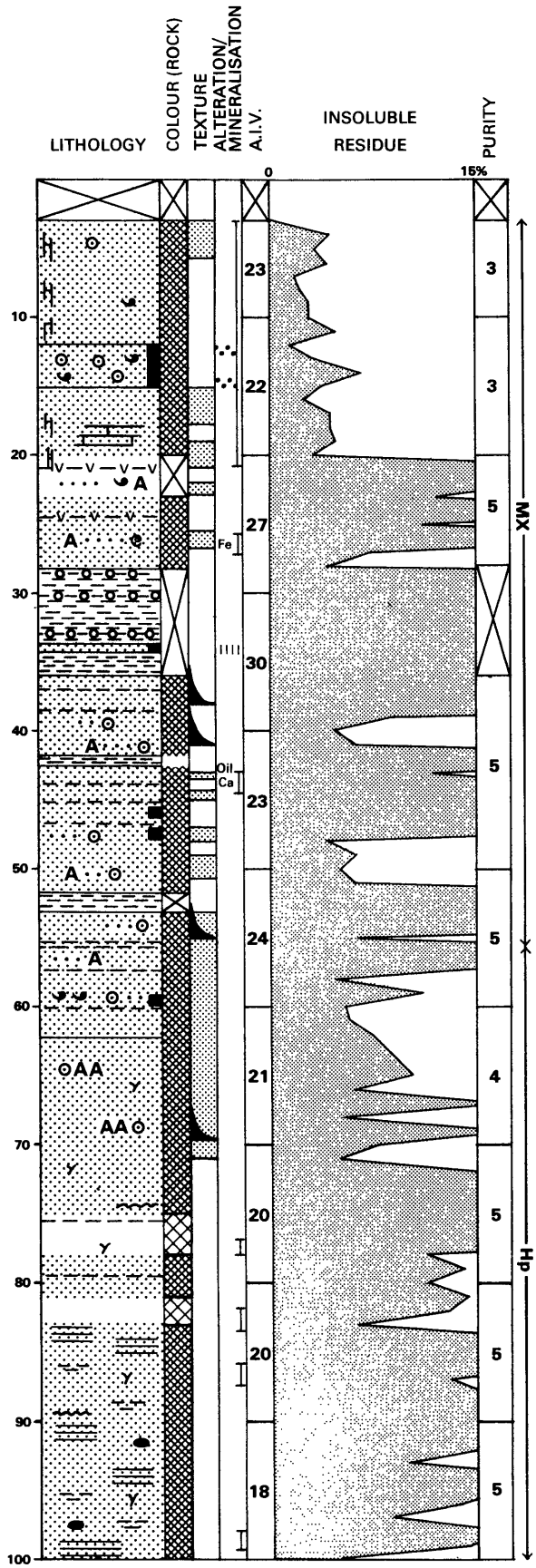
## 05 SE 19



**SK 05 SE 20 0826 5139 Waterfall**
Surface level c. +260 m
1977

**BLOCK C**
**05 SE 20**

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 3.00 | 3.00 |
| **Mixon Limestone-Shales** | | |
| Limestone (biosparite), dark grey, fine calcarenite/calcilutite, well-sorted comminuted shell fragments, foraminifera and peloid grains; scattered coarse crinoid debris below sharp base at 5.80 m. Traces of ferroan dolomite adjacent bedding planes, increasingly silicified towards base of unit; fissure-filling clays in jointed core from 4.90 to 5.20 m and from 9.50 to 12.00 m | 9.00 | 12.00 |
| Limestone (crinoidal biosparrudite), dark grey; dolomitised and silicified locally, traces of hematite and limonite; fissure-filling clay from 14.60 to 15.05 m | 3.05 | 15.05 |
| Limestone (biosparite), dark grey, mainly fine calcarenite with sporadic brachiopod shells, current laminated locally | 5.95 | 21.00 |
| Limestone (biosparite), dark grey, interbedded fine and coarse calcarenites, sharp-based units-some current laminated; bioclasts include foraminifera, peloid grains, dasycladacean algae and some coarse crinoid debris. Iron-staining common; variable silicification, rubbly core. Varicoloured mudstones at 21.00 m and 24.50 m. [Dip 48° at 23.75 m] | 7.28 | 28.28 |
| Mudstone, finely interlaminated, silty grey and dark grey with carbonised plant fragments and a few goniatites; coarsely bioclastic limestone band, dolomitic at base and fining towards top from 33.75 to 34.20 m; dolomite from 34.39 to 34.90 m | 7.72 | 36.00 |
| Limestone, dark grey, medium calcarenite to fine calcirudite, graded units 0.2 to 0.4 m thick separated by thin mudstone partings | 5.89 | 41.89 |
| Mudstone, pale and dark, laminated | 0.63 | 42.52 |
| Limestone, dark grey, mainly coarsely bioclastic with crinoids and dasycladacean algae; some finer grained lithologies separated by shaly/dolomitic partings; traces of disseminated quartz and dolomite. Mudstones at 43.63 m (19 cm) and 44.92 m (46 cm). [Dip near vertical from 52.00 to 53.00 m] | 10.48 | 53.00 |
| Limestone (biosparite), medium to coarse calcarenite, well-sorted and locally graded units approximately 0.3 m thick separated by thin shaly partings, some silicification of bioclasts, traces of mineralisation, oil residue in vugs | 2.17 | 55.17 |
| Mudstone, dark grey [Dip 34° at 55.61 m] | 0.44 | 55.61 |
| **Hopedale Limestones** | | |
| Limestone (crinoidal biosparite), dark grey, well-sorted crinoids | | |

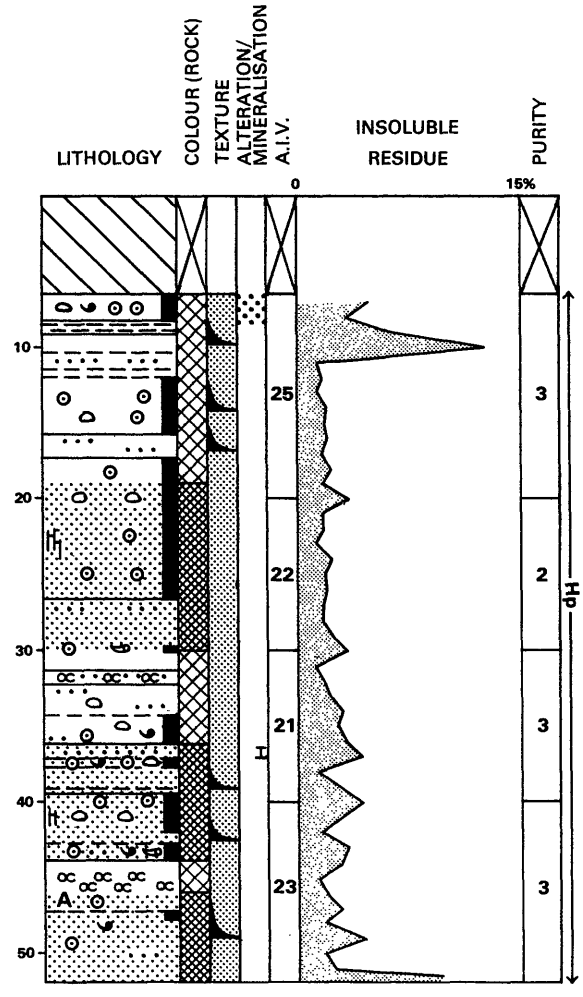


| | | |
|---|---|---|
| peloids and foraminifera in units 0.1 to 0.3 m thick separated by shale partings. [Dip 2½° at 59.02 m] | 6.62 | 62.23 |
| Limestone, mainly dark grey, fine to medium calcarenite, spar-cemented units, locally graded and containing dasycladacean algae, crinoid ossicles and peloid grains; mudstone intercalations. Passing at 71.00 m into less sparry, bioturbated lithologies containing much clay-grade silica. Traces of oil and disseminated pyrite. Calcite veinlets at 82.40 m [Dip variable: 60° at 65.76 m, 37° at 78.08 m] | 21.27 | 83.50 |
| Limestone, dark grey, argillaceous, generally fine-grained, finely laminated, sporadic chert nodules; thin shaly partings. Oil in vugs, disseminated pyrite, extensive calcite veining at 86.20 m. [Dip 40° at 88.58 m] | 16.50 | 100.00 |

Borehole completed at 100.00 m

**SK 05 SE 21 0861 5033 Waterhouses**
Surface level c. +225 m
November 1980

| | Thickness m | Depth m |
|---|---|---|
| Made ground (quarry fill) | 6.50 | 6.50 |
| **Hopedale Limestones** | | |
| Limestone, mid-grey, calcirudite with crinoid fragments (3 cm diameter), brachiopod shells and intraclasts of micritic limestone; disseminated dolomite and silica, pyritous, oil in vugs | 1.75 | 8.25 |
| Shale | 0.81 | 9.06 |
| Limestone, mid- to dark grey, beds 20 cm thick separated by thin shale partings, allochems finer grained than above, graded unit from 9.65 to 9.85 m; disseminated silica | 1.14 | 10.20 |
| Shale | 0.23 | 10.43 |
| Limestone, mid- to dark grey, mainly medium calcarenite; sharp-based units up to 20 cm thick, some fining upwards; pelsparite from 11.35 to 11.55 m, black bituminous residue in pores. Shale bands at 11.50 m (5 cm) and 11.95 m (5 cm) | 1.57 | 12.00 |
| Limestone (biosparrudite), mid-grey, hematite-stained, coarsely bioclastic with spar-cemented crinoids, shells, corals and intraclasts; units are 10 to 60 cm thick and are sharp-based or separated by stylolitic surfaces. Some units show overall grading. Thin shaly partings. Bituminous residue in pores | 3.76 | 15.76 |
| Limestone (pelsparite), mid- to dark grey, finer grained and thinner bedded than unit above, graded from 16.60 to 16.70 m. Bituminous residue in pores. [Dip 30° at 16.90 m] | 1.54 | 17.30 |
| Limestone (intraclastic biosparrudite), mid to dark grey, thinly bedded (10 to 20 cm), subordinate crinoid debris; intraclasts | | |



| | | |
|---|---|---|
| abundant from 20.00 to 20.40 m. No grading apparent. Core very fractured and reddened from 22.30 to 22.50 m. Disseminated bituminous matter, bioclasts silicified | 9.23 | 26.55 |
| Limestone, mid- to dark grey, pelsparite to 27.40 m, current laminated with dispersed crinoid debris; reverse graded unit from 27.40 to 27.70 m, more coarsely bioclastic below 27.70 m with solitary corals. Hematite-stained adjacent vein at 28.90 m | 4.85 | 31.40 |
| Limestone (pelsparite) | 0.10 | 31.50 |
| Limestone, mid-grey, but paler coloured from 31.60 m, bioclasts extensively micritised. Bituminous residue at 32.00 m | 0.70 | 32.20 |
| Limestone (pelsparite), mid- to dark grey, fine-grained, with isolated intraclasts, abundant stylolitic seams around 32.70 m | 2.06 | 34.26 |
| Shale | 0.02 | 34.28 |
| Limestone, mid- to dark grey, coarsely bioclastic; pelsparite band from 35.85 to 35.95 m | 1.89 | 36.15 |
| Limestone (pelsparite), mid- to dark grey, units 10 cm thick separated by stylolitic seams. Calcite veining from 36.88 m | 0.93 | 37.08 |
| Limestone (biosparrudite), dark grey, bioclasts highly silicified | 0.50 | 37.58 |
| Limestone, dark grey, medium calcarenite, fine-grained peloid and dasycladacean fragments with coarse-grained dispersed crinoid and shell debris, graded from 38.80 to 39.07 m. Black shales at 39.07 (20 cm) and 39.33 m (17 cm) | 1.92 | 39.50 |
| Limestone, dark grey, calcirudite, abundant intraclasts from 41.50 to 41.80 m, dispersed dasycladacean algae; allochems extensively silicified. Core fractured from 40.50 to 40.93 m. Finer grained below 42.20 m with graded unit (10 cm) at 42.60 m [Dip 28° at 42. 60 m] | 3.20 | 42.70 |
| Shale, black | 0.10 | 42.80 |
| Limestone (biosparrudite), mid-grey, with crinoids, corals and large intraclasts, all highly silicified | 1.15 | 43.95 |
| Limestone, mid- to dark grey, calcarenite with dispersed coarse bioclasts, paler coloured from 45.10 to 46.20 m due to extensive micritisation | 3.38 | 47.33 |
| Shale | 0.02 | 47.35 |
| Limestons, dark grey, calcirudite from 47.45 to 47.95 m, graded from 48.90 to 49.05 m, bioclasts highly silicified from 47.65 to 47.95 m. Sporadic large intraclasts | 4.58 | 51.93 |

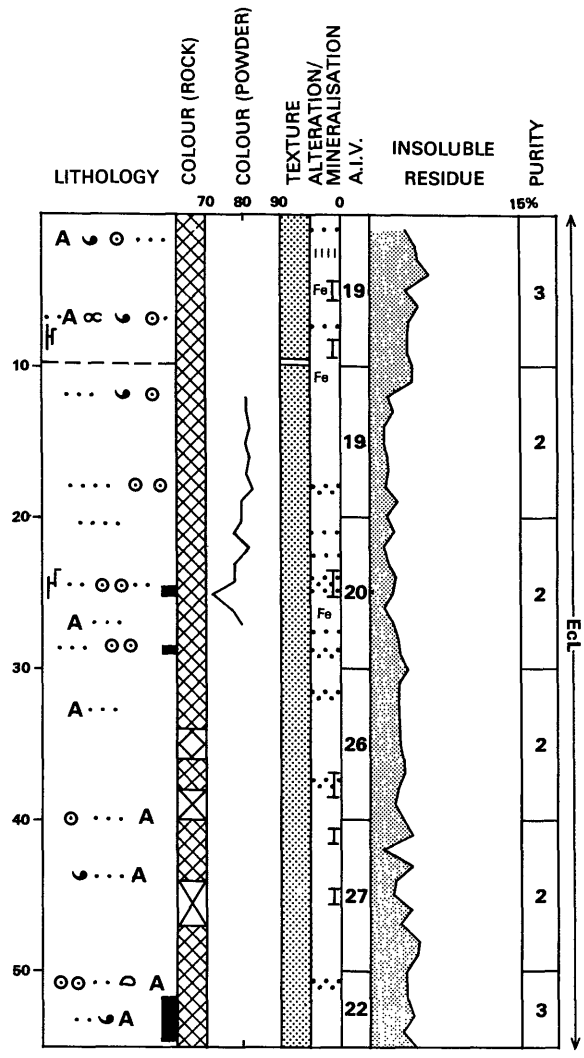
Borehole completed at 51.93 m

**SK 14 NW 4** **1317 4962** **Blore**
Surface level +267.0 m
January 1971

BLOCK C
14 NW 4

| | Thickness m | Depth m |
|---|---|---|
| Openhole: topsoil | 0.15 | 0.15 |
| **Ecton Limestones** | | |
| Limestone (biopelsparite), mid-grey, fine calcarenite with thin coarser bioclastic bands (12.83 - 13.20 m, 18.10-19.13 m), allochems are well-sorted and include crinoid, foraminifera, shell and algal debris; peloids are abundant locally. Much of the finely comminuted debris is micritised. Crinoidal biosparrudites containing large angular intraclasts occur locally (24.53-24.90 m, 28.66 - 29.05 m, 51.85-54.60 m). Patchy dolomitisation throughout, some silicification and hematite staining; core fractured and calcite-veined with red clay coatings on joint surfaces | 54.95 | 55.10 |

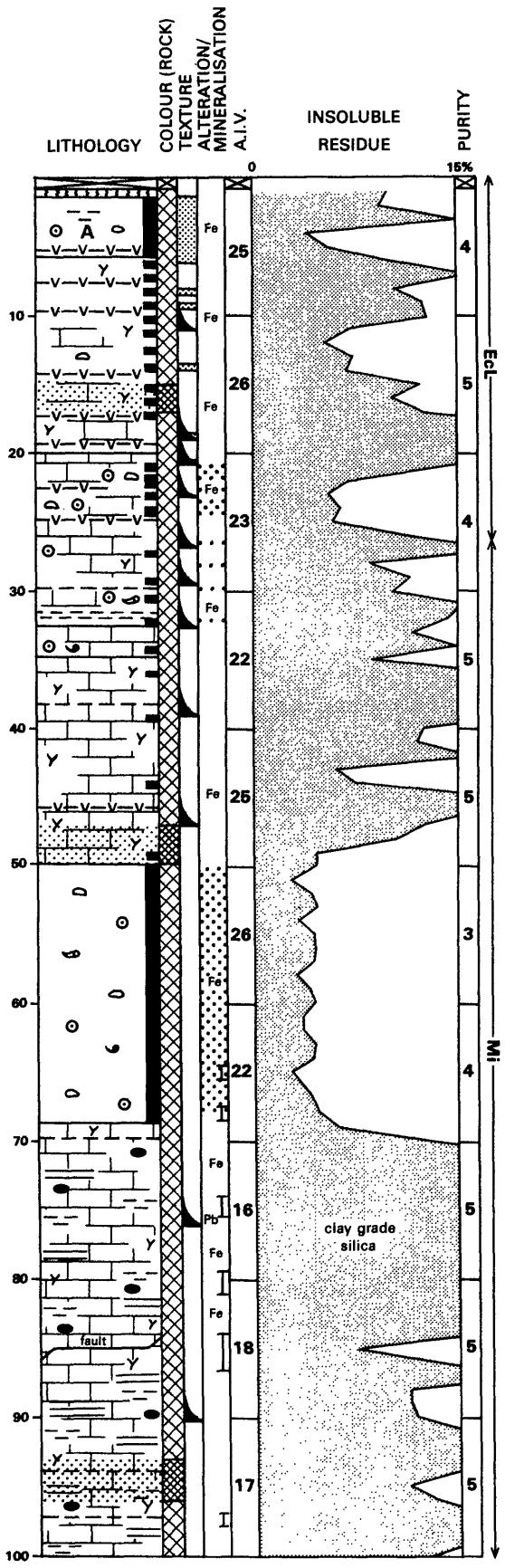
Boreholes completed at 55.10 m



**SK 14 NW 5** **1142 4880** **Caltonmoor House**
Surface level +308.8 m
December 1977

BLOCK C
14 NW 5

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 0.80 | 0.80 |
| **Ecton Limestones** | | |
| Limestone, mid-grey, hematite-stained reef facies limestone (allochthonous block?) with spar-filled cavities | 0.58 | 1.38 |
| Limestone, mid-grey, coarsely bioclastic to 5.62 m with intraclasts of reef facies limestone and abundant crinoid debris; below 5.62 m beds are 10 to 30 cm thick, sharp-based and locally graded with coarsely bioclastic lower parts and argillaceous bioturbated tops; in some beds only the upper argillaceous sections are present. Interbedded dark and pale grey-green, iron-stained mudstone bands up to 12 cm thick. Abundant hematite veinlets and blebs, bioclasts extensively silicified. [Dip 22° at 16.90 m] | 16.37 | 17.75 |
| Argillaceous limestone, mid- to purplish grey, mottled yellow locally, very fine-grained graded beds, each comprising a thin (3 to 5 cm) bioclastic basal sequence (not always present) and a thicker argillaceous and bioturbated upper part (10 to 20 cm); interbedded shaly mudstones at 19.00 and 19.60 m. Hematite staining common, some silicification of bioclasts | 3.05 | 20.80 |
| Limestone, mid-grey, coarsely bioclastic, beds 10 to 40 cm thick with crinoid debris and micrite intraclasts, interbedded with or grading into fine argillaceous limestones and thin (10 to 15 cm) mudstones. Much hematite staining and some veining | 5.32 | 26.12 |
| **Milldale Limestones** | | |
| Argillaceous limestone, mid-grey, limonite and hematite stained, very fine-grained, thinly bedded (5 to 30 cm), bioturbated with some coarsely bioclastic, sharp-based beds; coral-brachiopod fauna below 28.50 m. Interbedded shaly mudstones. Some silicification | 8.78 | 34.90 |
| Argillaceous limestone, mid- to dark grey, with streaks of darker carbonaceous material giving wispy laminated appearance, a few graded beds. Shaly mudstone at 37.70 m (15 cm), varicoloured mudstones at 46.10 (15 cm) and 44.05 (5 cm) | 14.86 | 49.76 |
| Limestone (intraclastic crinoidal biosparrudite), mid-grey, thickly bedded with intraclasts of reef material up to 7 cm diameter, subordinate very finely bioclastic limestone. Local dolomitisation, much hematite staining and veining especially towards base | 18.83 | 68.59 |



Argillaceous limestone, mid- to dark grey, thinly bedded, very fine calcarenite, bioturbated and cherty, with interbedded and interlaminated black shaly mudstone and paler shaly limestone, bioclastic bands rare: pink-stained clay-grade silica on etched rock surface, calcite-veined and brecciated from 84.90 to 86.04 m (small fault?), trace of galena at 74.70 m — 31.41 — 100.00

Borehole completed at 100.00 m

**SK 14 NW 6 1359 4944 Blore**
Surface level c. +240 m

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.40 | 1.40 |

**Ecton Limestones**

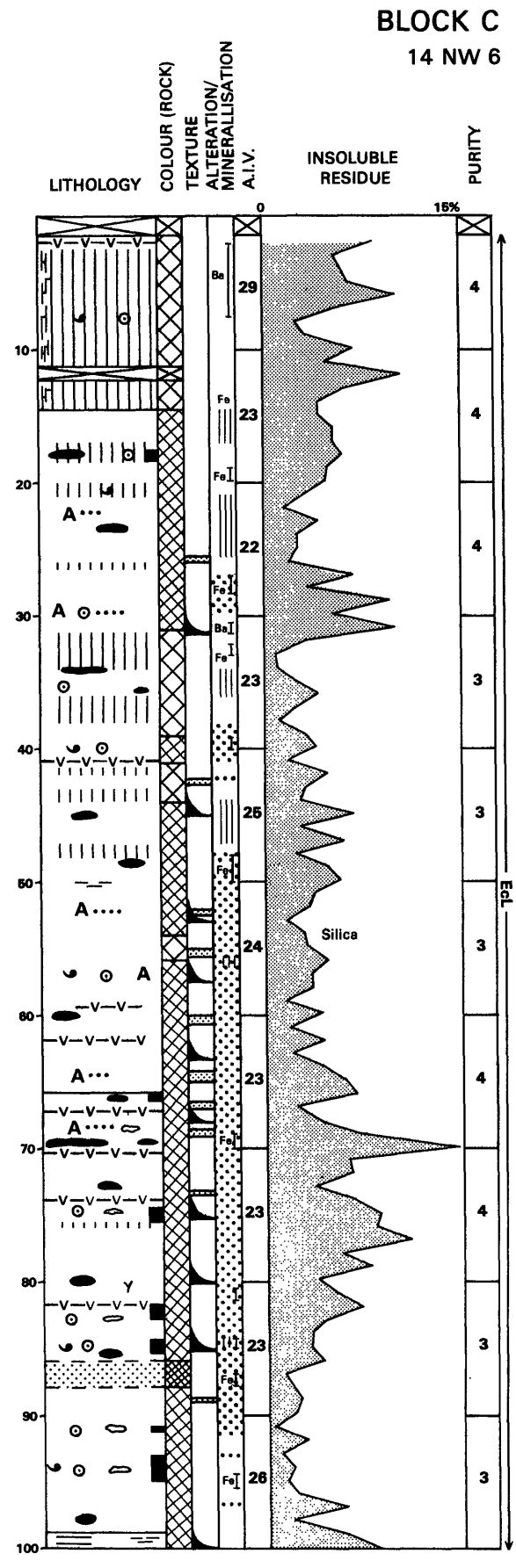
Calcitic dolomite, creamy white but darker where dedolomitised and limonite-stained; below 6.00 m core is only partially dolomitised and there are scattered bioclasts, mainly crinoids and brachiopods. Varicoloured mudstone at 1.70 m. Thick calcite veins with associated hematite and baryte below 1.70 m — 13.10 — 14.50

Dolomitic limestone, mid-grey but locally paler where dolomitised, medium to coarse crinoidal calcarenites, up to 1 m thick, locally graded and current laminated, rarely bioturbated. Interbedded thin, fine-grained biopelsparite bands. Dolomitisation mainly affects the coarser grained lithologies and is rare below 50.00 m, bioclasts are commonly silicified and there are sporadic bands and nodules of chert. Core veined with calcite and hematite and brecciated from 36.85 to 37.00 m. Variegated clays common between 41 and 51 m — 51.25 — 65.75

Limestone, mid-grey, graded in units ranging from 0.10 to 1.0 m in thickness; individual beds are coarsely bioclastic at base with dominant crinoid and some intraclastic debris and grade upwards into finer grained biopelsparites which are commonly current laminated; in places the upper parts of the beds are bioturbated and contain much clay-grade silica; beds are separated by purplish red clay partings. Thin (less than 1 cm) variegated clays common between 67 and 88 m. Pervasive silicification of bioclasts and chert common throughout, disseminated dolomite, some calcite veining and associated hematite staining. [Dip generally less than 10°; vertical from 69.25 to 70.25 m] — 33.15 — 98.80

Limestone, mid-grey, very fine-grained, graded; finely laminated towards base — 1.20 — 100.00

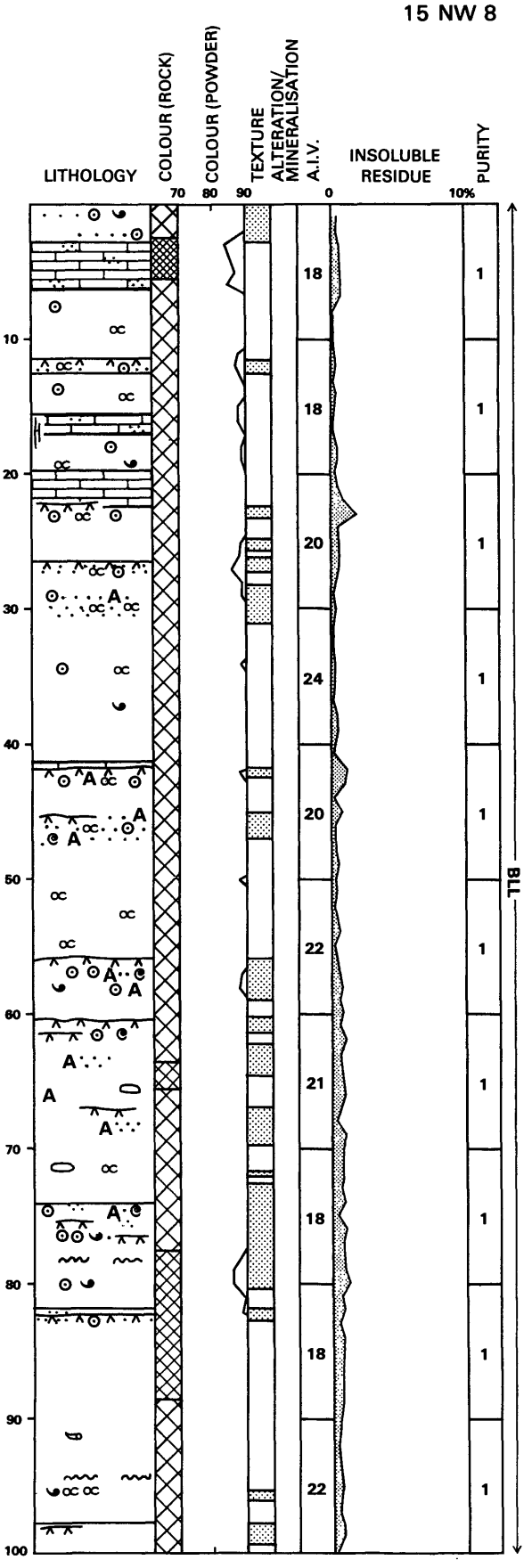
Borehole completed at 100.00 m



**SK 15 NW 8** **1373 5835** **Wolfscote Hill**
Surface level c. +388 m
March 1977

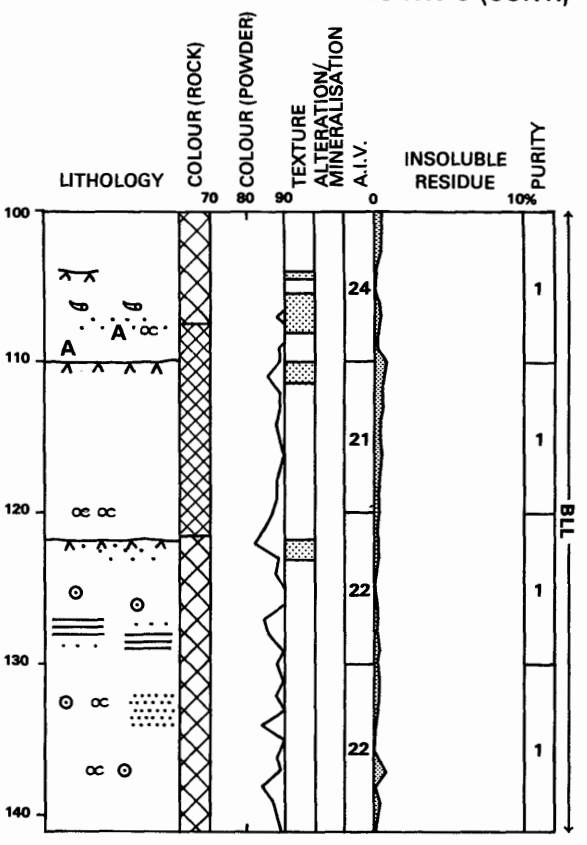
| | Thickness m | Depth m |
|---|---|---|
| Openhole | 0.20 | 0.20 |
| **Bee Low Limestones** | | |
| Limestone (biopelsparite), pale grey | 2.60 | 2.80 |
| Limestone (biomicrite), mid-grey mottled, sparse finely comminuted fauna, some spar-filled vugs | 3.43 | 6.23 |
| Limestone, very pale grey, medium to fine calcarenite with abundant micrite-coated crinoid debris; well-washed micritised assemblage (algal biopelsparite) from 11.50 to 12.50 m, associated brown pedogenic alteration | 9.27 | 15.50 |
| Limestone (biomicrite), mid-grey, mottled, scattered foraminifera and calcispheres. No coarse bioclastic debris | 1.50 | 17.00 |
| Limestone (biomicrosparite), pale grey, dispersed coarse crinoid and shell debris in finer grained, tightly packed bioclastic framework | 2.80 | 19.80 |
| Limestone, pale grey, fine to very fine calcarenite; anastomosing stylolites. No coarse bioclastic detritus | 2.65 | 22.45 |
| Limestone, well-sorted crinoidal biosparite with brown pedogenic alteration at top. Thicker pedogenic surfaces between 26.40 and 26.60 m, underlain by spar-cemented pelsparites and algal pelsparites. In lower part of unit allochems are more tightly packed, precluding the development of coarse spar; passage at 41.30 m into very fine calcarenite (biomicrite) | 19.55 | 41.90 |
| Limestone, pedogenic crust and associated yellow clay at top underlain by biosparite comprising crinoid, foraminifera and shell debris. Spar cement less evident below 42.40 m. Minor brown pedogenic alteration at 45.32 m capping well-washed assemblage with peloids and dasycladacean algal fragments as major components. Spar occurs mainly as overgrowths below 46.70 m. Pale limestone below 50.90 m contains abundant encrusting algae | 14.05 | 55.95 |
| Limestone (algal biopelsparite), pale grey. Spar-cemented lithologies developed below pedogenic surfaces at 60.50, 61.50 and 67.00 m grade downwards into lithologies where the bioclasts are in grain-to-grain contact; micrite-coated grains common throughout, scattered intraclasts of peloidal limestone | 18.05 | 74.00 |
| Limestone (biosparite), mid-grey, mottled to 78.10 m, no extensive micritisation hence darker colour, traces of brown pedogenic alteration throughout upper part | 7.90 | 81.90 |

**BLOCK A**
**15 NW 8**



| | | |
|---|---|---|
| Limestone (biosparite), mid- and pale grey, well developed spar cement around pedogenic horizon at 82.20 m, corals at 93.58 m, encrusting algae common around 95.50 m | 15.80 | 97.70 |
| Limestone (biosparite), mainly pale grey, traces of brown pedogenic staining at 98.00 m and from 105.50 to 108.00 m; well-sorted pelsparite below 105.50 m. Colonial corals at 106.50 m, abundant dasycladacean algae (often unbroken) towards base of unit | 13.30 | 110.00 |
| Limestone (biosparite), mid-grey, pedogenic horizon at top of unit capping spar-cemented assemblage of crinoids, peloids, foraminifera and dasycladacean algae | 11.80 | 121.80 |
| Limestone (crinoidal biosparite), pale grey, pedogenic crust containing spar-filled vugs at top, peloid-rich horizons occur throughout unit, some dispersed rudite-grade crinoid debris, fine current laminated calcarenite from 127.30 to 128.90 m, bioclasts extensively micritised | 19.20 | 141.00 |

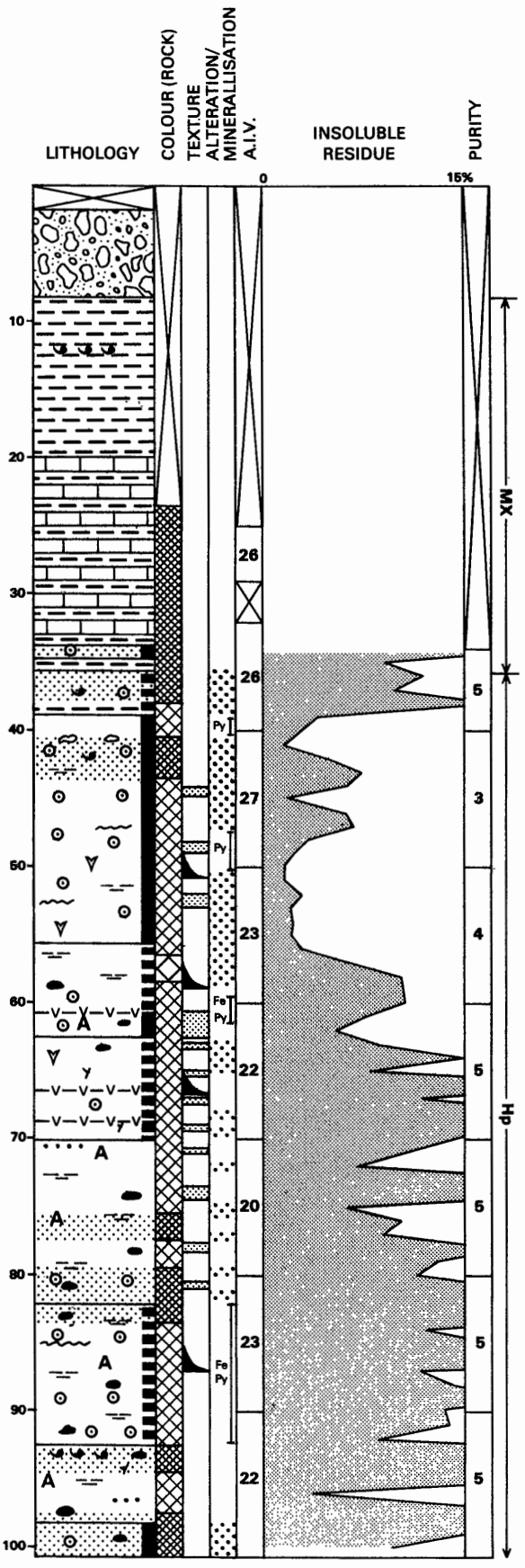
Borehole completed at 141.00 m



**SK 15 NW 9** **1167 5648** **Wetton**
Surface level c. +275 m
March 1977

**BLOCK C**
**15 NW 9**

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.80 | 1.80 |
| Boulder Clay | 6.32 | 8.12 |
| **Mixon Limestone-Shales** | | |
| Mudstone, black, weathered and partially decalcified, thin siltstone/silty sandstone bands 1.80 - 1.87 m, and 6.33-6.45 m, shelly argillaceous limestone bed at 12.32 m, scattered goniatites and bivalves, many small phosphatic nodules from 19.91 to 19.94 m | 11.99 | 20.01 |
| Argillaceous limestone interbedded with mudstone; limestones are commonly laminated and form thinly bedded, sharp-based units, some with basal bioclastic and upper argillaceous divisions | 15.59 | 33.80 |
| Limestone (crinoidal biosparite), dark grey, with rudite-grade crinoid and brachiopod debris. Thin mudstones at 34.19 and 34.43 m | 0.95 | 34.75 |
| Mudstone, interbedded with argillaceous limestone | 0.85 | 35.60 |
| **Hopedale Limestones** | | |
| Limestone, dark grey; alternation of crinoidal calcirudites with argillaceous biomicrites, units are sharp-based and show traces of grading, bioclasts are commonly silicified; disseminated dolomite crystals | 3.33 | 38.93 |
| Limestone (crinoidal calcirudite), mid- and dark grey, beds 10 to 40 cm thick, highly crinoidal and sometimes graded. Micrite intraclasts are common locally (41.00-41.35 m). Clay concentrated in stylolities. Thin shale partings. Much dolomitisation, some chert | 16.73 | 55.66 |
| Limestone, mid-grey, alternation of crinoidal calcirudites and laminated biomicrites. Units are 20-40 cm thick, some are graded. Varicoloured mudstones (wayboards) at 60.81, 66.50, 68.15, 68.40, 69.00 and 69.20 m. Sporadic chert nodules, finely disseminated hematite common adjacent wayboards; patchy dolomitisation [Dip 21° at 57 m, 47° at 63.60 m] | 14.45 | 70.11 |
| Limestone, mid- and dark grey, mainly fine calcarenite but with a few coarse crinoidal bands, some bioturbation. Wispy stylolites with clay infills and thin reddened shale partings; patchy dolomitisation. [Dip 50° at 75.90 m] | 11.99 | 82.10 |
| Limestone, mid-grey, alternating coarse crinoidal biomicrites and thin (<10 cm) fine-grained algal pelmicrites. Some units are graded. Extensive silicification; localised dolomitisation. [Dip 25° at 90.45 m] | 10.47 | 92.57 |



Limestone (biosparite), mid- and dark grey, fine calcarenite, bioturbation common. Some fine silicification and numerous chert nodules. Thin shaly partings. Disseminated pyrite. [Dip 58° at 94.57 m] 5.63 98.20

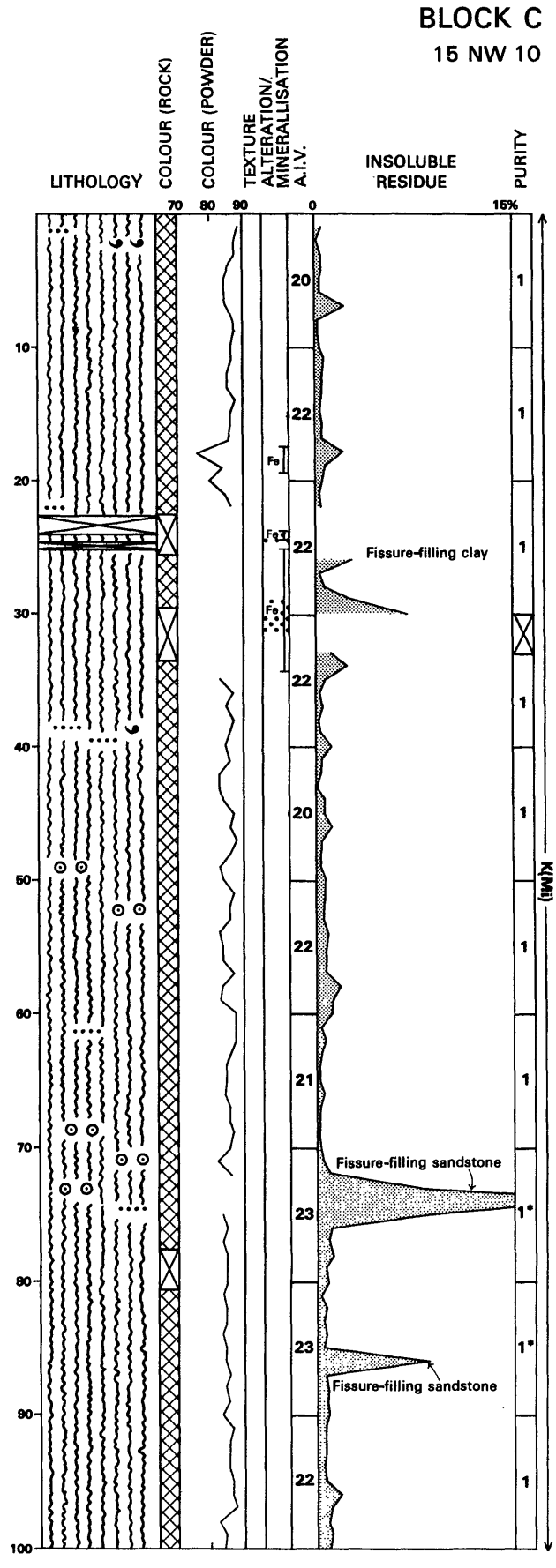
Limestone (crinoidal biosparrudite), dark grey, sporadic intraclasts, subordinate brachiopod and dasycladacean algal fragments. Some silicification and dolomitisation 1.86 100.06

Borehole completed at 100.06 m

**SK 15 NW 10 1371 5563 Alstonefield**
Surface level c. +270 m
March 1977

| | Thickness m | Depth m |
|---|---|---|
| **Knoll-reef** (in **Milldale Limestones**) | | |
| Limestone (micrite and biomicrite), mid-grey, convoluted cavities with radiaxial fibrous calcite, clear spar cement and internal sediment infillings in some cavities. Extensive limonite staining from 17.85 to 19.40 m and from 24.00 to 34.39 m, associated patches of dolomite; poor recovery from 22.65 to 25.11 m and from 30.23 to 32.10 m with traces of fissure-filling clay; thin bioclastic bands with peloids, ostracods and sporadic crinoid ossicles (22.50-22.65 m, 38.65-39.70 m, 61.65-63.50 m, 73.85-75.00 m); coarse crinoid debris from 68.60 to 73.00 m. Quartz sand (Triassic?) infilling fractures from 73.00 to 73.85 m and from 86.28 to 86.40 m | 100.00 | 100.00 |

Borehole completed at 100.00 m



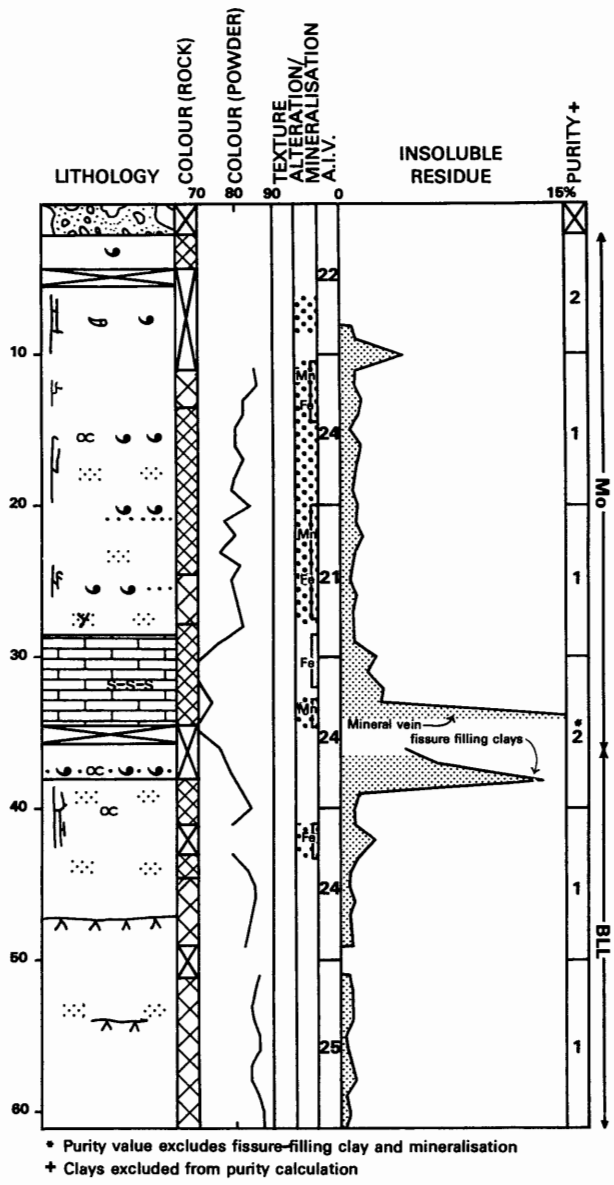

*Purity value excludes fissure-filling sandstone and clay

**SK 15 NE 2** **1763 5835** **Cardlemere Lane**
Surface level +371.6 m
March 1971

**BLOCK A**
**15 NE 2**

| | Thickness m | Depth m |
|---|---|---|
| Topsoil | 2.00 | 2.00 |
| **Monsal Dale Limestones** | | |
| Limestone, mid-grey, coarse calcarenite to fine calcirudite, scattered brachiopods, crinoids and corals, micritic envelopes developed on some bioclasts; bioturbation and mottling common near base. Core severely jointed; associated fissure-filling red clays. Dolomite rhombs common adjacent joints, hematite in calcite veins, trace of silicification below 15 m. Poor recovery in uppermost 9 m | 26.50 | 28.50 |
| Limestone (biomicrite), mid- to dark grey, locally mottled, finely bioclastic with Saccamminopsis and scattered corals. Anastomosing stylolites give nodular texture. Wisps of carbonaceous matter, dolomite rhombs adjacent joints, some calcite veining, trace silicification | 6.05 | 34.55 |
| Gap | 1.07 | 35.62 |
| **Bee Low Limestones** | | |
| Limestone, mid-grey, mixed assemblage of peloids, foraminifera and brachiopods with much encrusting algae; pelsparite band containing large brachiopods at base. Trace silicification, some hematite | 2.33 | 37.95 |
| Limestone, mainly pale grey, mottled to 44.50 m, coarse calcarenite with scattered rudite debris - mainly brachiopods and crinoids, bioclasts are micritised and show much algal encrustation Pedogenic structures at 47.30 and 53.90 m. Calcite veining with associated hematite and dolomite from 39.20 to 43.00 m | 23.05 | 61.00 |

Borehole completed at 61.00 m

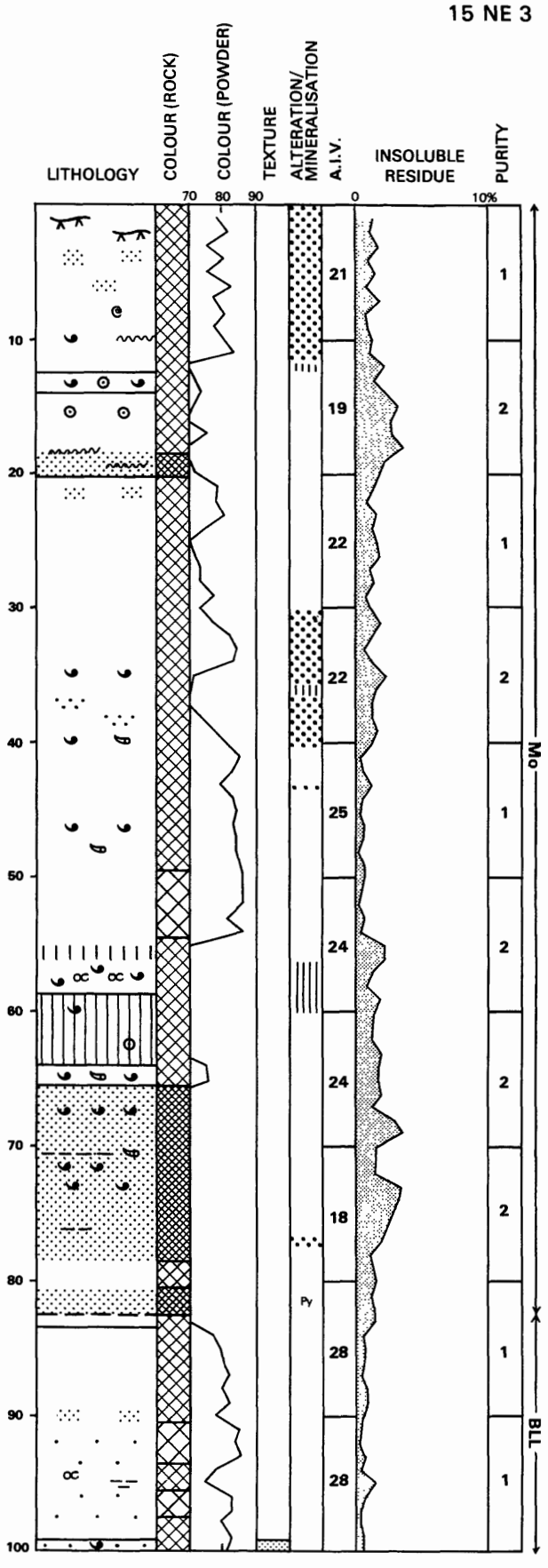



* Purity value excludes fissure-filling clay and mineralisation
\+ Clays excluded from purity calculation

**SK 15 NE 3** **1984 5924** **Pikehall**
Surface level +308.6 m
Water level +220 m
January 1977

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.00 | 1.00 |
| **Monsal Dale Limestones** | | |
| Limestone, mid-grey, locally mottled, scattered large brachiopods with a concentration at 10 m, abundant finely comminuted shell debris including many foraminifera. Brown pedogenic structures developed to 3.80 m. Anastomosing network of stylolites at 10 m. Brown ferroan dolomite/siderite alteration adjacent joint at 12.30 m. Minor traces of silicification | 11.40 | 12.40 |
| Limestone, mid-grey, calcirudite with coarse crinoid and brachiopod debris. Traces of silicification affecting shells | 1.60 | 14.00 |
| Limestone, mid-grey, encrinite to 15.30 m, passing down into dark grey, more argillaceous lithology; dispersed shells - some silicified. Many wispy stylolites with associated clay-grade insoluble material | 6.30 | 20.30 |
| Limestone, mid-grey with darker bands developed locally, bioturbational mottling common to 23.50 m, bands of coarse shells occur throughout, towards base shells are encrusted with thin Girvanella coatings. Biopelsparites developed locally, especially from 36.50 to 39.50 m. More micritic beds at 21.50 m, 24.12 to 25.00 m and 30.00 to 40.00 m. Rock altered to dolomite from 55.69 to 56.15 m | 38.39 | 58.69 |
| Dolomitic limestone; dolomitisation associated with jointing - intensity decreases away from joint surfaces | 5.31 | 64.00 |
| Limestone, mid-grey, dispersed massive coral colonies | 1.50 | 65.50 |
| Limestone, dark grey, with brachiopod bands (67.70-69.60 m, 71.80-73.00 m). Many stylolitic partings with black clay fillings. Disseminated pyrite. Traces of dolomitisation adjacent vein at 77.20 m | 16.93 | 82.43 |
| **Bee Low Limestones** | | |
| Limestone, mid-grey, some bioturbational mottling (89.30-90.30 m), mainly coarse arenite crinoid and shell debris with subordinate foraminifera and peloids. Allochems variably micritised. Uniform lithology | 15.80 | 99.20 |
| Limestone (pelsparite), mid-grey; local brachiopod clusters | 0.80 | 100.00 |

Borehole completed at 100.00 m

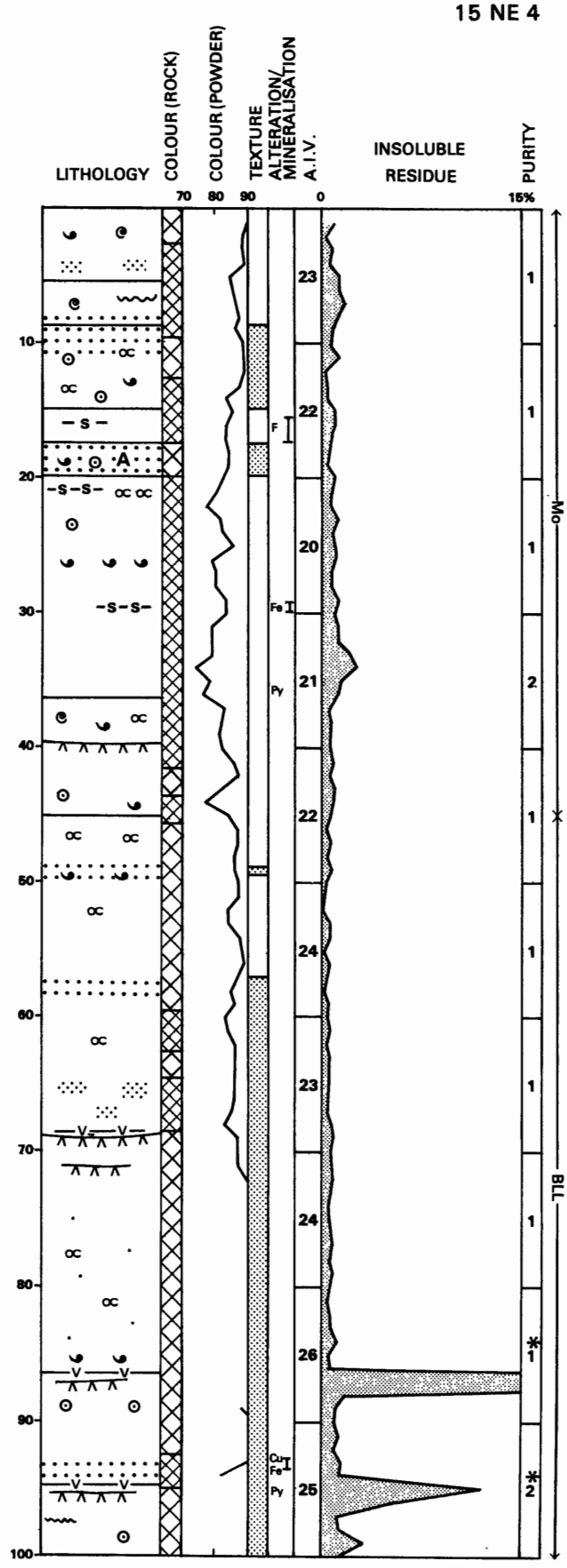


**SK 15 NE 4** **1525 5820** **Biggin**
Surface level +301.2 m
February 1977

**BLOCK A**
**15 NE 4**

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.00 | 1.00 |
| **Monsal Dale Limestones** | | |
| Limestone, pale grey, mottled in lower part, medium calcarenites; dispersed shell debris, local pockets of peloids | 4.35 | 5.35 |
| Gap | 0.51 | 5.86 |
| Limestone, mottled mid-grey, many foraminifera, peloidal debris increasing towards base; anastomosing network of stylolites | 2.69 | 8.55 |
| Limestone (biopelsparite), mid-grey, fine calcarenite grading to coarse calcarenite at 14.70 m; allochems are micritised and include peloids, brachiopod and crinoid fragments; foraminifera also common; cross laminated from 13.41 to 14.55 m; fine calcite/fluorite veinlets from 15.60 to 17.30 m | 8.75 | 17.30 |
| Limestone (biopelsparite), pale grey, abundant peloids and dasycladacean algae, subordinate crinoid and brachiopod debris | 2.50 | 19.80 |
| Limestone, mid-grey becoming darker below 29.00 m, bioclastic debris common to 24.00 m then becoming sparser, scattered Saccamminopsis, Girvanella common from 19.80 to 22.30 m, micritic envelopes widely developed; minor hematite veining at 29.56 m, trace silicification and wispy clays on etched surface | 16.50 | 36.30 |
| Limestone, mid-grey, mottled to 39.00 m with micritic envelopes on brachiopod debris, mainly finely comminuted shell debris, many foraminifera; pedogenic horizon at 39.00 m; anastomosing stylolites from 43.20 to 45.00 m | 8.70 | 45.00 |
| **Bee Low Limestones** | | |
| Limestone, pale grey, mottled from 64.57 to 68.60 m, allochems include highly micritised crinoid and brachiopod debris, with rare pelsparite bands (48.80-49.35 m, 57.00-58.85 m). Clay wayboard at 68.60 m overlies a pedogenic horizon, poorly developed pedogenic structures also occur between 71.50 and 72.20 m. Oncolitic nodules encrusting coarse brachiopod shells at 85.30 and 85.66 m | 11.50 | 86.50 |
| Clay, varicoloured, grey-green and red, hackly fracture | 0.30 | 86.80 |
| Limestone, pale grey, coarse crinoidal calcarenite capped by a pedogenic crust passing down into finer grained peloidal limestone with dispersed large brachiopods. Veining with calcite, copper and iron ores from 92.70 to 93.60 m. Pyritous at base | 8.06 | 94.86 |
| Clay, varicoloured | 0.39 | 95.25 |
| Limestone, pale grey, pedogenic crust at top, stylolites locally abundant | 4.75 | 100.00 |

Borehole completed at 100.00 m

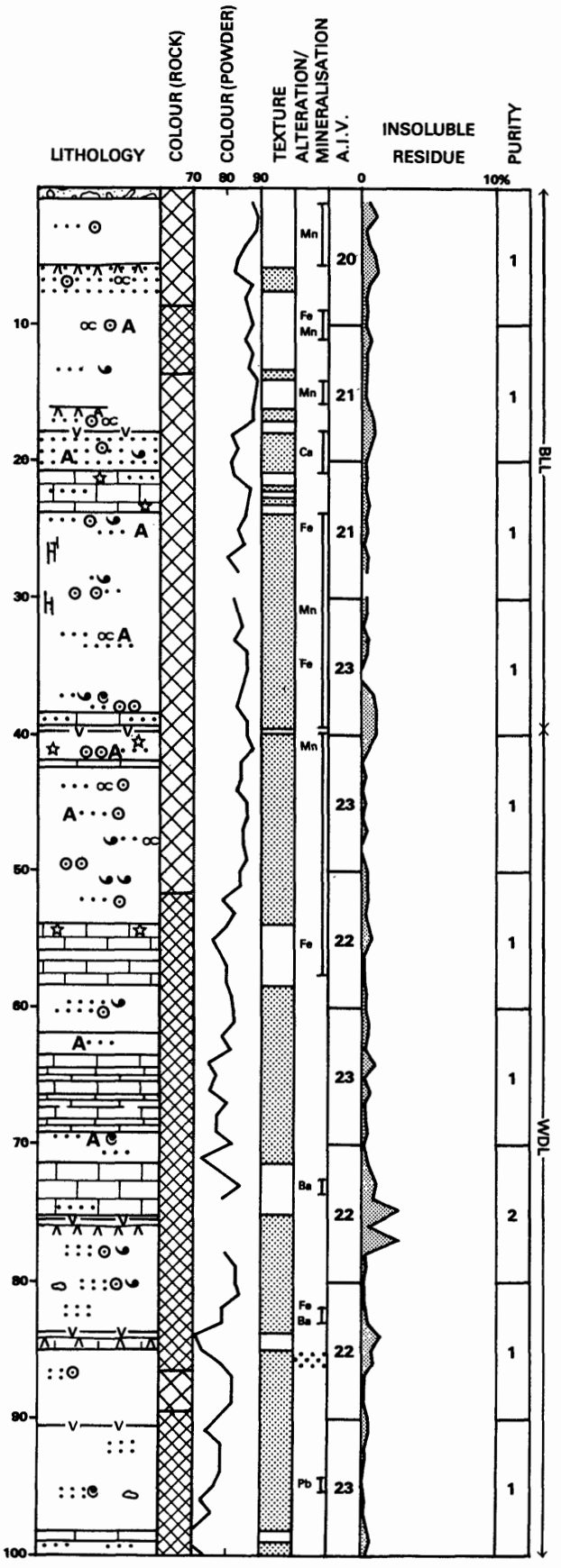



* Clays excluded from purity calculation

**SK 15 NE 5 1581 5674 Lees Barn, Coldeaton**
Surface level +304.5 m
February 1977

| | Thickness m | Depth m |
|---|---|---|
| Topsoil | 0.60 | 0.60 |
| **Bee Low Limestones** | | |
| Limestone (biopelsparite), pale and mid-grey, medium and coarse calcarenites, well-washed sparcemented lithologies developed below pedogenic structures at 5.63 and 16.05 m, bioclasts include micritised crinoid, shell and peloid debris with dispersed foraminifera and dasycladacean algae | 11.84 | 17.47 |
| Clay, varicoloured, ochreous, hackly fracture | 0.23 | 17.70 |
| Limestone (pelsparites and biopelsparites), pale grey, medium and coarse calcarenites, bioclasts as above; intercalations of laminated porcellanous micrites with bird's eye structures from 20.60 to 23.60 m and from 39.10 m to base | 21.50 | 39.20 |
| Clay, greenish grey, disrupted by fibrous calcite veins and overlain by coarsely crystalline calcite containing limestone clasts | 0.10 | 39.30 |
| **Woo Dale Limestones** | | |
| Limestone, mid-grey porcellanous micrites interbedded with pale grey biopelsparites; chief micrite horizons are from 41.95 to 42.35 m, 53.85 to 55.63 m, and 56.50 to 58.28 m, some show birds eye structures. Biopelsparite bands between 48.00 and 52.00 m are 2 to 3 cm thick with sharp bases and contain oncolitic nodules and subordinate well-washed crinoid and shell debris. Bituminous residue in pores between 58.00 and 58.90 m | 22.50 | 61.80 |
| Limestone, mid-grey, micrites/biomicrites (63.35-69.00 m, 71.35-75.10 m), sparsely fossiliferous except for calcispheres and foraminifera, locally porcellanous; interbedded algal biopelsparites containing highly micritised peloids, algally-bound peloidal intraclasts and algal fragments, subordinate crinoid and brachiopod debris. Minor calcite/baryte mineralisation from 72.50 to 73.50 m | 13.30 | 75.10 |
| Clay, greenish grey | 0.01 | 75.11 |
| Limestone (algal biopelsparite), mid- and pale grey with peloidal intraclasts. Traces of baryte and hematite in vein from 82.00 to 83.00 m | 8.84 | 83.95 |
| Clay, greenish grey wayboard | 0.01 | 83.96 |
| Limestone (micrite), mid-grey, pedogenic horizon developed below wayboard, some bird's eye structures, locally oncolitic at 84.50 m | 1.00 | 84.96 |
| Limestone (algal biopelsparite), colour varies according to degree of micritisation, algally-bound peloidal intraclasts are common, | | |

**BLOCK A**
**15 NE 5**



other debris includes crinoid ossicles, foraminifera and dispersed brachiopod shells. Micrite band from 98.50 to 98.90 m. Thin clay/mudstone at 90.55 m. Veining with galena at 94.80 m — 15.04 — 100.00

Borehole completed at 100.00 m

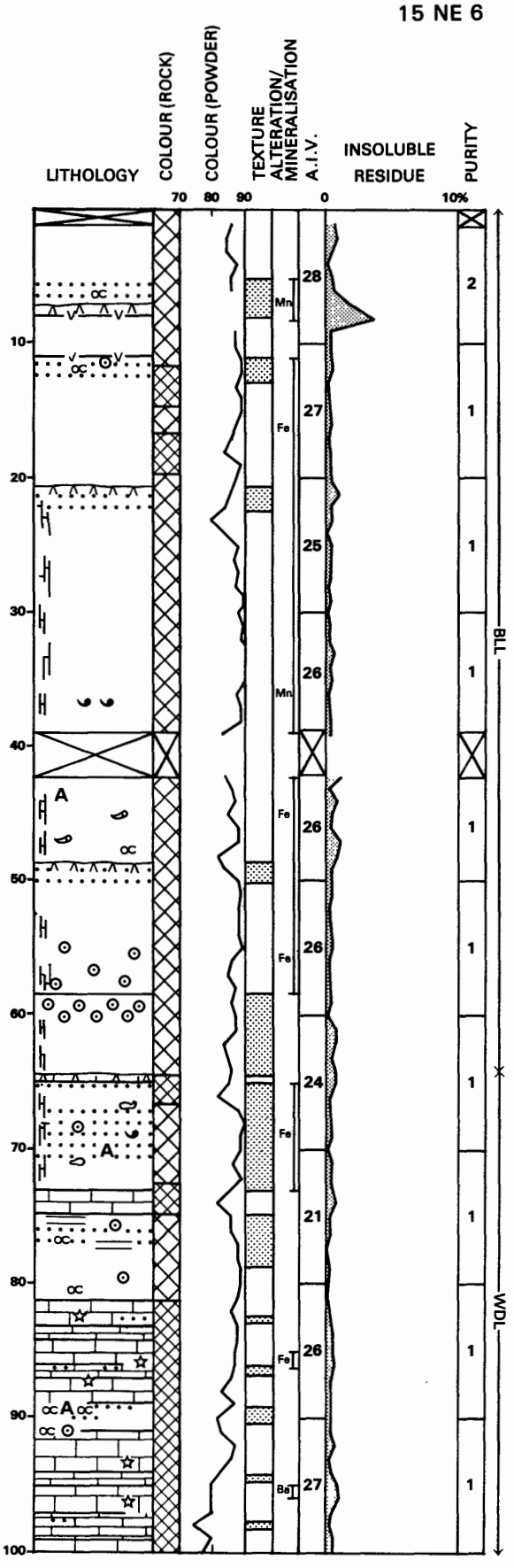
**SK 15 NE 6 1932 5712 Parwich**
Surface level +304.8 m
Water level +248 m
February 1977

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.00 | 1.00 |
| **Bee Low Limestones** | | |
| Limestone (algal biopelsparite), mid- and pale grey, fine and medium calcarenites, dasycladacean and encrusting algae common, well-washed spar-cemented assemblages present below pedogenic horizons from 6.70 to 7.25 m and from 21.30 to 21.50 m. Ochreous clays at 7.90 and 11.10 m. Matrix variably hematite-stained, iron-rich zones associated with joints and mineral veins, euhedral quartz crystals abundant adjacent clays, some pyrolusite | 37.80 | 38.80 |
| Gap | 3.30 | 42.10 |
| Limestone (biopelsparite), pale grey, medium calcarenites and fine calcirudites, pedogenic horizons at 48.64 m and at base of unit, upper horizon associated with thin greenish grey clay, spar matrix best developed immediately below pedogenic structures, encrinite from 58.40 to 61.00 m. Limestone heavily jointed and iron-stained | 22.34 | 64.44 |
| **Woo Dale Limestones** | | |
| Limestone, mid-grey micrites (64.44 - 64.98 m, 73.00 - 74.74 m), interbedded with pale grey algal biopelsparites, traces of bird's eye structure at 65.00 m, micritic envelopes developed on coarser grains, current lamination at 75.00 and 77.32 m, severe jointing and iron-staining in upper part of unit | 16.76 | 81.20 |
| Limestone, mid-grey, porcellanous micrites and biomicrites with bird's eye structures; interbedded biopelsparites from 89.17 to 90.60 m and from 97.00 to 97.40 m. Veining with abundant hematite from 85.78 to 86.10 m, some baryte at 95.10 m | 18.80 | 100.00 |

Borehole completed at 100.00 m

## BLOCK A

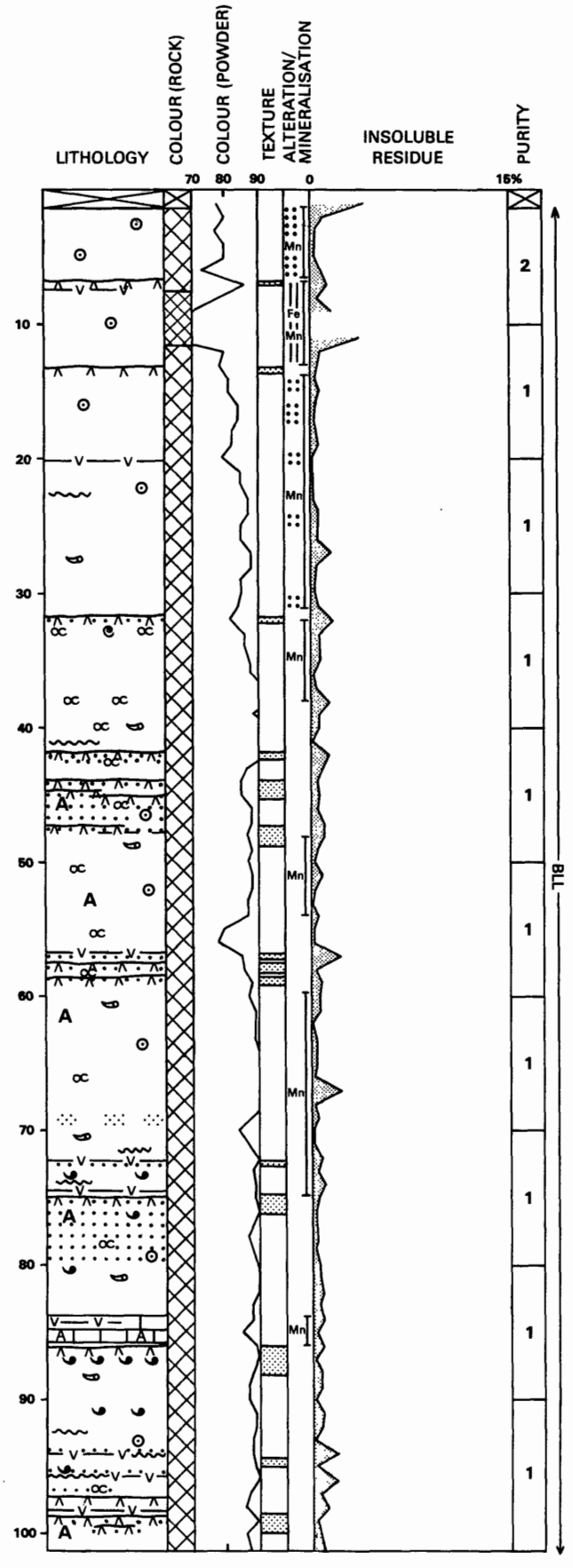
15 NE 6



**SK 15 NE 7** **1942 5587** **Twodale Barn, Parwich**
Surface level c.285 m
April 1977

**BLOCK A**
15 NE 7

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.20 | 1.20 |
| **Bee Low Limestones** | | |
| Limestone (biosparite), pale grey, medium to coarse calcarenite with dispersed crinoid debris. Dendritic pyrolusite. | 5.55 | 6.75 |
| Limestone (biosparite), pedogenic surface and thin wayboard at top of unit, limonite-stained and altered (? ferroan dolomite) from 7.70 to 13.00 m, dispersed rudite crinoid debris | 6.18 | 13.02 |
| Limestone, pale grey, medium and coarse calcarenites with brown pedogenic surfaces at top, much algal-encrusted debris - mainly crinoid and shell fragments. Well-washed, fine-grained biosparite associated with thin wayboard clay at 20.10 m. Very fine-grained from 30.70 m | 18.40 | 31.70 |
| Limestone, pale grey, pedogenic surface capping biopelsparite. Passing at 32.15 m into less sparry bioclastic limestone. Oncolitic nodules (up to 5 cm diameter) developed from 38.10 m. Basal 25 cm are finer grained and almost micritic | 9.73 | 41.88 |
| Limestone, pale grey, succession of thin brown pedogenic structures in upper part of unit underlain by well-washed biopelsparites; interbedded less sparry bioclastic limestones containing large oncolitic nodules (41.88-42.25 m) with subordinate crinoid, dasycladacean algae and brachiopod debris. Finer grained limestone in basal 50 cm. Thin clay at 47.85 m | 14.90 | 56.78 |
| Clay (wayboard) | 0.12 | 56.90 |
| Limestone (algal biopelsparite), very pale grey, micritic coatings on most grains | 0.62 | 57.52 |
| Limestone, pale grey, fine-grained algal biopelsparite developed beneath pedogenic surfaces at 58.65 and 58.74 m. Passage in middle of unit to creamy white medium calcarenites containing abundant micrite-coated grains. Very fine-grained below 69.50 m with a fine network of stylolites and some mottling | 14.66 | 72.18 |
| Clays; thin seams at 72.18 and 74.53 m, separating well-washed, fine-grained brachiopod biopelsparite; stylolitic network in basal 10 cm. | 2.37 | 74.55 |
| Limestone, pale grey, algal biopelsparite associated with pedogenic structures at 74.84 and 74.90 m, algal nodules and dasycladacean algal fragments common. Lower in unit micritic rims are more prominent and there is less clear spar. Finer grained towards base. Thin clay wayboard at 84.07 m | 11.20 | 85.75 |

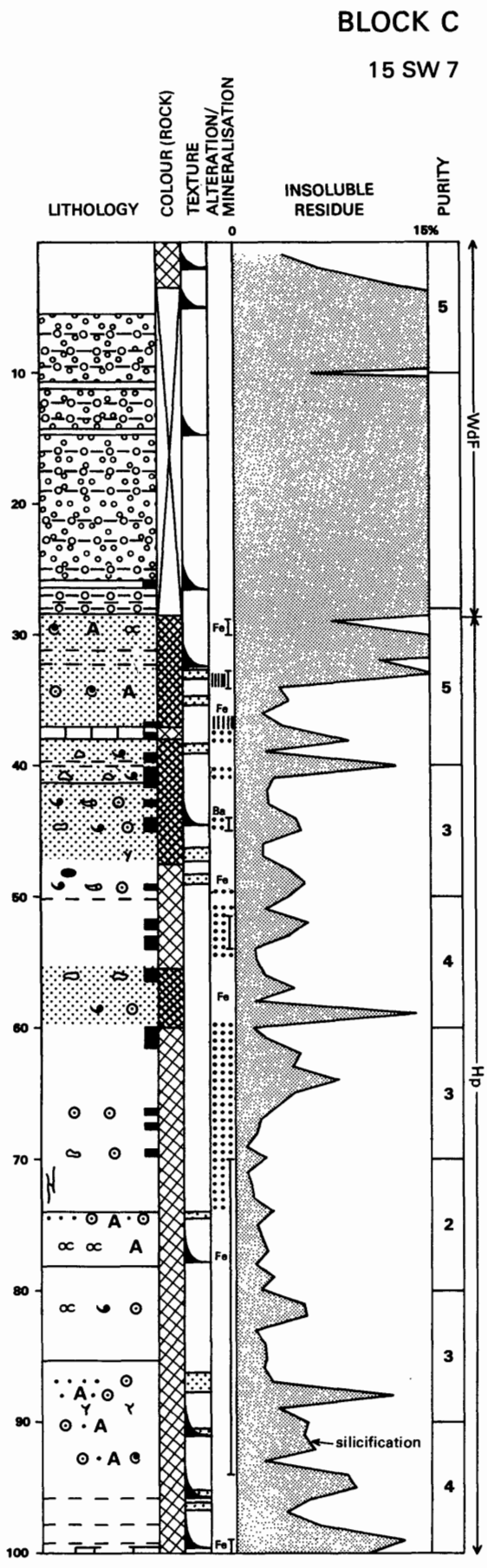


| | | |
|---|---|---|
| Limestone, pale grey, biopelsparite with associated pedogenic horizon 5 cm below top, becoming coarsely bioclastic with brachiopod shells at 87.10 and 87.30 m; continuing with alternations of well-washed peloidal limestones and algal biomicrosparites | 8.44 | 94.19 |
| Limestone (biopelsparite), crinoidal, very thin clays at top and base | 1.59 | 95.78 |
| Limestone, pale grey, alternations of algal crinoidal biosparites and biopelsparites. Pedogenic alteration at several horizons. Algal nodules at 96.50 m. Thin clay at 98.28 m | 5.52 | 101.30 |

Borehole completed at 101.30 m

**SK 15 SW 7 1113 5244 Throwley Hall**
Surface level c. +235 m
November 1977

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 0.30 | 0.30 |
| **Widmerpool Formation** | | |
| Limestone (biopelsparite), mid-grey, coarsely bioclastic units with crinoid and brachiopod debris, interbedded with finely laminated beds. Some coarse grading. Extensive silicification | 5.20 | 5.20 |
| Calcareous siltstone and sandstone, pale grey but weathering to a rust colour; occasional coarsely bioclastic shelly limestones up to 0.5 m thick showing graded bedding. Plant fragments common especially in calcareous sandstone-/siltstone laminae, fine cross-lamination in some beds, increasing hematitic staining below 27.00 m. [Dip 17° at 15.50 m, 4° at 28.20 m.] | 22.80 | 28.30 |
| **Hopedale Limestones** | | |
| Limestone (biosparite), dark grey but reddened locally by iron-staining, beds 5 to 30 cm thick comprising well-washed crinoid, brachiopod, foraminifera and dasycladacean algae, lesser amounts of peloid and intraclastic debris, sharp bases to most units, some beds show grading. Variable disseminated dolomite. Shaly intercalations at 32.30 and 32.80 m | 8.77 | 37.07 |
| Limestone (biomicrite), mid-grey, with fenestral fabric (reef material ?), conglomeratic in basal 14 cm, variably dolomitised | 0.70 | 37.77 |
| Limestone (intrasparrudite), dark and mid-grey, micritic limestone clasts common, some disseminated dolomite. Shale (30 cm) at 39.61 m | 3.45 | 41.22 |
| Limestone, mid- and dark grey, locally reddened, alternating coarse conglomeratic and finer bioclastic units (10 cm to 1.50 m thick), allochems mainly comprise micritic intraclasts, large crinoid | | |



| | | |
|---|---|---|
| fragments and dispersed brachiopod shells; sharp bases to most units, rare graded bedding. Sheared mudstone (4 cm) at 50.07. Disseminated dolomite throughout. Trace of chert. Veining with calcite and hematite from 51.00 to 53.80 m | 32.78 | 74.00 |
| Limestone (biopelsparite) mid- to pale grey, with several 4 to 5 cm thick graded, sharp-based units, bioturbated in upper parts | 4.10 | 78.10 |
| Limestone (biopelsparite), mid-grey disseminated dolomite, extensive veining | 7.20 | 85.30 |
| Limestone (biopelsparite), darker than above, several graded units 10 to 15 cm thick; lower part of each unit consists of spar-cemented crinoid, dasycladacean algae and peloid grains, upper part is commonly bioturbated - a feature picked out by clay-grade silica. Thin mudstone partings (interturbidites) at 95.80, 97.80 and 99.08 m. Extensive veining. [Dip 29° at 94.73 m, <10° below 97.57 m] | 14.70 | 100.00 |

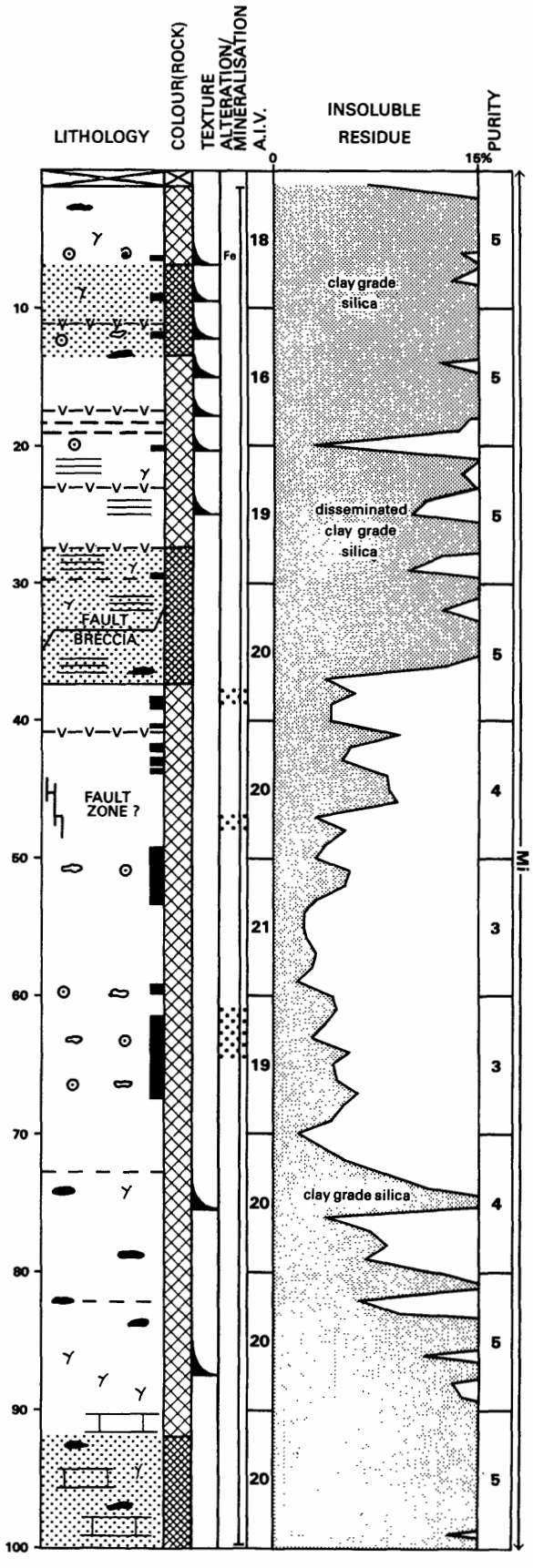
Borehole completed at 100.00 m

**SK 15 SW 8** **1062 5122** **Slade House**
Surface level c. +310 m
December 1977

**BLOCK C**
**15 SW 8**

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 1.10 | 1.10 |
| **Milldale Limestones** | | |
| Limestone, mid- and dark grey, beds 5 to 30 cm thick, graded with sharp bases, rudite grade material in basal parts of beds at 6.90, 9.50 and 12.20 m composed mainly of crinoid ossicles with subordinate foraminifera and indeterminate shell debris set in spar cement, upper part of each bed is finely laminated or argillaceous and commonly bioturbated. Pervasive silicification present throughout and seen as a fine white or pinkish white residue on the etched rock surface, chert nodules developed locally. Red stained clays at 11.40 and 17.50 m. Shaley partings at 17.53, 18.66 and 19.20 m. Iron oxide staining affects the unit and is related to the veining network. [Dip 32° at 12.75 m] | 19.30 | 20.40 |
| Limestone, mid- and dark grey, generally finer grained than above, beds are finely laminated and bioturbated, laminae are 2-3 mm thick and are picked out by clay-grade silica on the etched rock surface. Graded units are rare (5 cm sharp-based bed at 24.50 m, 20 cm thick bed at 29.70 m). Intercalations of pale grey mudstone and shaly limestone. Iron staining common [Dip 38° at 26.50 m]. Vertical bedding with silicified fault breccia from 33.60 to 34.27 m | 17.07 | 37.47 |
| Limestone, mid-grey, thickly bedded (up to 1.5 m), alternations of coarse and finely bioclastic units; coarse grained units contain dispersed intraclasts (up to 20 cm diameter) and large crinoids, debris in finer grained units is largely indeterminate. Junctions between the two lithologies are difficult to indentify as the core is highly fractured and veined particularly in interval 40 to 48 m (fault zone ?). No grading or lamination observed. Mudstone parting at 40.94 m. Red clay coatings on stylolitic surfaces. Traces of disseminated dolomite. Variable silicification. [Dip 50° at 57.65 m] | 34.45 | 72.92 |
| Limestone, mid- and dark grey, mainly thinly bedded fine calcarenites but with some thicker bedded coarser units (77.72-78.40 m, 78.60-79.34 m). Some beds are graded. Finer bioturbated lithologies containing considerable clay-grade silica are common below 81.50. Reddened mudstone (10 cm) at 81.85 m. [Dip 27° at 83.15 m] | 27.08 | 100.00 |

Borehole completed at 100.00 m

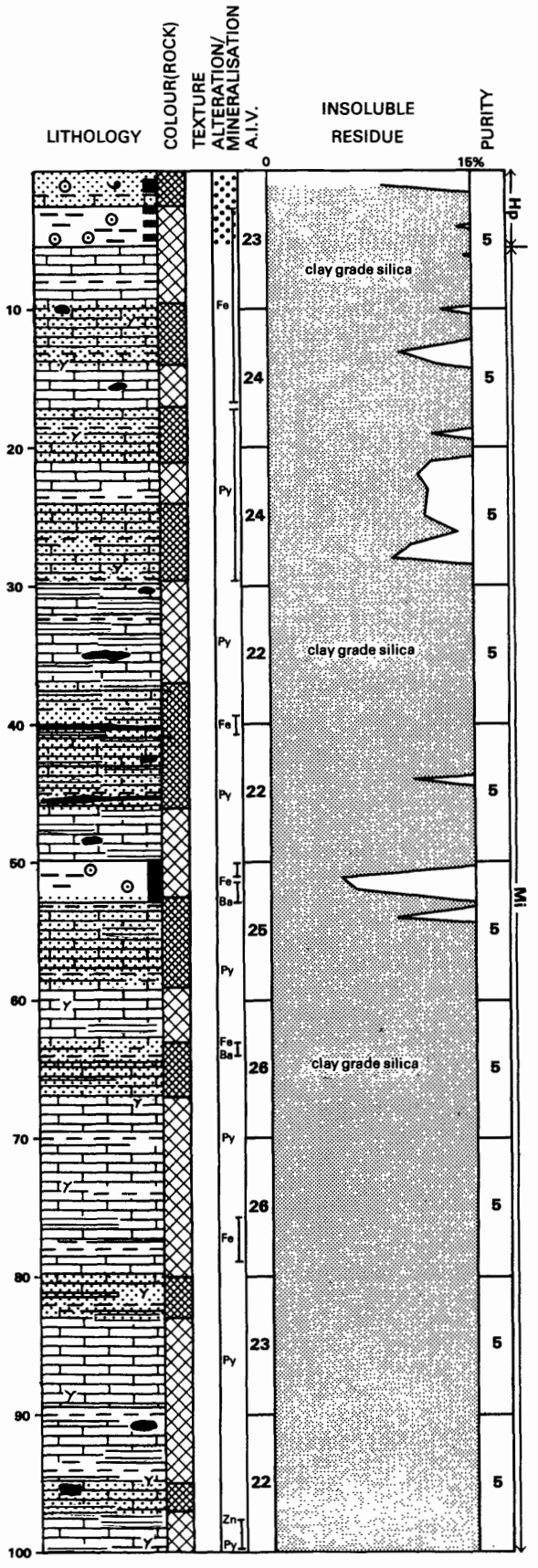


**SK 15 SW 9** **1255 5374** **Stanshope**
Surface level c. +370 m
October 1971

**BLOCK C**
**15 SW 9**

| | Thickness m | Depth m |
|---|---|---|
| Openhole | 0.60 | 0.60 |
| **Hopedale Limestones** | | |
| Limestone, mid- to dark grey calcirudite, very crinoidal and shelly, sharp-based units 6 to 7 cm thick, some finer grained and more argillaceous. Mudstone bands at 0.92 m (15 cm) and 1.17 m (7 cm). Extensive silicification. [Dip 17° at 1.30 m] | 0.89 | 1.49 |
| Mudstone, dark, weathered | 0.20 | 1.69 |
| Argillaceous limestone, dark grey, interbedded with shaly limestone, and coarsely crinoidal limestone, thicker crinoidal bed from 4.06 m to base. Extensive silicification | 3.74 | 5.43 |
| **Milldale Limestones** | | |
| Limestone (biomicrosparite), mid- and dark grey, very fine-grained, bioturbated, thin bands of dispersed crinoid debris, shaly limestone intercalations. Much disseminated clay and clay-grade silica on etched rock surface. Sporadic black cherts | 10.47 | 15.90 |
| Limestone (biomicrosparite), dark grey, generally as above, with wispy dark argillaceous lamination common; sharp-based graded crinoidal biosparite from 16.80 to 16.93 m, passage to argillaceous limestone below 25 m, traces of pyrite. [Dip 19° at 16.89 m] | 13.85 | 29.75 |
| Limestone (biomicrosparite), dark grey, very fine-grained, interlaminated with argillaceous limestone (often silicified) and thin shales. Some small-scale slump structures. Local calcite veining with associated hematite. [Dip variable: 40° at 36.50 m, 73° at 38.50 m, 90° from 46.40 to 46.69 m] | 20.05 | 49.80 |
| Limestone (crinoidal biosparrudite), dark grey, with iron-stained mudstone partings. Calcite veining with hematite staining and some baryte. [Dip 47° at 52.57 m] | 3.05 | 52.85 |
| Limestone (biomicrosparite), dark grey, very fine-grained, finely laminated, interbedded with argillaceous limestone; some bioturbation; thin shale partings. Pyrite common; calcite veining with associated hematite staining and a little baryte (63.90- 64.00 m). [Dip 50° at 55.70 m, steepening to 90° from 76.56 to 78.47 m] | 25.62 | 78.47 |
| Limestone, fault breccia | 0.28 | 78.75 |
| Argillaceous limestone, dark grey, fine-grained with dark argillaceous streaky lamination, some bioturbation. Numerous stylolites. Sporadic chert nodules below 80 m [Dip 28° at 99.57 m] | 21.25 | 100.00 |

Borehole completed at 100.00 m

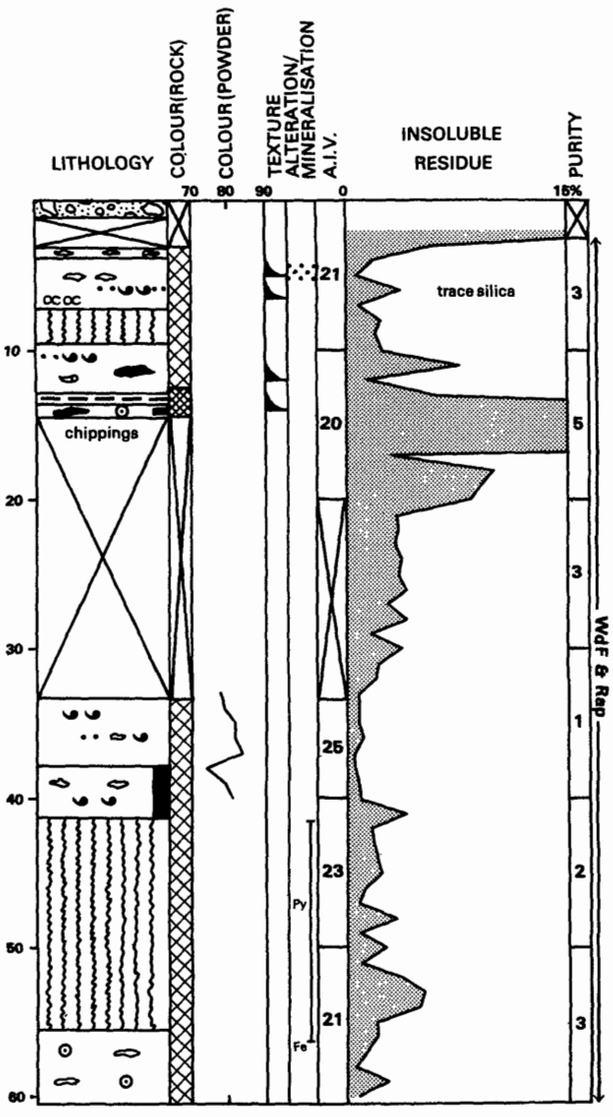


**SK 15 SE 7** **1785 5458** **Tithe Barn, Parwich**
Surface level + 203.3 m
March 1971

**BLOCK C**
**15 SE 7**

| | Thickness m | Depth m |
|---|---|---|
| Openhole: 1 m topsoil | 3.05 | 3.05 |
| **Widmerpool Formation and apron-reef limestones** | | |
| Limestone (biosparite), mid-grey, fine calcarenite with scattered gastropods, foraminifera and crinoid ossicles; some large brachiopods and intraclasts from 3.15 to 3.36 m, local silicification | 0.50 | 3.55 |
| Limestone (reef-facies), mid-grey, brecciated micrite with spar-filled structures | 0.20 | 3.75 |
| Limestone, mid-grey, with graded units up to 25 cm thick, coarse debris at base of some units comprises crinoid ossicles, brachiopods and sporadic large intraclasts of micritic limestone, upper parts of units are of fine calcarenite grade and are laminated. Trace silicification, some scattered dolomite rhombs | 3.14 | 7.16 |
| Limestone (reef-facies biomicrite), mid-grey, with spar-filled cavities - slumped block? | 2.34 | 9.50 |
| **Gap** | 0.40 | 9.90 |
| Limestone, mid-grey, but darker locally (9.90-10.60 m, 11.00-11.14 m), similar lithologically to interval 3.75 to 7.16 m with current laminated medium to coarse grained calcarenites, some showing grading; many brachiopods from 10.93 to 11.06 m. Dark and pale banded chert 11.06 to 11.13 m | 2.98 | 12.88 |
| Calcareous shale, dark grey, silty | 0.35 | 13.45 |
| Limestone (biosparrudite), dark grey, graded, with large intraclasts of micritic limestone, sharp base. Below 13.65 m thinly interbedded dark bituminous limestone and pale, graded calcarenites, all highly silicified | 1.00 | 14.45 |
| **Openhole** | 18.85 | 33.30 |
| Limestone (biosparite), mid-grey, medium to coarse calcarenite with scattered intraclasts, comminuted shell debris, peloids and foraminifera; units 20 to 30 cm thick, sharp-based and current laminated | 4.77 | 37.97 |
| Limestone breccia (biosparrudite), mid-grey, comprising large intraclasts of micrite and biopelsparite with abundant large brachiopods; passing down at 41.20 m into a brecciated micritic limestone with spar-filled cavities (**apron-reef limestone**), bituminous material concentrated along stylolites; becoming increasingly crinoidal, less micritic and more evenly bedded below 55.20 m. Iron-stained below 59.50 m | 22.48 | 60.45 |

Borehole completed at 60.45 m



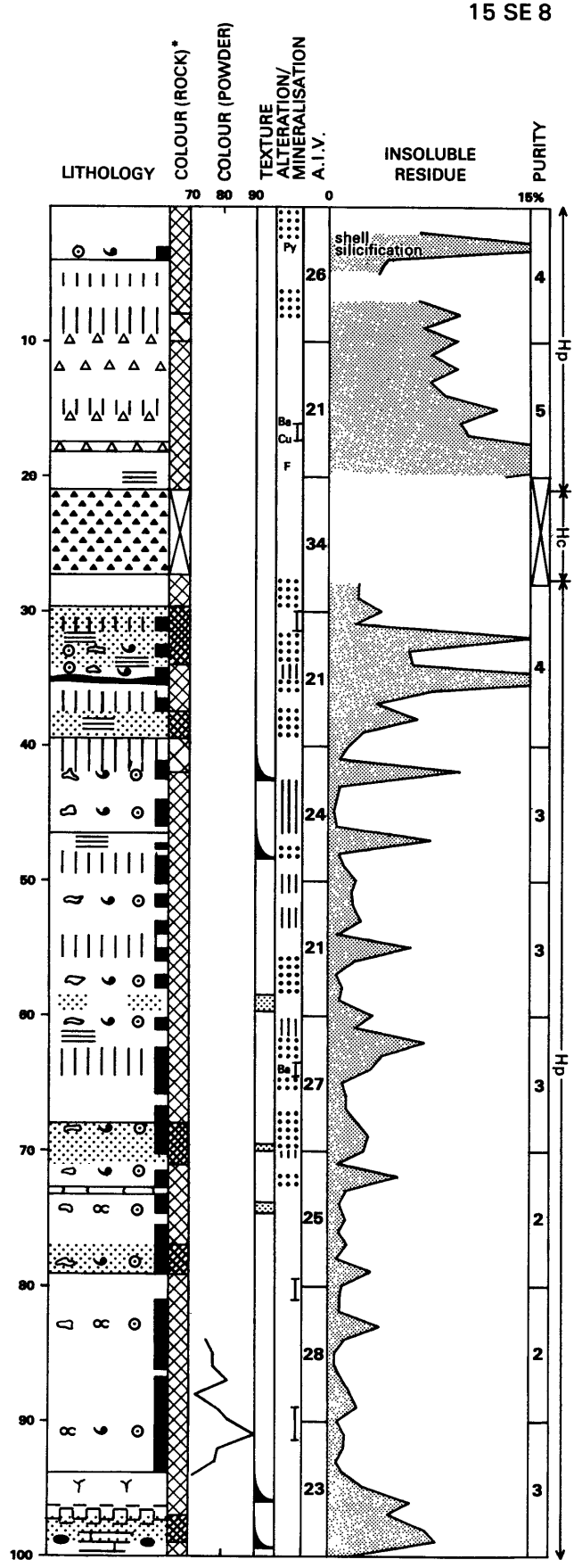
SK 15 SE 8 1736 5318 **Rusheycliff Barn, Tissington**

Surface level +272.9 m
May 1978

**BLOCK C**

**15 SE 8**

| | Thickness m | Depth m |
|---|---|---|
| **Hopedale Limestones** | | |
| Limestone, mid-grey, coarsely bioclastic with silicified brachiopods, crinoids and intraclasts; abundant peloids to 2.30 m. Traces of highly pyritised tuffaceous fragments | 4.00 | 4.00 |
| Limestone, mid-grey, locally limonite-stained, fine colour banding in upper and lower parts of unit, interbedded grey-green, pyritic tuffaceous limestones (9.90-10.00 m, 11.80-12.00 m, 15.40-15.45 m, 17.50-18.20 m, 20.00 m, 21.50 m); sporadic dolomitisation; abundant disseminated quartz at 12.00 m; veining with baryte and fluorite from 16.50 to 17.50 m and at 18.90 m | 17.00 | 21.00 |
| **Tissington Volcanics** | | |
| Tuff, grey-green, friable, bedded in upper part, agglomeratic at base with fragments of included limestone. Abundant disseminated pyrite and (?) chalcopyrite | 6.40 | 27.40 |
| **Hopedale Limestones** | | |
| Limestone, mid-grey, fine calcarenite, patchy dolomitisation | 2.35 | 29.75 |
| Limestone, dark grey, unsorted calcirudites (5 sharp-based beds) interbedded with dark and pale, laminated fine calcarenites; allochems include brachiopods, crinoids and subangular intraclasts. Trace chert; patchy dolomitisation | 9.75 | 39.50 |
| Dolomitic limestone (intrasparrudite), mid-grey, coarse-grained units fining towards tops with some current lamination. Extensive dolomitisation to 42.00 m | 8.00 | 46.50 |
| Argillaceous limestone, pale and dark grey, finely laminated | 0.91 | 47.41 |
| Dolomitic limestone, mid-grey, poorly graded intraclastic calcirudites up to 1 m thick, interbedded with paler biopelsparites containing well-sorted and micritised grains. Coarser units are sharp-based and preferentially dolomitised | 4.81 | 62.20 |
| Dolomitic limestone, pale to dark grey, laminated fine calcarenite | 0.40 | 62.60 |
| Clay, earthy seam | 0.05 | 62.65 |
| Dolomitic limestone (biosparrudite), mid- and dark grey, with crinoid, brachiopod and intraclast fragments; subordinate finer grained units. Dolomitisation is joint-controlled | 10.00 | 72.65 |
| Limestone (reef-facies), mid-grey, micrite - possibly large exotic block | 0.40 | 73.05 |




* Dolomitisation gives false colour in places

Limestone (biosparrudite), mid-grey, with coarse brachiopod, crinoid and intraclast debris. No grading seen. Veining at 80.12 m and from 89.12 to 91.50 m — 19.75 — 93.80

Limestone, dark grey, fine calcarenite/calcilutite, bioturbated, cherty; interbedded pale, fine calcarenite to medium calcirudite bands (5 to 25 cm thick) containing abundant peloids and dasycladacean algal fragments; local grading. Mudstone intercalations (96.19-96.50 m, 97.40-97.60 m) — 6.26 — 100.06

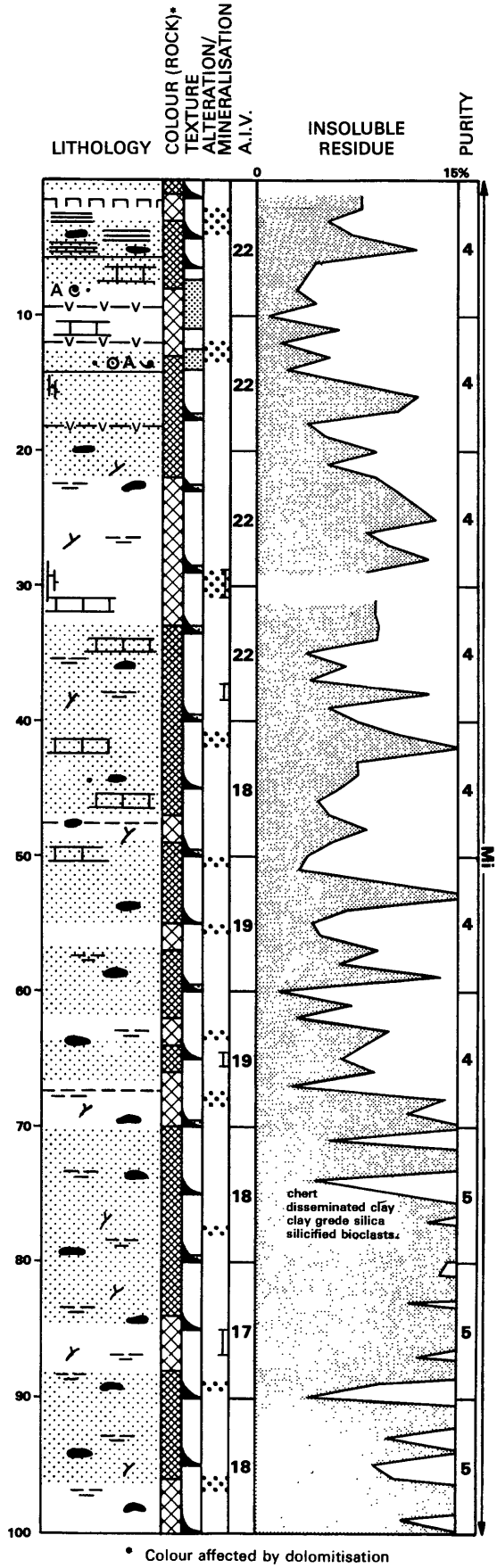
Borehole completed at 100.06 m

**SK 15 SE 9 1547 5258 Hollington Barn**
Surface level c. +360 m
May 1978

| | Thickness m | Depth m |
|---|---|---|
| **Milldale Limestones** | | |
| Limestone (crinoidal biosparite), dark grey, graded, bioclasts rimmed with hematite, localised dolomitisation. [Dip 5° at 1.20 m] | 1.20 | 1.20 |
| Mudstone, black, locally reddened | 0.20 | 1.40 |
| Limestone, mid-grey becoming dark grey towards base, finely laminated throughout (2 to 20 mm scale), laminae are uneven and are truncated by micro-faulting. Upper part of unit is completely dolomitised, below 1.67 m dolomitisation is sporadic and is concentrated in zones paralleling bedding structures or is associated with veining. Sporadic thin tabular cherts | 4.32 | 5.72 |
| Limestone, mid- and dark grey, coarse calcarenites and fine calcirudites, locally graded and containing spar-cemented crinoids, dasycladacean algae, foraminifera and peloids; interbedded very fine calcarenites. Thin clay horizons at 9.40 and 12.05 m. Hematite staining common | 8.58 | 14.20 |
| Limestone, dark grey, sharp-based, graded units 2 to 20 cm thick, each comprising a basal calcarenite (or calcirudite) fining upwards into a bioturbated argillaceous calcilutite. Units are commonly separated by thin shale partings. Detritus in base of turbidites includes crinoids, peloids and some intraclastic debris. From about 30 m to 50.70 m, argillaceous calcilutites predominate, coarse detritus is rare and grading is uncommon. Nodular chert occurs throughout. Disseminated dolomite is associated with joints from 15.18 to 15.27 m; core is more completely dolomitised between 29.00 and 31.00 m. Varicoloured wayboard at 15.80 m | 52.20 | 66.40 |
| Limestone, pale grey, bioclastic | 0.50 | 66.90 |
| Limestone, mainly dark grey, graded, dominantly fine-grained, sharp-based argillaceous units with abundant fine clay and/or dolomite visible on the etched rock surface | 33.10 | 100.00 |

Borehole completed at 100.00 m

BLOCK C
15 SE 9



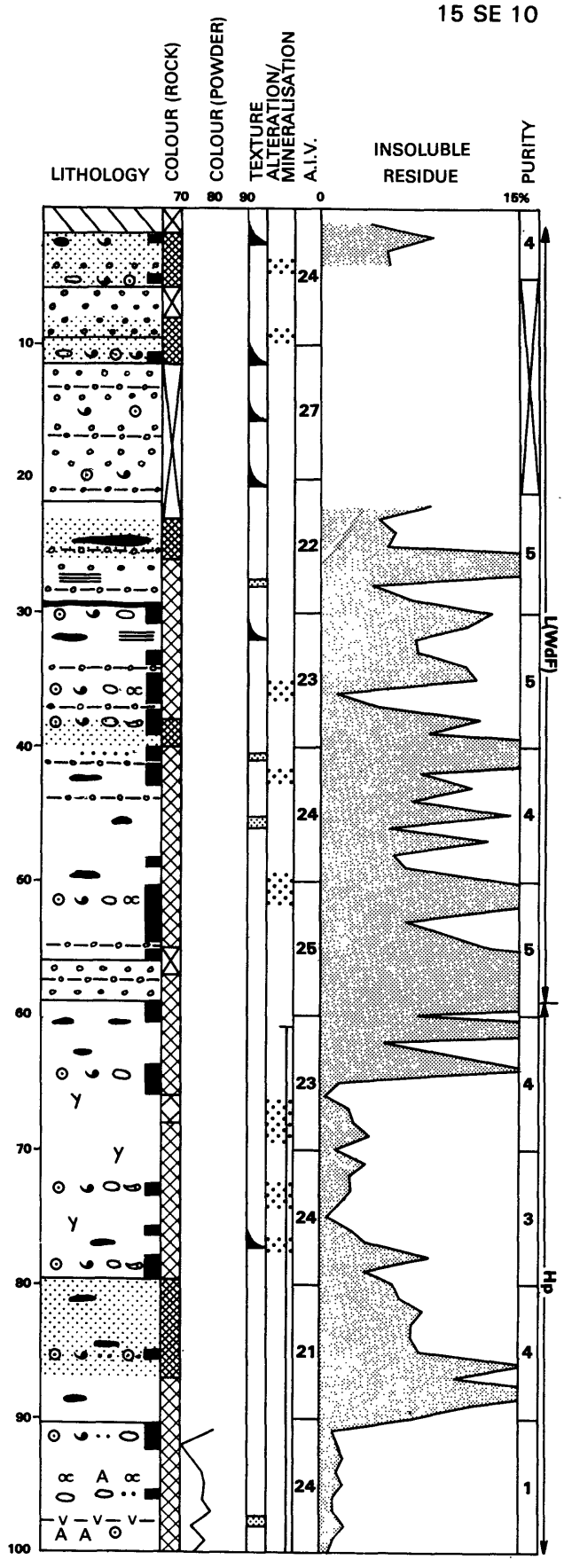

* Colour affected by dolomitisation

**SK 15 SE 10 1624 5122 Pike House**
Surface level +254.4 m
May 1978

**BLOCK C**
**15 SE 10**

| | Thickness m | Depth m |
|---|---|---|
| Made ground | 1.70 | 1.70 |
| **Widmerpool Formation** | | |
| Limestone, mid- and dark grey, coarsely bioclastic, locally conglomeratic with crinoids, shells and micritic intraclasts; units range from 0.20 to 0.60 m thick and are commonly graded; trace of incipient dolomitisation and silicification; interbedded sandstone grading upwards into thin shales or sandy limestones | 9.78 | 11.48 |
| Sandstone, silty sandstone and siltstone, grey finely laminated (2 mm to 40 mm); dark streaks of black organic material; interbedded calcareous units, bioclastic in basal parts but arenaceous towards tops | 12.02 | 21.80 |
| Limestone, dark and mid-grey, calcirudites containing crinoids, shell debris and micritic intraclasts interbedded with fine calcarenites, latter often laminated dark grey and black. Rare graded beds. Sporadic irregular chert nodules. Silty sandstone intercalations up to 0.20 m thick (28.00 m, 34.40-34.70 m, 37.20-37.40 m). [Dip 15-20° at 37.00 m]. Passage to | 15.70 | 37.50 |
| Limestone, mid- and dark grey, coarse arenite and rudite size bioclasts, generally as above, locally peloidal; abundant chert, sporadic silicification, trace of oil in vugs; interbedded bands of alternating pale and dark laminated silty sandstone (39.18 m, 41.42 m, 45.24-45.54 m, 52.90 m, 55.95-59.00 m). [Dip 45-50° at 57.00 m] | 21.50 | 59.00 |
| **Hopedale Limestones** | | |
| Limestone, mid-grey, predominantly coarse calcarenite to fine calcirudite with some fine calcarenite bands. No shaly horizons or well-defined bedding units. Sporadic chert nodules. Localised intense dolomitisation. Disseminated quartz crystals. Residual hydrocarbons at 77.00 m. Calcite-/baryte veining throughout. Fault-breccia at 61.60 m | 20.63 | 79.63 |
| Limestone, mid- and dark grey, mainly fine calcarenite, bioturbated; abundant chert. Conglomeratic bed from 85.00 to 85.60 m. Local hematite veining | 10.73 | 90.36 |
| Limestone, mid-grey, conglomeratic, abundant dasycladacean algae, crinoid debris and peloid grains, all micritised. Thin red-green mudstone at 97.80 m | 9.65 | 100.01 |

Borehole completed at 100.01 m



**SK 04 NE 1S** **Caldon Low Quarries 0784 4868 (Various sections)** **Block B**

Thickness m

**Milldale Limestones**

Limestone, mid-grey, thickly bedded, with some dark grey bands (colour banding visible on working faces), fine and medium calcarenites predominate with foraminifera, tightly compacted peloids, ostracods and much finely comminuted indeterminate debris; coarser-grained bioclasts include crinoid debris in lenses, oncolitic nodules and dispersed brachiopods. Minor shaly partings developed locally. Sequence is chert-free apart from the lower quarry level where some 11.00 m of cherty limestone are exposed. Local dolomitisation and hematite associated with master joints and faults, abundant authigenic quartz crystals — c.110

Dip: c. 10°

Purity: 98 % $CaCo_3$ (Category 2)

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**SK 04 NE 7S** **Kevin Quarry 0837 4612 (top) to 0877 4616** **Block B**

Thickness m

**Kevin Limestones**

Limestone, pale and mid-grey, locally mottled, fine to coarse grained massive calcarenites, *Davidsonina septosa* band at top of section, dasycladacean algae, algal-bound nodules and compacted peloid grains common throughout section, thin calcilutite bands at 15 and 64.50 m below top. Pedogenic structures common, particularly in interval 25 to 55 m, associated yellow and purple clay seams (up to 10 cm thick) — 131.10

Dip: 10°

Purity: 99.2 % $CaCO_3$ (Category 1)

AIV: 24-27

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**SK 04 NE 9S** **Cauldon Quarry 0860 4901** **Block B**

**Milldale Limestones**

Western Quarry: Limestone, mid-grey, thickly bedded, containing dispersed shells, interbedded at lowest quarry level with mid- and dark-grey, thin-bedded cherty limestone, some purplish clay partings

Eastern Quarry: Limestone, mid-grey, well-bedded, mainly in thick units, strongly jointed with some high dips

Dip: Variable

Purity (based on spot samples): 97 % $CaCO_3$ (Category 2)

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**SK 05 NE 2S** **Composite section along old railway track 0910 5794 (top) to 0950 5818** **Block C**

| | Thickness m |
|---|---|
| **Ecton Limestones** | |
| Limestone, mid- and dark-grey, thinly bedded, fine to coarsely bioclastic with few cherts, some graded bedding | c.16 |
| Limestone, dark grey, fine-grained, thinly bedded (1 to 15 cm) | c.18 |
| Limestone, mid- and dark grey, thin to thickly bedded, fine to coarsely bioclastic with a 2 m conglomerate bed about 3 m below the top, graded bedding and chert nodules and lenses common | 16.0 |
| Unexposed | 17.5 |
| Limestone, mid- and dark grey, mainly thin-bedded, fine to medium grained peloidal and bioclastic limestones with some chert nodules, shaly partings, and a 2.1 m conglomeratic bed 8.2 m below the top | 40.3 |
| **Milldale Limestones** | |
| Limestone, dark grey, thinly bedded, fine-grained with shaly partings | 19.5 |

Dip: Variable

Purity: c. 90 % $CaCO_3$ (Category 4)

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**SK 05 NE 4S** **Apes Tor Quarries 1000 5865 (top) to 0983 5868** **Block C**

| | Thickness m |
|---|---|
| **Ecton Limestones** | |
| Limestone, dark grey, thin to thickly bedded, fine to coarsely bioclastic, graded, shaly partings common, abundant chert nodules, dark thinly bedded limestones predominate in the middle 11 m of the sequence | c.63 |

Dip: Variable with well-displayed folds

Purity: c. 90 per cent $CaCO_3$ (Category 4)

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**SK 05 SE 1S** **Track of old railway, Manifold Valley 0936 5451 (top) to 0983 5445** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones (dark facies)** | |
| Limestone, dark grey, thinly bedded, mainly fine-grained foraminiferal calcarenites with some coarse calcarenite and calcirudite bands, interbeds of dark sparsely fossiliferous argillaceous calcilutite, some shale partings. Local colour lamination. Chert nodules, chalcedonic silica (replacing fossils) and disseminated authigenic quartz common throughout unit. Some hematite staining | c.62 |
| **Milldale Limestones** | |
| Limestone, mid- and dark grey; conglomeratic bands containing micrite intraclasts with associated crinoid and bryozoan debris interbedded with mud-supported crinoidal lithologies, allochems highly silicified | c.29 |
| Limestone (micrite), well-developed fenestral fabric, dispersed crinoid ossicles (reef affinity) | 2.00 |
| Limestone, dark grey, calcisiltite | 2.00 |

Dip: 55°

Purity: c. 91 % $CaCO_3$ (Category 4)

AIV: 23-24

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**SK 05 SE 3S** **Brownend Quarry, Waterhouses 0897 5026 (top) to 0910 5019** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone, mid-grey, thin to thickly bedded, coarsely crinoidal with micrite intraclasts in middle of unit, some sharp-based graded beds and parallel laminated bands | 14.26 |
| **Milldale Limestones** | |
| Limestone, dark grey, thinly bedded, fine calcarenites with some dispersed crinoid and shell debris, thin shale intercalations (4 % of unit), some chert lenses and nodules | 15.50 |
| Limestone, mid-grey, massive, parallel laminated, superficial micritic rims on bioclastic debris | 4.50 |
| Limestone, dark grey, thinly bedded with shaly intercalations (5 % of unit), some coarse crinoidal bands and a few scattered chert nodules, disseminated hematite imparts a reddish tinge to rock, abundant clay-grade silica in matrix | 33.06 |
| Limestone, thinly interbedded with shaly mudstone | 1.50 |
| Limestone, predominantly dark grey, fine-grained with bands of coarser debris containing micrite intraclasts, dispersed crinoid debris in lower part of unit, some graded bedding, shaly mudstone intercalations (10 % of unit) and a few chert nodules | 11.49 |
| Limestone, dark grey, thin-bedded and locally graded, with two micritic reef lenses in middle part of unit | 14.80 |

Dip: 65°

Purity: 98.3 % $CaCO_3$ (Category 2) for the Hopedale Limestones

<85 % $CaCO_3$ (Category 5) for the Milldale Limestones

AIV: 23-25

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**SK 05 SE 4S** **Leehouse Quarries, Waterhouses 0851 5029 (top) to 0868 5034** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone, comprising mainly brachiopod shells; interbedded mudstones 0.77 and 1.74 m from top of unit | 2.49 |
| Limestone, mid-grey, thin to thickly bedded (up to 1.6 m) with some lenticular bedding and current-lamination, scattered rudite debris (crinoids, brachiopods) with associated finer bioclasts (peloids, foraminifera) in locally sparry matrix, well-developed rudite band 3.5 m above base of unit, some intraclasts of dark limestone, disseminated dolomite rhombs present locally | 24.01 |
| Limestone (biomicrite), mid-grey with spar-filled cavities - reef affinity (?) | 1.00 |
| Limestone, coarsely bioclastic with crinoid debris and brachiopods | 0.49 |
| Limestone, mid-grey with interlaminated thin lenticular beds and dark shaly intercalations | 1.20 |
| Limestone (calcirudite) with intraclasts, crinoid debris and brachiopod shells; some disseminated dolomite | 2.20 |
| Limestone (pelsparite) thinly interbedded with dark fissile shales up to 4 cm thick | 2.60 |
| **No exposure** | 2.00 |
| Limestone, mid-grey, thin to thickly bedded, coarsely bioclastic with crinoids, brachiopods and scattered intraclasts (pale and dark varieties), interbedded finer-grained peloidal lithologies, locally well-sorted, some current-lamination, thin shale partings. Trace of bituminous matter in veins and as blebs, some disseminated dolomite | 20.24 |
| Shale | 0.06 |
| Limestone, dark grey, very fine-grained peloidal lithologies interbedded with coarse conglomeratic shelly biosparrudites, intercalations of black shale | 2.91 |

Dip: Variable up to 30°

Purity: 97.4 % $CaCO_3$ (Category 2)

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**SK 05 SE 6S** **Hamps Valley below Soles Hill 0946 5246** **Block C**

Thickness m

**Milldale Limestones**

Limestone, mid- to dark grey, thin-bedded in upper part, thicker bedded towards base with dispersed brachiopod and crinoid debris, silicified bioclasts common, cherty at base, hematite-stained throughout 15.00

Dip: 23°

Purity: c. 93 % $CaCO_3$ (Category 4)

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**SK 05 SE 7S** **Hamps Valley south-west of Soles Hill 0947 5208** **Block C**

Thickness m

Limestone mid- to dark grey, thinly bedded, fine-grained calcisiltites interbedded with coarser grained bioclastic bands, silicification of bioclasts common, abundant chert 10.00

Dip: 24°

Purity: <85 % $CaCO_3$ (Category 5)

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**SK 05 SE 8S** **Quarry near Redwayclose Barn 0896 5197** **Block C**

Thickness m

Limestone, dark grey, well-bedded (45 cm units) with silicified crinoid and brachiopod debris in top 5 m, becoming finer-grained and argillaceous in lower part with a few chert nodules. Argillaceous limestone partings separate main bedding units. Some disseminated dolomite 15.00

Dip: 30°

Purity: c. 94 % $CaCO_3$ (Category 4)

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**SK 05 SE 9S** **Quarry south-west of Redwayclose Barn 0886 5180** **Block C**

Thickness m

**Milldale Limestones**

Limestone, dark grey, thinly bedded (25 cm units), very fine calcarenite with argillaceous partings 3 to 4 cm thick, traces of chert, patchy dolomitisation along joints and fractures, disseminated rhombs in matrix 11.00

Dip: 36°

Purity: c. 87 % $CaCO_3$ (Category 4)

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**SK 05 SE 11S** **Quarry on Soles Hill 0982 5248** **Block C**

Thickness m

**Milldale Limestones**

Limestones, mid- and dark grey, thin to thickly bedded (up to 40 cm), fine and coarsely bioclastic with highly silicified fossil debris, some graded beds and a few scattered chert nodules. Much hematite and calcite veining, disseminated dolomite rhombs in matrix 13.00

Dip: Vertical

Purity: c. 94 % $CaCO_3$ (Category 3)

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**SK 05 SE 19S** **Quarry south of Oldfields Farm 0819 5276** **Block C**

Thickness m

**Ecton Limestones**

Limestone, mid-grey, massive (1.4 m) in upper part, thinly bedded (0.25 m) towards base, coarsely crinoidal with dispersed corals and intraclasts, beds crudely graded, matrix partly dolomitised 4.10

Dip: 21°

Purity: 98.4 % $CaCO_3$ (Category 2)

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**SK 05 SE 20S** **Quarry south-east of Grindon 0939 5407 (top) to 0936 5412** **Block C**

Thickness m

**Ecton Limestones**

Limestone, mid-grey, well-bedded in units averaging 0.25 m thick; the thicker beds are coarsely crinoidal with scattered intraclasts and are commonly graded, chert nodules and lenses (up to 14 % of the rock) occur in the uppermost 10 m of the section. Red clay partings occur between some beds and all lithologies are hematite-stained, some disseminated dolomite 24.90

Beds exposed in a small anticlinal structure

Purity: 0 to 10 m 86 % $CaCO_3$ (Category 4)

10 to 24.90 m 96.8 % $CaCO_3$ (Category 3)

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**SK 05 SE 21S** **Quarry in Deepdale 0888 5309** **Block C**

Thickness m

**Ecton Limestones**

Limestone, mid- and dark grey, thickly bedded (up to 2.30 m), coarsely cinoidal, parallel laminated with some thin shaly partings 2.4 m from top, local silicification and disseminated dolomite 14.49

Purity: 96.8% $CaCO_3$ (Category 3)

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**SK 14 NW 3S** **Quarry east-south-east of Huddale Farm 1007 4897** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones** | |
| Limestone (intraclastic crinoidal biosparrudite), mid-grey, thickly bedded, parallel laminated, with some hematite, calcite veining and incipient dolomitisation | 12.00 |

Dip: 12°

Purity: 98.7% $CaCO_3$ (Category 1)

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**SK 14 NW 4S** **Quarry north-east of Far Dale Farm 1073 4833** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones** | |
| Limestone (biopelsparite), mid-grey, thin to thickly bedded (up to 1.2 m), coarsely crinoidal with abundant algal-encrusted debris, some graded and cross-bedded units, strongly hematite-stained, purplish red mudstone intercalations up to 5 cm thick common in middle and upper part of section | 14.32 |

Dip: 9°

Purity: 95.9% $CaCO_3$ (Category 3)

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**SK 14 NW 5S** **Quarry south of Far Dale Farm 1046 4779** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones** | |
| Limestone, mid-grey, thin to thickly bedded (0.20 to 0.74 m), coarsely bioclastic in part | 6.33 |
| Limestone, mid-grey, flaggy, fine-grained, with argillaceous limestone partings, some hematite-staining and a few scattered chert nodules | 2.90 |

Dip: 12°

Purity: 93.4% $CaCO_3$ (Category 4)

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**SK 14 NW 6S** **Quarry north of Thorswood House 1163 4758** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones** | |
| Limestone, mid- and dark grey, thin-bedded (0.2 m) in upper part, thicker bedded (1.0 m) towards base, fine-grained with argillaceous intercalations. Bedded and nodular chert (about 10% of sequence) | c.23 |

Dip: 40°

Purity: c. 80% $CaCO_3$ (Category 5)

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**SK 14 NW 7S** **Quarry east of Weaver Farm 1067 4660** **Block C**

Thickness m

**Milldale Limestones**

Limestone, mid-grey, thinly bedded, fine-grained calcarenite with dispersed brachiopod, ostracod and gastropod shells, some well-washed peloidal bands in lower part of section. Much calcite and hematite veining, rare chert nodules — c.8

Dip: Variable - section folded and faulted

Purity: 97% $CaCO_3$ (Category 3)

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**SK 14 NW 8S** **Quarry near Swinscoe 1374 4795** **Block C**

Thickness m

**Ecton Limestones**

Limestone (crinoidal biosparite), thin to thickly bedded, coarsely bioclastic with dispersed intraclasts — 10.8

Dip: Variable - small anticlinal structure

Purity: 97.8% $CaCO_3$ (Category 2)

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**SK 14 NW 9S** **Marten Hill 1397 4768** **Block C**

Thickness m

**Milldale Limestones**

Limestones, mid- to dark grey, finely peloidal with abundant chert nodules and lenses — 6.0

Dip: Variable - section intensely folded

Purity: c. 86% $CaCO_3$ (Category 4)

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**SK 15 NW 1S** **Biggin Dale 1425 5777** **Block A**

Thickness m

**Woo Dale Limestones**

Limestone, pale and mid-grey, well-bedded; peloidal units containing oncolitic nodules and dispersed brachiopod and crinoidal debris alternate with subordinate micrites and biomicrites; abundant calcispheres and some bird's eye structures in fine-grained beds — 35.00

Dip: c. 10°

Purity: 99.4% $CaCO_3$ (Category 1)

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**SK 15 NW 2S** **Biggin Dale, near old lime kiln 1432 5899** **Block A**

| | Thickness m |
|---|---|
| **Monsal Dale Limestones (dark facies)** | |
| Limestone, dark and mid-grey, irregularly bedded, with *Girvanella* 4 m above base. Traces of dolomite and pyrolusite | 14.30 |
| **Bee Low Limestones** | |
| Limestone, pale grey, crinoidal | 7.70 |

Dip: <10°

Purity: 97.9% $CaCO_3$ (Category 2) Monsal Dale Limestones

99.5% $CaCO_3$ (Category 2) Bee Low Limestones

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**SK 15 NW 3S** **Junction of Biggin Dale and Wolfscote Dale 1411 5707 (top) to 1440 5685** **Block A**

| | Thickness m |
|---|---|
| **Bee Low Limestones** | |
| Limestones, pale grey, medium calcarenite, poorly exposed | 6.20 |
| **Woo Dale Limestones** | |
| Limestone, pale grey, peloidal calcarenites interbedded with sparsely fossiliferous calcilutites, some bird's eye structures developed in the finer grained lithologies | 88.80 |

Dip: c. 10°

Purity: 99.8% $CaCO_3$ (Category 1)

A.I.V.: 25-27

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**SK 15 NW 4S** **Quarry north of Wetton 1079 5570** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone (crinoidal biosparite), thin to thickly bedded (3 cm to 2.4 m), some coarsely crinoidal bands, scattered intraclasts and abundant dasycladacean algae, peloidal lithologies common in lower part of section. Thin brown clay seams and shale partings between beds. Local dolomite, limonite and hematite alteration. Blebs of clay partly weathered out (tuffaceous origin?). Bituminous residue in pores of lowest beds | 12.00 |

Dip: up to 20°

Purity: 98.8% $CaCO_3$ (Category 1)

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**SK 15 NW 5S** **Quarry near Brook Lodge 1190 5550** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone (intraclastic crinoidal biosparite), mid-grey, thinly bedded, abundant brachiopods - some partly silicified | 2.9 |
| Limestone, mid- and dark grey, thicker bedded with crinoid, peloid and dispersed brachiopod shells, some graded beds, scattered chert lenses. Many thin clay seams in lower part of unit. Traces of dolomitisation, local blebs of hematite | 6.8 |

Dip: 8°

Purity: c. 90% $CaCO_3$ (Category 4)

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**SK 15 NW 6S** **Coldeaton Bridge 1476 5598 (top) to 1460 5610** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones** (including dark facies) | |
| Limestone (biosparite), mid-grey with well-washed fine shells, peloids, some coarse crinoid debris and rare intraclasts | 21.50 |
| Limestone, dark grey with scattered chert nodules | 14.00 |
| Limestone (biosparite and biopelsparite), mid- and dark grey, argillaceous in parts with dispersed crinoid and shell debris. Traces of dolomitisation | 20.50 |
| Limestone, dark grey, thinly bedded, very fine grained, cherty. Dolomitised along fractures | 7.00 |

Dip: up to 30°

Purity: c. 98% $CaCO_3$ (Category 2) for mid-grey lithologies

<85% $CaCO_3$ (Category 5) for dark facies

AIV: 24-25

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**SK 15 NW 7S** **Dove Valley, north of Milldale 1457 5536** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones (dark facies)** | |
| Limestone, dark grey, thinly bedded, fine calcarenite with chert lenses. Thin shaly intercalations | 9.75 |

Dip: 16°

Purity: <85% $CaCO_3$ (Category 5)

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**SK 15 NW 8S** **Narrowdale Hill 1236 5733** **Block C**

| | Thickness m |
|---|---|
| **Knoll-reef** in the Hopedale Limestones | |
| Limestone (micrite), pale grey, brachiopods dispersed throughout | 17.00 |

Purity: 98.3% $CaCO_3$ (Category 2)

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**SK 15 NW 9S** **Gateham Grange 1130 5662** **Block C**

Thickness m

**Knoll-reef** in the Hopedale Limestones

Limestone (biomicrite), mid-grey with well-developed fenestral fabric, some crinoids, brachiopods and peloid grains. Hematite-stained locally 57.00

Purity: 99.7% $CaCO_3$ (Category 1)

AIV: 25-26

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**SK 15 NW 10S** **Roadside west of Wetton 1010 5520** **Block C**

Thickness m

**Milldale Limestones (dark facies)**

Limestone (crinoidal biosparite), dark grey, thinly bedded, partly argillaceous, hematite-stained, scattered chert nodules, some thin shale partings 10.00

Dip: 15 to 20°

Purity: <85% $CaCO_3$ (Category 5)

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**SK 15 NE 1S** **Quarries at Alsop Moor 1635 5674 (top) to 1625 5661** **Block A**

Thickness m

**Bee Low Limestones**

Limestone, pale grey, massive, shelly in places; *Davidsonina septosa* at 4.0 m above thin clay band on potholed surface at base 36.00

Limestone, pale grey, cinoidal with scattered brachiopods. Thin clay on potholed surface at base 6.48

Limestone, pale grey, massive, with scattered crinoid debris and brachiopods 8.20

Dip: <10°

Purity: 99.7% $CaCO_3$(Category 1)

AIV: 28

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**SK 15 NE 2S** **Tissington Trail 1620 5799 (top) to 1586 5707** **Block A**

Thickness m

**Monsal Dale Limestones**

Limestone, pale to mid-grey with some dark grey bands towards base, thickly bedded, some shell and crinoid bands, abundant fine-grained micritised debris including dasycladacean algae, peloids and foraminifera. Potholed surface with thin clay wayboard at base 34.50

**Bee Low Limestones**

Limestone, predominantly pale grey, thickly bedded, scattered crinoid and brachiopod debris, locally peloidal, abundant encrusting and dasycladacean algae. Red-stained clays resting on potholed surfaces common in lower part of unit, associated incipient pedogenic structures. Red hematitic horizon with clay fragments (tuffaceous origin?) about 35 m above base 65.50

Dip: <10°

Purity: 99% $CaCO_3$ (Category 1)

AIV: 25-27

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**SK 15 NE 3S** **Quarry east of Hawkslow Farm 1776 5634** **Block A**

Thickness m

**Bee Low Limestones**

Limestone, pale grey, massive, with crinoid debris and scattered brachiopods, 2-m peloidal band 9 m above base, bioclasts highly micritised in places 12.00

Dip: <10°

Purity: 99.1% $CaCO_3$ (Category 1)

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**SK 15 NE 4S** **Quarry west of Middlemoor Farm 1756 5706** **Block A**

Thickness m

**Bee Low Limestones**

Limestone, pale grey, massive, calcarenite, with foraminifera and algal-encrusted crinoid and brachiopod debris 10.67

Dip: <10°

Purity: 99.4% $CaCO_3$ (Category 1)

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**SK 15 SW 1S** **Hall Dale 1399 5360 (top) to 1399 5350** **Block C**

Thickness m

**Knoll-reef** in Milldale Limestones

Limestone (micrite), mid-grey, spar-filled cavities common 110.00

Purity: 99.6% $CaCO_3$ (Category 1)

AIV: 23-24

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**SK 15 SW 2S** **Weag's Bridge 1015 5406 (top) to 1000 5410** **Block C**

Thickness m

**Milldale Limestones**

Limestone (crinoidal biosparrudite), mid-grey, thick-bedded, variably dolomitised 7.8

**Milldale Limestones (dark facies)**

Limestone, dark grey, very fine-grained with some dispersed crinoid debris and scattered brachiopods, dolomitic at 4.2, 5.2 and 9.2 m below top, black cherts common, 1-m band of mid-grey crinoidal limestone 29.2 m below top 46.70

Limestone (crinoidal biosparrudite), mid-grey, dispersed shells, abundant hematite in interstices 2.50

Fault breccia

Limestone, mid- and dark grey, very fine grained, cherty, dispersed crinoid and shell debris, abundant clay-grade silica in matrix, more argillaceous than units above 26.00

Dip: c. 30°, strata folded

Purity: <85% $CaCO_3$ (Category 5)

AIV: 21-28

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**SK 15 SW 3S** **Milldale 1395 5480 (top) to 1401 5499** **Block C**

Thickness m

**Milldale Limestones**

Limestone, mainly mid-grey, massive to thinly bedded (1.5 to 0.40 m), bioclastic with shells, crinoids and peloid clusters, some local micritisation, scattered chert nodules in thinner-bedded units. c.40

Dip: up to 18°

Purity: c. 97% (Category 2)

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**SK 15 SW 4S** **Hall Dale 1339 5395 (top) to 1330 5388** **Block C**

Thickness m

**Knoll-reef** in Milldale Limestones

Limestone (micrite), mid-grey, locally crinoidal, some hematite-staining 70.00

Purity: 99.4% $CaCO_3$ (Category 1)

AIV: 24-25

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**SK 15 SW 5S** **Hall Dale 1308 5397** **Block C**

Thickness m

**Milldale Limestones**

Limestone; dark grey fine-grained biomicrosparites with sparse macrofauna interbedded with mid-grey bioclastic calcarenites containing crinoid and algal debris, locally graded; cherty and thinly bedded towards base; 10-cm shaly intercalations at 9.0 and 10.5 m from top 17.00

Dip: c. 36°

Purity: 92.9% $CaCO_3$ (Category 4)

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**SK 15 SW 6S** **The Nabs 1475 5355** **Block C**

Thickness m

**Knoll-reef** in Milldale Limestones

Limestone (biomicrite), mid-grey, massive, dispersed crinoid and brachiopod debris 30.00

Purity: 99.7% $CaCO_3$ (Category 1)

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**SK 15 SW 7S** **Rushley 1223 5140** **Block C**

Thickness m

**Milldale Limestones**

Limestone, dark grey, thinly bedded, fine-grained with abundant chert nodules 11.50

Dip: 22°

Purity: <85% $CaCO_3$ (Category 5)

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**SK 15 SW 8S** **Rushley Bridge 1250 5169** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone, mid-grey, thinly bedded with coarse crinoidal bands, subordinate shells, corals, byozoa and foraminifera, matrix locally spar-cemented, part mud-supported, bioclasts highly silicified, traces of chert | 4.10 |
| Limestone (micrite), mid-grey, locally peloidal, some spar-filled vugs (reef affinity?), patchy dolomitisation | 1.00 |
| Limestone, mid-grey, thin to thickly bedded, coarsely crinoidal, graded unit 6.90 m below top, dolomitised throughout, abundant dasycladacean algal fragments, sporadic shells, and intraclasts | 10.90 |

Dip: 32°

Purity: 94.3% $CaCO_3$ (Category 3)

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**SK 15 SW 9S** **Bingley Wood, Manifold Valley 1139 5282** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone, mid-grey, very fine-grained and partially dolomitised in uppermost 2 m, becoming darker and coarser grained below with spar-cemented assemblage consisting of dispersed crinoids, brachiopods and peloids. Incipient chert and bioclast silicification | 8.00 |

Dip: 18°

Purity: 88.5% $CaCO_3$ (Category 4)

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**SK 15 SW 10S** **North-west of Cheshire Wood, Manifold Valley 1096 5373** **Block C**

| | Thickness m |
|---|---|
| **Milldale Limestones (dark facies)** | |
| Limestone, dark grey, thinly bedded, fine-grained and bioturbated, scattered chert nodules, some thin shaly partings. Abundant clay-grade silica in matrix | 14.00 |

Dip: 15°

Purity: c. 93% $CaCO_3$ (Category 4)

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**SK 15 SW 13S** **North of Musden Low 1183 5035** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone (micrite), mid-grey, massive, dispersed fine grained bioclasts, hematite blebs and staining adjacent vein | 0.58 |
| Limestone (biopelsparite), mid-to-dark grey, well bedded, medium calcarenite with peloids, foraminifera, dasycladacean algae and crinoid fragments in clear spar cement, abundant hematite staining, localised silicification, some shaly intercalations | 2.92 |
| **Milldale Limestones** | |
| Limestone, mid-grey, interlaminated (1 mm to 3 cm scale) well-washed biosparites and fine-grained micrites, some graded units, a few scattered chert nodules, abundant clay-grade silica in matrix | 12.00 |

Dip: 16°

Purity: c. 88% $CaCO_3$ (Category 4)

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**SK 15 SE 1S** **Tissington Trail 1761 5344** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Calcitic dolomite, rubbly, with some unaltered brachiopod and crinoid debris | 5.25 |
| Limestone (intraclastic biosparite), mid-to dark grey with calcirudite bands containing micrite intraclasts, brachiopods and crinoid debris, thin-bedded in basal 4 m. Disseminated dolomite and some hematite veining | 11.5 |

Dip: Variable (5 - 25°)

Purity: 97.6% $CaCO_3$ (Category 2)

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**SK 15 SE 2S** **Quarry south-south-east of New Inns Hotel 1603 5416** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Dolomite and dolomitic limestone, massively bedded in uppermost 4 m, local baryte, hematite and limonite mineralisation | 8.3 |

Dip: 14°

Purity: c. 98% $CaCO_3$ (Category 2)

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**SK 15 SE 3S** **Tissington Trail near Newton Grange 1676 5372 (top) to 1687 5373** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Limestone (crinoidal biosparrudite) mid-grey, thinly bedded, some shells and intraclasts. Variable dolomitisation. Thin wayboard clays 7.3 and 8.5 m below top | 16.00 |
| **Hopedale Limestones (dark facies)** | |
| Limestone, dark grey, thinly bedded, very fine-grained, shaly mudstone at top, few bioclasts, somewhat paler below 21.0 m, some irregular bands of chert | 16.70 |

Dip: variable - small anticlinal structure

Purity: 96.7% $CaCO_3$ (Category 3) Hopedale Limestones

<85% $CaCO_3$ (Category 5) Hopedale Limestones (dark facies)

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**SK 15 SE 4S** **Quarry near Rusheycliff Barn 1756 5326** **Block C**

| | Thickness m |
|---|---|
| **Hopedale Limestones** | |
| Tuffaceous limestone, thinly bedded with thin yellow-brown ochreous clays in lower part | 7.0 |
| Dolomite | 0.4 |
| Tuffaceous limestone, mid- to dark grey, fine to medium calcarenite, bioclasts silicified and locally pyritised. Rare irregular clay bands | 3.6 |

Dip: 10°

Purity: 87.5% $CaCO_3$ (Category 4)

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**SK 15 SE 5S** **Quarry near Pike House 1621 5132** **Block C**

Thickness m

**Hopedale Limestones**

Limestone, mid-grey, thin bedded, flaggy in part with alternating coarse crinoidal and fine-grained bands, some shells and intraclasts in coarser lithologies, silicification of bioclasts and thin chert bands common, some localised dolomitisation — c.20

Dip: 13°

Purity: c.86% $CaCO_3$ (Category 3) (5% chert)

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**SK 15 SE 6S** **Quarry north of Thorpe 1566 5075** **Block C**

Thickness m

**Hopedale Limestones**

Limestone, mid-grey, thin to thick bedded (0.2 to 0.8 m), coarse-grained, intraclastic biosparites and crinoidal biosparites, some patchy dolomitisation — 13.8

Purity: 99.6% $CaCO_3$ (Category 1)

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**SK 15 SE 7S** **Stepping Stones, Dovedale 1518 5128** **Block C**

Thickness m

**Knoll-reef** in Milldale Limestones

Reef limestone (biomicrite), pale and mid-grey, scattered crinoid fragments, brecciated locally, well-developed fenstral fabric, traces of dolomitisation and hematite veining — 47.0

Purity: 99.6% $CaCO_3$ (Category 1)

AIV: 26

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**SK 15 SE 8S** **Thorpe Cloud 1519 5098 (top) to 1522 5082** **Block C**

Thickness m

**Knoll-reef** in Milldale Limestones

Reef limestone (biomicrite), pale and mid-grey, poorly bedded — 65.00

Purity: 99.2% $CaCO_3$ (Category 1)

AIV: 24-28

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## APPENDIX D
## CHEMICAL ANALYSES

Rapid instrumental and chemical methods of analysis were used. The table below shows estimated 95 per cent confidence limits for results on the very high, high and medium purity (>93.5 % $CaCO_3$) limestones, together with the determination limits below which the accuracy is uncertain. The detection limits, which are also shown, are the concentrations of each element reproducibly measurable above the instrumental background signal. For impure limestones, the accuracy is uncertain due to inter-element interference effects. Some results may therefore lie outside the tolerances obtainable using standard or referee chemical methods of analysis.

| | Estimated 95% confidence limits ± | Lower Determination Limit | Detection Limit |
|---|---|---|---|
| CaO | 0.8% | 50% | - |
| $SO_3$ | 0.10% | 0.10% | 0.01% |
| $Na_2O$ | 0.02% | 0.02% | 0.02% |
| F | 0.10% | 0.05% | 0.03% |
| $SiO_2$ | 0.10% | 0.10% | 0.02% |
| MgO | 0.14% | 0.10% | 0.02% |
| $Al_2O_3$ | 0.10% | 0.10% | 0.01% |
| $K_2O$ | 0.02% | 0.02% | 0.01% |
| $Fe_2O_3$ | 0.12% | 0.10% | 0.05% |
| SrO | 0.04% | 0.20% | 0.10% |
| $P_2O_5$ | 0.02% | 0.05% | 0.02% |
| Loss at 1050°C | 0.15% | - | - |
| Cu | 10 ppm | 3 ppm | 1 ppm |
| Pb | 10 ppm | 3 ppm | 1 ppm |
| Zn | 20 ppm | 5 ppm | 2 ppm |
| Acid-soluble MnO | 20 ppm | 10 ppm | 3 ppm |
| Acid-soluble $Fe_2O_3$ | 20 ppm | 10 ppm | 3 ppm |
| As | 2 ppm | 2 ppm | 1 ppm |

In the following tables of results the sampling interval is indicated as follows:-

(i) a single depth measurement indicates an analysis of a 1-m sample, the value given being the mid-point of that sample.

(ii) where an interval is quoted, then consecutive 1-m samples (in the case of sections, spot samples) have been combined and the analysis refers to the whole of the stated interval, which is usually 5 or 10 m thick.

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 04 NE 10 0888 4778 Rue Hill, Wardlow Block B** | | | | | | | | | | | | | | | | |
| 11.00 | 52.90 | 0.26 | 0.02 | 0.00 | 4.02 | 0.54 | 0.21 | 0.06 | 0.03 | 41.85 | 5 | 0 | 10 | 210 | - | 900 |
| 19.00 | 50.90 | 0.31 | 0.03 | 0.04 | 5.73 | 0.64 | 1.03 | 0.23 | 0.04 | 40.43 | 15 | 0 | 10 | 140 | - | 4200 |
| 32.00 | 52.10 | 0.64 | 0.03 | 0.04 | 3.62 | 0.75 | 1.09 | 0.25 | 0.02 | 41.86 | 5 | 10 | 0 | 180 | - | 4100 |
| 46.00 | 52.80 | 0.37 | 0.03 | 0.02 | 3.18 | 0.87 | 0.53 | 0.13 | 0.02 | 42.88 | 0 | 0 | 10 | 200 | 0 | 3400 |
| 55.00 | 51.50 | 0.27 | 0.02 | 0.03 | 5.37 | 0.52 | 0.85 | 0.19 | 0.04 | 40.78 | 0 | 0 | 10 | 220 | - | 7200 |
| 60.00 | 47.70 | 0.25 | 0.02 | 0.01 | 12.48 | 0.53 | 0.62 | 0.14 | 0.10 | 36.56 | 0 | 10 | 0 | 180 | - | 4900 |
| **SK 04 NE 36 0804 4822 Little Rue Hill Quarry: Caldon Low Borehole Block B** | | | | | | | | | | | | | | | | |
| 10.00 | 54.70 | 0.29 | 0.01 | 0.00 | 0.57 | 0.37 | 0.15 | 0.05 | 0.00 | 43.58 | 5 | 10 | 60 | 460 | - | 3400 |
| 20.00 | 54.30 | 0.32 | 0.02 | 0.00 | 1.13 | 0.36 | 0.40 | 0.06 | 0.00 | 43.08 | 15 | 50 | 80 | 350 | - | 4300 |
| 39.00 | 53.60 | 0.37 | 0.01 | 0.00 | 0.63 | 0.58 | 0.20 | 0.05 | 0.00 | 42.89 | 0 | 10 | 20 | 150 | - | 20500 |
| 45.00 | 51.60 | 0.35 | 0.02 | 0.03 | 3.29 | 0.61 | 1.03 | 0.20 | 0.02 | 41.15 | 10 | 40 | 90 | 280 | - | 21800 |
| 60.00 | 52.70 | 0.36 | 0.03 | 0.02 | 1.82 | 1.05 | 0.44 | 0.11 | 0.02 | 42.76 | 15 | 60 | 400 | 90 | - | 7200 |
| 70.00 | 54.50 | 0.37 | 0.02 | 0.00 | 1.14 | 0.43 | 0.27 | 0.07 | 0.01 | 43.21 | 5 | 20 | 50 | 290 | 2 | 2900 |
| 79.00 | 52.90 | 0.42 | 0.03 | 0.04 | 2.66 | 0.63 | 0.96 | 0.21 | 0.02 | 42.31 | 5 | 10 | 80 | 170 | - | 7400 |
| 90.00 | 54.60 | 0.24 | 0.01 | 0.00 | 0.30 | 0.39 | 0.11 | 0.03 | 0.01 | 43.77 | 5 | 0 | 50 | 230 | - | 600 |
| 95.00 | 52.20 | 0.33 | 0.02 | 0.04 | 3.85 | 0.66 | 1.04 | 0.23 | 0.02 | 41.50 | 0 | 10 | 60 | 190 | - | 5800 |
| **SK 05 NE 8 0942 5928 Old Quarry, Warslow Hall Block C** | | | | | | | | | | | | | | | | |
| 5.00 | 49.89 | 0.52 | 0.02 | 0.02 | 7.28 | 0.85 | 0.31 | 0.06 | 0.06 | 40.10 | 0 | 0 | 20 | 510 | - | 3500 |
| 11.00 | 47.19 | 0.73 | 0.02 | 0.01 | 14.08 | 1.12 | 0.45 | 0.08 | 0.07 | 36.43 | 5 | 0 | 20 | 400 | - | 900 |
| 20.00 | 35.20 | 1.40 | 0.04 | 0.06 | 32.00! | 1.53 | 2.05 | 0.36 | 0.22 | 29.37 | 5 | 30 | 150 | 610 | - | 9900 |
| 30.00 | 51.50 | 0.78 | 0.04 | 0.01 | 5.64 | 1.07 | 0.40 | 0.08 | 0.11 | 41.30 | 5 | 0 | 1200 | 1300 | - | 4500 |
| 41.00 | 48.53 | 0.76 | 0.04 | 0.05 | 9.27 | 1.86 | 0.69 | 0.15 | 0.05 | 38.75 | 5 | 0 | 20 | 730 | - | 6400 |
| 50.00 | 49.63 | 0.44 | 0.02 | 0.02 | 11.46 | 0.53 | 0.22 | 0.05 | 0.02 | 37.77 | 0 | 0 | 20 | 140 | - | 200 |
| 60.00 | 49.28 | 0.57 | 0.03 | 0.00 | 8.09 | 0.63 | 0.41 | 0.10 | 0.03 | 39.54 | 0 | 0 | 10 | 180 | - | 500 |
| 70.00 | 30.48 | 1.46 | 0.16 | 0.10 | 33.00! | 1.06 | 5.37 | 1.10 | 0.05 | 26.54 | 10 | 10 | 90 | 450 | - | 15500 |
| 80.00 | 48.17 | 0.71 | 0.02 | 0.01 | 10.50 | 0.38 | 0.32 | 0.08 | 0.02 | 38.40 | 10 | 40 | 10 | 410 | - | 800 |
| 90.00 | 42.74 | 1.16 | 0.03 | 0.09 | 17.00! | 0.76 | 2.14 | 0.46 | 0.03 | 33.97 | 5 | 10 | 10 | 210 | - | 500 |
| 99.00 | 47.92 | 0.42 | 0.02 | 0.07 | 10.70 | 0.49 | 0.47 | 0.10 | 0.02 | 38.42 | 10 | 10 | 10 | 350 | - | 800 |
| **SK 05 SE 19 0933 5410 Grindon Block C** | | | | | | | | | | | | | | | | |
| 0.90-10.50 | 53.62 | 0.06 | 0.01 | 0.06 | 3.00 | 0.65 | 0.62 | 0.15 | 0.06 | 41.94 | 10 | 0 | 0 | 350 | - | 4200 |
| 10.50-20.50 | 55.21 | 0.08 | 0.01 | 0.08 | 1.53 | 0.69 | 0.21 | 0.05 | 0.02 | 42.86 | 5 | 10 | 0 | 360 | - | 600 |
| 20.50-30.50 | 54.07 | 0.06 | 0.01 | 0.06 | 1.07 | 1.22 | 0.26 | 0.07 | 0.02 | 43.09 | 0 | 0 | 0 | 520 | - | 4000 |
| 30.50-40.50 | 54.98 | 0.08 | 0.00 | 0.05 | 0.94 | 0.85 | 0.19 | 0.05 | 0.03 | 43.17 | 0 | 0 | 0 | 350 | - | 500 |
| 40.50-50.50 | 54.23 | 0.06 | 0.01 | 0.04 | 0.77 | 1.35 | 0.18 | 0.05 | 0.04 | 43.38 | 5 | 0 | 0 | 380 | - | 3100 |
| 50.50-60.50 | 54.24 | 0.07 | 0.01 | 0.06 | 1.87 | 2.02 | 0.21 | 0.05 | 0.04 | 42.91 | 0 | 10 | 10 | 590 | - | 3500 |
| 60.50-70.50 | 54.05 | 0.06 | 0.00 | 0.00 | 0.14 | 1.90 | 0.15 | 0.04 | 0.05 | 43.77 | 0 | 0 | 10 | 500 | - | 3000 |
| 70.50-80.50 | 54.91 | 0.08 | 0.00 | 0.03 | 0.38 | 2.15 | 0.20 | 0.05 | 0.07 | 43.31 | 0 | 0 | 10 | 580 | - | 4000 |
| 80.50-90.50 | 54.62 | 0.06 | 0.00 | 0.00 | 0.25 | 1.66 | 0.18 | 0.04 | 0.09 | 43.48 | 0 | 0 | 10 | 430 | - | 3300 |
| 90.50-100.50 | 55.06 | 0.06 | 0.01 | 0.06 | 0.10 | 1.98 | 0.13 | 0.04 | 0.05 | 43.69 | 0 | 0 | 0 | 630 | - | 3800 |
| 100.50-110.50 | 54.47 | 0.05 | 0.00 | 0.00 | 0.17 | 1.66 | 0.16 | 0.04 | 0.06 | 43.63 | 0 | 0 | 10 | 660 | - | 3400 |
| 110.50-124.00 | 53.00 | 0.05 | 0.00 | 0.00 | 0.26 | 2.82 | 0.20 | 0.05 | 0.05 | 43.85 | 0 | 0 | 10 | 800 | - | 3500 |
| **SK 05 SE 20 0826 5139 Waterfall Block C** | | | | | | | | | | | | | | | | |
| 2.50-5.50 | 52.83 | 0.05 | 0.03 | 0.03 | 3.82 | 0.60 | 0.64 | 0.06 | 0.13 | 41.99 | 5 | 10 | 0 | 580 | - | 3400 |
| 5.50-11.50 | 53.62 | 0.05 | 0.00 | 0.03 | 2.60 | 0.62 | 0.26 | 0.04 | 0.07 | 42.70 | 5 | 10 | 0 | 580 | - | 3500 |
| 11.50-15.50 | 52.29 | 0.03 | 0.01 | 0.03 | 2.96 | 1.35 | 0.51 | 0.07 | 0.08 | 42.36 | 5 | 10 | 0 | 1030 | - | 7200 |
| 15.50-20.50 | 52.94 | 0.04 | 0.01 | 0.02 | 2.93 | 0.55 | 0.41 | 0.06 | 0.06 | 42.29 | 5 | 10 | 0 | 1700 | - | 6600 |
| 59.50-69.50 | 48.84 | 0.90 | 0.03 | 0.06 | 7.86 | 0.88 | 1.73 | 0.38 | 0.06 | 38.81 | 5 | 10 | 50 | 230 | - | 7800 |
| 69.50-79.50 | 45.76 | 0.95 | 0.03 | 0.09 | 12.23 | 0.95 | 2.37 | 0.55 | 0.04 | 36.23 | 5 | 20 | 40 | 130 | - | 9500 |
| 79.50-89.50 | 45.17 | 1.02 | 0.05 | 0.10 | 11.99 | 1.28 | 2.56 | 0.58 | 0.07 | 37.01 | 5 | 10 | 100 | 210 | - | 10300 |
| 89.50-100.00 | 45.51 | 1.01 | 0.06 | 0.09 | 12.51 | 0.89 | 1.73 | 0.40 | 0.05 | 37.21 | 5 | 10 | 20 | 230 | - | 11000 |
| **SK 14 NW 4 1317 4962 Blore Block C** | | | | | | | | | | | | | | | | |
| 10.00 | 53.50 | 0.17 | 0.03 | 0.02 | 2.08 | 0.47 | 0.32 | 0.07 | 0.02 | 42.91 | 0 | 10 | 30 | 300 | - | 2800 |
| 20.00 | 55.00 | 0.11 | 0.02 | 0.05 | 0.79 | 0.24 | 0.08 | 0.03 | 0.00 | 43.76 | 0 | 10 | 20 | 520 | 1 | 600 |
| 30.00 | 53.80 | 0.20 | 0.02 | 0.00 | 1.66 | 0.35 | 0.40 | 0.07 | 0.02 | 43.06 | 5 | 20 | 60 | 350 | - | 3200 |
| 41.00 | 54.10 | 0.22 | 0.01 | 0.00 | 1.80 | 0.31 | 0.15 | 0.04 | 0.01 | 42.83 | 5 | 30 | 70 | 650 | - | 2000 |
| 50.00 | 54.10 | 0.25 | 0.01 | 0.01 | 1.90 | 0.44 | 0.23 | 0.06 | 0.04 | 43.02 | 0 | 10 | 30 | 340 | - | 2600 |

! Silica values above 15% have been rounded to the nearest integer

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 14 NW 5 1142 4880 Caltonmoor House Block C** | | | | | | | | | | | | | | | | |
| 0.80-10.50 | 50.11 | 0.08 | 0.02 | 0.03 | 8.00 | 0.69 | 1.10 | 0.24 | 0.04 | 39.46 | 0 | 10 | 70 | 500 | - | 6400 |
| 10.50-20.50 | 48.28 | 0.10 | 0.07 | 0.07 | 10.36 | 0.79 | 1.73 | 0.40 | 0.04 | 38.20 | 0 | 0 | 30 | 280 | - | 8900 |
| 20.50-30.50 | 49.38 | 0.13 | 0.04 | 0.06 | 8.45 | 0.83 | 1.54 | 0.35 | 0.06 | 39.41 | 5 | 0 | 120 | 300 | - | 7800 |
| 30.50-40.50 | 46.61 | 0.14 | 0.06 | 0.10 | 12.54 | 0.82 | 2.13 | 0.47 | 0.05 | 37.75 | 10 | 0 | 170 | 300 | - | 9100 |
| 40.50-50.50 | 48.90 | 0.09 | 0.06 | 0.07 | 8.88 | 0.87 | 1.62 | 0.37 | 0.13 | 39.50 | 5 | 90 | 190 | 800 | - | 9300 |
| 50.50-60.50 | 51.11 | 0.05 | 0.02 | 0.05 | 2.88 | 2.56 | 0.34 | 0.08 | 0.55 | 42.00 | 10 | 60 | 210 | 1820 | - | 7600 |
| 60.50-70.50 | 51.17 | 0.04 | 0.01 | 0.04 | 3.67 | 2.01 | 0.42 | 0.11 | 0.20 | 41.93 | 5 | 80 | 180 | 1540 | - | 7500 |
| 70.50-80.50 | 42.61 | 0.04 | 0.01 | 0.04 | 22.00! | 0.49 | 1.07 | 0.23 | 0.03 | 33.79 | 10 | 70 | 110 | 380 | - | 4300 |
| 80.50-90.50 | 46.14 | 0.06 | 0.04 | 0.04 | 15.00 | 0.55 | 1.07 | 0.25 | 0.05 | 36.44 | 5 | 30 | 100 | 360 | - | 4700 |
| 90.50-100.00 | 47.58 | 0.08 | 0.03 | 0.05 | 12.51 | 0.58 | 1.12 | 0.27 | 0.02 | 37.58 | 0 | 10 | 80 | 270 | - | 5400 |
| **SK 14 NW 6 1359 4944 Blore Block C** | | | | | | | | | | | | | | | | |
| 1.50-5.50 | 32.23 | 0.14 | 0.04 | 0.00 | 9.56 | 15.02 | 1.10 | 0.25 | 0.08 | 34.47 | 20 | 10 | 20 | 3000 | - | 12600 |
| 5.50-10.50 | 35.81 | 0.43 | 0.04 | 0.00 | 4.49 | 14.24 | 0.27 | 0.06 | 0.05 | 43.54 | 15 | 0 | 20 | 4000 | - | 13100 |
| 10.50-15.50 | 40.15 | 0.01 | 0.04 | 0.00 | 5.69 | 10.21 | 0.44 | 0.11 | 0.05 | 42.66 | 10 | 0 | 20 | 3750 | - | 12200 |
| 15.50-20.50 | 46.40 | 0.02 | 0.01 | 0.00 | 5.68 | 4.90 | 0.25 | 0.06 | 0.05 | 41.69 | 10 | 10 | 20 | 3400 | - | 13300 |
| 20.50-25.50 | 45.01 | 0.03 | 0.02 | 0.00 | 3.36 | 6.70 | 0.19 | 0.04 | 0.04 | 43.33 | 0 | 0 | 20 | 3250 | - | 10500 |
| 25.50-30.50 | 47.69 | 0.06 | 0.01 | 0.00 | 4.97 | 4.09 | 0.29 | 0.07 | 0.04 | 41.91 | 5 | 10 | 20 | 3250 | - | 12000 |
| 30.50-35.50 | 41.43 | 0.20 | 0.02 | 0.00 | 3.23 | 10.00 | 0.16 | 0.04 | 0.01 | 43.65 | 15 | 10 | 30 | 3800 | - | 14000 |
| 35.50-40.50 | 45.15 | 0.03 | 0.01 | 0.00 | 4.63 | 6.86 | 0.24 | 0.06 | 0.04 | 42.60 | 10 | 10 | 30 | 3200 | - | 9400 |
| 40.50-45.50 | 45.66 | 0.04 | 0.02 | 0.01 | 4.48 | 6.35 | 0.37 | 0.08 | 0.03 | 42.70 | 5 | 0 | 20 | 2150 | - | 8600 |
| 45.50-50.50 | 48.40 | 0.05 | 0.00 | 0.01 | 4.30 | 4.09 | 0.39 | 0.09 | 0.04 | 42.13 | 5 | 10 | 40 | 3150 | - | 11600 |
| 50.50-55.50 | 45.78 | 0.02 | 0.01 | 0.01 | 3.10 | 6.63 | 0.21 | 0.05 | 0.03 | 43.28 | 10 | 10 | 20 | 3400 | - | 13000 |
| 55.50-60.50 | 48.79 | 0.04 | 0.01 | 0.02 | 3.45 | 4.04 | 0.34 | 0.07 | 0.03 | 42.73 | 5 | 0 | 30 | 2300 | - | 9100 |
| 60.50-65.50 | 49.83 | 0.07 | 0.01 | 0.00 | 4.45 | 3.03 | 0.38 | 0.09 | 0.03 | 42.33 | 0 | 0 | 10 | 680 | - | 4500 |
| 65.50-70.50 | 50.99 | 0.09 | 0.01 | 0.02 | 7.08 | 0.90 | 0.59 | 0.14 | 0.05 | 40.15 | 5 | 0 | 20 | 750 | - | 5000 |
| 70.50-75.50 | 51.77 | 0.10 | 0.01 | 0.02 | 6.12 | 0.73 | 0.46 | 0.11 | 0.02 | 40.76 | 0 | 0 | 10 | 330 | - | 4000 |
| 75.50-80.50 | 49.90 | 0.09 | 0.01 | 0.00 | 7.26 | 1.75 | 0.47 | 0.11 | 0.04 | 40.51 | 0 | 10 | 20 | 760 | - | 7000 |
| 80.50-85.50 | 49.76 | 0.07 | 0.01 | 0.02 | 4.68 | 3.05 | 0.36 | 0.08 | 0.03 | 42.04 | 0 | 0 | 10 | 1000 | - | 5900 |
| 85.50-90.50 | 52.03 | 0.11 | 0.01 | 0.02 | 2.62 | 2.20 | 0.33 | 0.08 | 0.03 | 42.94 | 0 | 10 | 10 | 730 | - | 4700 |
| 90.50-95.50 | 53.08 | 0.08 | 0.01 | 0.02 | 1.86 | 1.54 | 0.30 | 0.07 | 0.04 | 43.05 | 5 | 0 | 10 | 1500 | - | 5100 |
| 95.50-100.00 | 51.62 | 0.09 | 0.02 | 0.06 | 4.26 | 1.22 | 0.98 | 0.24 | 0.07 | 41.48 | 0 | 10 | 10 | 3000 | - | 6000 |
| **SK 15 NW 8 1373 5835 Wolfscote Hill Block A** | | | | | | | | | | | | | | | | |
| 10.00 | 55.70 | 0.11 | 0.00 | 0.00 | 0.01 | 0.21 | 0.04 | 0.03 | 0.01 | 43.43 | 5 | 0 | 0 | 190 | - | 300 |
| 23.00 | 55.20 | 0.13 | 0.01 | 0.00 | 0.63 | 0.22 | 0.48 | 0.04 | 0.02 | 43.19 | 5 | 0 | 10 | 100 | - | 300 |
| 35.00 | 55.90 | 0.13 | 0.02 | 0.00 | 0.04 | 0.15 | 0.04 | 0.03 | 0.01 | 43.26 | 5 | 0 | 10 | 120 | 2 | 200 |
| 45.00 | 55.50 | 0.12 | 0.00 | 0.00 | 0.25 | 0.17 | 0.18 | 0.04 | 0.01 | 43.29 | 5 | 0 | 10 | 130 | - | 300 |
| 55.00 | 55.70 | 0.09 | 0.00 | 0.00 | 0.00 | 0.13 | 0.03 | 0.03 | 0.01 | 43.42 | 5 | 0 | 10 | 140 | - | 200 |
| 65.00 | 55.50 | 0.11 | 0.01 | 0.00 | 0.27 | 0.18 | 0.05 | 0.03 | 0.01 | 43.12 | 0 | 0 | 10 | 150 | - | 200 |
| 75.00 | 55.40 | 0.12 | 0.01 | 0.01 | 0.01 | 0.18 | 0.04 | 0.02 | 0.06 | 43.54 | 0 | 10 | 10 | 110 | - | 200 |
| 85.00 | 55.60 | 0.09 | 0.01 | 0.00 | 0.21 | 0.17 | 0.05 | 0.03 | 0.01 | 43.22 | 0 | 0 | 10 | 100 | - | 200 |
| 95.00 | 55.60 | 0.11 | 0.00 | 0.01 | 0.19 | 0.20 | 0.12 | 0.04 | 0.01 | 43.58 | 0 | 0 | 10 | 110 | - | 700 |
| 105.00 | 55.80 | 0.11 | 0.00 | 0.00 | 0.00 | 0.17 | 0.02 | 0.02 | 0.01 | 43.27 | 0 | 10 | 10 | 100 | - | 100 |
| 115.00 | 55.60 | 0.14 | 0.00 | 0.00 | 0.06 | 0.27 | 0.08 | 0.03 | 0.01 | 43.46 | 0 | 0 | 10 | 120 | - | 200 |
| 125.00 | 55.70 | 0.10 | 0.10 | 0.00 | 0.00 | 0.19 | 0.02 | 0.02 | 0.01 | 43.29 | 0 | 0 | 10 | 120 | - | 100 |
| 135.00 | 55.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.02 | 0.02 | 0.01 | 43.21 | 0 | 10 | 10 | 120 | - | 100 |
| **SK 15 NW 9 1167 5648 Wetton Block C** | | | | | | | | | | | | | | | | |
| 38.00 | 46.10 | 0.88 | 0.04 | 0.12 | 10.29 | 0.93 | 2.82 | 0.46 | 0.41 | 38.18 | 30 | 10 | 80 | 250 | - | 11300 |
| 40.00 | 53.60 | 0.65 | 0.03 | 0.03 | 1.59 | 0.59 | 0.54 | 0.09 | 0.26 | 42.70 | 5 | 10 | 60 | 600 | - | 3700 |
| 46.00 | 51.80 | 0.91 | 0.02 | 0.03 | 3.66 | 0.59 | 1.21 | 0.19 | 0.22 | 41.31 | 5 | 20 | 70 | 660 | - | 5200 |
| 55.00 | 54.00 | 0.56 | 0.01 | 0.01 | 1.36 | 0.80 | 0.32 | 0.06 | 0.05 | 43.03 | 0 | 0 | 10 | 440 | 3 | 800 |
| 65.00 | 49.90 | 0.34 | 0.02 | 0.02 | 6.14 | 1.83 | 0.38 | 0.08 | 0.07 | 41.04 | 5 | 10 | 10 | 850 | - | 3400 |
| 75.00 | 52.50 | 0.39 | 0.01 | 0.03 | 4.23 | 0.65 | 0.69 | 0.15 | 0.04 | 41.42 | 0 | 0 | 0 | 250 | - | 800 |
| 85.00 | 47.60 | 0.70 | 0.03 | 0.01 | 12.06 | 0.76 | 0.68 | 0.15 | 0.04 | 36.78 | 5 | 0 | 10 | 450 | - | 4300 |
| 95.00 | 46.30 | 0.48 | 0.02 | 0.05 | 15.00! | 0.59 | 0.98 | 0.18 | 0.04 | 35.34 | 5 | 10 | 10 | 190 | - | 900 |

## CHEMICAL ANALYSES

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 15 NW 10 1371 5563 Alstonefield Block C** | | | | | | | | | | | | | | | | |
| 10.00 | 55.30 | 0.29 | 0.00 | 0.00 | 0.38 | 0.48 | 0.14 | 0.04 | 0.06 | 43.85 | 0 | 0 | 10 | 150 | - | 500 |
| 20.00 | 55.20 | 0.26 | 0.00 | 0.00 | 0.10 | 0.47 | 0.06 | 0.03 | 0.04 | 43.79 | 0 | 0 | 10 | 730 | - | 3800 |
| 28.00 | 54.60 | 0.26 | 0.00 | 0.01 | 0.47 | 0.43 | 0.24 | 0.06 | 0.18 | 43.47 | 5 | 0 | 20 | 600 | - | 2700 |
| 40.00 | 55.00 | 0.29 | 0.00 | 0.03 | 0.38 | 0.46 | 0.24 | 0.07 | 0.30 | 43.50 | 0 | 0 | 10 | 180 | - | 600 |
| 50.00 | 56.00 | 0.24 | 0.01 | 0.01 | 0.20 | 0.62 | 0.12 | 0.04 | 0.04 | 43.87 | 0 | 0 | 10 | 300 | 3 | 600 |
| 60.00 | 55.40 | 0.30 | 0.01 | 0.02 | 0.16 | 0.48 | 0.14 | 0.05 | 0.17 | 43.77 | 0 | 0 | 10 | 130 | - | 400 |
| 70.00 | 55.20 | 0.23 | 0.00 | 0.00 | 0.12 | 0.48 | 0.11 | 0.04 | 0.08 | 43.90 | 0 | 0 | 10 | 140 | - | 400 |
| 74.00 | 45.80 | 0.25 | 0.01 | 0.01 | 17.00! | 0.35 | 0.81 | 0.23 | 0.06 | 34.73 | 10 | 130 | 70 | 710 | - | 6900 |
| 80.00 | 55.30 | 0.27 | 0.00 | 0.03 | 0.21 | 0.48 | 0.14 | 0.04 | 0.24 | 43.62 | 5 | 0 | 20 | 230 | - | 700 |
| 90.00 | 54.60 | 0.25 | 0.00 | 0.01 | 0.57 | 0.50 | 0.20 | 0.06 | 0.18 | 43.64 | 0 | 0 | 10 | 180 | - | 500 |
| **SK 15 NE 2 1763 5835 Cardlemere Lane Block A** | | | | | | | | | | | | | | | | |
| 10.00 | 54.90 | 0.17 | 0.01 | 0.02 | 3.54 | 0.18 | 0.43 | 0.07 | 0.03 | 42.24 | 5 | 20 | 10 | 540 | - | 800 |
| 20.00 | 55.40 | 0.17 | 0.01 | 0.01 | 0.88 | 0.21 | 0.20 | 0.05 | 0.02 | 43.44 | 5 | 0 | 10 | 410 | 1 | 500 |
| 30.00 | 54.10 | 0.16 | 0.00 | 0.00 | 1.09 | 0.46 | 0.32 | 0.06 | 0.06 | 43.33 | 5 | 0 | 10 | 260 | - | 700 |
| 35.00 | 47.50 | 0.13 | 0.03 | 0.03 | 8.90 | 0.65 | 2.75 | 0.36 | 0.09 | 38.25 | 20 | 110 | 230 | 1150 | - | 18600 |
| 45.00 | 55.40 | 0.16 | 0.00 | 0.00 | 0.10 | 0.13 | 0.05 | 0.03 | 0.02 | 43.56 | 5 | 0 | 10 | 300 | - | 400 |
| 55.00 | 55.70 | 0.14 | 0.00 | 0.02 | 0.20 | 0.16 | 0.07 | 0.03 | 0.01 | 43.45 | 5 | 0 | 10 | 300 | - | 300 |
| **SK 15 NE 3 1984 5925 Pikehall Block A** | | | | | | | | | | | | | | | | |
| 10.00 | 55.90 | 0.26 | 0.03 | 0.02 | 0.74 | 0.32 | 0.22 | 0.05 | 0.07 | 43.20 | 5 | 0 | 50 | 300 | 3 | 700 |
| 18.00 | 53.40 | 0.38 | 0.02 | 0.05 | 2.21 | 0.48 | 0.62 | 0.12 | 0.15 | 43.10 | 5 | 10 | 70 | 230 | - | 800 |
| 30.00 | 55.30 | 0.15 | 0.00 | 0.02 | 0.63 | 0.32 | 0.15 | 0.04 | 0.03 | 43.12 | 5 | 0 | 20 | 130 | - | 500 |
| 40.00 | 55.60 | 0.17 | 0.01 | 0.01 | 0.43 | 0.24 | 0.08 | 0.04 | 0.02 | 43.39 | 5 | 0 | 50 | 480 | - | 800 |
| 50.00 | 55.80 | 0.17 | 0.00 | 0.00 | 0.06 | 0.21 | 0.05 | 0.03 | 0.02 | 43.09 | 5 | 0 | 10 | 120 | - | 400 |
| 60.00 | 50.40 | 0.17 | 0.00 | 0.01 | 0.19 | 4.33 | 0.07 | 0.03 | 0.02 | 43.84 | 5 | 0 | 70 | 1200 | - | 15100 |
| 69.00 | 54.70 | 0.51 | 0.01 | 0.02 | 0.66 | 0.57 | 0.25 | 0.06 | 0.06 | 43.24 | 5 | 10 | 80 | 140 | - | 600 |
| 80.00 | 55.20 | 0.39 | 0.00 | 0.00 | 0.38 | 0.52 | 0.12 | 0.04 | 0.02 | 43.65 | 5 | 0 | 30 | 270 | - | 400 |
| 90.00 | 55.90 | 0.11 | 0.00 | 0.02 | 0.08 | 0.25 | 0.08 | 0.04 | 0.03 | 43.48 | 5 | 10 | 20 | 130 | - | 500 |
| **SK 15 NE 4 1525 5820 Biggin Block A** | | | | | | | | | | | | | | | | |
| 10.00 | 55.40 | 0.10 | 0.09 | 0.00 | 0.29 | 0.25 | 0.05 | 0.05 | 0.02 | 42.72 | 5 | 0 | 0 | 170 | - | 800 |
| 20.00 | 55.10 | 0.14 | 0.00 | 0.00 | 0.36 | 0.32 | 0.08 | 0.03 | 0.02 | 43.12 | 5 | 0 | 10 | 170 | - | 400 |
| 30.00 | 55.10 | 0.15 | 0.04 | 0.02 | 0.37 | 0.38 | 0.14 | 0.05 | 0.03 | 43.33 | 5 | 40 | 20 | 440 | - | 600 |
| 40.00 | 55.80 | 0.12 | 0.01 | 0.01 | 0.15 | 0.24 | 0.05 | 0.03 | 0.02 | 43.26 | 5 | 0 | 10 | 190 | 2 | 300 |
| 50.00 | 55.70 | 0.12 | 0.00 | 0.00 | 0.05 | 0.20 | 0.03 | 0.03 | 0.02 | 42.71 | 5 | 10 | 10 | 200 | - | 300 |
| 60.00 | 55.40 | 0.13 | 0.00 | 0.00 | 0.06 | 0.22 | 0.05 | 0.03 | 0.02 | 43.09 | 5 | 10 | 20 | 200 | - | 300 |
| 70.00 | 55.60 | 0.14 | 0.00 | 0.01 | 0.24 | 0.20 | 0.06 | 0.03 | 0.02 | 43.19 | 10 | 0 | 40 | 230 | - | 700 |
| 80.00 | 55.80 | 0.11 | 0.00 | 0.00 | 0.16 | 0.14 | 0.03 | 0.03 | 0.01 | 42.33 | 5 | 10 | 20 | 170 | - | 200 |
| 90.00 | 55.40 | 0.12 | 0.00 | 0.00 | 0.45 | 0.11 | 0.03 | 0.02 | 0.01 | 42.55 | 5 | 0 | 0 | 100 | - | 200 |
| **SK 15 NE 5 1581 5674 Lees Barn, Coldeaton Block A** | | | | | | | | | | | | | | | | |
| 10.00 | 55.60 | 0.09 | 0.10 | 0.01 | 0.32 | 0.15 | 0.09 | 0.08 | 0.02 | 43.38 | 0 | 10 | 20 | 200 | - | 300 |
| 20.00 | 55.20 | 0.11 | 0.00 | 0.00 | 0.31 | 0.06 | 0.05 | 0.03 | 0.01 | 43.39 | 5 | 30 | 40 | 570 | - | 800 |
| 30.00 | 55.60 | 0.14 | 0.00 | 0.00 | 0.00 | 0.07 | 0.04 | 0.03 | 0.02 | 43.74 | 5 | 70 | 70 | 300 | - | 2700 |
| 40.00 | 56.10 | 0.16 | 0.02 | 0.04 | 0.14 | 0.15 | 0.08 | 0.03 | 0.02 | 43.46 | 0 | 10 | 30 | 130 | - | 200 |
| 50.00 | 55.50 | 0.12 | 0.00 | 0.00 | 0.06 | 0.09 | 0.03 | 0.02 | 0.02 | 43.42 | 0 | 30 | 30 | 200 | - | 200 |
| 60.00 | 55.70 | 0.15 | 0.00 | 0.00 | 0.11 | 0.28 | 0.10 | 0.03 | 0.02 | 43.68 | 0 | 10 | 80 | 160 | - | 200 |
| 70.00 | 55.40 | 0.16 | 0.00 | 0.00 | 0.12 | 0.19 | 0.05 | 0.03 | 0.02 | 43.57 | 0 | 20 | 40 | 130 | - | 200 |
| 80.00 | 56.00 | 0.15 | 0.00 | 0.00 | 0.04 | 0.15 | 0.05 | 0.03 | 0.02 | 43.58 | 0 | 30 | 50 | 160 | 3 | 200 |
| 90.00 | 55.30 | 0.12 | 0.00 | 0.00 | 0.00 | 0.23 | 0.06 | 0.03 | 0.02 | 43.53 | 0 | 10 | 30 | 200 | - | 200 |
| **SK 15 NE 6 1932 5712 Parwich Block A** | | | | | | | | | | | | | | | | |
| 10.00 | 55.30 | 0.11 | 0.00 | 0.00 | 0.25 | 0.23 | 0.05 | 0.03 | 0.01 | 43.25 | 5 | 10 | 20 | 400 | - | 700 |
| 20.00 | 55.60 | 0.14 | 0.00 | 0.01 | 0.00 | 0.21 | 0.03 | 0.03 | 0.01 | 43.61 | 5 | 0 | 20 | 240 | - | 700 |
| 30.00 | 55.60 | 0.14 | 0.00 | 0.01 | 0.00 | 0.26 | 0.04 | 0.03 | 0.01 | 43.54 | 5 | 0 | 10 | 240 | - | 700 |
| 40.00 | 55.70 | 0.13 | 0.01 | 0.01 | 0.07 | 0.28 | 0.06 | 0.03 | 0.01 | 43.19 | 5 | 0 | 20 | 250 | 2 | 600 |
| 50.00 | 55.10 | 0.15 | 0.00 | 0.00 | 0.14 | 0.29 | 0.06 | 0.03 | 0.01 | 43.05 | 5 | 0 | 10 | 170 | - | 400 |
| 60.00 | 55.40 | 0.16 | 0.00 | 0.00 | 0.03 | 0.34 | 0.03 | 0.02 | 0.01 | 43.43 | 5 | 0 | 20 | 170 | - | 500 |
| 70.00 | 55.70 | 0.15 | 0.00 | 0.00 | 0.00 | 0.29 | 0.02 | 0.02 | 0.01 | 43.40 | 5 | 0 | 20 | 240 | - | 400 |
| 80.00 | 55.50 | 0.11 | 0.00 | 0.00 | 0.00 | 0.27 | 0.03 | 0.02 | 0.01 | 43.38 | 5 | 0 | 10 | 150 | - | 300 |
| 90.00 | 55.30 | 0.13 | 0.00 | 0.00 | 0.05 | 0.35 | 0.09 | 0.04 | 0.01 | 43.39 | 5 | 0 | 20 | 220 | - | 400 |

! Silica values above 15% have been rounded to the nearest integer

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 15 NE 7 1942 5587 Twodale Barn, Parwich Block A** | | | | | | | | | | | | | | | | |
| 5.00 | 55.31 | 0.27 | 0.01 | 0.02 | 0.39 | 0.18 | 0.21 | 0.05 | 0.01 | 43.74 | 0 | 10 | 20 | 460 | - | 300 |
| 11.00 | 53.39 | 0.32 | 0.02 | 0.03 | 2.11 | 0.22 | 0.14 | 0.04 | 0.01 | 42.53 | 0 | 5 | 30 | 2060 | - | 10000 |
| 15.00 | 54.86 | 0.24 | 0.00 | 0.01 | 0.38 | 0.17 | 0.15 | 0.03 | 0.00 | 43.56 | 0 | 10 | 20 | 350 | - | 300 |
| 20.00 | 55.15 | 0.23 | 0.00 | 0.02 | 0.19 | 0.21 | 0.11 | 0.03 | 0.00 | 43.72 | 0 | 10 | 20 | 370 | - | 300 |
| 25.00 | 54.91 | 0.26 | 0.01 | 0.02 | 0.25 | 0.18 | 0.10 | 0.05 | 0.01 | 43.71 | 0 | 10 | 20 | 360 | - | 300 |
| 30.00 | 54.97 | 0.26 | 0.00 | 0.01 | 0.25 | 0.18 | 0.10 | 0.03 | 0.00 | 43.77 | 0 | 5 | 10 | 260 | 0 | 200 |
| 35.00 | 54.91 | 0.28 | 0.00 | 0.01 | 0.49 | 0.16 | 0.10 | 0.03 | 0.00 | 43.00 | 0 | 20 | 10 | 180 | - | 200 |
| 40.00 | 55.06 | 0.25 | 0.00 | 0.01 | 0.19 | 0.14 | 0.08 | 0.03 | 0.00 | 43.64 | 0 | 20 | 10 | 140 | - | 200 |
| 45.00 | 54.78 | 0.27 | 0.01 | 0.01 | 0.39 | 0.18 | 0.09 | 0.03 | 0.01 | 43.48 | 0 | 0 | 10 | 140 | - | 200 |
| 50.00 | 55.07 | 0.26 | 0.00 | 0.01 | 0.32 | 0.17 | 0.09 | 0.03 | 0.01 | 43.65 | 0 | 0 | 10 | 250 | - | 200 |
| 55.00 | 54.78 | 0.23 | 0.00 | 0.01 | 0.21 | 0.15 | 0.08 | 0.03 | 0.00 | 43.63 | 0 | 0 | 10 | 230 | - | 300 |
| 60.00 | 54.90 | 0.24 | 0.00 | 0.02 | 0.56 | 0.20 | 0.09 | 0.04 | 0.00 | 43.40 | 0 | 10 | 10 | 170 | - | 100 |
| 65.00 | 55.23 | 0.28 | 0.00 | 0.01 | 0.15 | 0.19 | 0.09 | 0.03 | 0.01 | 43.61 | 0 | 10 | 10 | 90 | - | 100 |
| 70.00 | 55.15 | 0.28 | 0.01 | 0.01 | 0.10 | 0.21 | 0.11 | 0.04 | 0.01 | 43.65 | 0 | 10 | 10 | 100 | - | 100 |
| 75.00 | 55.24 | 0.27 | 0.01 | 0.01 | 0.20 | 0.25 | 0.12 | 0.04 | 0.01 | 43.63 | 0 | 10 | 10 | 100 | - | 200 |
| 80.00 | 55.49 | 0.26 | 0.02 | 0.03 | 0.08 | 0.24 | 0.08 | 0.03 | 0.01 | 43.57 | 0 | 30 | 10 | 140 | - | 200 |
| 85.00 | 55.40 | 0.21 | 0.01 | 0.00 | 0.19 | 0.26 | 0.11 | 0.03 | 0.01 | 43.66 | 0 | 30 | 10 | 120 | - | 200 |
| 90.00 | 55.37 | 0.23 | 0.01 | 0.02 | 0.16 | 0.20 | 0.10 | 0.03 | 0.01 | 43.56 | 0 | 0 | 10 | 80 | - | 100 |
| 95.00 | 55.28 | 0.27 | 0.02 | 0.01 | 0.06 | 0.16 | 0.09 | 0.03 | 0.01 | 43.72 | 0 | 0 | 10 | 80 | - | 100 |
| 100.00 | 55.29 | 0.19 | 0.00 | 0.01 | 0.14 | 0.17 | 0.10 | 0.03 | 0.01 | 43.75 | 0 | 0 | 10 | 60 | - | 100 |
| **SK 15 SW 7 1113 5244 Throwley Hall Block C** | | | | | | | | | | | | | | | | |
| 5.00 | 46.95 | 0.39 | 0.03 | 0.07 | 11.73 | 1.01 | 1.25 | 0.24 | 0.17 | 37.49 | 15 | 10 | 100 | 400 | - | 8900 |
| 10.00 | 51.72 | 0.51 | 0.04 | 0.05 | 3.07 | 0.91 | 0.70 | 0.16 | 0.12 | 42.27 | 0 | 10 | 50 | 1300 | - | 7800 |
| 20.00 | 31.62 | 2.73 | 0.06 | 0.07 | 35.00! | 0.84 | 3.17 | 0.65 | 0.17 | 21.29 | 5 | 10 | 20 | 1040 | - | 23000 |
| 30.00 | 47.71 | 0.29 | 0.02 | 0.06 | 9.83 | 0.75 | 1.83 | 0.34 | 0.03 | 38.10 | 0 | 10 | 10 | 400 | - | 10800 |
| 40.00 | 47.39 | 0.31 | 0.04 | 0.10 | 8.84 | 1.12 | 2.49 | 0.53 | 0.07 | 39.12 | 0 | 20 | 10 | 350 | - | 9300 |
| 50.00 | 51.03 | 0.25 | 0.01 | 0.01 | 1.95 | 2.38 | 0.37 | 0.08 | 0.03 | 43.21 | 0 | 0 | 10 | 420 | - | 4600 |
| 60.00 | 53.96 | 0.23 | 0.01 | 0.02 | 0.67 | 0.80 | 0.17 | 0.05 | 0.06 | 43.73 | 0 | 0 | 10 | 460 | - | 3000 |
| 70.00 | 54.62 | 0.20 | 0.03 | 0.04 | 0.55 | 0.85 | 0.12 | 0.04 | 0.02 | 43.76 | 0 | 10 | 20 | 380 | 1 | 2700 |
| 80.00 | 54.51 | 0.27 | 0.02 | 0.03 | 0.92 | 0.67 | 0.17 | 0.05 | 0.02 | 43.51 | 5 | 10 | 10 | 510 | - | 3000 |
| 90.00 | 53.84 | 0.35 | 0.04 | 0.02 | 2.30 | 0.55 | 0.27 | 0.07 | 0.05 | 42.95 | 5 | 0 | 10 | 530 | - | 900 |
| 100.00 | 49.97 | 0.35 | 0.03 | 0.09 | 7.27 | 0.74 | 1.42 | 0.32 | 0.10 | 39.92 | 0 | 10 | 10 | 380 | - | 7700 |
| **SK 15 SW 8 1062 5122 Slade House Block C** | | | | | | | | | | | | | | | | |
| 5.00 | 49.28 | 0.25 | 0.02 | 0.04 | 10.25 | 0.53 | 0.42 | 0.10 | 0.03 | 38.79 | 5 | 0 | 10 | 460 | - | 1000 |
| 10.00 | 45.15 | 0.31 | 0.03 | 0.03 | 17.00! | 0.54 | 0.54 | 0.12 | 0.03 | 34.98 | 5 | 0 | 10 | 410 | - | 3900 |
| 20.00 | 51.71 | 0.30 | 0.01 | 0.03 | 5.19 | 0.46 | 0.46 | 0.12 | 0.03 | 41.25 | 0 | 0 | 20 | 3600 | - | 3700 |
| 30.00 | 51.67 | 0.26 | 0.01 | 0.05 | 5.16 | 0.46 | 0.46 | 0.12 | 0.03 | 42.13 | 10 | 0 | 20 | 1640 | - | 3800 |
| 40.00 | 45.85 | 0.26 | 0.04 | 0.10 | 13.01 | 0.68 | 1.84 | 0.42 | 0.15 | 35.83 | 0 | 10 | 20 | 3950 | - | 900 |
| 50.00 | 52.49 | 0.30 | 0.01 | 0.03 | 3.26 | 0.50 | 0.27 | 0.07 | 0.08 | 42.67 | 0 | 10 | 20 | 2400 | - | 3300 |
| 60.00 | 53.14 | 0.37 | 0.02 | 0.04 | 2.30 | 0.60 | 0.31 | 0.08 | 0.07 | 42.57 | 0 | 10 | 20 | 2200 | - | 3900 |
| 70.00 | 53.15 | 0.38 | 0.02 | 0.03 | 2.56 | 0.60 | 0.35 | 0.09 | 0.05 | 42.86 | 5 | 30 | 30 | 1900 | 1 | 800 |
| 80.00 | 48.50 | 0.07 | 0.03 | 0.01 | 10.96 | 0.43 | 0.54 | 0.12 | 0.02 | 38.09 | 5 | 20 | 80 | 1130 | - | 4100 |
| 90.00 | 45.90 | 0.04 | 0.03 | 0.00 | 17.00! | 0.46 | 0.43 | 0.10 | 0.02 | 35.74 | 5 | 20 | 60 | 500 | - | 700 |
| 100.00 | 42.84 | 0.13 | 0.05 | 0.02 | 21.00! | 0.53 | 0.98 | 0.20 | 0.03 | 32.81 | 5 | 10 | 30 | 200 | - | 3100 |
| **SK 15 SW 9 1255 5374 Stanshope Block C** | | | | | | | | | | | | | | | | |
| 5.00 | 45.12 | 0.29 | 0.06 | 0.18 | 18.00! | 0.56 | 0.30 | 0.08 | 0.04 | 34.03 | 0 | 10 | 0 | 310 | - | 3200 |
| 10.00 | 48.25 | 0.69 | 0.04 | 0.14 | 11.11 | 0.69 | 0.72 | 0.16 | 0.05 | 38.12 | 0 | 10 | 0 | 200 | - | 900 |
| 20.00 | 45.41 | 0.39 | 0.05 | 0.12 | 13.36 | 0.90 | 2.32 | 0.52 | 0.05 | 37.34 | 0 | 50 | 10 | 210 | - | 6400 |
| 30.00 | 37.34 | 1.22 | 0.14 | 0.14 | 27.00! | 1.28 | 3.54 | 0.71 | 0.04 | 31.80 | 5 | 20 | 10 | 230 | - | 10500 |
| 40.00 | 39.16 | 3.07 | 0.09 | 0.34 | 21.00! | 0.51 | 1.20 | 0.24 | 0.04 | 30.54 | 55 | 40 | 70 | 590 | - | 4500 |
| 50.00 | 45.64 | 0.88 | 0.04 | 0.08 | 14.16 | 0.68 | 1.11 | 0.25 | 0.11 | 36.65 | 5 | 20 | 10 | 350 | - | 900 |
| 60.00 | 43.26 | 1.27 | 0.05 | 0.11 | 15.00! | 1.06 | 2.63 | 0.59 | 0.04 | 35.00 | 10 | 10 | 10 | 390 | - | 10700 |
| 70.00 | 43.03 | 1.00 | 0.08 | 0.09 | 16.00! | 1.36 | 2.99 | 0.65 | 0.04 | 35.71 | 0 | 10 | 30 | 140 | - | 11500 |
| 80.00 | 39.16 | 0.23 | 0.09 | 0.04 | 27.00! | 0.93 | 1.88 | 0.39 | 0.02 | 31.43 | 0 | 20 | 10 | 430 | - | 5800 |
| 90.00 | 40.83 | 0.94 | 0.06 | 0.10 | 22.00! | 1.05 | 1.88 | 0.41 | 0.02 | 32.60 | 0 | 10 | 60 | 430 | - | 8200 |
| 100.00 | 43.97 | 1.10 | 0.04 | 0.49 | 17.00! | 0.64 | 1.29 | 0.29 | 0.04 | 33.60 | 120 | 20 | 1000 | 960 | - | 8900 |

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 15 SE 7 1785 5458 Tithe Barn, Parwich Block C** | | | | | | | | | | | | | | | | |
| 8.00 | 54.10 | 0.24 | 0.01 | 0.01 | 1.22 | 0.49 | 0.64 | 0.12 | 0.13 | 43.09 | 5 | 0 | 30 | 570 | - | 3600 |
| 20.00 | 51.50 | 0.55 | 0.03 | 0.02 | 4.39 | 0.53 | 1.07 | 0.16 | 0.12 | 41.10 | 10 | 20 | 60 | 490 | - | 8800 |
| 30.00 | 53.90 | 0.32 | 0.03 | 0.05 | 1.94 | 0.53 | 0.51 | 0.08 | 0.24 | 42.62 | 5 | 10 | 30 | 510 | - | 5300 |
| 40.00 | 54.90 | 0.00 | 0.00 | 0.02 | 4.47 | 0.42 | 0.19 | 0.05 | 0.20 | 43.45 | 5 | 0 | 20 | 460 | 3 | 3500 |
| 50.00 | 54.20 | 2.31 | 0.00 | 0.02 | 0.28 | 0.40 | 0.12 | 0.04 | 0.11 | 41.16 | 5 | 40 | 70 | 400 | - | 13500 |
| 60.00 | 54.80 | 0.00 | 0.01 | 0.04 | 0.17 | 0.57 | 0.12 | 0.04 | 0.24 | 43.59 | 0 | 0 | 10 | 220 | - | 5800 |
| **SK 15 SE 8 1736 5318 Rusheycliff Barn, Tissington Block C** | | | | | | | | | | | | | | | | |
| 0-5.50 | 50.32 | 0.97 | 0.01 | 0.05 | 7.08 | 1.00 | 0.95 | 0.15 | 0.11 | 38.68 | 5 | 0 | 30 | 760 | - | 14900 |
| 5.50-10.50 | 39.41 | 0.43 | 0.02 | 0.02 | 5.76 | 10.49 | 0.65 | 0.12 | 0.02 | 41.80 | 5 | 20 | 170 | 3500 | - | 17600 |
| 10.50-15.50 | 47.35 | 0.64 | 0.02 | 0.07 | 6.62 | 3.32 | 0.96 | 0.16 | 0.05 | 40.09 | 5 | 30 | 50 | 2000 | - | 12700 |
| 15.50-20.50 | 48.49 | 0.73 | 0.01 | 0.84 | 9.36 | 0.99 | 1.42 | 0.17 | 0.07 | 37.25 | 100 | 10 | 20 | 1190 | - | 11000 |
| 27.50-30.50 | 49.85 | 0.18 | 0.02 | 0.03 | 1.78 | 4.07 | 0.27 | 0.06 | 0.04 | 43.19 | 0 | 0 | 20 | 2100 | - | 11000 |
| 30.50-35.50 | 40.16 | 0.87 | 0.04 | 0.07 | 6.92 | 8.87 | 1.00 | 0.22 | 0.08 | 41.01 | 5 | 10 | 10 | 1800 | - | 11400 |
| 35.50-40.50 | 38.73 | 0.21 | 0.03 | 0.07 | 2.58 | 13.00 | 0.51 | 0.09 | 0.03 | 44.72 | 5 | 20 | 20 | 2100 | - | 7900 |
| 40.50-45.50 | 39.85 | 0.00 | 0.03 | 0.26 | 0.24 | 13.17 | 0.14 | 0.03 | 0.05 | 45.92 | 5 | 0 | 20 | 3000 | - | 10300 |
| 45.50-50.50 | 44.37 | 0.11 | 0.02 | 0.04 | 1.08 | 9.06 | 0.41 | 0.09 | 0.11 | 44.67 | 5 | 10 | 30 | 2000 | - | 6600 |
| 50.50-55.50 | 45.52 | 0.25 | 0.03 | 0.21 | 0.67 | 7.94 | 0.18 | 0.04 | 0.10 | 44.29 | 5 | 80 | 160 | 2300 | - | 9000 |
| 55.50-60.50 | 50.93 | 0.05 | 0.02 | 0.05 | 0.44 | 3.82 | 0.14 | 0.03 | 0.16 | 43.69 | 5 | 180 | 700 | 2200 | - | 10100 |
| 60.50-65.50 | 43.37 | 0.16 | 0.02 | 0.02 | 1.27 | 8.84 | 0.38 | 0.09 | 0.12 | 44.03 | 5 | 80 | 180 | 3100 | - | 14700 |
| 65.50-70.50 | 50.69 | 0.08 | 0.02 | 0.05 | 0.33 | 3.22 | 0.17 | 0.04 | 0.11 | 43.10 | 5 | 600 | 780 | 3700 | - | 21600 |
| 70.50-75.50 | 53.77 | 0.04 | 0.01 | 0.04 | 0.53 | 1.55 | 0.28 | 0.06 | 0.11 | 43.22 | 5 | 180 | 300 | 1800 | - | 8500 |
| 75.50-80.50 | 54.87 | 0.08 | 0.03 | 0.01 | 0.22 | 0.78 | 0.16 | 0.04 | 0.09 | 43.37 | 5 | 120 | 1750 | 1400 | - | 5700 |
| 80.50-85.50 | 55.35 | 0.17 | 0.02 | 0.02 | 0.15 | 0.55 | 0.12 | 0.03 | 0.08 | 43.34 | 5 | 50 | 1150 | 1300 | - | 4900 |
| 85.50-90.50 | 55.70 | 0.04 | 0.00 | 0.04 | 0.47 | 0.41 | 0.18 | 0.05 | 0.13 | 43.25 | 5 | 20 | 50 | 800 | - | 3000 |
| 90.50-95.50 | 55.51 | 0.06 | 0.01 | 0.00 | 0.45 | 0.41 | 0.20 | 0.05 | 0.04 | 43.37 | 5 | 20 | 30 | 820 | - | 2700 |
| 95.50-100.00 | 52.91 | 0.11 | 0.01 | 0.02 | 4.30 | 0.58 | 0.44 | 0.09 | 0.03 | 41.45 | 0 | 10 | 30 | 600 | - | 3600 |
| **SK 15 SE 9 1547 5258 Hollington Barn Block C** | | | | | | | | | | | | | | | | |
| 0-10.50 | 52.23 | 0.08 | 0.00 | 0.04 | 4.38 | 1.28 | 0.56 | 0.11 | 0.04 | 41.43 | 10 | 0 | 20 | 1250 | - | 4900 |
| 10.50-20.50 | 51.59 | 0.19 | 0.01 | 0.03 | 4.62 | 1.26 | 1.03 | 0.24 | 0.03 | 41.00 | 5 | 0 | 20 | 1120 | - | 7100 |
| 20.50-30.50 | 49.70 | 0.37 | 0.01 | 0.04 | 6.36 | 1.59 | 1.35 | 0.33 | 0.03 | 39.75 | 5 | 10 | 150 | 920 | - | 8100 |
| 30.50-40.50 | 50.89 | 0.39 | 0.02 | 0.04 | 5.39 | 1.55 | 1.08 | 0.26 | 0.03 | 40.66 | 5 | 0 | 340 | 1000 | - | 7800 |
| 40.50-50.50 | 52.43 | 0.26 | 0.01 | 0.01 | 5.15 | 0.79 | 0.67 | 0.16 | 0.03 | 40.88 | 5 | 0 | 140 | 410 | - | 4300 |
| 50.50-60.50 | 51.91 | 0.48 | 0.02 | 0.08 | 5.42 | 0.94 | 0.96 | 0.24 | 0.03 | 40.34 | 0 | 0 | 60 | 600 | - | 4900 |
| 60.50-70.50 | 50.66 | 0.44 | 0.01 | 0.06 | 6.57 | 1.21 | 0.92 | 0.23 | 0.04 | 39.86 | 5 | 0 | 20 | 1270 | - | 6000 |
| 70.50-80.50 | 47.62 | 0.53 | 0.01 | 0.05 | 12.65 | 0.99 | 1.08 | 0.26 | 0.04 | 36.68 | 5 | 0 | 30 | 760 | - | 5700 |
| 80.50-90.50 | 47.99 | 0.36 | 0.03 | 0.06 | 12.38 | 0.84 | 1.06 | 0.25 | 0.03 | 36.87 | 5 | 10 | 40 | 470 | - | 5500 |
| 90.50-100.00 | 48.78 | 0.31 | 0.02 | 0.03 | 11.21 | 0.80 | 0.99 | 0.23 | 0.04 | 37.70 | 5 | 10 | 60 | 370 | - | 5000 |
| **SK 15 SE 10 1624 5122 Pike House Block C** | | | | | | | | | | | | | | | | |
| 20.50-25.50 | 52.22 | 0.21 | 0.01 | 0.05 | 4.84 | 0.90 | 0.44 | 0.09 | 0.03 | 41.40 | 5 | 10 | 80 | 520 | - | 4200 |
| 25.50-30.50 | 47.32 | 0.53 | 0.02 | 0.03 | 12.61 | 0.79 | 1.31 | 0.23 | 0.05 | 37.03 | 5 | 10 | 190 | 210 | - | 5400 |
| 30.50-35.50 | 48.67 | 0.16 | 0.00 | 0.05 | 10.18 | 1.10 | 0.79 | 0.14 | 0.10 | 38.55 | 5 | 0 | 60 | 450 | - | 3800 |
| 35.50-40.50 | 48.28 | 0.66 | 0.01 | 0.12 | 9.05 | 1.11 | 1.59 | 0.29 | 0.20 | 38.04 | 5 | 40 | 100 | 550 | - | 7000 |
| 40.50-45.50 | 47.86 | 0.45 | 0.01 | 0.08 | 10.33 | 0.94 | 1.35 | 0.22 | 0.08 | 38.01 | 10 | 20 | 90 | 600 | - | 6600 |
| 45.50-50.50 | 49.39 | 0.72 | 0.01 | 0.10 | 7.25 | 0.91 | 0.98 | 0.18 | 0.10 | 39.12 | 10 | 0 | 80 | 750 | - | 5700 |
| 50.50-55.50 | 47.40 | 0.53 | 0.02 | 0.09 | 11.55 | 1.13 | 1.01 | 0.21 | 0.15 | 37.34 | 5 | 10 | 80 | 680 | - | 6000 |
| 55.50-60.50 | 42.31 | 1.13 | 0.02 | 0.14 | 17.00! | 1.39 | 3.21 | 0.64 | 0.30 | 33.92 | 10 | 20 | 40 | 710 | - | 10600 |
| 60.50-65.50 | 49.13 | 0.27 | 0.00 | 0.05 | 11.01 | 0.47 | 0.40 | 0.07 | 0.12 | 38.10 | 10 | 100 | 90 | 660 | - | 400 |
| 65.50-70.50 | 51.06 | 0.36 | 0.02 | 0.06 | 1.19 | 2.99 | 0.20 | 0.05 | 0.12 | 43.04 | 15 | 0 | 130 | 1660 | - | 5400 |
| 70.50-75.50 | 52.50 | 0.31 | 0.01 | 0.01 | 1.56 | 1.80 | 0.18 | 0.04 | 0.08 | 42.73 | 10 | 10 | 90 | 1840 | - | 5800 |
| 75.50-80.50 | 52.28 | 0.09 | 0.01 | 0.03 | 3.75 | 1.22 | 0.35 | 0.07 | 0.06 | 42.00 | 5 | 0 | 10 | 780 | - | 3000 |
| 80.50-85.50 | 52.00 | 0.12 | 0.01 | 0.01 | 5.77 | 0.68 | 0.54 | 0.12 | 0.03 | 40.62 | 0 | 0 | 0 | 280 | - | 400 |
| 85.50-90.50 | 49.30 | 0.43 | 0.01 | 0.00 | 9.95 | 0.50 | 0.46 | 0.10 | 0.02 | 38.08 | 20 | 0 | 0 | 420 | - | 300 |
| 90.50-95.50 | 55.00 | 0.07 | 0.00 | 0.02 | 1.20 | 0.46 | 0.20 | 0.05 | 0.03 | 43.32 | 10 | 0 | 10 | 410 | - | 300 |
| 95.50-100.00 | 54.83 | 0.07 | 0.00 | 0.00 | 1.10 | 0.63 | 0.20 | 0.05 | 0.04 | 43.35 | 5 | 0 | 10 | 470 | - | 400 |

! Silica values above 15% have been rounded to the nearest integer

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 04 NE 1S 0784 4868 Caldon Low Quarries Block B** | | | | | | | | | | | | | | | | |
| **Old quarry 0830 4870 (top)** | | | | | | | | | | | | | | | | |
| 0.00-5.00 | 54.66 | 0.05 | 0.00 | 0.01 | 0.77 | 0.48 | 0.24 | 0.07 | 0.01 | 43.25 | 0 | 0 | 40 | 480 | - | 600 |
| 6.00-10.00 | 55.26 | 0.05 | 0.01 | 0.02 | 0.27 | 0.48 | 0.14 | 0.04 | 0.01 | 43.43 | 0 | 0 | 20 | 300 | - | 200 |
| 11.00-15.00 | 54.10 | 0.13 | 0.01 | 0.01 | 1.26 | 0.61 | 0.41 | 0.11 | 0.01 | 42.89 | 0 | 0 | 10 | 170 | - | 400 |
| 16.00-20.00 | 54.61 | 0.07 | 0.01 | 0.00 | 0.36 | 0.57 | 0.12 | 0.03 | 0.01 | 43.35 | 5 | 30 | 40 | 260 | - | 100 |
| 21.00-23.00 | 54.31 | 0.08 | 0.01 | 0.00 | 0.97 | 0.73 | 0.32 | 0.07 | 0.01 | 43.30 | 0 | 10 | 40 | 250 | - | 200 |
| **Working quarry 0758 4883 (top)** | | | | | | | | | | | | | | | | |
| 0.00-5.00 | 54.71 | 0.05 | 0.01 | 0.00 | 0.56 | 0.55 | 0.18 | 0.05 | 0.01 | 42.77 | 5 | 0 | 20 | 410 | - | 400 |
| 5.00-10.00 | 53.43 | 0.11 | 0.01 | 0.01 | 1.55 | 0.73 | 0.44 | 0.12 | 0.04 | 42.73 | 0 | 0 | 20 | 270 | - | 500 |
| 10.00-15.00 | 54.87 | 0.07 | 0.01 | 0.00 | 0.44 | 0.57 | 0.12 | 0.04 | 0.05 | 43.33 | 0 | 0 | 20 | 160 | - | 100 |
| 15.00-20.00 | 54.38 | 0.07 | 0.01 | 0.00 | 0.88 | 0.56 | 0.23 | 0.07 | 0.01 | 43.04 | 0 | 0 | 10 | 200 | - | 200 |
| 20.00-25.00 | 52.79 | 0.07 | 0.01 | 0.00 | 3.50 | 0.81 | 0.35 | 0.11 | 0.01 | 41.88 | 5 | 0 | 30 | 560 | - | 700 |
| 25.00-30.00 | 54.35 | 0.09 | 0.01 | 0.00 | 0.77 | 0.57 | 0.22 | 0.06 | 0.01 | 43.21 | 5 | 0 | 30 | 350 | - | 400 |
| 30.00-35.00 | 54.41 | 0.06 | 0.02 | 0.00 | 0.58 | 0.55 | 0.19 | 0.06 | 0.01 | 43.29 | 0 | 0 | 60 | 520 | - | 500 |
| 35.00-38.00 | 54.26 | 0.07 | 0.00 | 0.01 | 1.08 | 0.58 | 0.21 | 0.06 | 0.00 | 42.57 | 5 | 0 | 30 | 200 | - | 200 |
| **SK 04 NE 7S 0837 4612 (top) to 0877 4616 Kevin Quarry Block B** | | | | | | | | | | | | | | | | |
| 0.00-5.00 | 55.27 | 0.03 | 0.00 | 0.00 | 0.16 | 0.33 | 0.16 | 0.04 | 0.01 | 43.77 | 0 | 10 | 10 | 160 | - | 200 |
| 5.00-11.00 | 55.74 | 0.03 | 0.01 | 0.03 | 0.00 | 0.21 | 0.09 | 0.03 | 0.01 | 43.55 | 5 | 30 | 20 | 350 | - | 600 |
| 11.00-15.00 | 55.35 | 0.01 | 0.00 | 0.00 | 0.33 | 0.21 | 0.24 | 0.05 | 0.01 | 43.64 | 5 | 20 | 10 | 130 | - | 200 |
| 15.00-20.00 | 55.46 | 0.04 | 0.00 | 0.00 | 0.03 | 0.20 | 0.09 | 0.03 | 0.02 | 43.93 | 0 | 10 | 10 | 230 | - | 400 |
| 20.00-25.00 | 55.59 | 0.03 | 0.00 | 0.00 | 0.11 | 0.24 | 0.13 | 0.03 | 0.03 | 43.89 | 0 | 10 | 10 | 170 | - | 200 |
| 25.00-30.00 | 55.24 | 0.02 | 0.00 | 0.00 | 0.05 | 0.24 | 0.11 | 0.03 | 0.01 | 43.70 | 5 | 10 | 10 | 210 | - | 200 |
| 30.00-35.00 | 55.41 | 0.02 | 0.00 | 0.00 | 0.01 | 0.18 | 0.10 | 0.03 | 0.01 | 43.98 | 5 | 20 | 20 | 250 | - | 300 |
| 35.00-40.00 | 55.63 | 0.02 | 0.00 | 0.00 | 0.00 | 0.21 | 0.09 | 0.03 | 0.01 | 43.98 | 5 | 20 | 20 | 330 | - | 400 |
| 40.00-45.00 | 55.75 | 0.02 | 0.00 | 0.00 | 0.10 | 0.20 | 0.10 | 0.03 | 0.01 | 43.86 | 5 | 10 | 20 | 270 | - | 400 |
| 45.00-50.00 | 55.59 | 0.02 | 0.00 | 0.00 | 0.01 | 0.19 | 0.09 | 0.03 | 0.00 | 43.87 | 0 | 10 | 10 | 230 | - | 200 |
| 50.00-55.00 | 55.30 | 0.01 | 0.00 | 0.00 | 0.24 | 0.20 | 0.09 | 0.03 | 0.01 | 43.84 | 0 | 30 | 20 | 260 | - | 300 |
| 55.00-60.00 | 55.66 | 0.01 | 0.00 | 0.00 | 0.15 | 0.19 | 0.10 | 0.03 | 0.01 | 43.91 | 5 | 20 | 20 | 310 | - | 400 |
| 60.00-65.00 | 55.22 | 0.01 | 0.01 | 0.00 | 0.31 | 0.28 | 0.20 | 0.05 | 0.01 | 43.76 | 5 | 20 | 20 | 240 | - | 200 |
| 65.00-70.00 | 55.70 | 0.01 | 0.00 | 0.00 | 0.06 | 0.26 | 0.10 | 0.03 | 0.01 | 43.87 | 5 | 20 | 20 | 250 | - | 200 |
| 70.00-75.00 | 55.37 | 0.01 | 0.01 | 0.00 | 0.11 | 0.27 | 0.11 | 0.03 | 0.01 | 43.80 | 15 | 30 | 30 | 250 | - | 400 |
| 75.00-80.00 | 55.49 | 0.01 | 0.01 | 0.00 | 0.11 | 0.30 | 0.13 | 0.04 | 0.01 | 43.72 | 5 | 30 | 20 | 170 | - | 200 |
| 80.00-85.00 | 55.56 | 0.01 | 0.01 | 0.00 | 0.15 | 0.27 | 0.10 | 0.03 | 0.01 | 43.77 | 5 | 20 | 20 | 200 | - | 100 |
| 85.00-90.00 | 55.54 | 0.01 | 0.01 | 0.00 | 0.08 | 0.29 | 0.12 | 0.04 | 0.01 | 43.84 | 5 | 20 | 20 | 210 | - | 200 |
| 90.00-95.00 | 55.36 | 0.00 | 0.01 | 0.00 | 0.15 | 0.27 | 0.09 | 0.03 | 0.01 | 43.70 | 5 | 10 | 20 | 160 | - | 200 |
| 95.00-100.00 | 55.36 | 0.01 | 0.01 | 0.00 | 0.22 | 0.28 | 0.10 | 0.03 | 0.01 | 43.78 | 0 | 10 | 10 | 170 | - | 200 |
| 100.00-105.00 | 55.61 | 0.01 | 0.01 | 0.00 | 0.06 | 0.28 | 0.10 | 0.03 | 0.01 | 43.82 | 10 | 0 | 20 | 210 | - | 300 |
| 105.00-110.00 | 55.42 | 0.02 | 0.01 | 0.00 | 0.16 | 0.34 | 0.12 | 0.04 | 0.01 | 43.79 | 0 | 20 | 20 | 180 | - | 200 |
| 110.00-115.00 | 55.57 | 0.01 | 0.01 | 0.00 | 0.00 | 0.27 | 0.09 | 0.03 | 0.01 | 43.87 | 5 | 20 | 20 | 210 | - | 300 |
| 115.00-120.00 | 55.38 | 0.02 | 0.00 | 0.00 | 0.06 | 0.35 | 0.12 | 0.04 | 0.01 | 43.89 | 5 | 30 | 30 | 230 | - | 300 |
| 120.00-125.00 | 55.19 | 0.01 | 0.01 | 0.00 | 0.08 | 0.30 | 0.12 | 0.04 | 0.01 | 43.87 | 5 | 30 | 20 | 220 | - | 400 |
| 125.00-131.10 | 55.24 | 0.01 | 0.01 | 0.00 | 0.14 | 0.41 | 0.15 | 0.04 | 0.01 | 43.87 | 0 | 10 | 20 | 180 | - | 200 |
| **SK 04 NE 9S (various spot samples) Cauldon Quarry Block B** | | | | | | | | | | | | | | | | |
| **Western Quarry 086 488** | | | | | | | | | | | | | | | | |
| 4 samples | 55.18 | 0.05 | 0.02 | 0.05 | 0.60 | 0.42 | 0.10 | 0.04 | 0.01 | 43.75 | 5 | 0 | 20 | 350 | - | 200 |
| **Eastern Quarry 089 489** | | | | | | | | | | | | | | | | |
| 3 samples | 54.73 | 0.06 | 0.02 | 0.01 | 0.71 | 0.59 | 0.22 | 0.06 | 0.01 | 43.22 | 5 | 40 | 30 | 280 | - | 400 |
| **Eastern Quarry 088 486** | | | | | | | | | | | | | | | | |
| 3 samples | 54.19 | 0.05 | 0.02 | 0.00 | 1.02 | 0.58 | 0.28 | 0.08 | 0.01 | 43.38 | 0 | 20 | 40 | 280 | - | 500 |

| Depth (m) | percentages | | | | | | | | | | parts per million | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CaO | $SO_3$ | $Na_2O$ | F | $SiO_2$ | MgO | $Al_2O_3$ | $K_2O$ | $P_2O_5$ | Loss at 1050 C | Cu | Pb | Zn | MnO | As | $Fe_2O_3$ |
| **SK 05 SE 3S** | **0897 5026 (top) Brownend Quarry, Waterhouses Block C** | | | | | | | | | | | | | | | |
| 0.00-5.00 | 54.32 | 0.06 | 0.02 | 0.00 | 1.41 | 0.51 | 0.13 | 0.04 | 0.03 | 43.29 | 0 | 0 | 10 | 420 | - | 400 |
| 5.00-10.00 | 53.98 | 0.13 | 0.02 | 0.00 | 1.10 | 0.56 | 0.21 | 0.05 | 0.04 | 43.22 | 0 | 10 | 20 | 780 | - | 4000 |
| 10.00-15.00 | 54.44 | 0.13 | 0.02 | 0.00 | 0.86 | 0.62 | 0.15 | 0.04 | 0.02 | 43.54 | 0 | 0 | 10 | 320 | - | 300 |
| 15.00-20.00 | 52.32 | 0.10 | 0.03 | 0.03 | 3.75 | 0.73 | 0.98 | 0.25 | 0.03 | 41.91 | 0 | 10 | 10 | 320 | - | 4500 |
| 20.00-30.00 | 51.26 | 0.10 | 0.03 | 0.00 | 4.67 | 0.75 | 0.96 | 0.25 | 0.02 | 41.61 | 0 | 10 | 0 | 220 | - | 5200 |
| 30.00-40.00 | 53.40 | 0.09 | 0.03 | 0.00 | 2.58 | 0.68 | 0.43 | 0.12 | 0.02 | 42.64 | 0 | 0 | 0 | 250 | - | 3300 |
| 40.00-50.00 | 50.51 | 0.11 | 0.03 | 0.00 | 6.33 | 0.76 | 1.08 | 0.27 | 0.02 | 40.91 | 0 | 0 | 10 | 150 | - | 5600 |
| 50.00-60.00 | 47.49 | 0.13 | 0.03 | 0.02 | 10.94 | 0.80 | 1.15 | 0.29 | 0.02 | 37.86 | 0 | 0 | 10 | 250 | - | 6500 |
| 60.00-70.00 | 50.60 | 0.16 | 0.03 | 0.01 | 5.46 | 0.87 | 1.16 | 0.30 | 0.02 | 40.89 | 0 | 0 | 10 | 290 | - | 8400 |
| 70.00-80.00 | 48.48 | 0.14 | 0.04 | 0.04 | 9.70 | 0.85 | 1.25 | 0.32 | 0.03 | 38.76 | 0 | 0 | 10 | 380 | - | 6900 |
| 80.00-93.00 | 48.30 | 0.13 | 0.03 | 0.00 | 9.54 | 0.84 | 1.26 | 0.32 | 0.02 | 39.50 | 0 | 10 | 10 | 320 | - | 7000 |
| **SK 14 NW 4S** | **1073 4833 Quarry North-east of Far Dale Farm Block C** | | | | | | | | | | | | | | | |
| 0.00-5.00 | 53.25 | 0.08 | 0.04 | 0.00 | 2.57 | 0.61 | 0.35 | 0.11 | 0.02 | 42.55 | 0 | 10 | 10 | 190 | - | 500 |
| 5.00-10.00 | 53.42 | 0.07 | 0.02 | 0.03 | 2.16 | 0.64 | 0.34 | 0.10 | 0.02 | 42.86 | 5 | 10 | 20 | 260 | - | 4100 |
| **SK 14 NW 6S** | **1163 4758 Quarry north of Thorswood House Block C** | | | | | | | | | | | | | | | |
| 0.00-5.00 | 52.17 | 0.11 | 0.03 | 0.05 | 4.48 | 0.73 | 0.52 | 0.13 | 0.01 | 41.86 | 0 | 0 | 10 | 200 | - | 3300 |
| 5.00-10.00 | 52.33 | 0.13 | 0.03 | 0.01 | 3.64 | 0.79 | 0.47 | 0.12 | 0.02 | 42.31 | 0 | 0 | 10 | 110 | - | 400 |
| 10.00-16.00 | 48.22 | 0.08 | 0.04 | 0.03 | 11.07 | 0.79 | 1.04 | 0.25 | 0.08 | 38.47 | 0 | 10 | 10 | 330 | - | 5000 |
| **SK 15 NW 8S** | **1236 5733 Narrowdale Hill Block C** | | | | | | | | | | | | | | | |
| 0.00-5.00 | 55.14 | 0.05 | 0.02 | 0.01 | 0.35 | 0.47 | 0.11 | 0.04 | 0.07 | 43.79 | 0 | 0 | 10 | 230 | - | 100 |
| 5.00-10.00 | 55.33 | 0.05 | 0.01 | 0.00 | 0.17 | 0.46 | 0.13 | 0.04 | 0.06 | 43.88 | 0 | 10 | 10 | 250 | - | 100 |
| 10.00-17.00 | 54.33 | 0.04 | 0.01 | 0.00 | 1.33 | 0.45 | 0.21 | 0.05 | 0.12 | 43.28 | 0 | 10 | 10 | 220 | - | 100 |
| **SK 15 NW 9S** | **1130 5662 Gateham Grange Block C** | | | | | | | | | | | | | | | |
| 0.00-10.00 | 55.16 | 0.07 | 0.01 | 0.00 | 0.08 | 0.57 | 0.12 | 0.04 | 0.08 | 44.08 | 0 | 0 | 10 | 160 | - | 200 |
| 10.00-20.00 | 55.24 | 0.06 | 0.01 | 0.00 | 0.02 | 0.52 | 0.09 | 0.03 | 0.08 | 43.94 | 0 | 0 | 10 | 150 | - | 100 |
| 20.00-30.00 | 55.08 | 0.06 | 0.02 | 0.00 | 0.05 | 0.52 | 0.11 | 0.03 | 0.06 | 43.96 | 0 | 0 | 10 | 150 | - | 200 |
| 30.00-40.00 | 55.20 | 0.06 | 0.02 | 0.00 | 0.08 | 0.56 | 0.10 | 0.03 | 0.05 | 43.95 | 5 | 0 | 10 | 300 | - | 200 |
| 40.00-50.00 | 54.75 | 0.05 | 0.01 | 0.00 | 0.21 | 0.54 | 0.16 | 0.05 | 0.10 | 43.80 | 0 | 0 | 10 | 310 | - | 400 |
| 50.00-57.00 | 54.60 | 0.07 | 0.01 | 0.05 | 0.25 | 0.57 | 0.19 | 0.05 | 0.11 | 43.82 | 0 | 0 | 10 | 290 | - | 400 |
| **SK 15 NE 1S** | **1635 5674 (top) Quarries at Alsop Moor Block A** | | | | | | | | | | | | | | | |
| 0.00-5.00 | 55.66 | 0.03 | 0.01 | 0.02 | 0.01 | 0.24 | 0.09 | 0.03 | 0.01 | 43.87 | 5 | 0 | 10 | 210 | - | 800 |
| 5.00-10.00 | 55.82 | 0.03 | 0.02 | 0.05 | 0.08 | 0.27 | 0.09 | 0.03 | 0.01 | 43.89 | 5 | 0 | 10 | 290 | - | 400 |
| 10.00-15.00 | 55.68 | 0.05 | 0.01 | 0.03 | 0.11 | 0.26 | 0.10 | 0.03 | 0.01 | 44.00 | 5 | 0 | 10 | 210 | - | 200 |
| 15.00-20.00 | 55.24 | 0.03 | 0.00 | 0.00 | 0.07 | 0.27 | 0.09 | 0.03 | 0.01 | 43.92 | 0 | 0 | 10 | 180 | - | 200 |
| 20.00-25.00 | 55.67 | 0.04 | 0.00 | 0.00 | 0.05 | 0.23 | 0.08 | 0.03 | 0.01 | 43.92 | 5 | 20 | 10 | 170 | - | 100 |
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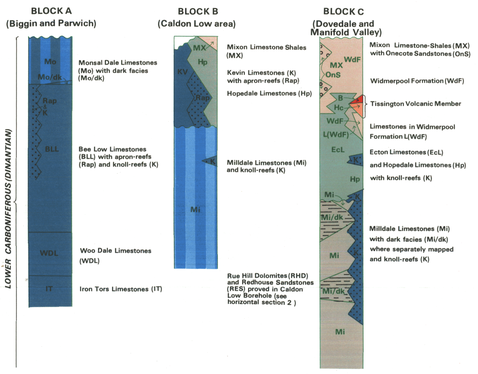
THE LIMESTONE AND DOLOMITE RESOURCES OF
THE COUNTRY NORTH AND WEST OF ASHBOURNE, DERBYSHIRE

129

This map should be read in conjunction with the accompanying Report which contains details of the assessment of resources.

## GENERALISED VERTICAL SECTIONS

Scale 1:5000 (1cm to 50m)




## EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Shades of blue are used to indicate the regional distribution of high calcium limestones ($CaCO_3$ ≥ 93·5%) and also to show the variation in purity at data points.

Shades of grey are used to indicate the regional distribution of deposites of variable carbonate content ($CaCO_3$ commonly < 93·5%)

CATEGORIES OF ROCK

LIMESTONES

| | | Composition ($\%CaCO_3$) |
|---|---|---|
| CAT-L9 | Very high purity | ≥98.5 |
| CAT-L18 | High purity | ≥97.0-<98.5 |
| CAT-L19 | Medium purity | ≥93.5-<97.0 |
| CAT-L20 | Low purity | ≥85.0-<93.5 |
| CAT-L21 | Impure | <85.0 |
| CAT-L5 | Undivided high to very high purity | ≥97.0 |
| CAT-L11 | Undivided medium to high purity | ≥ 93.5-<98.5 |

DOLOMITE

DOL-5

NON-CARBONATE SEDIMENTS

POC-1 PD Pocket Deposits (sands and clays)

VOLCANIC ROCKS

IGR-2 Basalt

IGR-3 Tuff

DRIFT

Alluvium (includes river terrace and alluvial fan deposits and small patches of head in valley bottoms)

Head

Boulder Clay

MADE GROUND

MG-2

LANDSLIP

L-1

BOUNDARY LINES

Geological boundary, Solid + category deposit

Geological boundary, Drift

Boundary between categories (for boundaries not coincident with geological boundaries)

Inferred boundary between high calcium limestones and deposits generally of lower purity

Resource block boundary (blocks designated by letters A to C)

Working quarry (see opposite margin for details)

LIMESTONES (variable purity)
INTERBEDDED WITH NON-MINERAL

EcL Hp — Medium purity to impure limestone, locally cherty with sporadic shale intercalations — CAT-L23

Mi L(WdF) — Chiefly low purity and impure limestone commonly cherty with shale intercalations — CAT-L24

Mi/dk — CAT-L24

MX WdF — Thinly interbedded limestone, silty mudstone and shale; sandstone beds in Widmerpool Formation — CAT-L25

OnS — Sandy limestone and sandstone — CAT-L26

Localities in Resource Block C where medium to high purity limestone may be present

IGNORE

STRUCTURAL SYMBOLS

Inclined strata, dip in degrees

Anticlinal axis, direction of plunge indicated by arrow

Synclinal axis, direction of plunge indicated by arrow

Fault at surface, crossmark indicates downthrow side

Mineral Vein

Approximate underground position of old workings in mineralised 'pipe'

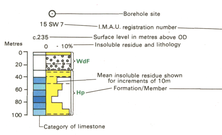
BOREHOLE AND SECTION DATA
SITE LOCATIONS

Industrial Minerals Assessment Unit (I.M.A.U.) boreholes

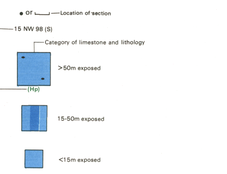
Other boreholes

Collected sections (bracket indicates limits of longer sections)

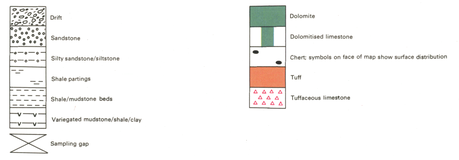
BOREHOLE FORMAT




SECTION FORMAT

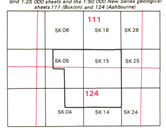



LITHOLOGICAL SYMBOLS




Detailed records may be consulted on application to the Head, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Keyworth, Nottingham NG12 5GG.

*Diagram showing the relation of the resource sheet to the National Grid 1:25 000 sheets and the 1:50 000 New Series geological sheets 111 (Buxton) and 124 (Ashbourne)*

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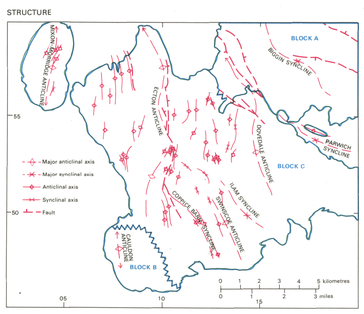
STRUCTURE




SUMMARY OF RESOURCES

Block A: Pale-coloured limestones of high and very high chemical purity suitable for use in a wide range of chemical, agricultural and constructional applications. The deposits have a maximum exposed thickness of 535m and are characterised by gentle folding and predominant low dips (<10°). Thin clay bands interbedded with the limestones, are not considered to be a major source of contamination.

Block B: Pale-coloured limestones and darker coloured limestones ranging from medium to very high purity. The pale limestones are over 180m thick and are similar in composition to the limestones of Block A; the darker limestones are more variable in composition with a higher silica and argillaceous content.

Block C: Mid-and dark grey limestones of variable composition, interbedded,in places, with non-carbonates (shales and sandstones). The purest deposits are mid-grey coloured, massively bedded knoll-reef limestones but chert-free high calcium limestones are also to be found in the Hopedale and Ecton limestone formations. Dips throughout the block are high and the beds are strongly folded locally.

For detailed discussion see Report.

ACTIVE QUARRYING OPERATIONS (1982)

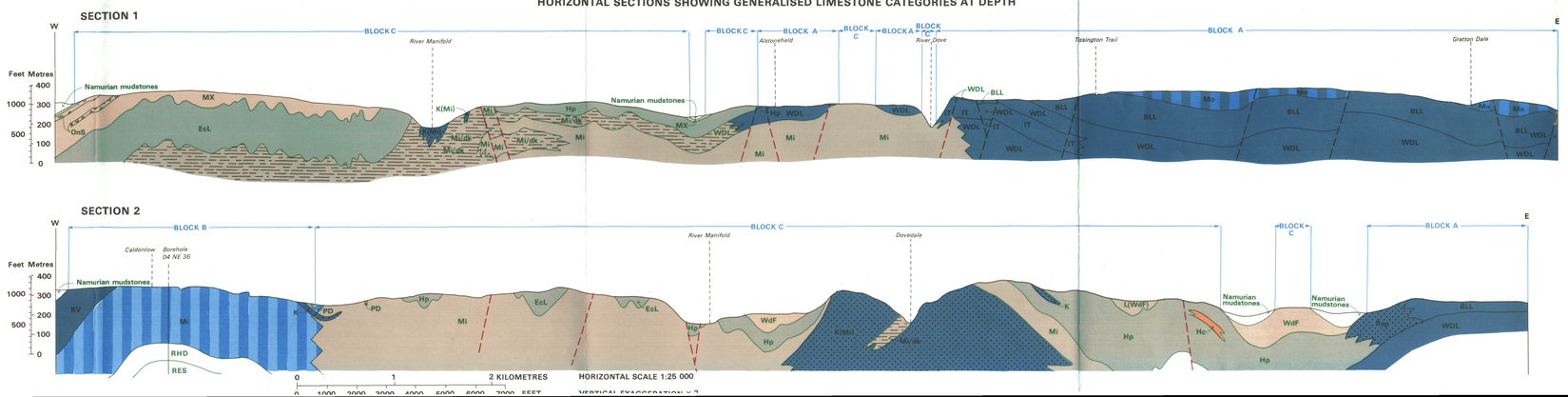
| QUARRY | RESOURCE BLOCK | GRID REFERENCE |
|---|---|---|
| A.Ballidon | A | 196556 |
| B.Caldon Low | B | 080485 |
| C.Cauldon | B | 090487 |
| D.Wardlow | B | 085473 |
| E.Wredon | B | 087472 |
| F.Kevin | B | 085462 |

*Geological survey by N.Aitkenhead, T.J.Charsley, J.I.Chisholm, D.Price and I.P.Stevenson 1969-77. W.B.Evans and I.P.Stevenson, District Geologists.*

*Limestone and dolomite survey by Industrial Minerals Assessment Unit 1977-81. R.G.Thurrell, Head of Unit.*

*1:25 000 Limestone and Dolomite Resource Sheet published 1983. G.M.Brown, D.Sc.,F.R.S.,Director, Institute of Geological Sciences. 11/0183*

## HORIZONTAL SECTIONS SHOWING GENERALISED LIMESTONE CATEGORIES AT DEPTH






The GRID lines on this sheet are at 1 Kilometre interval.
*Heights are in feet and metres above Mean Sea Level at Newlyn.*

*Contours values are in metres*
*1 square inch on this map represents 99 078 acres on the ground*



Compiled form 6" and 1:10 000 sheets last fully revised 1920-75.
Other partial systematic revision 1933-78 has been incorporated.
Some major roads revised 1966-79.

*Made and published by the Ordnance Survey, Southampton.*