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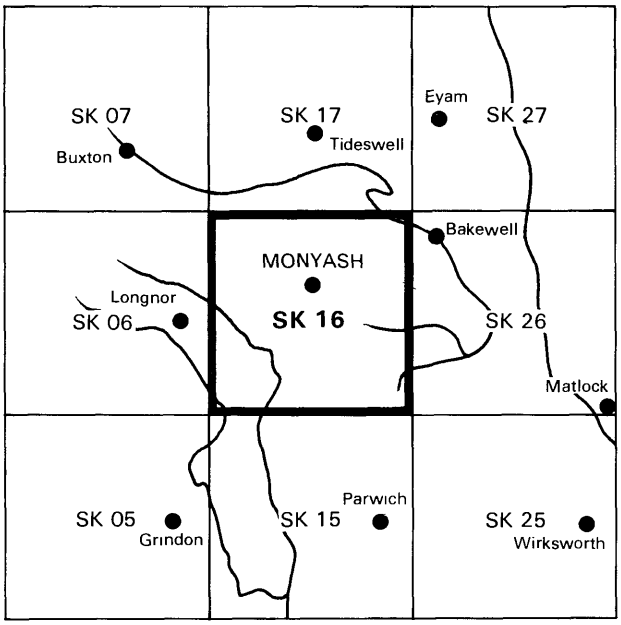

The limestone and dolomite resources of the country around Monyash, Derbyshire

Description of 1:25 000 resource sheet SK 16

F. C. Cox and D. McC. Bridge

With a contribution by J. I. Chisholm and N. Aitkenhead

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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 Mineral Assessment Unit began systematic surveys in 1972. The work is now being financed by the Department of the Environment and is being undertaken with the cooperation of members of the British Quarrying and Slag Federation.

This Report describes the limestone and dolomite resources of some 91 km^2 of country around Monyash, Derbyshire, shown on the accompanying 1:25 000 resource map SK 16. The survey was conducted by Dr F. C. Cox and Mr D. McC. Bridge with the assistance of Mrs L. C. Jones and Messrs J. T. Dove and J. L. Grayson. The work was controlled from a sub-unit based in Leeds (officer-in-charge, J. H. Hull) and is based on a geological survey at the 1:10 560 scale conducted in 1968-1972 by Dr N. Aitkenhead, Mr J. I. Chisholm and Mr D. Price of the Institute's North-West England Field Unit. The first two officers also contributed the section on the geology.

Mr J. W. Gardner, CBE (Land Agent) was responsible for negotiating access to land for drilling. The ready cooperation of land owners and tenants in this work is gratefully acknowledged.

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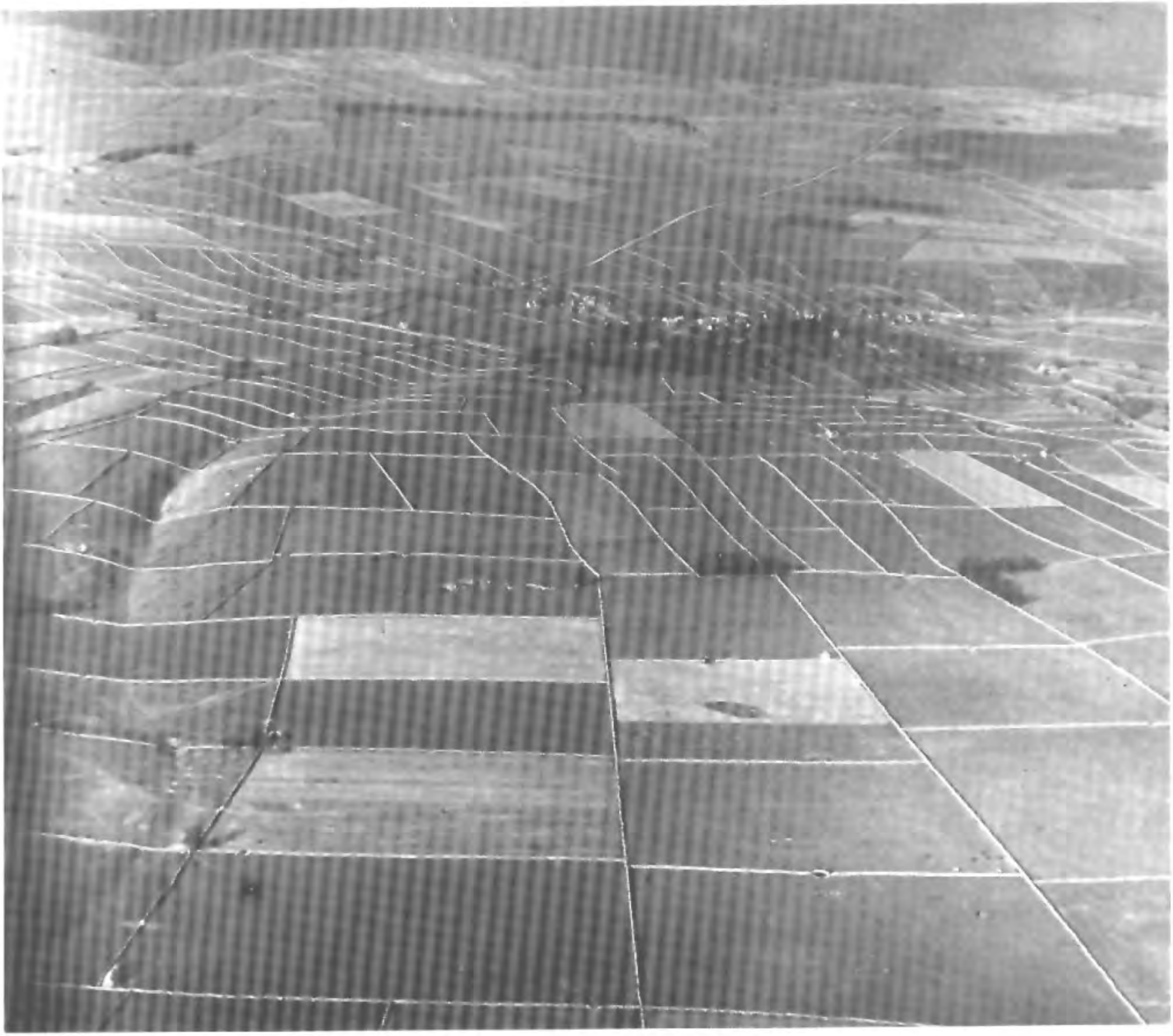

Plate 1. Frontispiece: The limestone plateau centred on Monyash: oblique air photograph looking north-north-east towards Sheldon, Derbyshire

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SUMMARY

The study of samples specially collected from 23 cored boreholes and 15 major exposures, together with information from the records and geological maps of the Institute of Geological Sciences, form the basis of the assessment of limestone and dolomite resources in the Monyash area, Derbyshire. Eighteen boreholes were drilled under contract for the Mineral Assessment Unit and in addition, members of the Unit drilled five shallow holes using a small portable drilling machine.

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 in the uppermost 10 m of strata, for which most information is available. Horizontal sections construtted from the borehole data and from knowledge of the regional geology, indicate the categories likely to be encountered below this depth.

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

The limestone and dolomite resources of the country around Monyash, Derbyshire

F. C. Cox and D. McC. Bridge

Introduction

In recent years it has become clear that more detailed and comprehensive information on the physical and chemical constitution of limestones is required to generally extend knowledge of the resource, to facilitate land-use and mineral planning by central and local government and other interests and to assist in the formulation of national policies to ensure continuing supplies to all the industries for which limestone is an essential raw material. Ideally, the information should relate to all the multiple uses of this commodity, ranging, for example, from strength, which relates to its use as aggregate, to trace element composition, important in more specialised uses, for example, in the glass and steel industries. The provision of such information on limestone resources is the objective of the survey.

The Carboniferous limestones of the Derbyshire and North Staffordshire area have been quarried since pre-Roman times for building stone and as a source of lime for agricultural purposes. During the seventeenth century the Dove Valley abounded with lime kilns and coal began to be used extensively for lime burning. The growth of the canal system, later superseded by railways, brought limestone within easy reach of the iron and steel industry in the surrounding coalfield areas. More recently, the increased demand for roadstone and concreting aggregates and the post-war growth of the chemical and glass industry has resulted in an upsurge in production, so that today, limestones from this region are vital to the country's industrial economy. In 1973, Derbyshire and Staffordshire produced 22 509 thousand tonnes representing approximately 26 per cent of the total production in Great Britain (Healing and Harrison, 1975, p. 124). With continued growth of the industry, well developed systems of railways, roads and much more recently, motorways, have developed to link the region with the surrounding conurbations (Fig. 1).

The methods of assessment were developed from a feasibility study and embody the most cost-effective procedures for assessing limestone resources on a regional scale (Cox and others, in press). The material for study has been obtained from cored boreholes, natural sections and quarry faces. Although boreholes have generally been spaced at intervals of approximately 3 km, material from a closer spacing is available for this report, as the area of survey coincides partly with that of the feasibility study. Where possible, boreholes were drilled to a depth of at least 60 m, exceeding (at the time of the assessment) the depth of the deepest working quarry; exceptionally, one borehole was drilled down to 207 m to prove the geological sequence. The petrological, mineralogical, chemical and certain of the physical properties of the samples have been determined in the laboratory. Conventional geological nomenclature is used for technical descriptions, ensuring compatibility between this report and the literature; a glossary is appended. The rocks are classified in terms of their calcium carbonate ($CaCO_3$) content so that the relation between limestone category and possible end use can be easily deduced.

Whilst detailed results are set out in the following report and its appendices, the accompanying resource map is more generalised. It should be noted that the distribution of limestone categories shown on the map was determined by reference to the average calcium carbonate content over the uppermost 10 m of strata. In the horizontal sections, the vertical distribution of the limestone categories is inferred by extrapolation from knowledge of the local geology augmented by the results from the boreholes, which are given for each 5 m interval down to a maximum depth of 60 m. The more detailed assessment of limestones within 10 m of the surface reflects the relative abundance and widespread distribution of data points for this interval, compared with their paucity for the more deeply buried strata: to improve the reliability of the assessment of limestones below 10 m would require a much higher sampling frequency, which would be prohibitively costly. A summary of the results is given in Table 9 and amplified in the text.

Lying largely within the Peak District National Park (Fig. 1), the area includes terrain of great scenic beauty; it is rural and the local economy is largely based on the rearing of sheep and beef cattle. The population of the region is low and the many small villages each have generally less than 500 inhabitants. In the past, limestone and lead were extensively worked, but activity is now confined to relatively small opencast operations for fluorite and calcite in Dirtlow and Long Rakes [185 687; 190 643]. The area is crossed by the A515 Buxton-Ashbourne road.

Topography

The scenery is dominated by the limestone plateau which extends from Chelmorton in the north-west, where it is over 366 m (1200 ft) above OD to the Friden area [170 607] (Fig. 2). Between Friden and Sparklow [127 660] the plateau undulates between 305 m (1000 ft) and 366 m and is strongly dissected by steep-sided

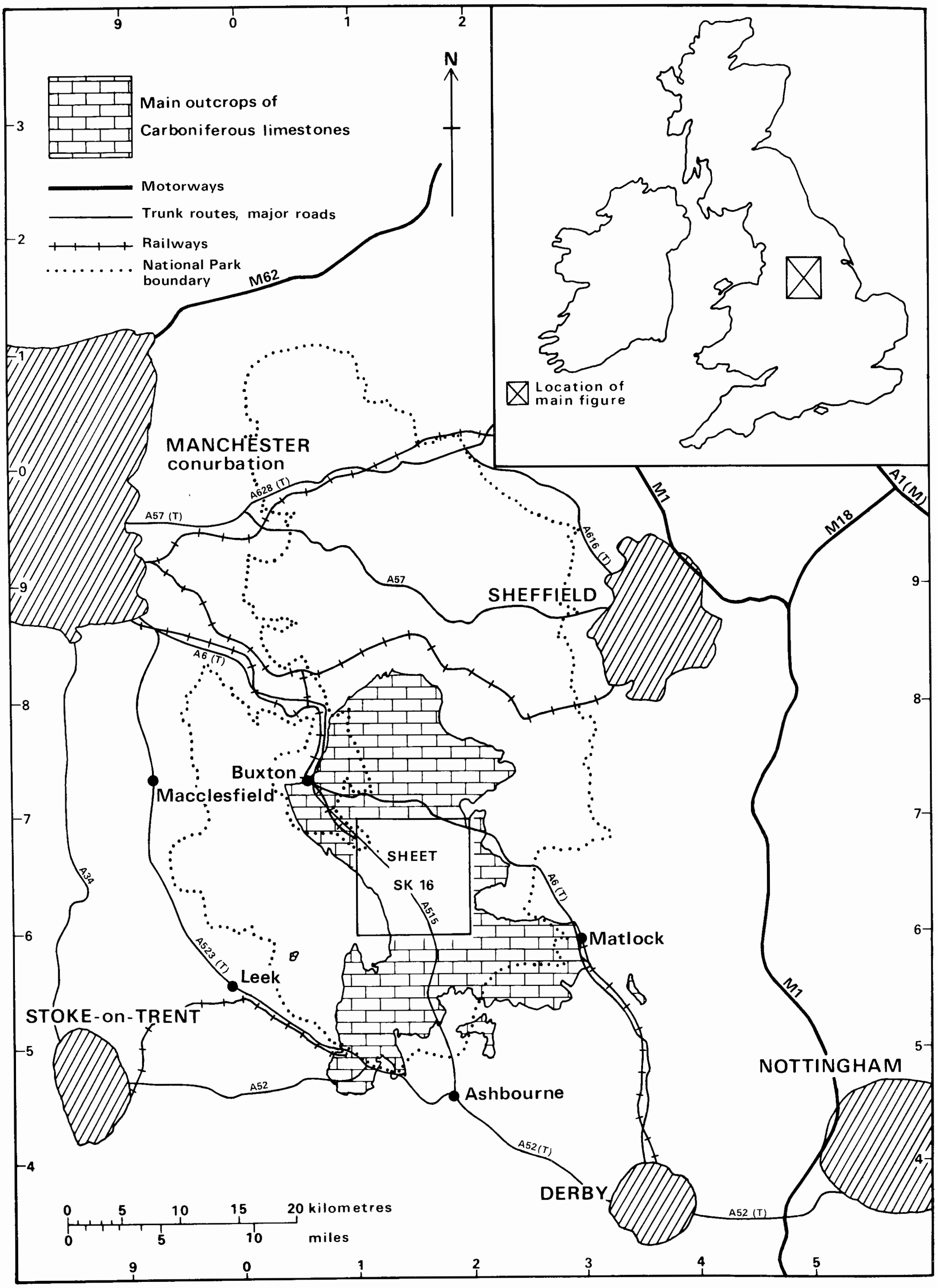


Fig. 1. Sketch map showing the location of sheet SK 16

valleys, including Lathkill Dale, which are often dry in their upper reaches. In the south-west the Dove Valley follows the junction between Namurian mudstones and sandstones and Carboniferous limestones. The rural scenery of the area is typical of the Peak District, its network of dry stone walls and almost treeless grassland sharply contrasting with the wooded gorges of Lathkill Dale and the Wye Valley.

Geology

Most of the Carboniferous limestones of Derbyshire belong to the Viséan Series. During their deposition an area of slow subsidence, variously called shelf, block or massif, occupied much of the present limestone outcrop. Flanking it to north, west and south were more rapidly subsiding tracts termed basins or gulfs; where the shelf and basin environments abut, discontinuous apron reefs were formed. The basins are now largely concealed by later sediments, as is the shelf area to the east.

The shelf and basin areas each have their own characteristic rock types. Most of the shelf limestones are pale in colour, and comprise detritus derived from the calcareous skeletons of animals and plants that lived in a shallow well aerated sea, free from substantial influxes of terrigenous material. Small patch reefs are common at some horizons. The basin limestones formed under less aerated conditions, generally in deeper water. They tend to be darker in colour and to contain interbedded mudstones. At depth, towards the centres of the basins, many of the limestones are bituminous and may be subordinate to mudstones. The apron reefs are shelly fine grained limestones with depositional dips directed away from the shelf.

The fossil content of the limestones is also dependent on their depositional environment. In the shelf facies, subdivision and correlation of the sequence is most readily achieved by study of the corals and brachiopods and a zonal scheme using these forms is well established. The basin facies typically contains goniatites which enable a more refined scheme to be employed. The apron reefs contain elements of both faunas, thus establishing an equation between the two zonal systems.

At intervals throughout the deposition of the limestones, volcanic activity produced local outpourings of lava with associated falls of tuffaceous material. On the shelf, ephemeral volcanic islets were built up and local variations in water depth gave rise to facies variations in the limestones. In the basins the volcanic rocks are probably wholly submarine.

Limestone deposition was succeeded by that of shales and sandstones, the outcrop of which now surrounds that of the limestones. For the most part these terrigenous sediments belong to the Namurian (Millstone Grit) Series, but their lowermost portion is locally of Viséan age. As a generalisation the upward change from limestone to shale is conformable in the fully basinal areas, but marked by unconformity on, and immediately adjacent to, the shelf, where even minor uplift led to emergence.

On the limestone outcrop, steep-sided solution cavities have been filled by a variety of sediments grouped together as Pocket Deposits, the oldest of which are chert-breccias, probably a product of pre-Namurian erosion and solution of the highest Viséan limestones. The chert-breccias are overlain by red and white pebbly sands (which are being used as refractories) and then by the youngest deposits, grey clays of Pliocene age. The solution cavities (Fig. 3) lie along a 2 km-wide belt running north-westwards through Friden [171 608]. They are circular or elliptical in plan, ranging up to 300 m across and up to at least 50 m deep.

Of the Quaternary deposits only Head is widespread. It consists of reddish brown silt and clay containing angular chert debris and lies chiefly in hollows, where it rarely exceeds 4 m in thickness. It also fills solution-widened joints and fissures in underlying limestones.

LIMESTONE SUCCESSION

The sequence of limestones exposed in the area (Fig. 3) is set out in Table 1.

The Woo Dale Limestones

The Woo Dale Limestones underlie the entire area at depth, but crop out only near Hartington where about 100 m of pale chert-free limestone are known in the core of a faulted anticline.

The Bee Low Limestones

The Bee Low Limestones crop out along a 3 km-wide belt, in a complex monoclinal structure along the western margin of the shelf. Their thickness is fairly constant at 200 to 215 m. A sharp basal contact with the Woo Dale Limestones may mark a non-sequence.

Most of the limestones were deposited on the shelf and are calcarenites. Thin clay beds, ranging up to 45 cm thick, occur at up to about twenty separate horizons throughout the sequence. Popularly known as clay wayboards, these are probably of volcanic origin. In the extreme west the calcarenites pass into an apron reef of finer grained limestone that dips steeply south-westwards into the basin, some of the dip being depositional.

The Monsal Dale Limestones

The Monsal Dale Limestones have the most extensive outcrop of any of the limestone units, occupying much of the north-eastern half of the area. Their base is taken at a distinct facies change, and, although in the shelf area the junction is conformable, there is local disconformity in the vicinity of the apron reef. In thickness the beds range from 120 to 200 m, the thickest sections lying in the east. In contrast to the underlying beds the division exhibits marked and rapid changes in facies. Pale, massively bedded and dark thinly bedded limestones are found together in many places; there is a tendency for the latter to be dominant where the sequence is thickest. A broad sequence can be recognised – relatively pale limestones are followed by darker limestones which in turn are

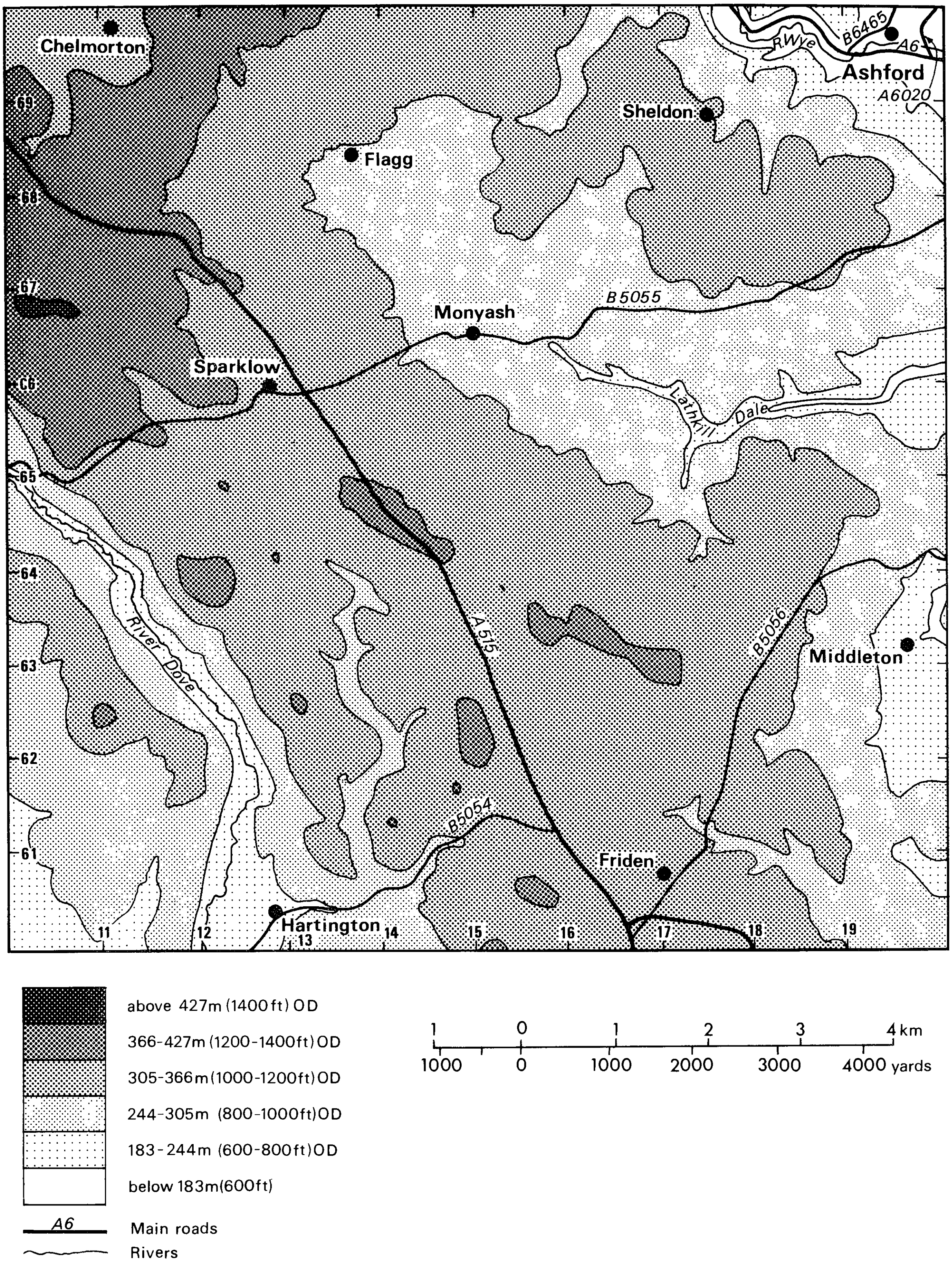


Fig. 2. Topography

Table 1. The geological sequence in sheet SK 16.

Name of formation	Coral-brachiopod Zone	Goniatite Zone	Thickness (m)	Lithology
Eyam Limestone	D_2	P_2	0-30	Dark and mid-grey cherty limestones with local patch reefs of pale limestone
Monsal Dale Limestones	D_2		120-200+	Pale, mid-grey and dark limestones, cherty in part
Bee Low Limestones	D_1		200-215	Pale grey massive limestones without chert: apron reef facies at west margin
Woo Dale Limestones	S_2		100+	Mainly pale limestones, fine grained bands in upper 35 m; no chert

overlain by further pale limestones. Chert is found mainly in the two highest subdivisions. The boundaries between these types of limestone appear to be diachronous. In particular, dark limestones appear to have continued to form in the extreme north-east while the uppermost subdivision of pale limestone was still being deposited farther west and south.

The Monsal Dale Limestones also outcrop along and near the edge of the shelf in the south-west, where variable sequences of dark and pale limestone lie disconformably on the eroded surface of both the shelf and apron reef facies of the Bee Low Limestones and are succeeded unconformably, and locally overstepped, by Namurian mudstones.

Basaltic lavas are associated with the Monsal Dale Limestones locally at three levels. The Upper Miller's Dale Lava is at the base. In the north-west it is up to 18 m thick but dies out at the surface southwards near Hurdlow Town [119 667] and at depth eastwards near Over Wheal [156 695]. A second flow, the Shacklow Wood Lava, is exposed in the extreme north [177 697], where it lies about 60 m above the base of the Monsal Dale Limestones and reaches a thickness of 17 m. It dies out both westwards and southwards. The third is the Gratton Dale Lava, which enters the sheet at the extreme south-east corner and dies out rapidly westwards. It lies about 65 m above the base of the Monsal Dale Limestones.

The Eyam Limestones

The Eyam Limestones are restricted in outcrop to outliers resting, possibly disconformably, on the Monsal Dale Limestones of the shelf. Two main facies are present. The more widespread consists of dark to mid-grey thinly bedded limestone with chert nodules and dark shaly partings. Of more restricted occurrence is a reef facies that comprises lenses of shelly fine grained limestone with surrounding accumulations of coarsely crinoidal material. Some of the reefs stand up as knolls, others have a broader and flatter profile. All are patch-reefs in contrast to the apron reefs fringing the block. They are commonest at the base of the Eyam Limestones, but there are others at higher levels, especially north-east of Monyash [150 665] where they are up to 12 m thick. In the north-east, the Eyam Limestones thin, the upper part having passed laterally into shale.

DOLOMITISATION

Secondary dolomitisation has affected parts of the Bee Low and Monsal Dale Limestones along a belt about 1 km wide (Fig. 4) that runs north-westwards from Gratton Moor [199 603] through Blakemoor to Custard Field [137 640]. The south-west margin of the belt coincides quite closely with the Blakemoor fault. The limits of the dolomite are irregular in detail but appear to be approximately vertical as if the alteration had been controlled by vertical joints. The cause of the dolomitisation is unknown: it may have been due to solutions rising from below, or to the action of Permian seawater or groundwater from above. The alteration appears to be older than the lead-zinc mineralisation.

STRUCTURE

Two areas of contrasting structure can be distinguished within the limestone outcrop (Fig. 5). They are separated by a north-westerly trending belt of faults, the Cronkston-Blakemoor fault zone [192 600 to 100 663], which continues the line of the Bonsall Fault. North-easterly downthrows in this belt range up to 200 m in places and locally there are associated areas of steep dip.

To the north-east of the fault-zone the rocks are in gentle folds of varying trend and are comparatively free of faults. The largest fold is the Monyash Syncline, of north-westerly trend, with dips up to about 6°. To the east are smaller folds in which low dips also predominate, though locally, up to 15° has been recorded. The main faulting, which trends westerly to north-westerly, is restricted to the north-east of the area. Mineralised joints and veins are widespread, mainly along north-westerly and east-north-easterly lines (Fig. 4).

South-west of the Cronkston-Blakemoor fault zone the rocks are more strongly folded, with dips up to 30°; faulting is widespread, but

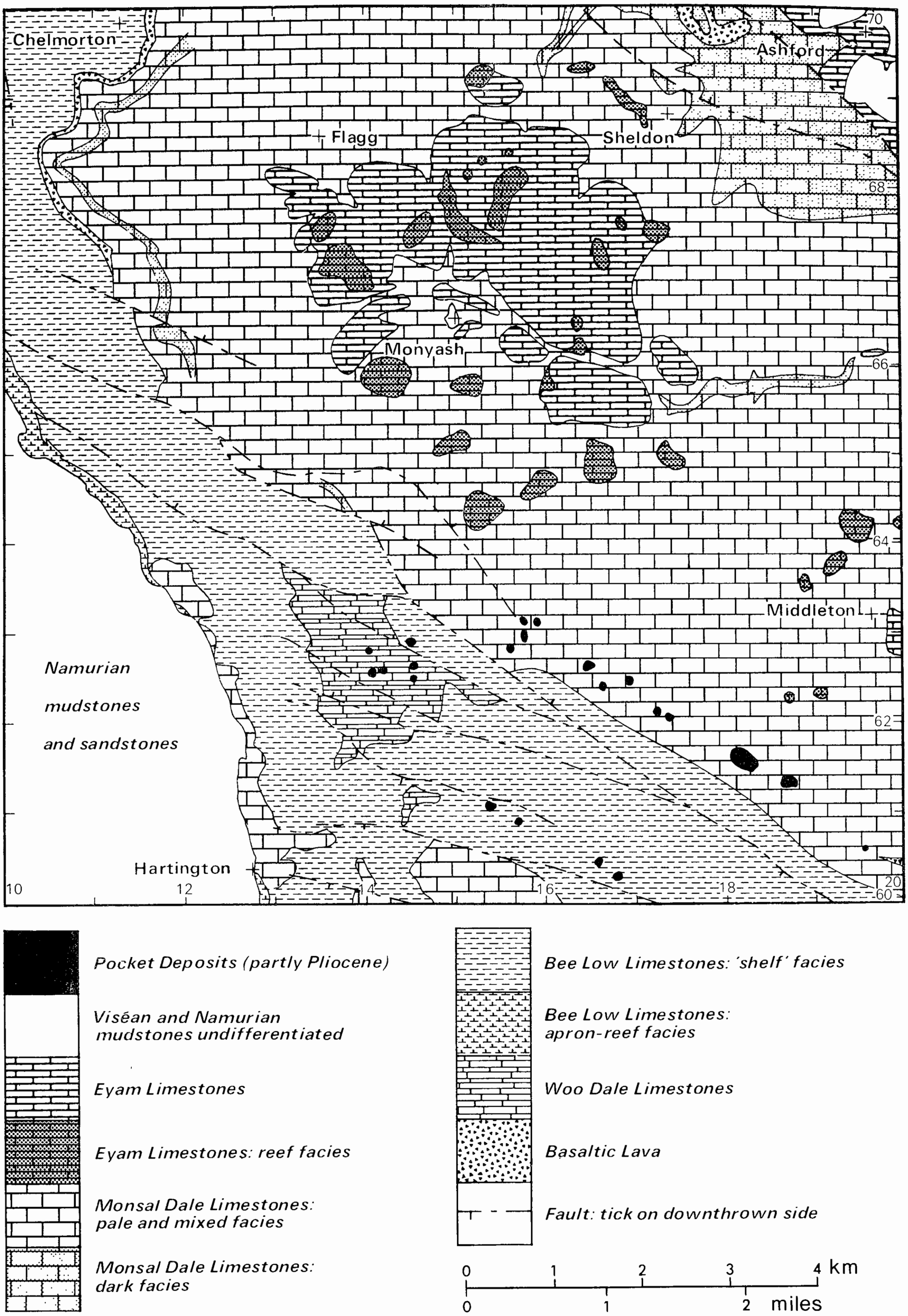


Fig. 3. Simplified map of the solid geology

mineralisation is slight. The main folds are the Hartington Anticline and the End Low Syncline, both of northerly trend. A monoclinal belt with moderate (15° to 30°) south-westerly dips forms the south-westerly limit of the limestone outcrop and coincides with the line of the D_1 apron reef. Faults are of west-north-westerly trend and include both normal and reversed types. Most appear to branch off the Blakemoor fault and die out westwards towards the bounding monocline.

LEAD-ZINC MINERALISATION

In common with the rest of the Derbyshire orefield, the limestones within the area have been affected by mineralisation, probably Permian or Triassic, that gave rise to a suite of veins and replacement bodies in which the lead and zinc sulphide ores, galena and sphalerite, lie in a matrix of the gangue minerals, calcite, baryte and fluorite. The veins are generally vertical, trending in two main directions, one between north-east and east, and the other approximately north-west (Fig. 4). Major veins ('rakes'), most of which belong to the north-easterly trending group, range up to 20 m in width. Minor veins range up to about 4 m wide. Most of the veins lie in joints but a minority (Figs. 4 and 5) lie in faults. Less common ore bodies ('pipes' and 'flats') are horizontal rather than vertical and were formed by replacement of limestone adjacent to veins and major bedding planes. Calcite is the dominant gangue mineral, with fluorite and baryte in very variable but subordinate amounts; the regional eastward increase in the latter minerals noted by Mueller (1954) cannot be demonstrated within the area.

Alteration of the limestone wall rocks can be detected up to about 10 m from the veins, the width of the altered zone in any particular instance depending on the degree of minor fracturing of the rock walls. The commonest alteration is the replacement of calcite by dolomite and quartz.

Most of the mineralisation is found north-east of the Cronkston-Blakemoor fault zone, thus it is the Monsal Dale and Eyam limestones that are mainly affected. The concentration of mineralisation along anticlines has been noted elsewhere in Derbyshire but in this area the main concentrations appear to be situated on the flanks of folds (Figs. 4 and 5).

Assessment Procedures

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

FIELD SURVEY

As up-to-date 1:10 560 maps were available, fieldwork mainly involved examining the extensive natural exposures and collecting samples at 1 m intervals from some, followed by drilling and sampling continuously from boreholes. Initially 12 boreholes were drilled to depths ranging from 25 to 102 m and continuous cores of at least 74 mm diameter were obtained. To provide additional data, a further four boreholes were drilled to an average depth of 60 m, the fifth and deepest going to 207 m. All these boreholes were drilled by contractors using truck or trailer-mounted Reich, Boyles and Joy Sullivan rigs. Drilling was by air and water flush methods. In general the recovery of limestone cores exceeded 90 per cent, but some difficulties were encountered with cherty limestone, clay and shale bands. Information was also obtained by the use of a portable 'Packsack' drill operated by Institute staff. Limestone cores up to 22 m diameter were obtained down to a maximum depth of 7.6 m. Although recovery was almost 100 per cent, the fractured nature of the limestone near the surface effectively limited the depth to which this machine could be used. All samples, whether collected from exposures or boreholes were subjected to preliminary lithological and mechanical logging in the field; fracture spacing was recorded and the tensile strength measured using a point load strength apparatus (Franklin and others, 1971).

LABORATORY PROGRAMME

Lithological, petrological and mineralogical determinations were made using a combination of microscopical and staining techniques applied to sawn and etched rock surfaces, peels and thin sections. Additional data were obtained from semiquantitative X-ray methods and reflectivity measurements. A primary classification of the rocks, based on carbonate content, was achieved by measuring the magnitude and nature of the acid-insoluble residue. Chemical analyses for major and trace elements were performed by the Analytical and Ceramics Unit of the Institute on samples from both borehole cores and exposures. A summary of these results is given in Appendix C. More detailed records may be consulted at the appropriate office of the Institute on application to the Head, Mineral Assessment Unit.

CLASSIFICATION

Limestones can be classified in a variety of ways, but the two methods chosen for use in this report are based on petrology (see Appendix A) and on calcium carbonate ($CaCO_3$) content. The former is used to describe the rocks in lithological terms and the latter is preferred in the assessment of resources by grade and to demonstrate them on the assessment map. The relationship between the five categories adopted, their $CaCO_3$ contents and possible end uses is shown in Table 2.

Results

The data obtained from the laboratory investigations are reported in the following sections.

STRATIGRAPHICAL PETROGRAPHY

The different types of limestone within the four limestone formations, their distribution and the relationship between their petrography and purity can be summarised as follows.

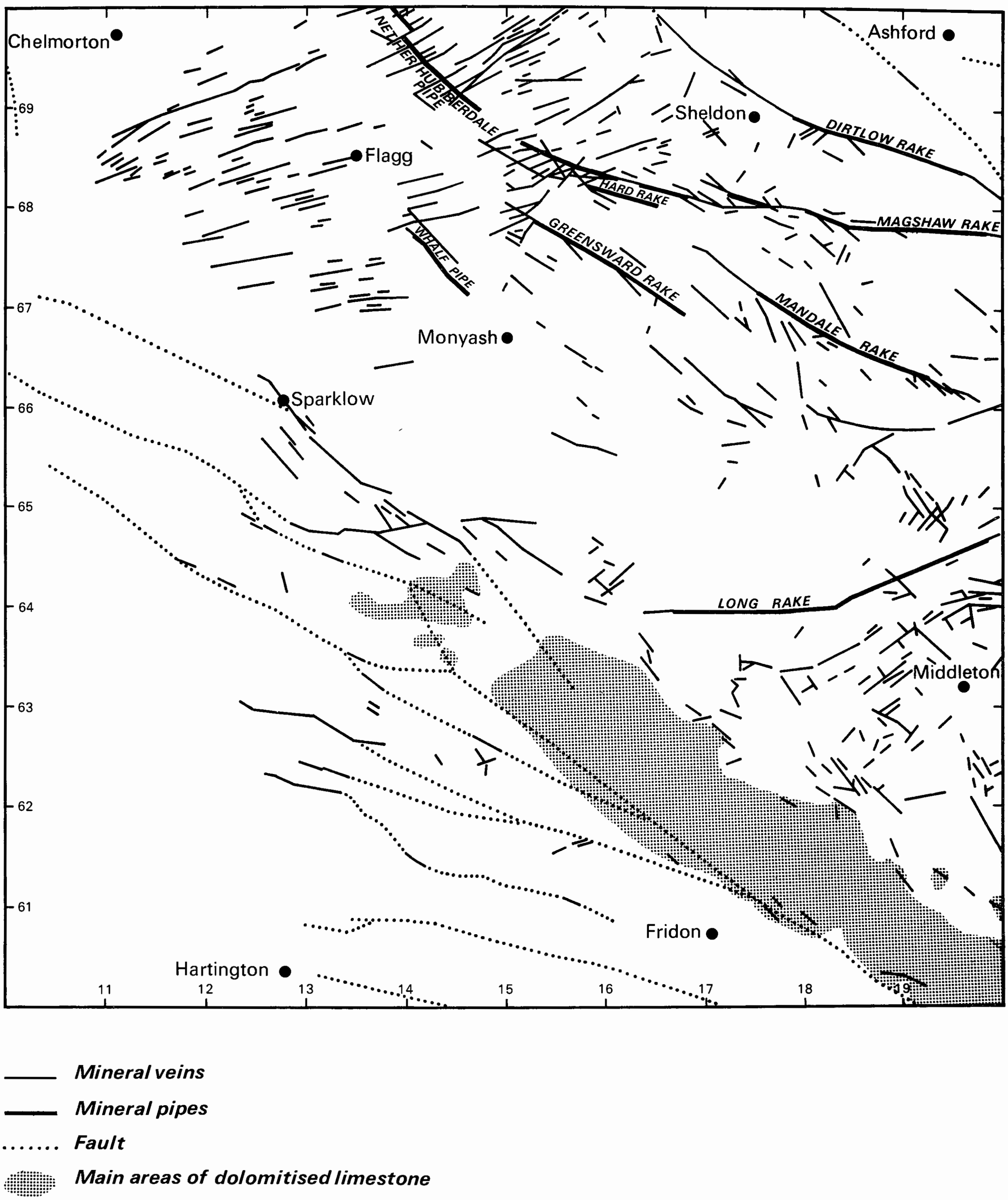


Fig. 4. Distribution of mineral veins and secondary dolomite

Table 2. Classification of limestones by purity with some possible industrial uses.

Category	Percentage $CaCO_3$	Equivalent CaO	Possible industrial use*
1. Very high purity	98.5	55.18	steel, glass, rubber, plastics, paint, whiting
2. High purity	97 - 98.5	54.34 - 55.18	iron, ceramics, general chemical use, Portland cement, sugar
3. Medium purity	93.5 - 97	52.38 - 54.34	paper, animal feeding stuffs, agriculture
4. Low purity	85 - 93.5	47.62 - 52.38	asphalt
5. Impure	85	47.62	natural cement, mineral wool

*$CaCO_3$ content is only one of several chemical specifications governing end use: silica, iron, sulphur and certain trace elements may be as important in some of these applications.

The Woo Dale Limestones

The Woo Dale Limestones have a maximum exposed thickness of about 65 m but a borehole [136 628] near Vincent House Farm proved a further 35 m without reaching the base of the sequence. The validity of the subdivision into Vincent House Beds and overlying Hand Dale Beds (Sadler, 1966) is confirmed by the present study. The former consist of pale coloured, massively bedded calcarenites in which the dominant lithology is an Algal Crinoidal biosparite (for convention and glossary see Appendix A). Commonly occurring algae include Koninckopora and encrusting forms similar to 'Girvanella'. Other allochems, notably pellets, brachiopod shells and foraminifera, occur less commonly. In contrast, the Hand Dale Beds, which are about 35 m thick, consist of white weathering, fine grained biomicrites interbedded with coarser grained biopelsparites.

The chief noncarbonate mineral present in both subdivisions is quartz which occurs as a minor accessory (less than 5 per cent) in the form of scattered euhedral crystals (average length 80 microns). Clay infillings along joint planes are common and traces of haematite and sphalerite have also been recorded. Collectively the Woo Dale Limestones may be classified as very high purity limestone (more than 98.5 per cent $CaCO_3$), although some of the upper beds are only of high purity (97 to 98.5 per cent $CaCO_3$).

The Bee Low Limestones

The Bee Low Limestones crop out between Chelmorton and Hartington and consist almost exclusively of alternating Algal Crinoidal biosparites and biopelsparites. The faunal and textural characteristics of these lithologies are broadly similar to those of the Vincent House Beds. A widespread current-sorted limestone which typically contains an assemblage of algal-encrusted crinoid, shell and pelletal debris enclosed in a spar matrix (Plate 6a) marks the top of the Bee Low Limestones. Other diagnostic marker beds are rare and detailed subdivision of the formation has not been attempted. Towards the western edge of the limestone crop the beds pass laterally into a discontinuous marginal reef belt (Fig. 3).

Impersistent clays and clay wayboards, which range in thickness from a few millimetres to over 1 m, occur throughout the Bee Low Limestones and locally account for 3 per cent of the total thickness of the division. These beds have not been of value in correlation in this area (but see Walkden, 1972).

The limestones in this formation are consistently of very high purity. The chief non-carbonate mineral is authigenic quartz, rarely exceeding 0.5 per cent, which occurs as doubly terminated euhedral prisms. Locally, however, up to 5 per cent has been recorded at restricted horizons, for example, in a quarry (Plates 5a and 6b) about 2½ km north-east of Hartington village, at Hartington Station [151 613] and in the adjacent Heathcote quarry [149 607].

The Monsal Dale Limestones

The Monsal Dale Limestones crop out in the north-eastern half of the area and in several small outliers along the western and southern margin of the limestone crop. In contrast to the Woo Dale and Bee Low limestones they are much more variable and contain several distinctive marker horizons (Fig. 6). The succession can be divided into three: two pale limestone sequences separated by darker, diachronous, limestones. The distribution of these divisions is shown in Fig. 3 and their thickness variations are given in Table 3.

Thick dark limestone sequences proved in the east thin westwards; the zone of thickness changes is shown conjecturally by a line on the inset in Fig. 6.

The lower pale limestones crop out in the western area between Chelmorton Thorn [119 697] and Crookston Grange [119 656]; in the east, these beds are only seen at outcrop in a

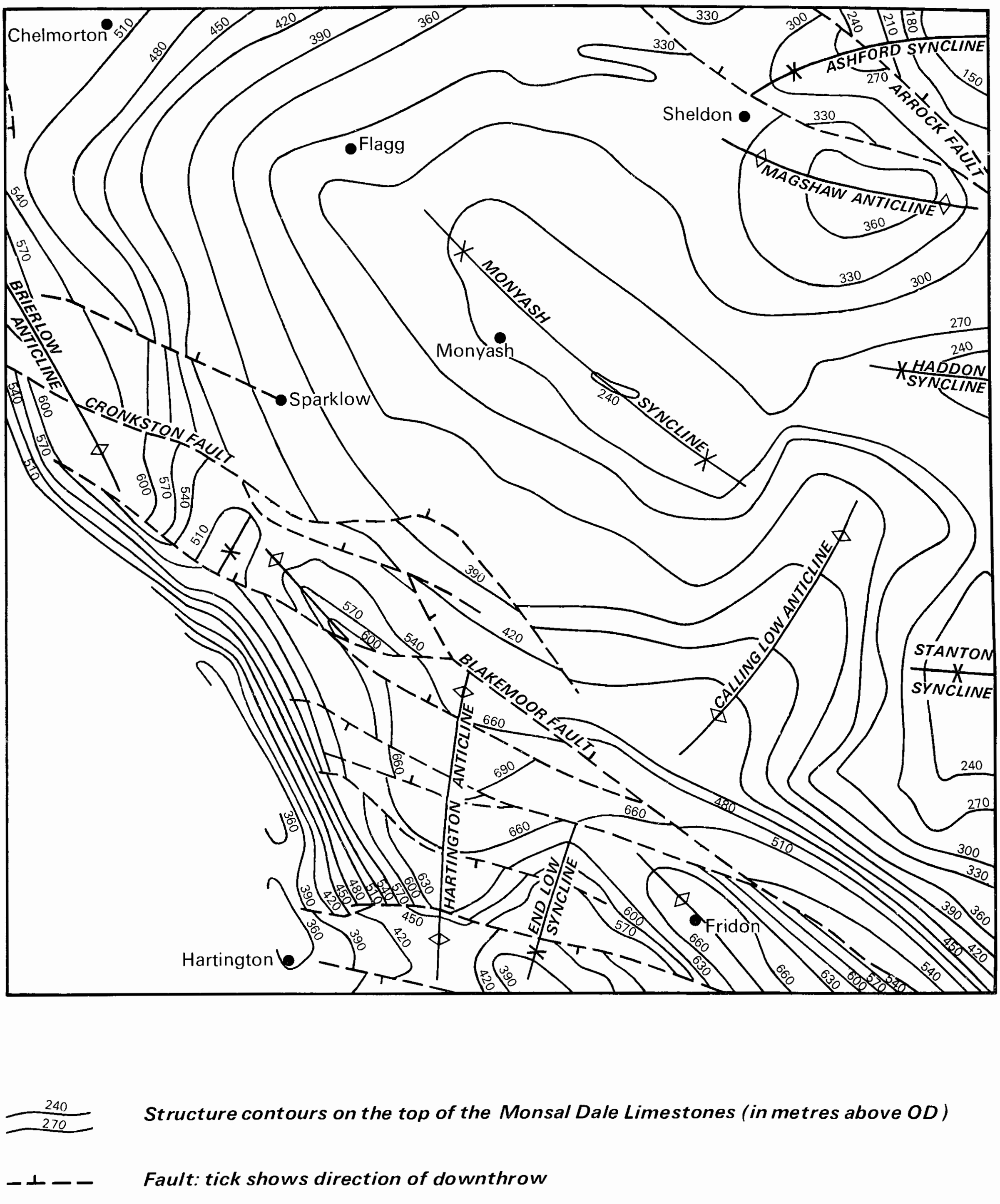


Fig. 5. Structure

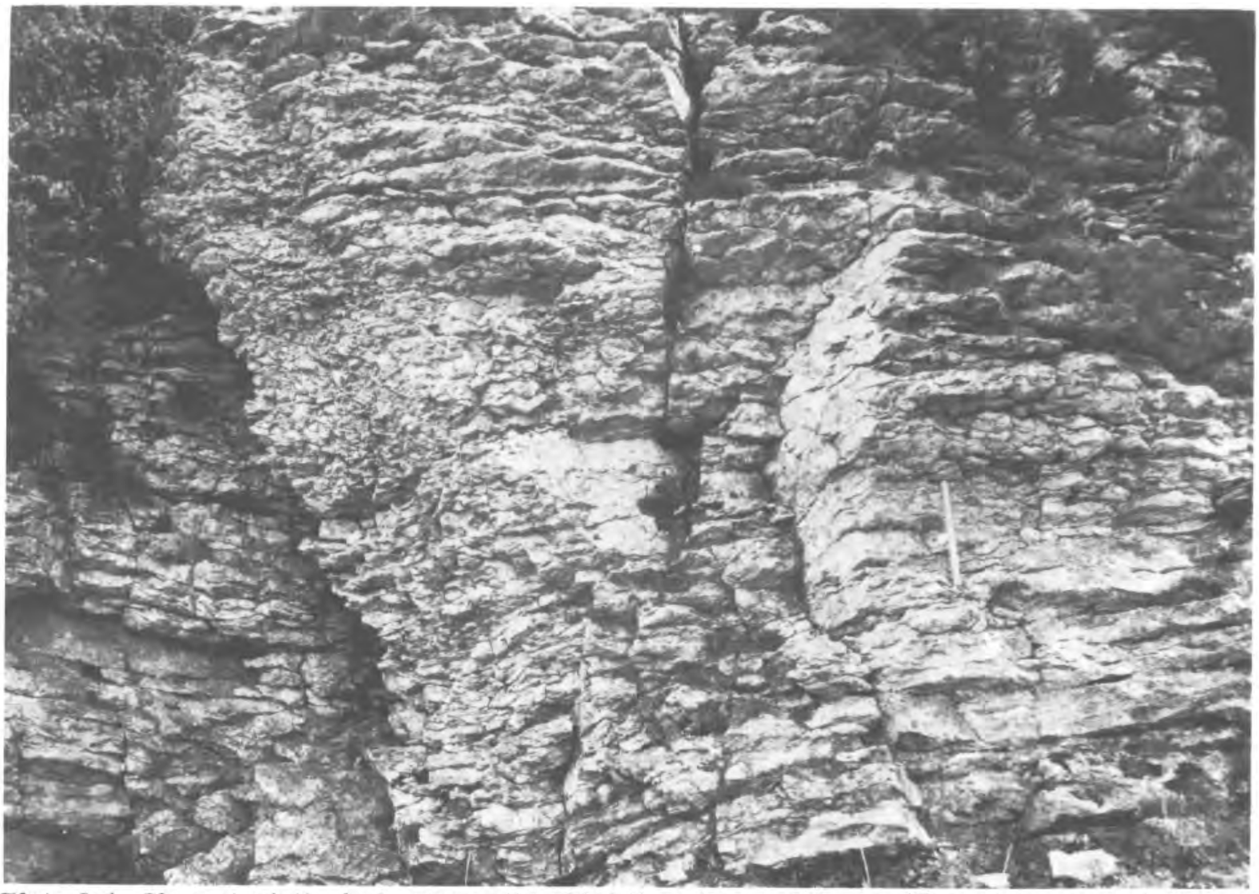


Plate 2.1 Characteristic dark grey well bedded limestones of P_2 age (Eyam Limestones) SK 1486 6768

Plate 2.2 Pale grey limestones of probable D_2 age (Monsal Dale Limestones) SK 6317 6324

Plate 3. Flat reef complex in the Eyam Limestones (P_2 Zone), consisting of elongate lenses of pale grey brachiopod-rich micritic limestone interbedded with thinly bedded crinoidal calcirudites and grey calcarenites with large productoids and chert nodules. SK 1491 6774.

Plate 4.1 Lathkill Dale. Dark lithofacies of the Monsal Dale Limestones (D_2 Zone) showing irregular bands of dark chert which have formed at or near bedding surfaces; equivalent to those seen at Ashford (Plate 4.2). SK 1944 6587

Plate 4.2 Ashford Quarry. Thinly bedded D_2 limestones and chert in the 'dark facies' of the Monsal Dale Limestones. SK 1908 6939

Plate 5.1 Hartington Station Quarry. Massively bedded D_1 limestones with thin clay wayboards (Bee Low Limestones). SK 1510 6132

Plate 5.2 Lathkill Dale. Base of thick shell bed in the Monsal Dale (D_2) Limestones. The silicified shells, partially etched out by solution weathering, probably belong mainly to the genus Gigantoproductus; most are in their original living positions. SK 1836 6552

Table 3. Thickness variations in the Monsal Dale Limestones.

Limestones in the western area	Thickness (m)	Equivalent limestones in the eastern area	Thickness (m)
Pale, cherty in part	up to 65	Pale, cherty	0 to 65
Dark, cherty in part	up to 20	Dark, cherty	up to 160
Pale, no chert	up to 40	Pale, no chert	50+

small roadside quarry [178 700] beneath the Shacklow Wood Lava. Facies variations affect the thickness and lateral persistence of specific lithologies but in the main the sequence consists of massively-bedded biomicrosparites with crinoid, brachiopod and foraminiferal debris as the most commonly occurring skeletal constituents. Over the western part of the crop regional correlation is controlled by several reliable marker horizons; the base of the sequence is marked by an increase in 'Girvanella' and the appearance of Koninckopora. Distinctive pelsparite beds, often less than 2 m thick, occur throughout; at the top, a 3 m bed, rich in 'Girvanella', is again developed. Silica in the form of doubly terminating euhedral quartz grains, averaging 80 microns m length, is the only major non-carbonate mineral present. The distribution of quartz crystals is stratigraphically controlled. Additionally, the silica content increases towards the north-western part of the outcrop to about 2 per cent.

The overlying dark limestones crop out in the western part of the sheet in a narrow arcuate strip parallel to the Upper Millers Dale Lava. The rocks ranging in colour from mottled shades of grey to true dark greys, are predominantly free of chert and consist of biosparites and biomicrosparites. They contain a diverse fauna which includes a large population of recrystallised gastropod shells, various algae and foraminifera (notably Coelosporella and Saccamminopsis). The sequence thickens rapidly towards the east and north-east where the limestones become darker, finer grained and are associated with bedded cherts. Substantial amounts of terrigenous and calcareous mud are concentrated in the matrix of the rock but true micritic limestones (Plate 7b) are rare. Thin shale partings and sporadic clay wayboards constitute a minor part of the sequence. Several distinctive lithologies have been recorded in borehole NE 10 and are tentatively correlated with named bands exposed in the Ashford area. The Upper Dale Coral Band is represented at the base of the dark facies by a 5 m bed containing Lithostrotion junceum (Fleming), Dibunophyllum bipartitum konincki (Milne Edwards and Haime) and Diphyphyllum lateseptatum (McCoy). A pale, coral-brachiopod biomicrite some 30 m higher in the sequence is taken to be the Hobs House Coral Band. The next higher marker is an approximately 2 m thick, laminated bed which is known locally at the Rosewood Marble. Finely crystalline dolomite rhombs occur in patchy concentrations which are generally unrelated to any bedding structures but coincide more often with zones of silicification or chert formation. Farther south, sections through the uppermost beds of the dark facies are displayed in the sides of Lathkill Dale and similar lithologies were recorded from the lower part of borehole SE 5, near Middleton, but whether or not the sequence is of comparable thickness has not been established. Silica, which is the chief impurity in these rocks, occurs predominantly as discrete chert nodules, but smaller amounts occur as chalcedonic replacement of shell debris. Clay-grade silica and isolated euhedral quartz crystals have also been detected. Other important non-carbonate impurities are pyrite and clay minerals. The purity of the dark limestones is primarily related to the amount of chert or clay or both in the rocks. In the eastern part of the area, both contribute to the low carbonate values (less than 93.5 per cent $CaCO_3$) of these limestones. However, towards the west and north-west, a reduction in the two chief impurities results in somewhat purer limestones (93.5 to 97 per cent $CaCO_3$).

Of the three subdivisions, the uppermost covers the greatest surface area. It is 65 m thick where fully developed and is composed mainly of pale massively bedded, cherty biosparites and biomicrosparites. Coral bands, gigantoproductoid shell beds and foraminiferal biosparites are characteristic of the middle and upper parts of the sequence. Sporadically, dark biosparites, more typical of the underlying facies are developed, but these only become important in the north-east where pale limestones pass laterally into darker equivalents. Marker horizons are rare and only a broad regional correlation is possible.

The chief non-carbonate materials in the upper pale limestones are chert nodules and chalcedonic silica. Locally the distribution of chert appears to be stratigraphically controlled but there is a regional trend of increase towards the east. The distribution of silica in skeletal debris is closely allied to the lithology. Calcirudites, particularly the gigantoproductoid beds, show most silicification and frequently contain more than 6 per cent quartz or chalcedonic silica replacing shell debris. Subordinate clay minerals and pyrite are normal insoluble constituents of the darker limestones. The sporadic development of non-carbonate minerals results in a wide range of limestone impurities. Where chert is abundant the limestones are of low (less than 85 per cent) or

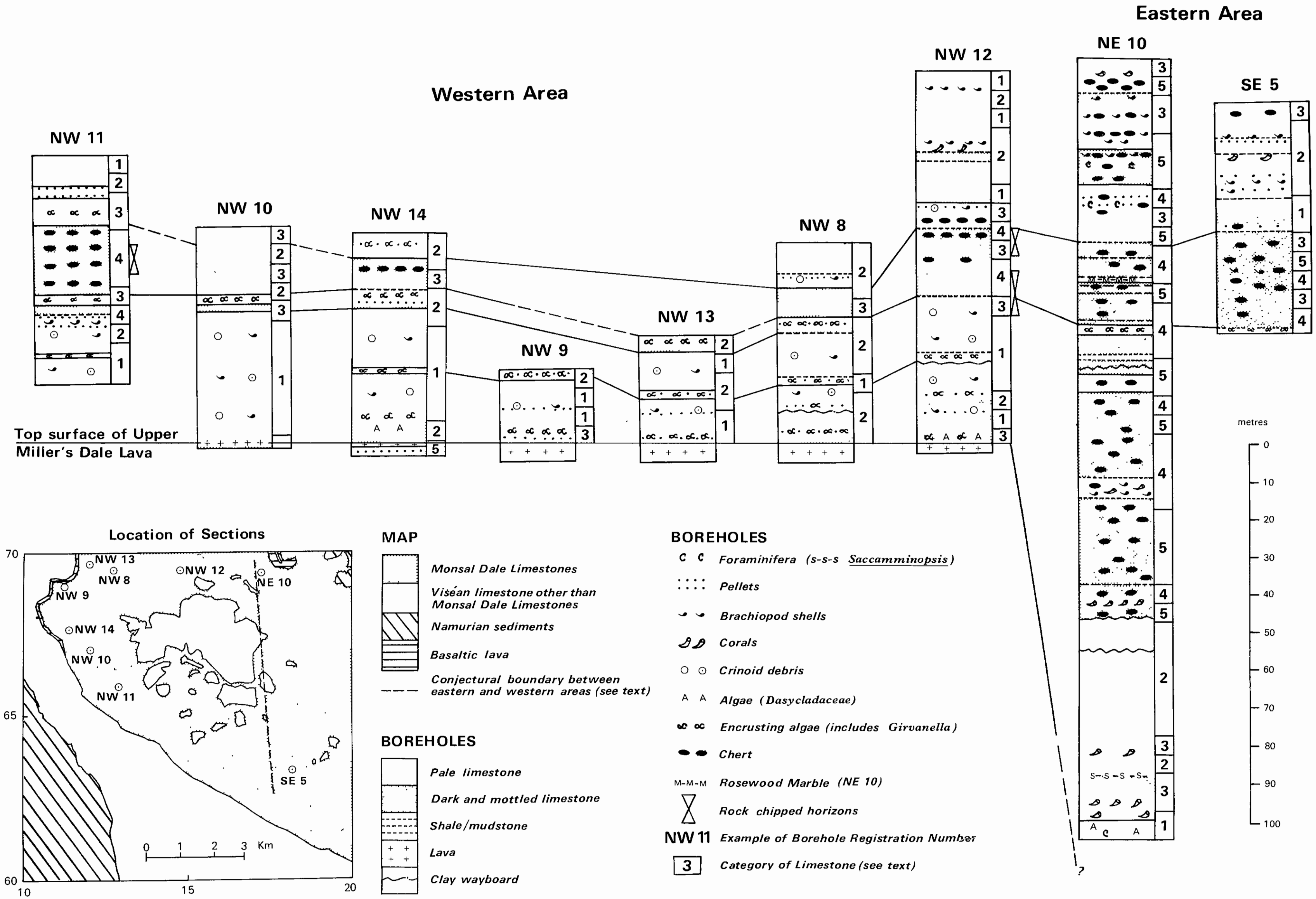


Fig. 6. Generalised vertical sections of the Monsal Dale Limestones

medium purity (85 to 97 per cent $CaCO_3$). Over the remainder of the crop high purity limestones predominate but individual beds of higher or lower purity are not uncommon.

A zone of pyrite enrichment, up to 1 m thick, is usually present at the contacts between the basalts and the Monsal Dale Limestones.

The Eyam Limestones

The Eyam Limestones, up to about 30 m in thickness, crop out in outliers along the axis of the Monyash syncline (Fig. 5). Over much of the outcrop the most commonly occurring limestones are dark, cherty biomicrites and biosparites which together resemble the darker beds of the Monsal Dale Limestones. Coarse grained shelly crinoidal calcarenites are locally important, but most rocks contain only indeterminate finely comminuted shell debris. Nodular chert is present throughout the area in variable amounts, while in the north-east the limestones appear to pass laterally into shales.

Patch-reefs occur at different stratigraphical levels and consist of an open framework of bryozoa, brachiopods and crinoid debris (Plate 8b). Original cavities have been infilled by micrite or spar or both. Flat-bedded crinoidal biosparrudites are usually developed around the reef deposits, as for example in the valley side of upper Lathkill Dale.

Apart from traces of silicified shell debris, non-carbonate minerals are rare in the reef facies and these rocks are of high purity. In the dark lithofacies, however, the presence of chert nodules and clay (concentrated in stylolites) reduces the purity of these limestones to low to medium purity (85 to 97 per cent $CaCO_3$).

DOLOMITISATION

The distribution of dolomite in the Bee Low Limestones and Monsal Dale Limestones has been discussed earlier. The full thickness of the affected sequence has not been established, but over 48 m have been proved in borehole SE 48 on Green Lane. Locally, at depth, the dolomitisation is intermittent and appears to have been contained by clay wayboards. The rocks, which are grey-brown in colour and have a vuggy appearance, exhibit considerable mineralogical and textural variation: in some the original depositional textures have been completely destroyed and replaced by an interlocking mosaic of dolomite crystals. Such rocks are true dolomites (Appendix A, Plate 7b). Where dolomitisation has been incomplete, as in beds of calcitic dolomite or dolomitic limestone, relict structures are commonly preserved.

NON-CARBONATE FRACTION

Detailed data, as determined by insoluble residue and X-ray methods, are recorded in Appendix C. The non-carbonate fraction of the limestones within 10 m of the surface increases in amount across the area in a north-easterly direction (Fig. 7). A similar trend exists in the rocks down to at least 30 m; although information from greater depths is scanty, a consistently high non-carbonate fraction was recorded to a depth of almost 150 m in borehole NE 10, near Sheldon (Fig. 8). Silica and clay minerals form up to 90 per cent of the residue, the balance comprising pyrite, galena, sphalerite, baryte and fluorite.

Silica is the major constituent as demonstrated by the results from borehole NW 6B (Fig. 9).

It occurs in the form of euhedral quartz crystals, as a replacement for shell structures and as chert. The first are found scattered throughout the rock, but concentrations at several horizons commonly increase the local insoluble residue by between 2 and 3 per cent; exceptionally it is increased by 5 per cent. The crystals may include calcite dust or haematite. Fossil debris may be partially or completely replaced by silica giving rise to very high insoluble residue values; brachiopods are the most susceptible, but silification of all the main fossil groups has been recorded. The distribution of chert, recorded from field and borehole observations, is shown in Fig. 7. The data give a fairly detailed picture of chert distribution within 10 m of the surface, but at greater depths they provide only a broad indication of major trends. The field observations confirm the trend suggested by the insoluble residues that the concentration of siliceous impurities increases towards the east and north-east of the sheet.

Similarly the clay content of the limestones shows an increase towards the north-east. Illite, kaolinite, and mixed-lattice clays are the most commonly occurring clay minerals. Clay content may rise to more than 30 per cent, particularly in the Ashford area where the limestones are interbedded with thin mudstones and mudstone partings.

Finely divided pyrite is common in the darker coloured limestones, while baryte and fluorite are recorded in the residues adjacent to veins.

ROCK CHEMISTRY

Gross variations in limestone chemistry reflect changes in the depositional environment. Accordingly, purity (Table 2) changes systematically on a regional scale and may be predicted with accuracy when a stratigraphic correlation has been established. In contrast, many of the trace elements (lead, zinc, copper, arsenic and fluorine) are the product of epigenetic mineralisation, resulting in local concentrations, so that the distribution of these elements is difficult to predict even with close sampling grids. Chemical changes due to groundwater circulation, which may include dolomitisation and the redistribution of iron and manganese, show both regional and random local variation.

The chemical results are summarised in Table 4. Chert-free samples were selected for chemical analysis and consequently the mean silica values recorded for the Eyam Limestones and the upper two divisions of the Monsal Dale Limestones are low (1.10 to 2.45 per cent). This results in discrepancies between $CaCO_3$ contents calculated from analyses and the stated limestone categories (see p. 19) which make allowance for the presence of chert.

In the Woo Dale and Bee Low limestones the normative composition consistently exceeds

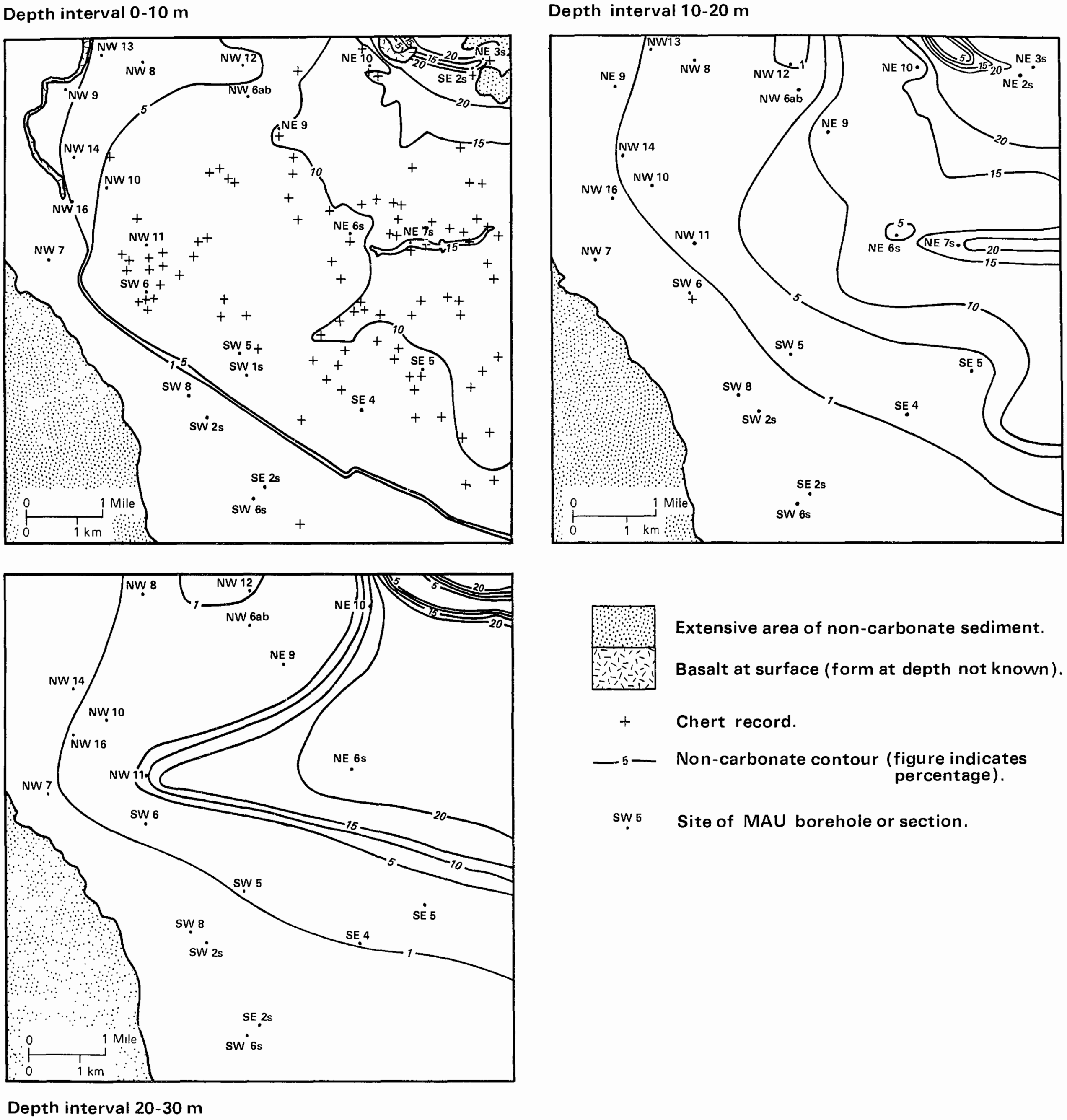


Fig. 7. Contours showing regional variations in the distribution of the non-carbonate fraction for given depth intervals

Table 4. Summary of the mean chemistry of the main limestone divisions.

LITHOSTRATIGRAPHY			MAJOR ELEMENTS (percent)										TRACE ELEMENTS (ppm)						Limestone Category
			CaO	SiO_2	Loss on ignition	Al_2O_3	MgO	SO_3	P_2O_5	Na_2O	K_2O	F	Fe_2O_3	Cu	Zn	Pb	Mn	As	
EYAM LIMESTONE		mean value ($\bar{x}$)	53.17	1.70	43.09	0.53	0.47	0.33	0.04	0.03	0.07	0.09	462	16	16	31	257	0	2, 3, or 4
		standard deviation (σ)	1.14	1.43	1.02	0.53	0.14	0.16	0.03	0.01	0.07	0.07	626	27	24	44	203	0	
		max. observed value (x max)	54.45	4.47	44.28	1.44	0.56	0.65	0.10	0.04	0.19	0.18	1600	75	10	130	530	0	
		min. observed value (x min)	51.25	0.50	41.24	0.06	0.39	0.16	0	0.01	0.01	0.02	70	0	0	10	60	0	
MONSAL DALE LIMESTONES	upper pale facies	$\bar{x}$	54.31	1.10	43.34	0.09	0.38	0.46	0.03	0.02	0.02	0.06	240	12	19	6	114	1	1, 2, 3, or 4
		σ	0.89	0.94	8.1	0.11	0.33	0.68	0.02	0.03	0.02	0.04	201	16	11	6	81	4	
		x max	56.38	5.92	44.04	0.62	0.78	2.20	0.11	0.21	0.13	0.19	1180	100	60	30	600	17	
		x min	47.95	0.08	40.0	0	0	0.04	0	0	0	0	40	0	0	0	30	0	
	dark facies	$\bar{x}$	53.28	2.45	43.93	0.26	0.64	0.46	0.06	0.04	0.05	0.06	581	15	27	7	114	3	2, 3, 4, or 5
		σ	2.30	3.29	4.22	0.32	0.81	0.27	0.07	0.14	0.07	0.08	597	9	27	16	62	6	
		x max	56.24	19.21	44.11	1.54	7.08	1.45	0.27	1.16	0.55	0.24	2500	55	130	100	310	25	
		x min	44.47	0.10	34.02	0	0.24	0.05	0	0	0	0	80	5	0	0	35	0	
	lower pale facies	$\bar{x}$	54.43	0.62	43.53	0.08	0.27	0.44	0.04	0.01	0.01	0.04	333	12	20	4	137	2	2*
		σ	0.85	0.70	0.50	0.19	0.10	0.21	0.01	0.02	0.01	0.06	381	8	10	18	121	3	
		x max	57.30	6.32	44.06	1.81	0.68	1.11	0.10	0.15	0.10	0.29	3195	60	50	160	850	5	
		x min	48.65	0.01	39.46	0	0.15	0.07	0.02	0	0	0	70	5	10	0	55	0	
BEE LOW LIMESTONES		$\bar{x}$	55.99	0.15	43.84	0.01	0.21	0.38	0.02	0.02	0	0.03	199	6	17	2	136	2	1*
		σ	0.43	0.22	0.17	0.04	0.03	0.11	0.01	0.02	0	0	162	5	7	5	44	4	
		x max	56.35	1.02	44.13	0.17	0.28	0.65	0.03	0.11	0.01	0.03	702	15	40	20	280	8	
		x min	54.00	0.01	43.39	0	0.17	0.15	0.01	0	0	0.03	70	0	5	0	75	0	
WOO DALE LIMESTONES		$\bar{x}$	55.44	0.16	43.93	0.03	0.26	0.20	0.01	0.02	0.01	0.05	146	9	12	15	86	0	1*
		σ	0.38	0.03	0.07	0.01	0.08	0.15	0	0.01	0	0.01	147	6	6	3	27	0	
		x max	55.88	0.21	44.05	0.05	0.44	0.23	0.02	0.02	0.01	0.07	630	25	30	20	130	0	
		x min	54.65	0.12	43.84	0.01	0.21	0.18	0.01	0.01	0	0.02	50	5	10	10	60	0	
DOLOMITIZED LIMESTONES		$\bar{x}$	31.63	1.34	46.98	0.06	20.17	0.42	0.02	0.05	0.03	0.03	3430	24	209	15	856	1	
		σ	1.45	0.90	0.56	0.05	1.48	0.09	0.02	0.01	0.02	0.04	1600	14	100	13	241	1	
		x max	36.52	3.82	47.75	0.22	21.34	0.68	0.06	0.06	0.07	0.13	8200	60	360	50	1250	3	
		x min	30.65	0.74	45.65	0.02	15.54	0.31	0	0.04	0.02	0	2100	10	60	0	490	0	

[Boxed] Analyses of selected chert–free samples; limestone category determined from insoluble residue data modified to include a factor for chert

* Limestone category calculated from analyses. (Pure calcium carbonate contains 56.02% CaO)

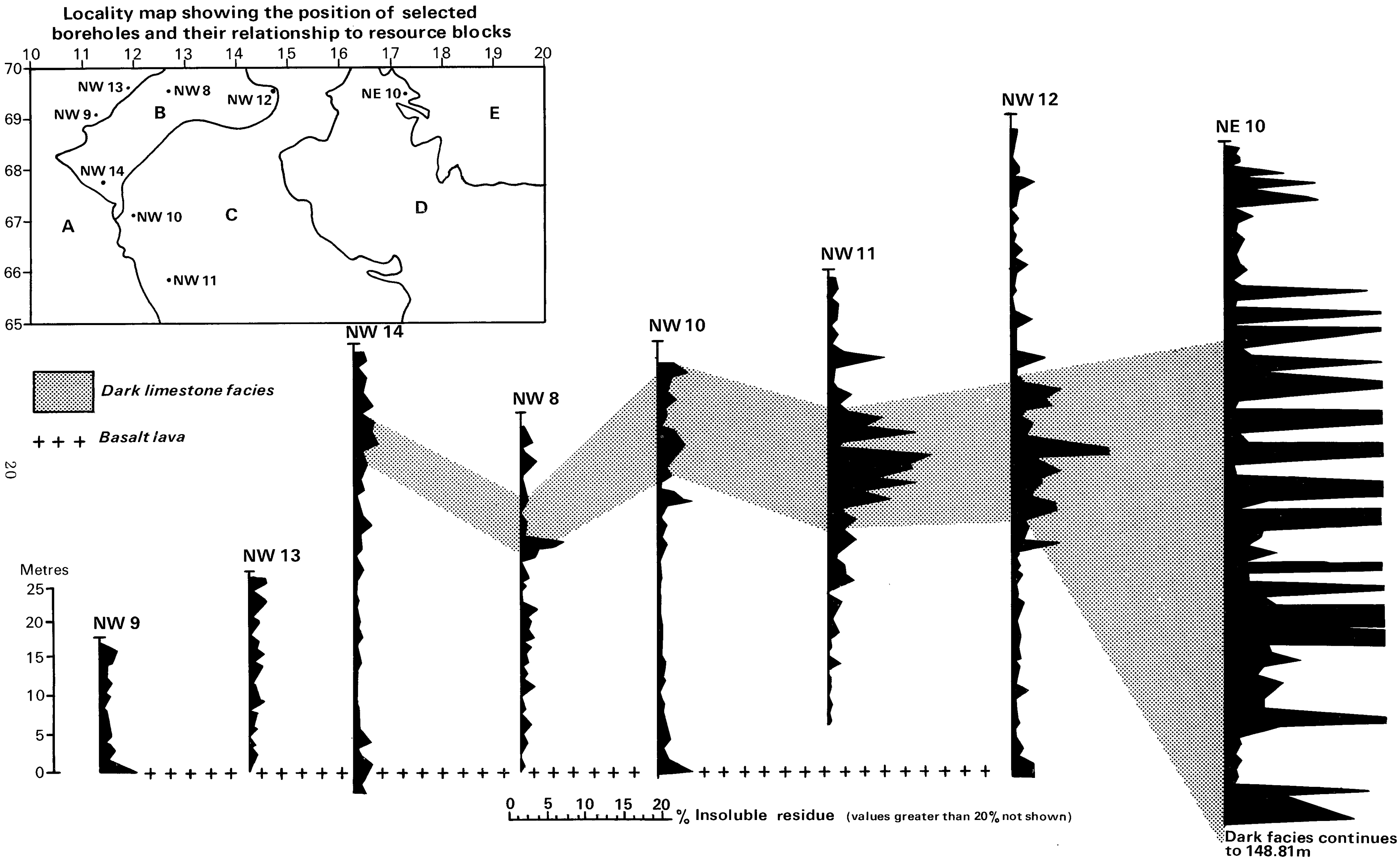


Fig. 8. The variation in non-carbonate fraction (acid-insoluble residue) across the northern half of sheet SK 16

99 per cent calcium carbonate. Accessory elements are combined in trace amounts to form dolomite, clay minerals and iron ores. Free silica is present in varying amounts; exceptionally values up to 5 per cent have been recorded in the course of insoluble residue determinations (Fig. 9) but such occurrences are very restricted vertically. The limestones of the lower pale facies of the Monsal Dale Limestones are chemically similar to the upper pale facies which, however, have slightly higher silica values.

Throughout the remainder of the sequence the widespread development of chert accounts for most of the chemical variation. The only other elements to show systematic variation are aluminium, magnesium, iron and sulphur. These occur in highest concentrations in darker coloured limestones where they are present in clay or iron minerals. Additionally, magnesia concentrations up to 7.08 per cent have been recorded in secondary dolomites from the dark facies of the Ashford area. A detailed study of chemical variation along the main north-westerly trending dolomite belt has not been undertaken but results are quoted for borehole SE 4 [170 625]. The results show that the sequence includes both true and calcitic dolomites (Appendix A).

Boreholes were sited well away from known mineral veins so that trace element concentrations, therefore, are more likely to approximate to the background level. Nevertheless, in extensively mineralised sequences, such as the Eyam Limestones, background levels are appreciably higher than, for example, in the Bee Low Limestones where mineralisation is rare. Trace amounts of zinc, copper, manganese and iron have been recorded at all stratigraphic levels. In contrast, the localised occurrence of lead, fluorine and arsenic makes it difficult to predict variations in regional distribution from the data available.

The chemical data have been subjected to statistical and graphical analysis and cumulative frequency curves have been produced for most elements. The curves for lead and zinc confirm the irregular occurrence of these metals and emphasise the need for closer sampling if their true regional distribution is to be determined.

Table 5 is a matrix of correlation coefficients produced from the chemical and insoluble residue data. The degree of interdependence of any two variables is given by a figure at the junction of the appropriate column and row. Values of +0.5 or more indicate positive correlations, whereas values less than -0.5 indicate a negative relationship. The matrix confirms the expected positive relationships between insoluble residue and silica, alumina, potash and magnesia (that is, quartz and the clay minerals) as well as the negative correlation between insoluble residue and both lime (CaO) and loss on ignition (approximately equivalent to carbon dioxide content). The weak negative correlation between MgO and CaO may indicate that the rocks are free of dolomite; additionally the correlation between alumina and magnesia suggests the presence of the latter in and its preference for the clay minerals. The positive correlation between SO_3, K_2O and Fe_2O_3 confirms both the presence of pyrite and its association with clay-rich rocks.

Among the trace elements, manganese appears to follow iron oxide but the other non-ferrous metals vary independently of each other.

COLOUR

Quantitative colour determinations are important for limestones which are to be used for the production of whiting, glass and paper. Measurements of tri-colour reflectance values were made using an EEL reflectance spectrophotometer. The limestones exhibit variations from white, through greys to black. Three colours, pale grey, mid-grey and dark grey are defined (Table 6) by reference to three filters (wavelengths 660, 520 and 470 nm respectively) and the relevant limiting reflectance percentages. Table 6 also shows the percentage distribution of these shades of grey for the four limestone formations present in the area. Dark-coloured rocks are almost entirely confined to the Eyam Limestones, around Monyash, and to the dark facies of the Monsal Dale Limestones, which crop out near Ashford and in the bottom of Lathkill Dale. Over the remainder of the crop, pale colours dominate the Bee Low and Woo Dale limestones, while mid-greys are more common in the upper and lower beds of the Monsal Dale Limestones. Systematic colour determinations indicate that lateral variations are small and colour is therefore an important aid to correlation (see Fig. 6).

The relationship between colour and chemical composition is complex in detail, but some generalisations seem valid. From analytical evidence it is known that the majority of the very high purity limestones are located along the western margin of the crop in the Bee Low and Woo Dale limestones. Reflectance measurements on powder tablets prepared from these and the Monsal Dale Limestone are summarised in Table 7. For each filter fairly constant values are obtained, irrespective of stratigraphy, and it could be concluded, therefore, that values in excess of, say, 82, 73 and 72 per cent respectively indicate rocks of very high purity. Although colour is also used industrially to predict chemistry (Anon., 1966) nevertheless some caution should be exercised. The generalisation that the paler the colour, the purer the rock, is true only for limestones with low silica contents. The pale-coloured upper part of the Monsal Dale Limestones, for example, has a variable silica content which makes accurate purity predictions unreliable using this method.

MECHANICAL PROPERTIES

Details of fracture spacing and point load strength indices are shown graphically for most boreholes in Appendix C. Fracture indices for all the limestones commonly fall between 300 and 1000 mm, values of less than 500 mm usually being associated with the thinly bedded dark facies of the Monsal Dale Limestones. A comparable range of values was obtained from

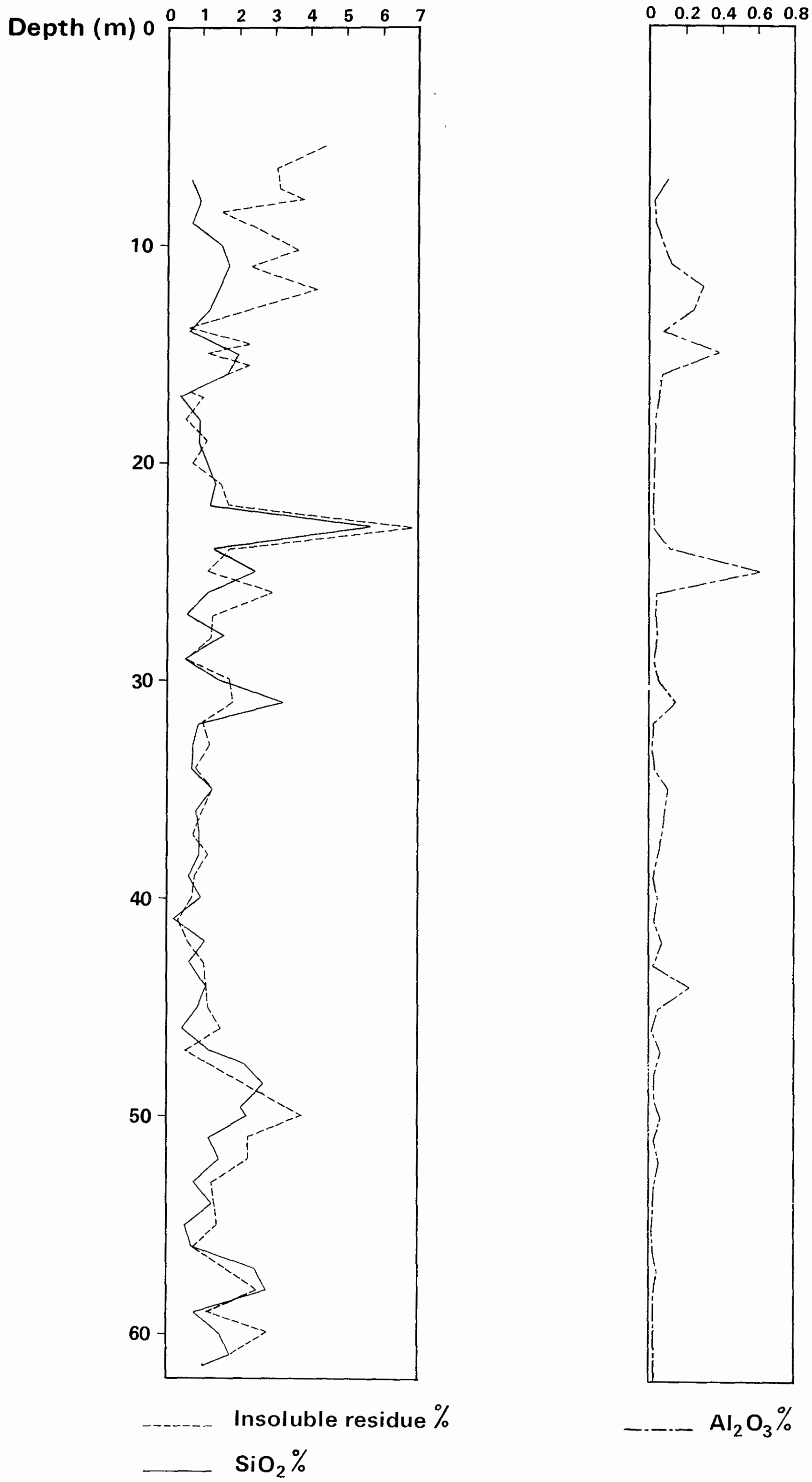


Fig. 9. The relationship between insoluble residue and chemistry in borehole NW 6B (apparent discrepancies magnitudes are due to sampling)

Table 5. Correlation matrix.

	INSOL. RESD.	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	LOSS ON IGNITION	MANGANESE	COPPER	ZINC	LEAD	IRON OXD. 3
INSOL. RESD.	1.0000	0.5094	0.6146	0.7813	0.2422	0.4794	0.6701	−0.6756	−0.5816	0.3126	0.0128	0.1217	0.0919	0.4906
MgO	0.5094	1.0000	0.5603	0.3912	0.2479	0.2006	0.4941	−0.4926	−0.2485	0.0677	0.0648	−0.0631	0.2677	0.3554
Al_2O_3	0.6146	0.5603	1.0000	0.6528	0.2922	0.3945	0.8773	−0.7136	−0.5055	0.3153	0.0907	0.0959	0.2545	0.6105
SiO_2	0.7813	0.3912	0.6528	1.0000	0.2149	0.4098	0.6780	−0.6572	−0.5907	0.3788	−0.1463	0.1933	0.0827	0.4889
P_2O_5	0.2422	0.2479	0.2922	0.2149	1.0000	0.2399	0.2972	−0.3417	−0.0969	0.0121	0.3312	0.2790	−0.1724	0.2450
SO_3	0.4794	0.2006	0.3945	0.4098	0.2399	1.0000	0.5354	−0.6953	−0.6993	0.3799	0.2500	0.2671	−0.1896	0.5390
K_2O	0.6701	0.4941	0.8773	0.6780	0.2972	0.5354	1.0000	−0.7756	−0.6024	0.3523	0.0641	0.1385	0.1071	0.6050
CaO	−0.6756	−0.4926	−0.7136	−0.6572	−0.3417	−0.6953	−0.7756	1.0000	0.7211	−0.3679	−0.2564	−0.1165	−0.0137	−0.6546
LOSS ON IGNITION	−0.5816	−0.2485	−0.5055	−0.5907	−0.0969	−0.6993	−0.6024	0.7211	1.0000	−0.3808	−0.0011	−0.0323	−0.0661	−0.5167
MANGANESE	0.3126	0.0677	0.3153	0.3788	0.0121	0.3799	0.3523	−0.3679	−0.3808	1.0000	0.0162	0.2124	0.0568	0.6155
COPPER	0.0128	0.0648	0.0907	−0.1463	0.3312	0.2500	0.0641	−0.2564	−0.0011	0.0162	1.0000	0.2213	0.0212	0.1641
ZINC	0.1217	−0.0631	0.0959	0.1933	0.2790	0.2671	0.1385	−0.1165	−0.0323	0.2124	0.2213	1.0000	−0.2104	0.2058
LEAD	0.0919	0.2677	0.2545	0.0827	−0.1724	−0.1896	0.1071	−0.0137	−0.0661	0.0568	0.0212	−0.2104	1.0000	0.0642
IRON OXIDE 3	0.4906	0.3554	0.6105	0.4889	0.2450	0.5390	0.6050	−0.6546	−0.5167	0.6155	0.1641	0.2058	0.0642	1.0000

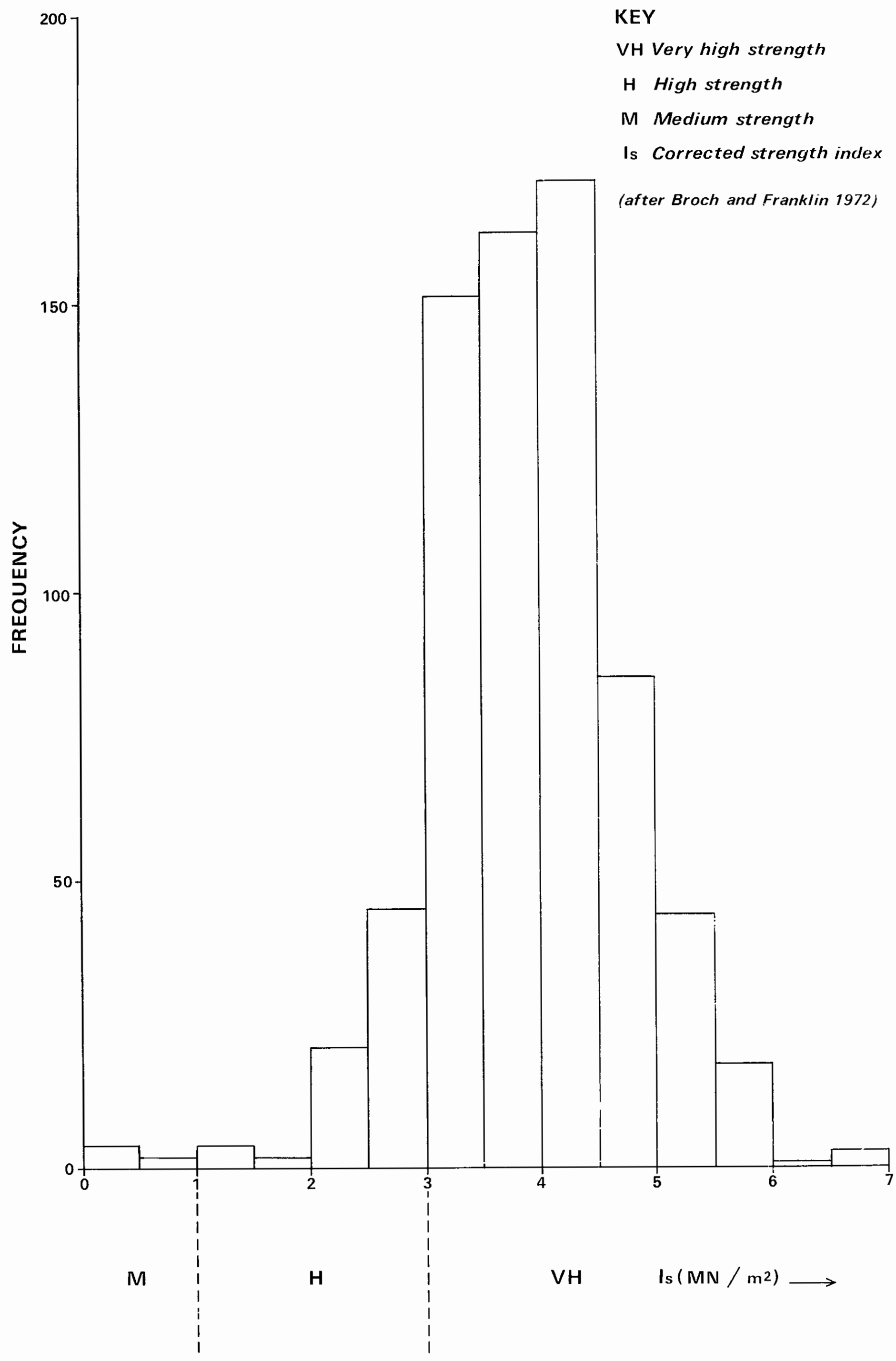


Fig. 10. Histogram of point load strength test index values

Table 6. Distribution of rock colour.

Formation and subdivisions		Colour (percentage) distribution: Pale 660 nm >35 per cent	Pale 520 nm >26 per cent	Pale 470 nm >24 per cent	Mid-grey 660 nm 35-15 per cent	Mid-grey 520 nm 26-12 per cent	Mid-grey 470 nm 24-11 per cent	Dark 660nm < 15 per cent	Dark 520 nm <12 per cent	Dark 470nm <11 per cent
EYAM LIME-STONES	Reef facies	12			88			0		
EYAM LIME-STONES	Dark lithofacies	0			21			79		
MONSAL DALE LIME-STONES	Upper Beds	24			66			10		
MONSAL DALE LIME-STONES	Dark lithofacies	3			26			71		
MONSAL DALE LIME-STONES	Lower Beds	35			59			6		
BEE LOW LIMESTONES		57			43			0		
WOO DALE LIME-STONES	Hand Dale Beds Vincent House Beds	70			27			3		

Table 7. Summary of powder reflectance results for very high purity rocks

Borehole	Formation	$CaCO_3$ per cent	Mean reflectance percentage (standard deviation) 660 nm	520 nm	470 nm
NW 7	Bee Low Limestones	>98.5	81(3)	75(3)	72(2)
NW 16	Bee Low Limestones		84(5)	79(6)	78(7)
SW 8	Woo Dale Limestones		81(3)	73(3)	73(3)
NW 6	Monsal Dale Limestones		86(1)	79(2)	77(3)
NW 11	Monsal Dale Limestones		82(3)	74(3)	72(4)
NW 13	Monsal Dale Limestones		83(2)	75(4)	72(3)
NW 14	Monsal Dale Limestones		82(2)	76(3)	74(3)

unweathered lava, while values of less than 50 mm are recorded, locally, from shale bands and friable argillaceous limestones which overlie the Upper Miller's Dale Lava.

Mean values for point load strength index (Is), corrected to a nominal 76 mm core diameter, are summarised by stratigraphical formation in Table 8.

All the limestones may be described as having very high strength (Broch and Franklin, 1972, fig. 22) and statistically there is no significant difference between the various formations. This is demonstrated by a histogram embodying the results for all the limestone (Fig. 10), in which a slightly skewed normal distribution with a mode between 4.0 and 4.5 MN/m^2, but a mean somewhat below 4.0 MN/m^2, are apparent. Despite the limited sensitivity of the testing method it seems likely that the strength of Carboniferous limestones is reasonably constant and largely independent of lithology in this area of Derbyshire. In this study unweathered lava was found to give similar strength values to limestone.

The 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 in grey. For cartographic reasons, geological data are restricted to those most likely to have a bearing on the extraction of limestone and dolomite: these include faults and other structural information which are shown in

Table 8. Summary of point load strength indices.

Formation		Mean value (Is) MN/m^2	Standard deviation MN/m^2	Number of observations
EYAM LIMESTONES		3.78	± 0.70	24
MONSAL DALE LIME-STONES	Upper beds	3.93	± 0.90	107
	Dark facies	3.90	± 0.82	161
	Lower beds	3.96	± 0.96	205
BEE LOW LIMESTONES		3.80	± 0.98	79
WOO DALE LIMESTONES		3.60	± 0.80	55

red and major geological boundaries in green. For a comprehensive geological background, the resource map should be read, therefore, in conjunction with a suitable large-scale geological map. An alternation of red and black dashes indicates the line of a mineral deposit. Drift is shown by black ornament.

CARBONATE RESOURCE INFORMATION

Shades of blue indicate the purity of the limestones to a depth of 10 m from the surface. Purity values were determined at sample points as follows: the measurements of insoluble residue (that is, the non-carbonate fraction) were grouped into an upper set covering the first 10 m of depth and others for each succeeding 5 m of depth. For each group the mean, standard deviation and confidence limits were calculated for 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 one hundred, gave a conservative (worst) estimate of the calcium carbonate content for each thickness increment. This value then determined the category of limestone according to the classification in Table 2. In some cases, where selective sampling has excluded chert and mudstone partings from insoluble residue determinations their percentage contribution was obtained by direct measurement on the core and the insoluble residue value adjusted by calculation.

Where beds of limestone of different purities are present within 10 m of the surface, a system of colour banding is used on the map to indicate 'zones of intermixing' (Fig. 11). The width of a zone depends on the attitude of the contact between the limestone categories. Where the interface dips gently, the zone will be broad (for example, the plateau between Monyash and Flagg); where it is vertical the system is, of course, not needed. Zones of intermixing are enclosed by a dotted line and the limestone categories involved by alternating stripes of the appropriate colours. This system is also used where 'solid' non-carbonate rocks form part of the uppermost 10 m of limestone.

Areas of dolomite or dolomitisation are indicated in green and by green stripes respectively. No attempt has been made to subdivide the dolomite quantitatively on a chemical basis, because it occurs intermittently both vertically

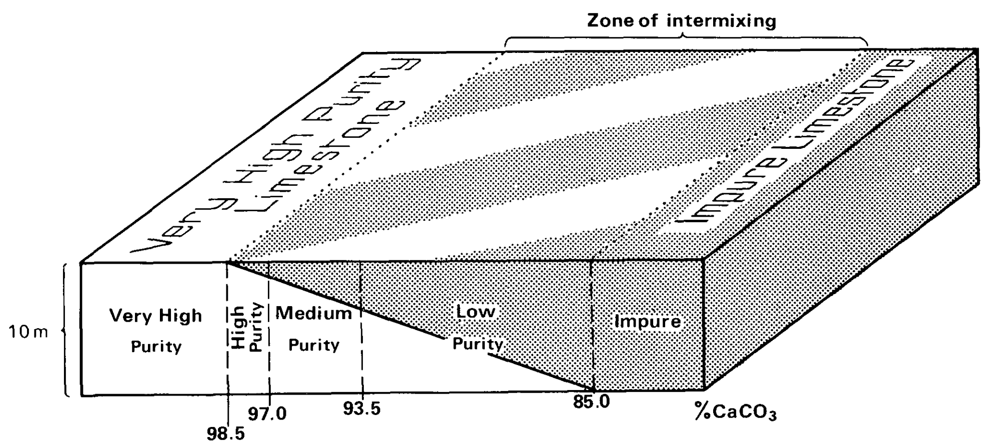


Fig. 11. Zones of intermixing produced at the contact of disparate qualities

and laterally and its margin is difficult to map.

STRUCTURAL AND MINERALISATION DATA

This information is largely abstracted from the 1:10 560 scale geological maps based on the survey by the North-West England Field Unit during 1969 to 1972. The structural interpretation has been augmented by information obtained from the assessment boreholes.

DRIFT GEOLOGY

Locally the limestone is covered by scree and up to 3 m of Head. Areas where these are thicker than 1.5 m are indicated in black, with the appropriate symbol. These deposits are ignored when calculating limestone quality.

MAU SITE DATA

At the site of each borehole or extensive natural section, the purity and other properties of the limestone are indicated in a tablet. The right half of the tablet shows the mean insoluble residue value for each 5 m increment of thickness. Where natural sections are recorded Ordnance Datum is given for the highest stratigraphical horizon collected.

Horizontal Sections

Horizontal sections have been drawn to show the relationships of the various limestone categories. These 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 biostratigraphy. They are therefore an interpretation using all the available data and should be treated only as a guide to the likely distribution of purity at depth. In particular, there is insufficient evidence to permit illustration of the depth of dolomitisation. Zig-zag lines have been used diagramatically to indicate the approximate position of a change in limestone category. The lines do not indicate the precise boundaries between categories.

Description of Resource Blocks

BLOCK A

The block covers an area of 28.9 km^2 and extends along the western margin of the limestone outcrop in a belt from 2 to 5 km wide. The ground surface rises from 335 m (1100 ft) in the east to over 366 m (1200 ft) on knolls overlooking the steep-sided valley of the River Dove in the south-west. In the north, near Chelmorton, the plateau surface is broken by the outcrop of the Upper Miller's Dale Lava which locally forms a steep escarpment. Although there is no surface drainage within the block, deeply cut dry valleys are common, especially in the south.

The groundwater level over most of the block is expected to be at about 244 m (800 ft) above sea level (Downing and others, 1970). Drilling has proved there is no perched water table above the lava.

The areas covered by each of the main rock types within 10 m of the surface are as follows: limestone, 25.7 km^2, dolomite and dolomitised limestone 2.7 km^2, basalt and limestones intermixed with basalt 0.5 km^2. Pocket deposits were not measured.

The block boundary encompasses outcrops of the Woo Dale and Bee Low limestones, and of the lower pale facies of the Monsal Dale Limestones: all are very high purity mineral. However, a capping of less pure Monsal Dale Limestones in the south of the block, near Heathcote, results in a local zone of intermixing between very high and high purity rocks. In the same general area, purity is further reduced by local concentrations up to 5 per cent of euhedral quartz, as, for example, in restricted horizons exposed in quarries at Hartington Station, [153 612] and Heathcote [149 607].

The limestones in the block are physically and chemically uniform: they average more than 99 per cent $CaCO_3$. Typically the rocks are pale-coloured and massively bedded with strength index values falling within the range 3.6 to 4.0 MN/m^2. Chert has not been seen and the only impurities other than disseminated quartz euhedra are trace amounts of clay minerals, iron oxides and sulphides.

Clays and clay 'wayboards', up to about 1 m thick, are commonly interbedded with the limestones. Although they have rarely been recorded in borehole cores due to sampling difficulties, these clays are seen in quarry faces in the south of the block. Their presence lowers the purity of the limestone, but as they are readily removable by high-pressure water jets during quarrying, they have been excluded from purity calculations. Illite/smectite, kaolinite, chlorite, anatase, quartz and pyrite have been recorded from clay wayboards (Walkden, 1972). Clay is also found infilling joints and fissures.

Along the eastern margin of the block, between Parsely Hay Farm [144 641] and Grattan Moor Farm [198 603], the limestones are extensively dolomitised. Some dolomitisation has been recorded outside the main belt, in Hartington Town Quarter for example, but these occurrences are limited to the vicinity of major faults or joint planes or both. Chemical analyses of dolomites show high trace element concentrations (Table 4).

A small area of limestone in the north of the block is affected by the Upper Miller's Dale Lava. Although this limestone (and the unweathered basalt, which has a similar strength index to that of limestones) could be used for aggregate, the chemical quality is much lower than elsewhere in the block. They account for a small part of the block, although other similar deposits probably exist, unmapped.

The purity of the limestones is largely maintained for more than 10 m below the surface over most of the block. A minimum thickness of at least 100 m of very high purity mineral has been proved in the Hartington pericline and over the rest of the block up to 330 m or more is likely to be present, except where effected by the Upper Miller's Dale Lava.

In the north the limestones dip at a low angle (less than 10°) into the Monyash Syncline (Fig. 5) and there is almost no faulting. South

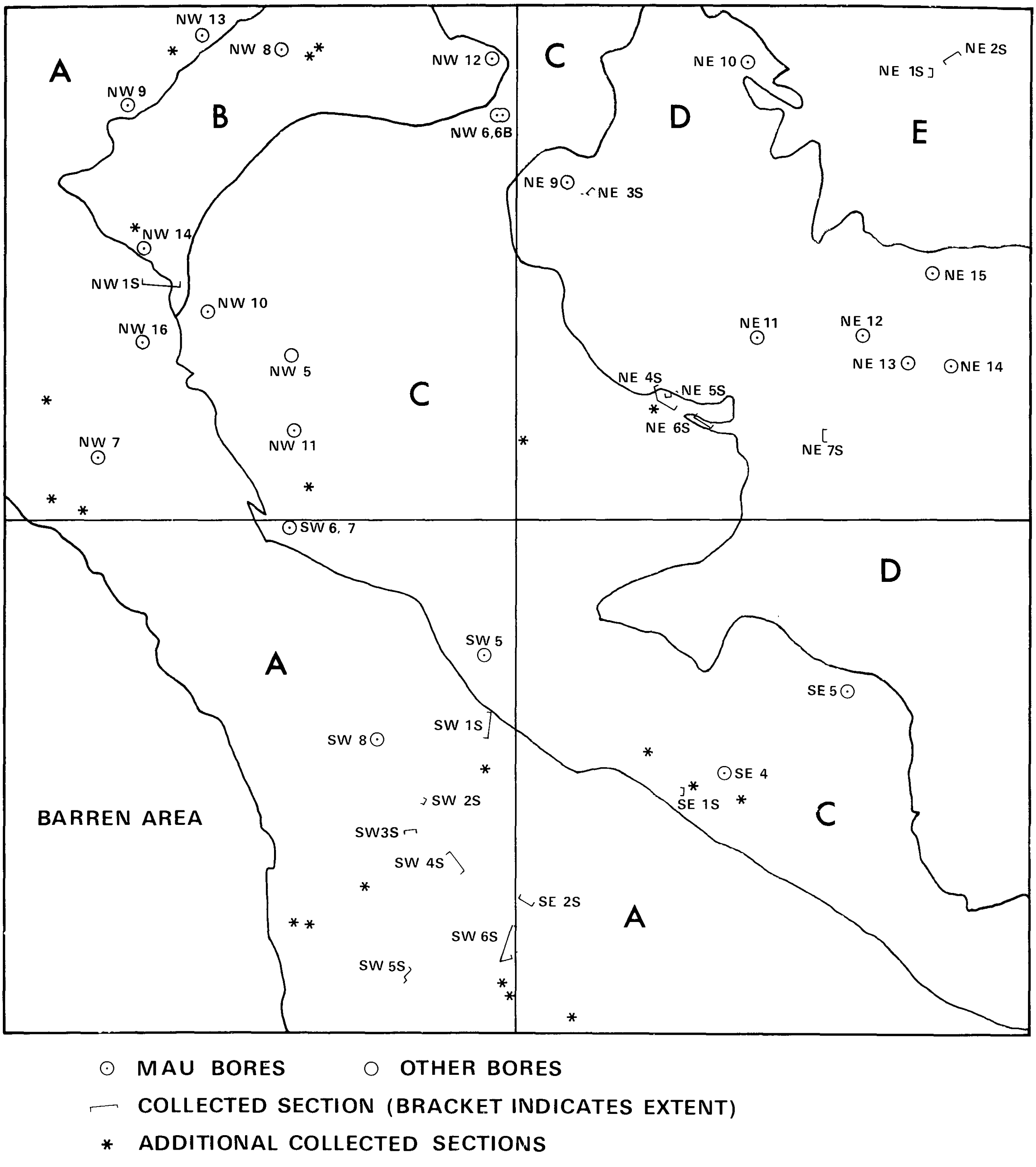


Fig. 12. Distribution of resource blocks and data points

of the Cronkston- Blakemoor Fault, however, the limestones are more strongly folded and faulted. Dips up to 30° are common and values over 60° have been recorded close to fault zones.

Mineralisation of the limestones is slight, but a number of old lead workings are recorded to the south side of Carder Low [130 626] and north-west of Pilsbury Lodge [126 639]. The major faults are not extensively mineralised. Vein deposits normally contain calcite, haematite and, locally, baryte, but fluorite is rare.

There is no drift cover over most of the block, but thin patches of Head occur as valley fill in the south. Small scree deposits are present below limestone scars in Long Dale and the Dove Valley.

BLOCK B

The block (Fig. 12) covers an area of 5.0 km^2 and is located on the limestone plateau which rises north-westwards to over 396 m (1300 ft). Numerous small dry valleys cross the area towards the south-east margin of the block.

Although the limestones are concealed only beneath a soil cover of about 1 m thickness, there are no major exposures in the area.

Groundwater is thought to lie at about 259 m (850 ft) above Ordnance Datum (Downing and others, 1970). There is no conclusive evidence that the perched water table above the Upper Miller's Dale Lava found in nearby areas is present in this block.

The limestones lying within 10 m of the surface belong mainly to the upper pale facies of the Monsal Dale Limestones and are of high purity. However, the purity is reduced by dark limestones in a narrow zone at the boundary between blocks A and B. Elsewhere the sequence comprises mainly pale-coloured, massively bedded limestones. The samples tested were found to have a mean strength index of 3.93 MN/m^2. Chert has been recorded only from some beds in the dark facies adjacent to the western block boundary, while silica replacing shell debris accounts for most of the insoluble fraction in the pale lithologies.

Purity remains high down to the base of the upper pale facies of the Monsal Dale Limestones (section 1 of the resource map), which is thicker to the east, a maximum of 40 m being proved in borehole NW 12. The dark facies of the Monsal Dale Limestones produces a zone of low purity or impure rocks up to 20 m thick, distinguished by high silica, alumina, magnesia and potash due to the presence of chert and clay minerals. Beneath this dark facies, lower pale facies limestones up to a maximum thickness of 40 m are present; they are mainly of very high purity, although locally of only high purity.

The Upper Miller's Dale Lava underlies the entire block but its thickness is only known at outcrop. Beneath the lava very high purity mineral of the type described in block A is present.

Structurally, the block includes the north-western closure of the Monyash Syncline. Dips are directed into this structure and range from 3° to 4° in the north-east and up to 7° in the south-west.

The block is mineralised by a complex of veins, aligned approximately east-northeastwards, which were formerly worked for lead.

BLOCK C

This block covers 29.3 km^2: limestone occupies an area of 24.6 km^2, dolomite and dolomitised limestone 4.5 km^2 and limestone intermixed with basalt 0.2 km^2. The limestone plateau lies mainly between 305 m (1000 ft) and 366 m (1200 ft). Up to 120 m (400 ft) of limestone is above the water table which is slightly more than 244 m (800 ft) above Ordnance Datum throughout the block.

The upper pale facies of the Monsal Dale Limestones, which outcrops over most of the block, comprises chert-rich bioclastic limestones of medium purity which attain thicknesses of between 80 and 150 m. However, in the vicinity of boreholes SW 6 and 7 [128 649], there is a small area of low purity limestone (due to secondary silicification) separated by faulting from the surrounding medium purity limestones. Additionally, the average quality of the rocks over the upper 10 m is lowered adjacent to the thin Grattan Dale Lava in the extreme south-east of the sheet area. Also in the south-east, the Monsal Dale Limestones are affected by extensive dolomitisation and some dolomites are recorded. However, the distribution of dolomite, limestone and dolomitised limestones cannot be delineated precisely. There are considerable quantities of ferroan calcite in these rocks and these are responsible for the high ferric oxide values obtained (Table 4).

The Eyam Limestones, up to 25 m thick, are present in outliers in the northern part of the block. They are dominantly low carbonate dark biomicrites with much randomly distributed nodular chert; shell debris may be partially silicified and euhedral quartz crystals are common. However, within the Eyam Limestones, there are bryozoan and crinoidal biosparites of high purity, which represent localised patch reefs.

Beneath the mapped categories of limestone, the north-west part of the block contains a considerable thickness of very high purity rocks, which are similar to those that crop out in block A. Farther east, however, the limestones are dark, low grade and impure, with high silica contents. The relationships of these categories are illustrated in section 2 of the map.

In the northern part of the block the limestones are largely free of overburden, except for thin Namurian shales which form an outlier in Monyash village. Farther south, extensive patches of Head cover the limestones: however, they rarely exceed 3 m and are commonly less than 2 m in thickness. Numerous pockets of sand and silt also occur in the southern part of the block and some are currently worked for refractory use. These deposits have subsided into the limestone to depths of at least 50 m and each may occupy up to 0.05 km^2.

The axis of the Monyash Syncline is on the eastern margin of the block and the rocks have a north-easterly dip of about 4°. Locally, the main synclinal structure is modified by the Calling Low Anticline (Fig. 5) which results in dips varying from 5° to the north-west to 7° to the south-east, while in the extreme south-east beds dip at 18° into the Stanton Syncline. Fracturing has taken place along two major directions, either of which may be locally dominant. On the western margin of the block from Hartington Middle Quarter to the south-eastern corner of the sheet a north-west trend dominates and several major faults follow it. In the Flagg area, however, there are many east-north-east trending, commonly mineralised, fractures many of which were formerly worked. The chief ore is galena with subsidiary sphalerite. Gangue minerals include fluorite, calcite and baryte. Whalf Pipe is the only major mineral deposit recorded in this region (Fig. 4).

BLOCK D

This forms the eastern part of the main plateau and covers 22 km^2. Most of the ground ranges between 244 and 351 m (800 and 1150 ft) but the deeply incised gorges of Lathkill and Bradford dales cut down below the 152 m (500 ft) contour. The level of the water table falls eastwards across the block from about 213 m (700 ft) to below 183 m (600 ft) above sea level. In consequence, a maximum thickness, about 868 m (550 ft) of mineral could be worked without pumping.

The limestones of this block are, on average, of low purity and belong chiefly to the Eyam Limestones and upper pale facies of the Monsal Dale Limestones. Dark facies limestones of the latter formation occur within a few metres of the plateau surface on the southern and eastern flanks of Bole Hill [182 676], shown on the resource map by a zone of intermixing between low purity and impure mineral. They also have limited outcrops in Lathkill Dale and at isolated localities farther south.

Chert, as nodules or beds, constitutes the chief impurity but subordinate amounts of silica occur as replacements of fossil debris. Argillaceous matter is present in relatively high concentrations in both the matrix of the darker limestones and along stylolitic seams. Patch reefs within the Eyam Limestones, together with relatively thin discrete chert-free beds in the facies of the Monsal Dale limestones are of medium or high purity.

Below 10 m the purity is variable: in the north-west of the block low purity Eyam Limestones are present to a maximum depth of 30 m and overlie pale Monsal Dale Limestones of medium or high purity. Over the remaining northern part of the block low purity or impure mineral is present down to a depth of 150 m. In the area south-west of Lathkill Dale medium or high purity pale limestones, up to 30 m thick, occur down to 40 m depth. Except for isolated thin patches of Head there is no drift cover.

The main structural elements affecting the limestones are shown in Fig. 5. Regional dips are everywhere low, (usually less than 10°). In the north, the direction of dip is controlled by the Monyash Syncline while in the south, the Calling Low Anticline and Stanton Syncline are the dominant folds. The area is intensively mineralised by pipe and vein deposits; current exploitation is restricted to the Long Rake [190 643] and Mandale Rake [184 666] from which calcite and fluorite respectively are being won.

BLOCK E

The chief topographic feature is the narrow, steep-sided valley of the River Wye. Tributary dry valleys, such as Kirk Dale [182 687] have further dissected the terrain which ranges in elevation from 137 m (450 ft) in the main valley floor to over 305 m (1000 ft) on the plateau top. The block covers 5.4 km^2 in the north-east corner of the sheet, and limestone crops out over 4.7 km^2, shale and shale intermixed with limestone occupies 0.5 km^2 and basalt, often intermixed with limestone, 0.2 km^2. Within 10 m of the surface, the rocks belong mainly to the dark facies of the Monsal Dale Limestones. Silica occurs widely as bedded or nodular chert, disseminated clay-grade quartz and chalcedonic replacements of shell debris. Other non-carbonate materials include clay, which is found either in the limestone matrix or in shale and clay-wayboard partings. Additionally, magnesia concentrations may be more than 7 per cent in zones of patchy dolomitisation. These rocks are of comparable strength to limestones elsewhere on the sheet, but fracture spacing index values are consistently lower (less than 500 mm).

Sections in the eastern part of the Wye valley and borehole NE 10 show that impure rocks are present below the plateau surface to a depth of at least 100 m (330 ft), but the thickness is progressively reduced westwards along the Wye valley as lower beds of medium or high purity are brought nearer the surface by the easterly dip. The base of the dark facies is seen in Great Shacklow Wood [177 697] immediately above the basaltic lava (Fig. 3). This lava extends southwards underground at least to Magshaw Rake where subsurface information from the Magshaw and True Blue mines [1830 6789; 1777 6702] indicates the presence of a substantial thickness (14 m) of 'toadstone' (that is, lava) at depths of 110 and 128 m respectively. The only indication of the lava in borehole NE 10 is a thin clay wayboard at 149 m which suggests that the lava dies out rapidly toward the south-west. At least three volcanic horizons have been noted in records of mine workings west of Magshaw Mine but the relationship between these lavas and the Shacklow Wood Lava is not known. The groundwater level can be expected at about 450 ft (137 m) throughout the block.

Landslips, mainly comprising limestone debris, are present in Arrock Plantation [186 690] and on the south side of the Wye valley, where the northerly dip of the limestone has resulted in bedding-plane slip. Thin patches of Head are also developed on the steep valley sides south of Ashford. Deposits of tufa, alluvial clay and limestone gravel up to 3 m thick occur in the floor of the Wye valley, which is flanked by low discontinuous terraces. Visean and Namurian

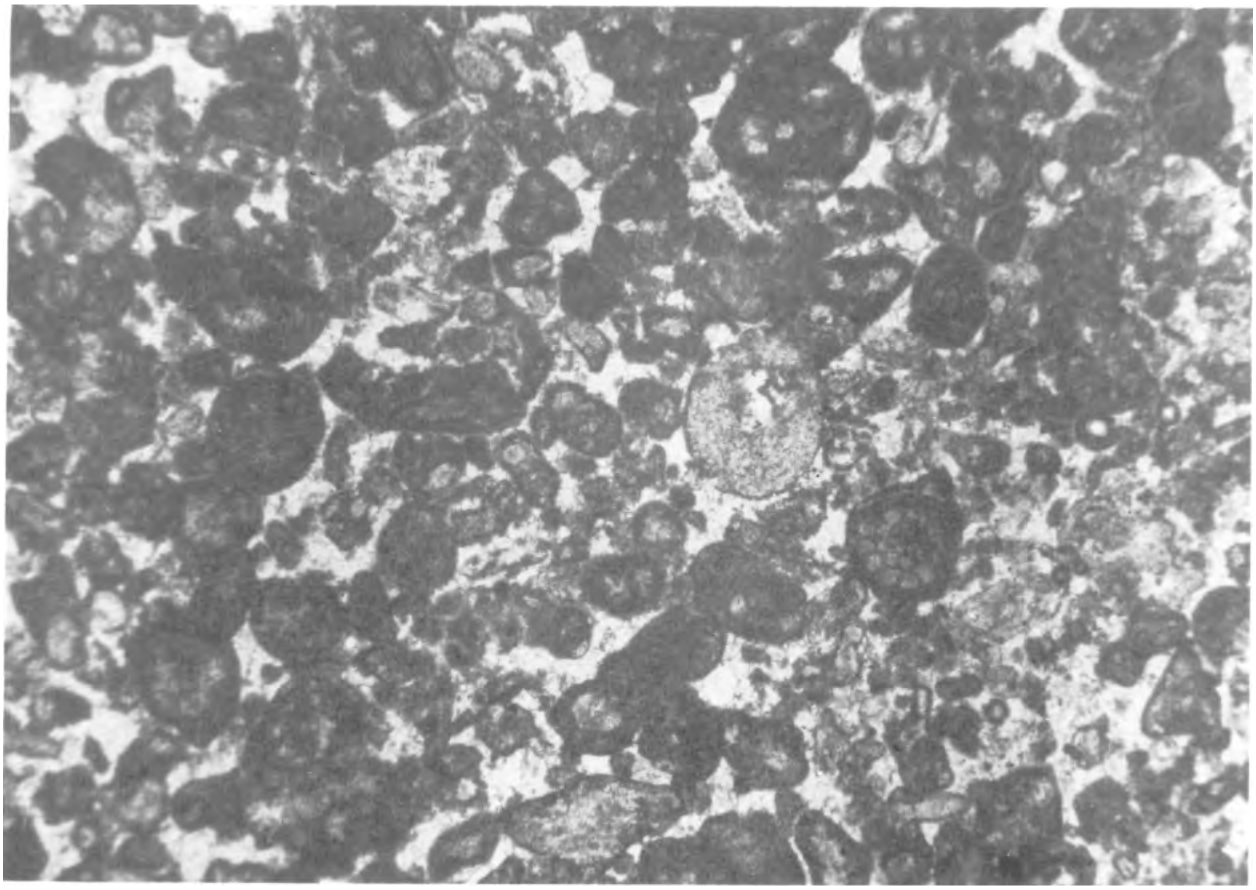


Plate 6.1 Pelsparite. Rounded micrite grains and shell debris micritised by encrusting algae in clear spar matrix: very high purity limestone; Bee Low Limestones (D_1). Specimen E40927 from a depth of 31.10 m in Borehole NW 7, plane polarised light. X20

Plate 6.2 Biosparite. Many euhedral quartz grains in a biosparite containing algae, crinoid and other shell debris: medium purity limestone; Bee Low Limestones (D_1). Specimen E43832 from a depth of 6.60 m in Borehole SW 6S, plane polrised light. X60

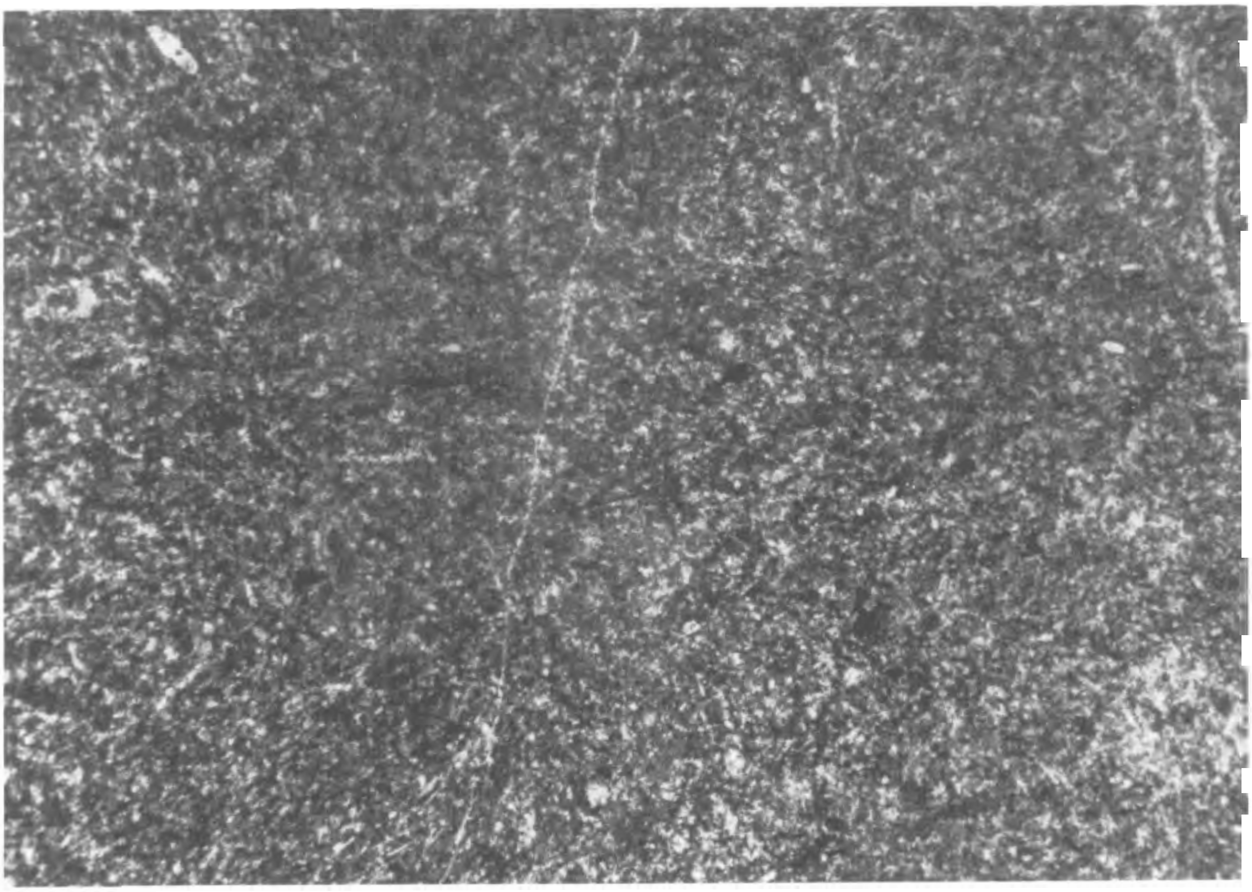
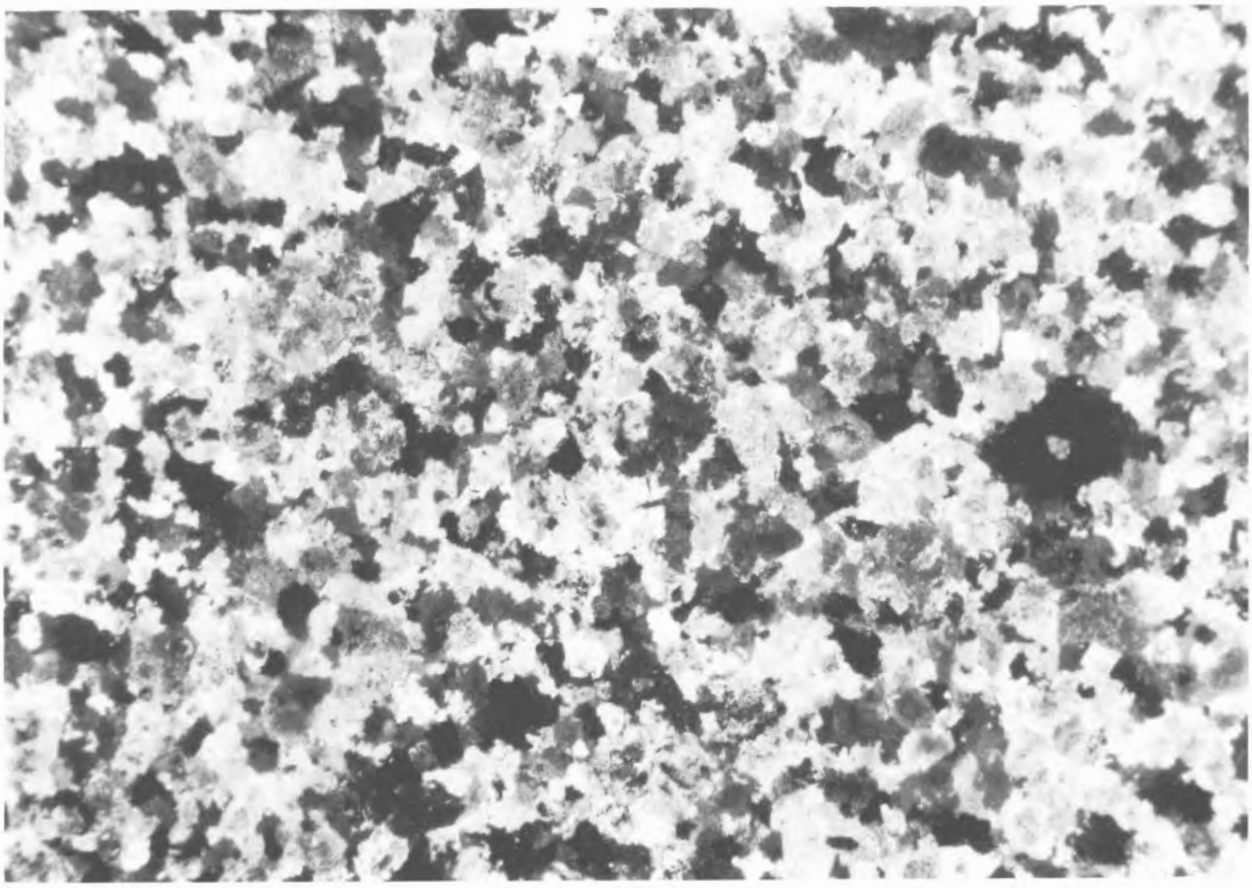


Plate 7.1 Micrite. Allochems virtually absent; medium purity limestone; Monsal Dale Limestone (dark facies) D_2. Specimen E44437 from a depth of 127.75 m in Borehole NE 10, plane polarised light. X10

Plate 7.2 Dolomite. Equant mosaic of dolomite crystals. Specimen E41219 from a depth of 3.8 m in Borehole SE 4, crossed polars. X10



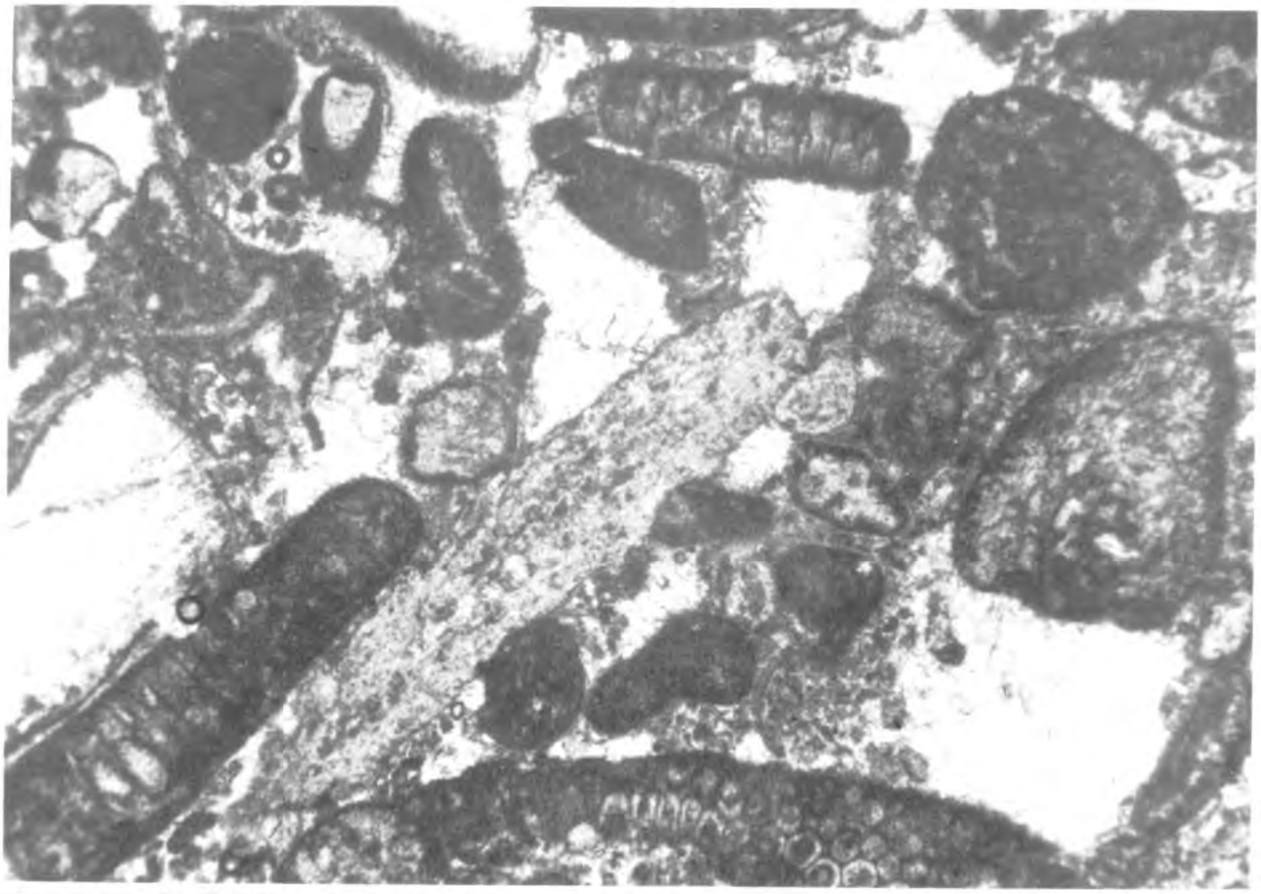


Plate 8.1 Algal biosparite. Chiefly Dasycladacean algae with associated brachiopod and crinoid debris in a clear spar matrix; very high purity limestone. Bee Low Limestone (D_1). Specimen E40938 from a depth of 47.75 m in Borehole NW 7, plane polarised light. X50

Plate 8.2 Bryozoa biosparite. Bryozoan fragments in a cloudy spar matrix. High purity limestone. Eyam Limestones (P_2) reef deposit. Specimen E42651 from a depth of 4.5 m in Borehole NE 5S, plane polarised light. X40

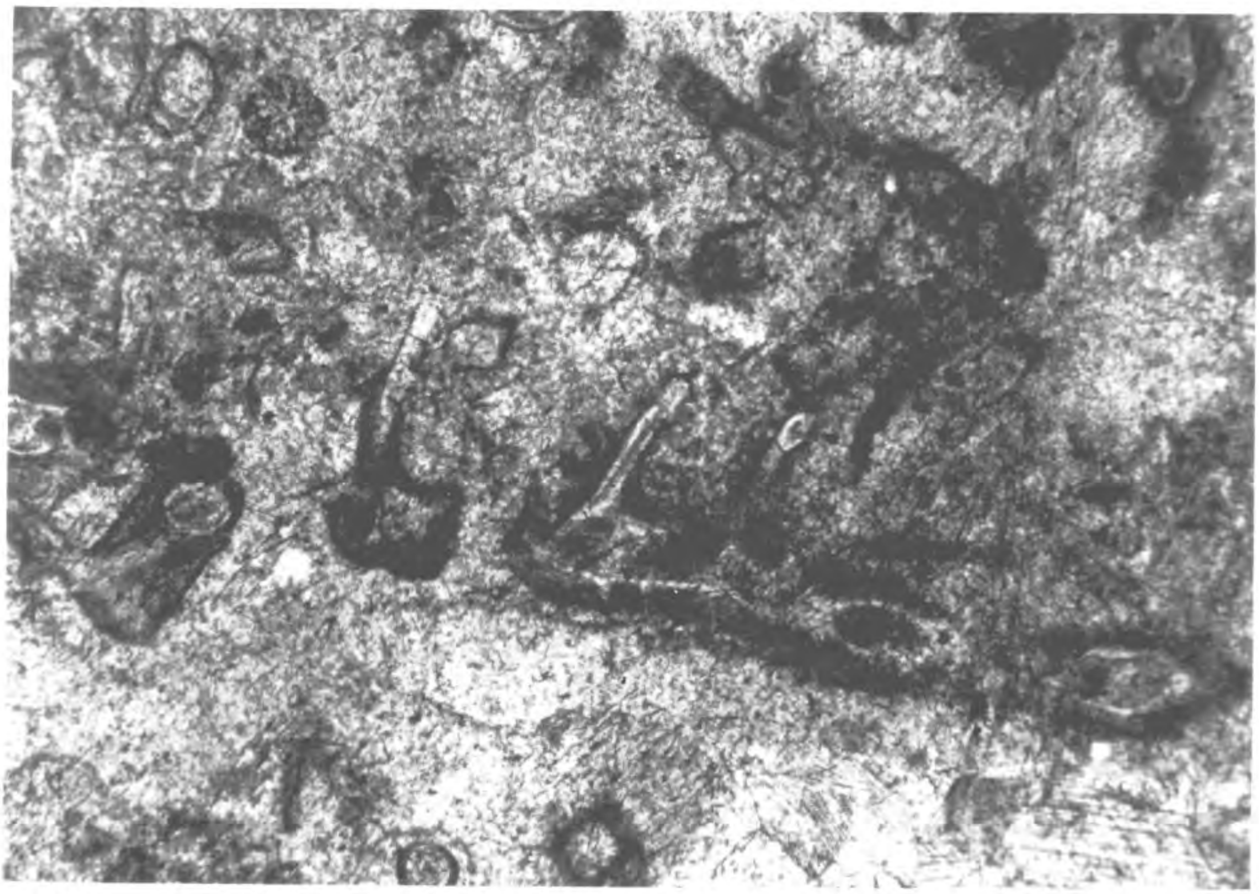


Plate 9.1 Brachiopod biomicrite. Brachiopod shell and spines in a micrite matrix: impure limestone. Monsal Dale Limestones (dark facies) D_2. Specimen E42659 from a depth of 4.00 m in Borehole NE 7S, plane polarised light. X20

Plate 9.2 Foraminiferal biosparite. Foraminifera and brachiopod spines in coarse spar matrix: very high purity limestone; Eyam Limestones (P_2). Specimen E42670 from a depth of 0.30 m in Borehole NE 4S, plane polarised light. X40

shales, up to 17 m thick, overlie the limestones immediately north and south of Ashford village.

The Ashford Syncline and Magshaw Anticline (Fig. 5) are the two principal folds which affect the attitude of the strata in this block. Dips on the flanks of these structures are for the most part gentle, averaging about 7°.

Summary of Assessment

The estimated volumes of limestones by categories, of dolomite and dolomitised limestones and of waste within each block to a depth of 60 m are shown in Table 9.

The limestones in the area are Carboniferous (Viséan) in age. They consist of the Woo Dale, the Bee Low, the Monsal Dale and the Eyam limestones.

In general the Woo Dale Limestones and the Bee Low Limestones are fairly uniform, massive limestones with high and very high carbonate values. They form most of block A and are exposed on the western half of the sheet and extend eastwards beneath the Monsal Dale Limestones.

The Monsal Dale Limestones crop out in all the blocks and range in composition from impure to very high carbonate rocks. The low carbonate and impure types are dominant on the north-eastern part of the sheet area.

The Eyam Limestones occur as outliers above the Monsal Dale Limestones and are commonly of low purity, although local developments of reefs give rise to rocks of medium purity.

Dolomite and dolomitised limestones are recorded from a tract between Middleton and Smerrill and Hartington Middle Quarter which coincides with the boundary between the Monsal Dale and the Bee Low limestones (Fig. 3). Analyses show a mean MgO content of about 20 per cent.

Powders prepared from limestones of various ages, with chemical compositions of about 98 per cent $CaCO_3$, were found to give reflectance values greater than 82, 73 and 72 per cent using 660 nm, 520 nm and 470 nm filters respectively (white standard MgO = 100 per cent).

The results of point load strength tests indicate that over 90 per cent of the limestones are of very high strength. Fracture spacing indices (Broch and Franklin, 1972) are between 300 and 1000 mm.

Examination of the non-carbonate fraction showed much of the material to be silica, which is present as chert, chalcedony (replacing fossils) and quartz crystals; some of the silica approaches clay grade. Clay minerals which form an important part of the fraction are particularly abundant in the impure rocks.

Table 9. Summary of carbonate resources of sheet SK 16.

Block	Area (km^2)	Depth below ground surface (m)	Volume (million m^3)	Category of limestone present (%)					Dolomite/ dolomitised limestone (%)	Waste (%)
				98.5 per cent $CaCO_3$	97-98.5 per cent $CaCO_3$	93.5-97 per cent $CaCO_3$	85-93.5 per cent $CaCO_3$	85 per cent $CaCO_3$		
A	28.9	0-10*	289	70	10	ŧ	ŧ	-	10	10 (Drift, lava, pocket deposits)
		10-30	578	85	5	-	-	-	10	ŧ (Lava, pocket deposits)
		30-60	867	85	5	-	-	-	10	ŧ (Lava, pocket deposits)
B	5.0	0-10	50	5	80	5	-	-	-	10 (Drift)
		10-30	100	20	70	10	-	-	-	-
		30-60	150	20	50	10	15	-	-	5 (Lava)
C	29.3	0-10*	293	5	15	40	15	-	15	10 (Drift, lava, shale)
		10-30	586	5	35	35	10	-	15	-
		30-60	879	10	30	20	20	5	15	-
D	22.0	0-10*	220	5	5	10	65	5	-	10 (Drift)
		10-30	440	-	20	30	30	20	-	-
		30-60	660	5	20	15	30	30	-	ŧ (Lava)
E	5.4	0-10	54	-	5	-	-	80	-	15 (Drift, lava, shale)
		10-30	108	-	5	-	-	90	-	5 (Lava)
		30-60	162	-	10	-	-	90	-	ŧ (Lava)

*For the purpose of this calculation, zones of limestone intermixing within 10 m of the surface are assigned to the lower purity catetory.

Trace = ŧ.

Appendix A: Classification, Terminology and Glossary

CLASSIFICATION

The petrographic classification of limestones proposed by Folk (1959; 1961) is widely accepted and is used in this report in a slightly modified form. The classification is summarised in Table 10.

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, intraclasts and pellets. The matrix is subdivided on grain size into: microcrystalline ooze (less than 4 microns) termed micrite, a slightly coarser crystalline fabric (4 to 16 microns) termed microspar and crystalline calcite cement or spar (greater than 16 microns).

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.

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.

TERMINOLOGY

The nomenclature of the major rock types is set out in Table 10. If a rock contains more than 25 per cent of allochems which are not mentioned in the main rock name, these are used to qualify the rock name and have a capital letter, for example, Crinoidal biosparite. Subordinate diagnostic allochems may also precede the main rock name; these are differentiated by the use of a small initial letter, for example, algal Brachiopod biosparite.

Table 10. Classification of rocks (based on Folk, 1959).

				LIMESTONES			
				>10% Allochems Allochemical Rocks		<10% Allochems Microcrystalline Rocks	
				Sparry calcite cement > micocrystalline ooze	Microcrystalline ooze > sparry calcite cement	1-10% allochems	<1% allochems
Volumetric Allochem Composition	>25% Intraclasts			Intrasparite	Intramicrite (rare)	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	
			3:1 to 1:3	Biopelsparite	Biopelmicrite	Pellets: Pelletiferous Micrite	
			<1:3	Pelsparite	Pelmicrite		

GLOSSARY

Allochem	A collective term for one of several varieties of discrete and organised carbonate aggregates, such as fossil fragments, oolites and pellets that serve as the coarser framework grains in most mechanically deposited limestones.
Anticline	An arch fold, the core of which contains the stratigraphically older rocks.
Authigenic	Refers to those constituents that came into existence with or after the formation of the host rock.
Biostratigraphy	The study of stratified rocks, their subdivisions and correlation based on their fossil content.
Calcarenite	A limestone consisting predominantly (more than 50 per cent) of detrital calcite particles of sand size (0.062 to 1 mm).
Calcilutite	A limestone consisting predominantly (more than 50 per cent) of detrital particles of silt and/or clay size (less than 0.062 mm).
Calcirudite	A limestone consisting predominantly (more than 50 per cent) of detrital calcite particles larger than sand size (greater than 1 mm) and often also cemented with calcareous material.
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.
Conformable	A sequence of beds are said to be conformable when they represent an unbroken period of deposition.
Diachronous	Applied to beds of rock or stratigraphical formations which are of varying age in different areas.
Disconformity	An erosion surface separating two parallel series of beds and indicating an interruption in the stratigraphical succession representing a period of geological time.
Epigenetic	A term used to describe mineral deposits of later origin than the enclosing rocks.
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.
Ferroan calcite	Crystalline $CaCO_3$ (calcite) containing iron (usually as Fe^{++}) locked within the crystal lattice.
Gangue	A mineral in a vein, other than an ore mineral.
Intraclast	Material created by penecontemporaneous erosion within a basin of deposition.
Lithofacies	The group of sedimentary features of a rock type which characterise a particular environment of deposition.
Monocline	A unit of strata that dips or flexes from the horizontal in one direction only and is not part of an anticline or syncline. It is generally a large feature of gentle dip.
Non-sequence	A break in the continuity of the geological record, representing a time during which no permanent deposition took place.
Outlier	An area or group or rocks surrounded by older rocks.
Overstep	A stratum resting unconformably on an inclined series of older rocks is said to "overstep" each of them in turn.
Oolite or Ooid	A spherical or subspherical accretionary grain generally less than 2.00 mm in

diameter. In section, oolites display concentric structure and may also exhibit radial structure.

Pericline	An elongate dome structure.
Stylolite	An irregular suture-like boundary developed in some limestones.
Syncline	A trough fold, the core of which contains stratigraphically younger rocks.
Unconformable	Describes strata which do not succeed the underlying rocks in immediate order of age. It indicates a substantial break or gap in the geological record.
Wayboard	An old mining term used commonly in Derbyshire to describe a discrete and deleterious thin rock bed, usually of clay.

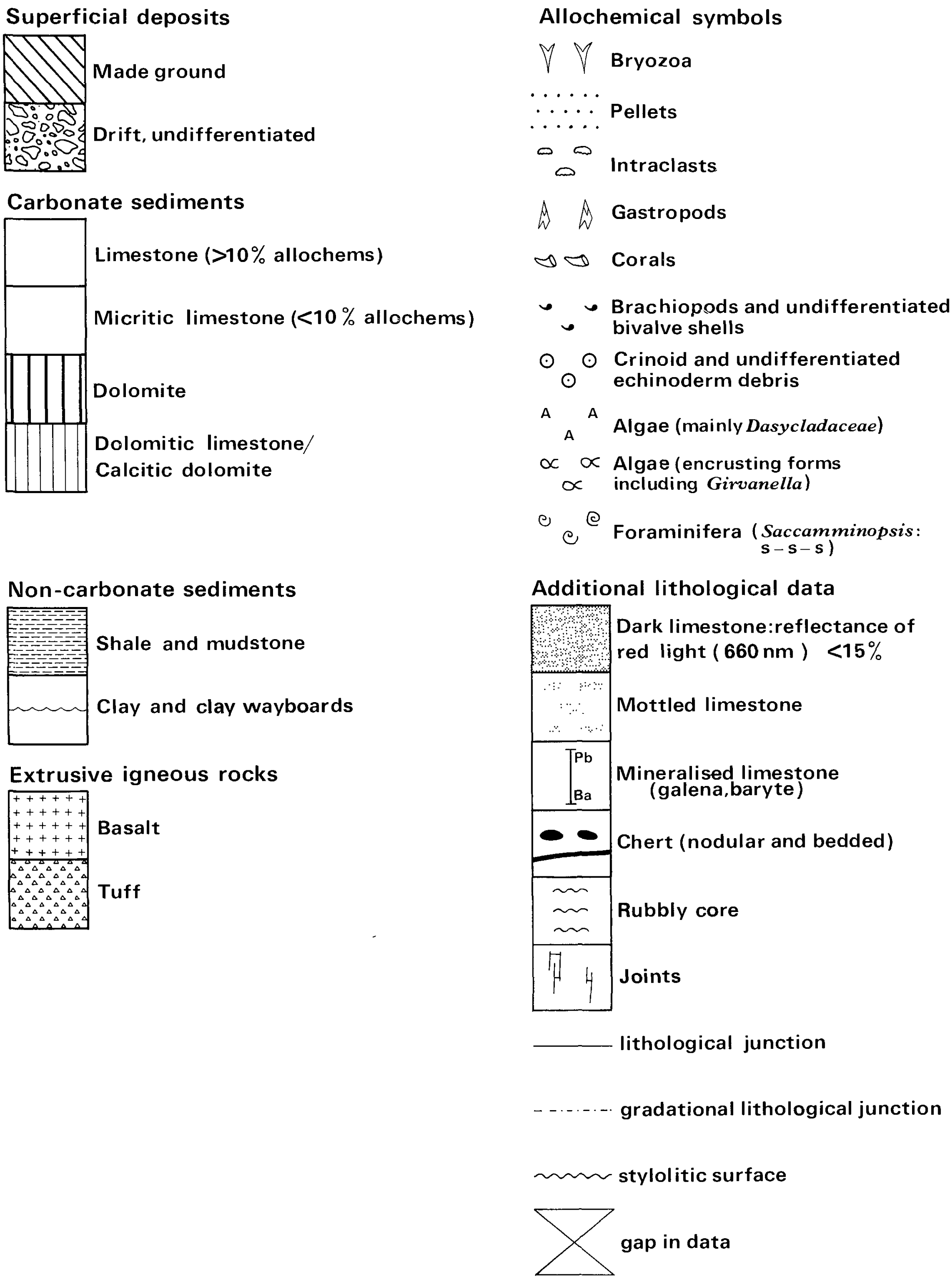


Fig. 13. Explanation of symbols used on graphical logs

Appendix B: Explanation of Format for Borehole Logs

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

1. *The Registration Number*
This consists of two statements.
1 The number of the 1:25 000 sheet on which the borehole lies, for example, SK 16.
2 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 8.

Thus the full Registration Number is SK 16 NW 8. This is abbreviated to NW 8 in the text.

Collected sections are registered in a similar manner using a similar manner using a separate series of numbers, suffixed by letter S, for example, SK 16 NW 7S.

2. *The National Grid Reference*
All National Grid References in this publication lie within the 100 km square SK unless otherwise stated. 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 and feet above Ordnance Datum. For collected sections surface level is taken to be the top of the sampled sequence. When groundwater has been recorded in airflushed boreholes, the depth at which seepage occured is given.

5. *Type of Drill and Date of Drilling*
The drilling machines which have been used in this survey are listed below:

Flushing Agent	Type of Rig	
Air	Reich JO 82	
	Reich JO 94	
	Boyles BBS 20	
Water	Edeco Stratadrill	
	Joy Sullivan	
	Pack Sack	Portable drills
	Minute Man	

The type of machine, diameter of core produced and the month and year of the completion of the borehole are given.

6. *Descriptive Borehole Log*
The major rock types are listed, for example, limestone, dolomite.

7. Each major rock type is sub-divided, where possible, using the rock classification and nomenclature explained in Appendix A and followed by a brief description.

8. *Depth*
The figures given relate to depths to the base of lithologies described in the log. The plus sign (+) indicates that the base of a particular rock type was not reached during drilling.

9. *Graphical Borehole Log*
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 Fig. 13.

10. *Energy (Sorting) Index*
In the column representing energy (sorting) index (Plumley and others, 1962), the shaded intervals highlight carbonate lithologies which exhibit textural and compositional properties characteristic of moderate to strongly agitated water conditions at the time of deposition.

11. *Colour*
The percentage reflectance of red light (peak wavelength of 660 nm) from the flat, acid-etched rock surface is shown graphically. A white magnesian carbonate standard with a reflectance value of 100 per cent was used to calibrate the spectrophotometer.

12. *Mechanical Properties*
For certain boreholes, the fracture spacing index (If) is measured in millimetres and plotted on a logarithmic scale (see, for example, A NW 9).

13. For certain boreholes the point load strength index (Is) is measured in meganewtons per metre squared and is plotted on a logarithmic scale (see, for example, A NW 9).

14. *Insoluble Residue Data*
Residue values are expressed as weight percentages.

15. Residue mineralogy is summarised.

16. *Classification into categories by purity (=quality)*
The overall purity of a limestone, averaged over consecutive 5 m intervals of depth, is stated, using the following system (see also Fig. 2):

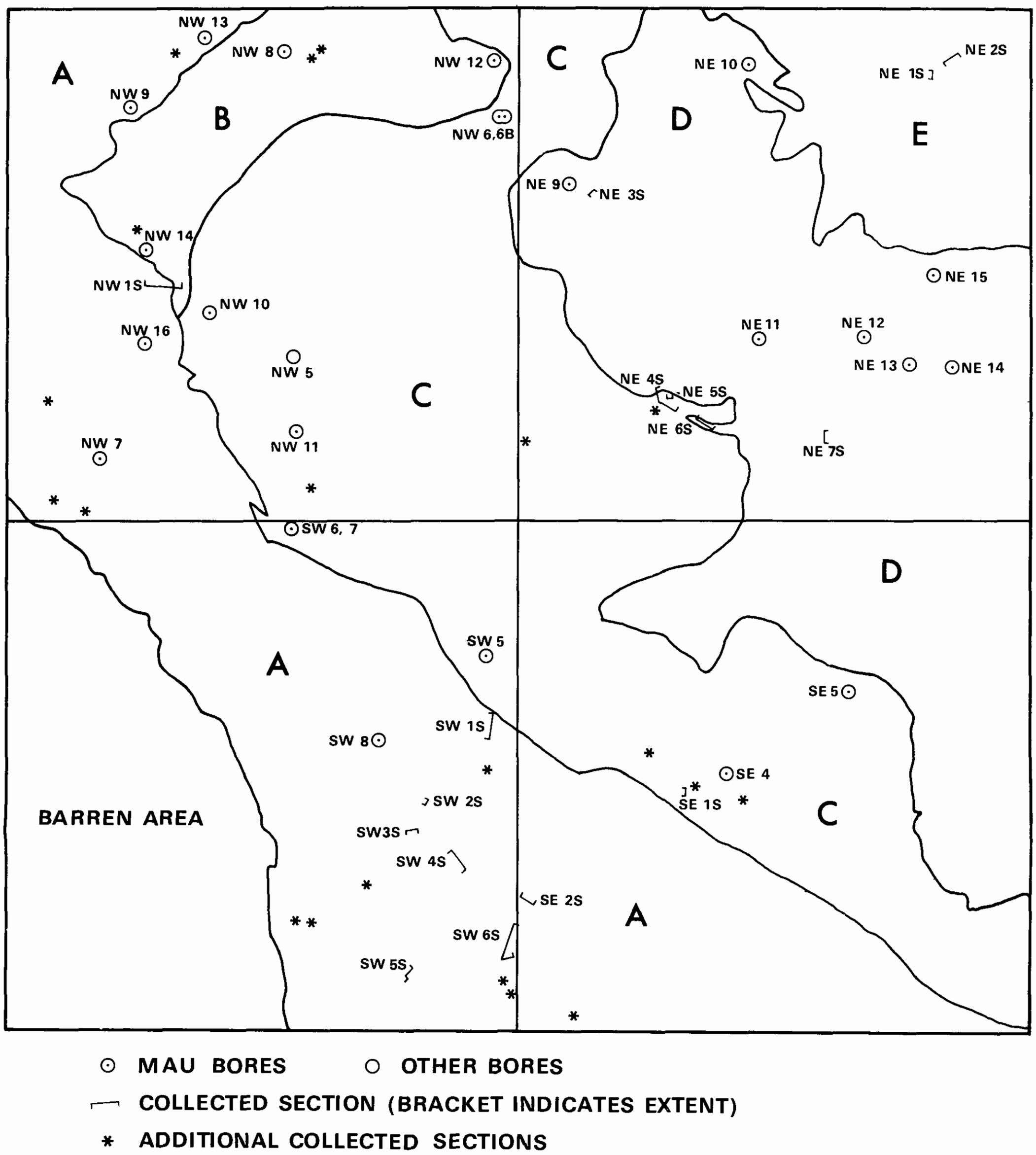
		Composition (per cent $CaCO_3$)
1	Very high purity	98.5
2	High purity	97.0 - 98.5
3	Medium purity	93.5 - 97.0
4	Low purity	85.0 - 93.5
5	Impure	85.0

17. *Chemical Data*
Where available, chemical data are shown in tabular form for each borehole on the pages following the graphical log.

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

Appendix C: Records of Borehole and Sections



Resource Block A

Source of data	Registration number	Grid reference
MAU boreholes (drilled by contractor)	NW 7	1091 6561
	9	1120 6902
	13	1195 6970
	16	1135 6674
	SW 8	1365 6287
Major sections used in the assessment	NW 1S	1173 6724
	SW 1S	1471 6300
	2S	1412 6229
	3S	1395 6198
	4S	1450 6153
	5S	1395 6049
	6S	1490 6068
	SE 2S	1505 6122

Logs of additional collected sections may be consulted at the appropriate office of the Institute.

RESOURCE BLOCK A

SK 16 NW 7[1] 1091 6561[2] High Needham[3]

Surface level +378.9 m (+1243 ft)[4]

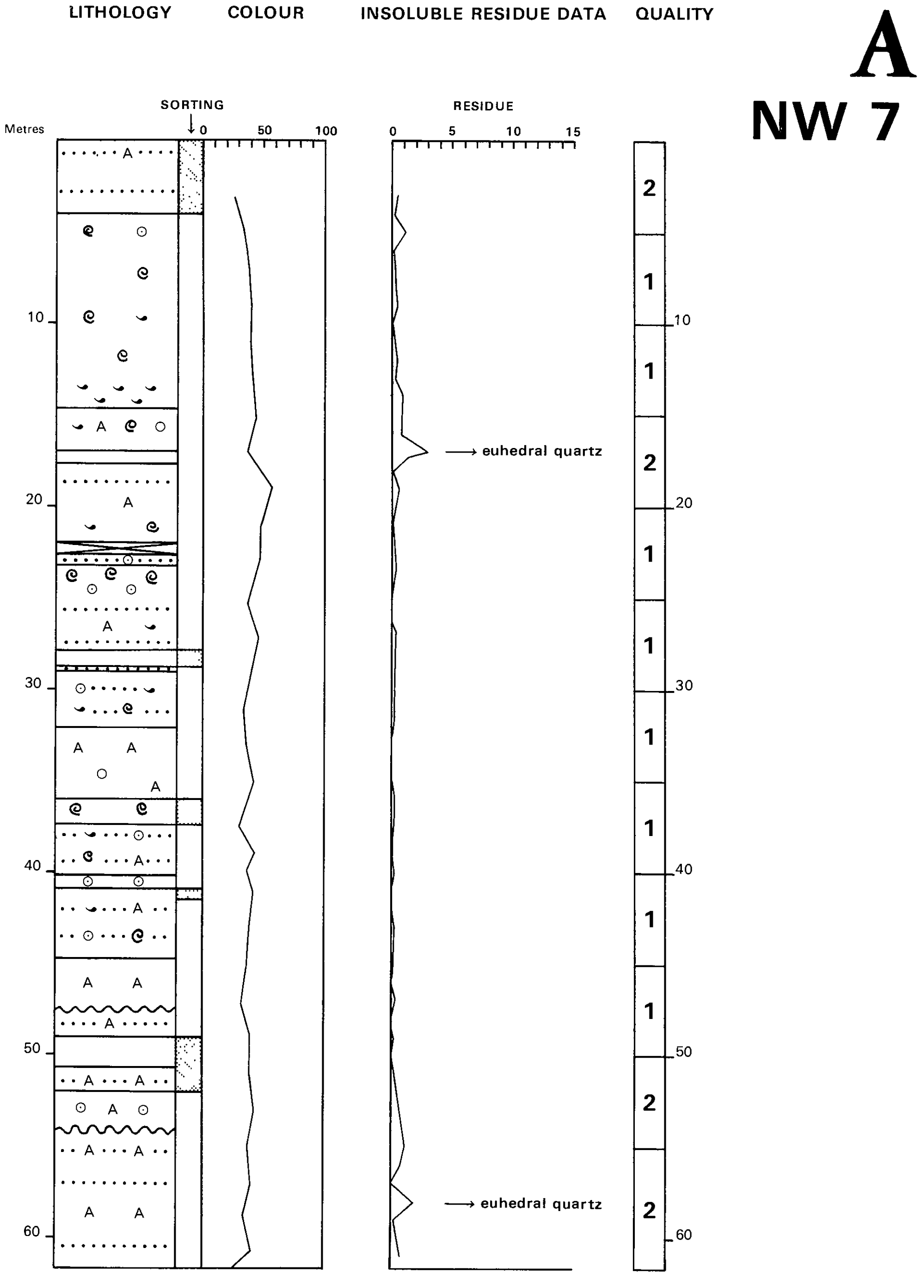
Reich (airflush), 74 mm diameter[5]

January 1971

		Thickness (m)	Depth[8] (m)
Limestone[6]	[7]Biopelsparite, rare Koninckopora crinoid and brachiopod debris; allochems increase near base	4.35	4.35
	foraminiferal biosparite, crinoid debris, subordinate pellets and brachiopod fragments; brachiopod band at 13.5 m and at 14.36 m; bioturbated from 5.7 m	10.25	14.60
	Biosparite, with algae, foraminifera, crinoid and shell debris; bioturbated at base	2.40	17.00
	Crinoid Brachiopod biosparite, subordinate spines and foraminifera	0.70	17.70
	Crinoidal biopelsparite, scattered foraminifera and algal debris, suborinate brachiopod debris increasing near middle of bed; bioturbated	5.54	23.24
	foraminiferal pelsparite, subordinate brachiopods and crinoids; burrows in lower part, occasional Koninckopora	4.66	27.90
	Intrasparite, subordinate brachiopods and crinoids; bioturbated throughout	0.83	28.73
	Biopelsparite, with formaminifera and crinoid ossicles	0.27	29.00
	Brachiopod biopelsparite; bioturbated; pyrolusite coating joints	3.10	32.10
	Crinoidal Algal biosparrudite, common Koninckopora, rare pellets and brachiopod debris, local micrite and microspar,	3.90	36.00
	formaminiferal biomicrite	1.40	37.40
	Biopelmicrite, algal-coated pellets with subordinate brachiopod, crinoid and foraminiferal debris	2.72	40.12
	Crinoidal biosparite, subordinate shells and spines	0.78	40.90
	Biomicrosparite; quartz grains common; burrowed near base	3.80	44.70
	Algal biomicrite, abundant Koninckopora, subordinate brachiopod and crinoid debris; stylolites in lower half	2.90	47.60
	Algal biopelsparite, abundant Koninckopora, rare crinoid ossicles, bioturbated	2.45	49.05
	Biomicrosparite, rare Koninckopora	1.65	50.70
	Algal biopelsparite, abundant Koninckopora, rare crinoid and brachiopod debris	1.30	52.00
	algal Crinoid biosparite, rare brachiopods; bioturbated at the base	2.20	54.20
	Algal biomicrosparite, subordinate brachiopod crinoid debris and pellets	7.40	61.60

Borehole completed at 61.60 m

The annotations are explained on p.41



A
NW 7
LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
RESIDUE
Metres
0
50
100
0
5
10
15
10
20
30
40
50
60
euhedral quartz
euhedral quartz
2
1
1
2
1
1
1
1
1
1
2
2

RESOURCE BLOCK A
SK 16 NW 7 1091 6561
High Needham

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Loss on ignition at 1050° C
3.00	0.03	0.28	0.01	0.59	0.02	0.30	0.00	55.80	43.42
5.00	0.03	0.26	0.01	1.02	0.01	0.30	0.00	55.70	43.39
6.00	0.03	0.20	0.00	0.11	0.01	0.25	0.00	56.15	43.90
7.00	0.03	0.22	0.00	0.07	0.01	0.30	0.00	56.30	43.93
9.00	0.03	0.21	0.00	0.05	0.01	0.30	0.00	56.20	43.88
11.05	0.03	0.17	0.00	0.14	0.01	0.25	0.00	56.30	43.61
13.10	0.03	0.19	0.00	0.35	0.01	0.30	0.00	56.20	43.70
15.10	0.03	0.18	0.00	0.45	0.01	0.15	0.00	56.15	43.70
17.15	0.03	0.21	0.00	0.19	0.01	0.25	0.00	56.30	43.83
19.00	0.11	0.18	0.06	0.37	0.01	0.65	0.01	56.15	43.84
21.00	0.02	0.19	0.03	0.03	0.30	0.30	0.00	56.20	43.88
22.80	0.02	0.17	0.00	0.05	0.01	0.30	0.00	56.10	43.64
25.20	0.03	0.19	0.00	0.01	0.01	0.30	0.00	56.25	44.00
27.10	0.03	0.20	0.00	0.01	0.01	0.25	0.00	56.15	43.84
29.00	0.03	0.23	0.01	0.19	0.01	0.30	0.00	56.10	43.97
31.10	0.01	0.26	0.00	0.04	0.03	0.50	0.00	55.85	43.99
33.05	0.00	0.19	0.00	0.05	0.03	0.40	0.00	56.15	43.92
35.10	0.00	0.18	0.00	0.02	0.03	0.40	0.00	55.85	43.96
37.10	0.02	0.19	0.00	0.03	0.03	0.55	0.00	55.75	43.75
39.00	0.01	0.23	0.00	0.03	0.03	0.35	0.00	55.70	44.00
40.00	0.01	0.23	0.00	0.02	0.03	0.35	0.00	55.95	43.91
41.00	0.01	0.21	0.00	0.02	0.03	0.50	0.00	55.90	43.96
42.95	0.01	0.21	0.00	0.07	0.03	0.50	0.00	56.05	43.96
45.10	0.01	0.22	0.00	0.02	0.03	0.50	0.00	55.90	43.88
47.05	0.00	0.23	0.00	0.07	0.02	0.45	0.00	54.00	43.79
48.90	0.00	0.20	0.00	0.05	0.03	0.40	0.00	55.95	44.13
50.94	0.01	0.21	0.00	0.02	0.03	0.45	0.00	56.35	43.95
52.85	0.03	0.22	0.00	0.05	0.03	0.45	0.00	56.00	43.57
54.80	0.01	0.21	0.01	0.12	0.03	0.60	0.00	55.95	43.87
56.80	0.00	0.21	0.00	0.05	0.03	0.45	0.00	56.10	43.96
58.80	0.01	0.21	0.00	0.03	0.02	0.45	0.00	56.20	44.01
60.60	0.02	0.24	0.13	0.35	0.02	0.40	0.01	55.95	43.86
61.60	0.02	0.24	0.17	0.40	0.03	0.40	0.01	56.00	43.78

SK 16 NW 7 1091 6561
High Needham

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	Fe_2O_3	As	F (%)
3.00	85	5	10	0	165		0
5.00	160	0	25	0	265		0
6.00	100	0	20	10	130	8	0
7.00	175	0	20	20	210		0
9.00	85	0	15	5	110		0
11.05	94	0	10	5	125		0
13.10	105	0	15	0	135		0
15.10	75	5	15	0	155		0
17.15	90	0	10	0	70		0
19.00	165	10	20	5	460		0
21.00	135	0	15	0	115		0
22.80	80	0	10	5	80		0
25.20	100	0	15	0	80	0	0
27.10	90	0	10	0	70		0
29.00	175	0	25	5	280		0
31.10	85	5	10	0	85		0
33.05	145	10	20	0	90		0
35.10	190	10	20	0	135		0
37.10	280	15	40	10	495		0
39.00	115	10	10	0	95		0
40.00	195	10	20	0	120		0
41.00	135	10	20	0	230		0
42.95	125	10	10	0	200	0	0
45.10	125	10	10	0	95		0
47.05	115	10	10	0	85		0
48.90	155	10	10	0	110		0
50.94	185	10	20	0	170	0	0
52.85	140	10	10	0	110		0
54.80	145	10	10	0	270		0
56.80	175	10	20	0	325		0
58.80	145	10	10	0	130		0
60.60	140	10	30	0	702		0
61.60	165	10	30	10	665	0	0

RESOURCE BLOCK A
SK 16 NW 9 1120 6902 Chelmorton

Surface level +388.92 m (1276 ft)
Reich (airflush), 74 mm diameter
March 1971

		Thickness (m)	Depth (m)
Topsoil		0.80	0.80
Limestone	Algal pelsparite, common encrusting algae (Girvanella), subordinate shell debris and crinoid ossicles; rare foraminifera; well sorted	1.65	2.45
	Brachiopod Crinoid biosparite, pelletal at top subordinate bryozoa, foraminifera and Girvanella, matrix micritic near base; scattered euhedral quartz grains	4.61	7.06
	Brachiopod Crinoid biomicrosparite, mottled abundant crinoid and brachiopod debris of fine rudite size; sparry matrix in darker mottled zones; pelletal at base	0.89	7.95
	Brachiopod biomicrosparrudite, local spar in bioturbations	0.10	8.05
	algal Brachiopod Crinoid biosparite, occasional pellets, mottling developed at 12.50 to 13.00 m, Girvanella present throughout; subordinate foraminifera, bryozoa, corals and spines; common bioturbations	10.45	18.50
	algal Brachiopod biomicrosparite, coarse rudite size shell clusters rimmed with Girvanella subordinate foraminifera and pellets, spar developed locally	1.60	20.10
Altered Calcified Lava	Clay, yellowish-orange at top grading to greenish-grey, pyritous, amygdaloidal lava	0.70	20.80
Unaltered Lava	Greenish-black, compact	4.22	25.02

Borehole completed at 25.02 m

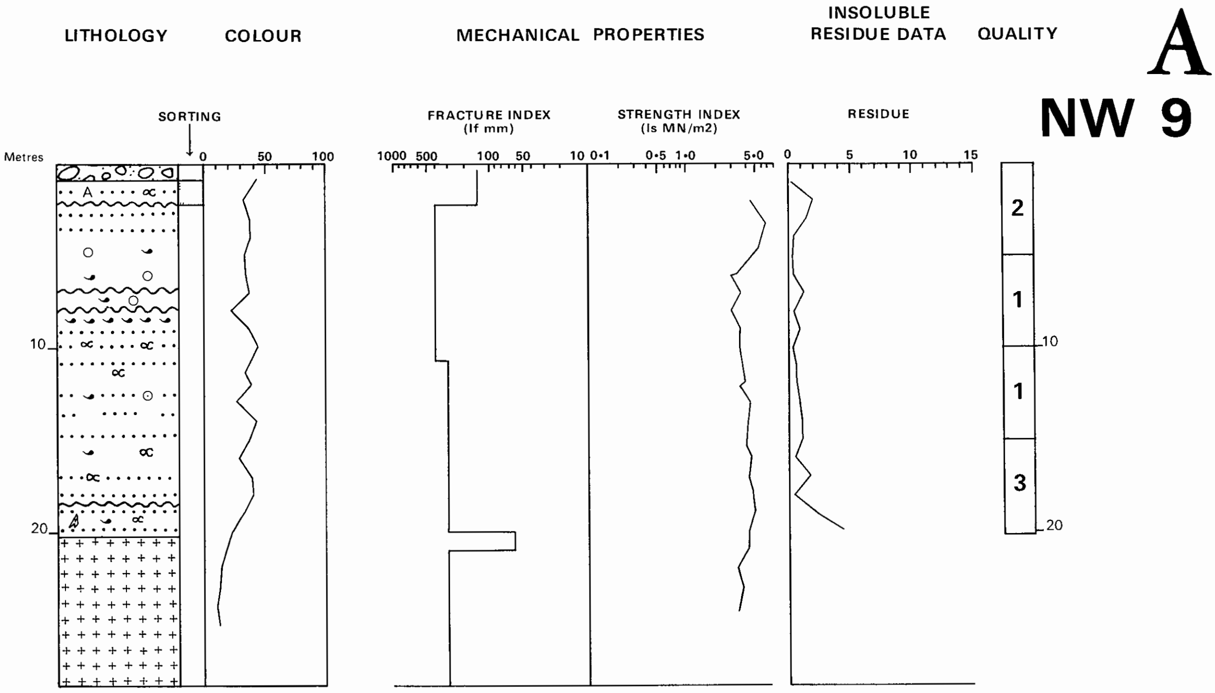
No chemical data available

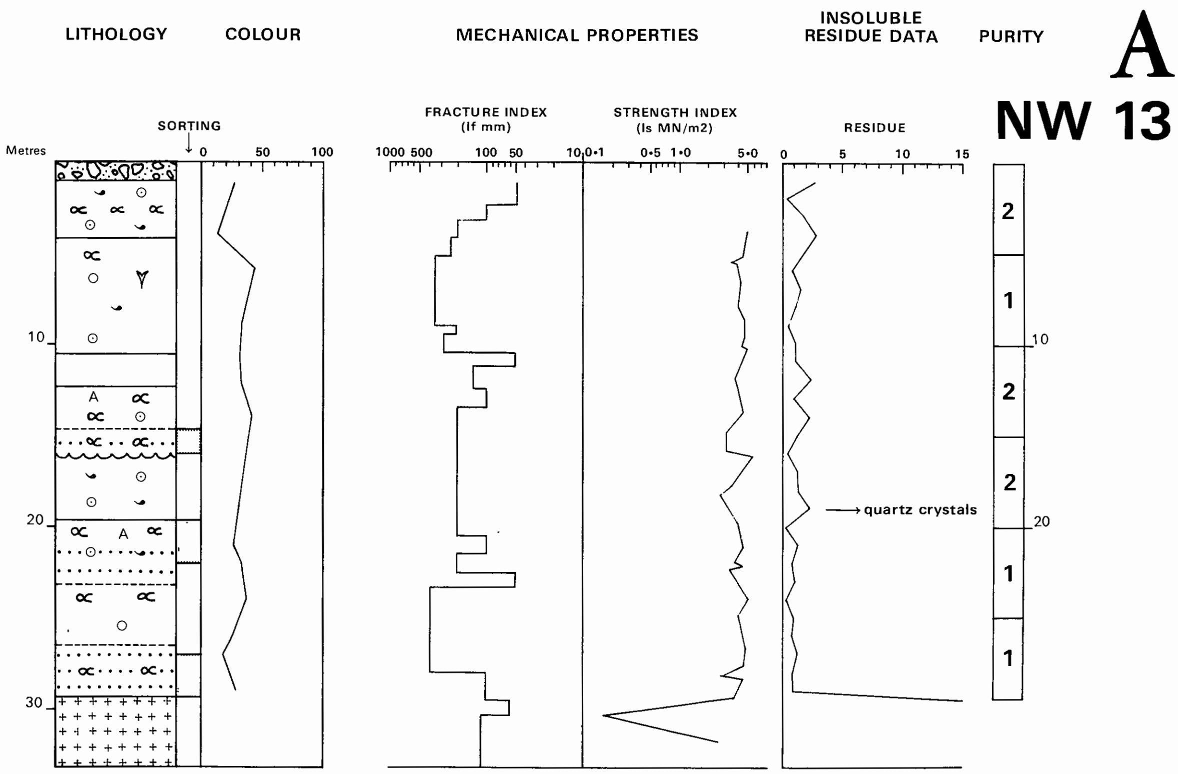
RESOURCE BLOCK A
SK 16 NW 13 1195 6970 Chelmorton Thorn

Surface level +385.3 m (+1264 ft)
Reich (airflush), 74 mm diameter
March 1971

		Thickness (m)	Depth (m)
Topsoil		1.00	1.00
Limestone:	Openhole to 1.10 m. algal biosparrudite, dark grey at base; abundant Girvanella encrusting crinoid and brachiopod debris, subordinate foraminifera and pellets	3.18	4.18
	Crinoid Brachiopod biomicrosparite, mottled from 10.55 m, massively bedded; Girvanella encrustations to 5.50 m, subordinate foraminifera, bryozoa and finely comminuted debris throughout; scattered quartz	8.20	12.38
	algal biomicrosparite, mainly coarse calcarenite (consisting of crinoid and shell debris) grading to fine calcarenite from 14.30 m; abundant Girvanella and Coelosporella	2.27	14.65
	algal pelsparite, locally iron stained; 4 cm clay wayboard at 15.65 m	1.52	16.17
	Brachiopod Crinoid biomicrosparite, coarse calcarenite to fine calcirudite, locally jointed	3.43	19.60
	Biopelsparite; well sorted brachiopod and crinoid debris in beds alternating between fine and coarse calcarenite, Girvanella and Coelosporella occur below 23.20 m	6.90	26.50
	algal pelsparite; local Girvanella with subordinate crinoid and shell debris; pyrite present in increasing amounts towards base	3.01	29.51
Basalt	Pale grey-green, friable and altered at top; pyrite streaks	3.65+	33.16

Borehole completed at 33.16 m


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
A
NW 9
SORTING
Metres
0
50
100
FRACTURE INDEX
(If mm)
1000 500 100 50 10
STRENGTH INDEX
(Is MN/m2)
0·1 0·5 1·0 5·0
RESIDUE
0 5 10 15
10
20
2
1
1
3


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
A
NW 13
SORTING
Metres
0
50
100
FRACTURE INDEX
(If mm)
1000 500 100 50 10
STRENGTH INDEX
(Is MN/m2)
0·1 0·5 1·0 5·0
RESIDUE
0 5 10 15
10
20
30
quartz crystals
2
1
2
2
1
1

RESOURCE BLOCK A
SK 16 NW 13 1195 6970
Chelmorton Thorn

17 Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
1.10	0.01	0.38	0.13	1.54	0.04	0.32	0.02	54.20	0.06	43.33
3.90	0.01	0.34	0.09	1.63	0.03	0.35	0.02	54.35	0.02	43.16
5.85	0.00	0.21	0.03	0.45	0.04	0.36	0.01	55.20	0.01	43.71
9.00	0.00	0.22	0.05	1.49	0.04	0.32	0.01	54.40	0.03	43.09
11.00	0.00	0.22	0.04	0.98	0.05	0.34	0.01	55.15	0.01	43.51
12.00	0.00	0.23	0.06	1.25	0.05	0.32	0.01	54.75	0.01	43.22
14.00	0.00	0.22	0.03	1.01	0.04	0.32	0.01	55.15	0.01	43.26
16.00	0.00	0.23	0.03	0.83	0.03	0.26	0.01	55.10	0.03	43.49
19.00	0.03	0.25	0.04	1.39	0.04	0.37	0.01	54.65	0.03	43.31
21.00	0.00	0.23	0.04	0.62	0.03	0.30	0.01	55.00	0.02	43.69
22.00	0.00	0.25	0.03	0.63	0.03	0.26	0.01	55.00	0.03	43.74
24.00	0.00	0.20	0.01	0.40	0.03	0.23	0.01	55.10	0.01	43.82
26.00	0.00	0.29	0.20	0.55	0.03	0.26	0.02	54.65	0.05	43.73
27.00	0.00	0.31	0.12	1.00	0.03	0.22	0.01	54.60	0.04	43.52
28.90	0.00	0.27	0.23	0.58	0.03	0.23	0.03	54.40	0.48	43.43

SK 16 NW 13 1195 6970
Chelmorton Thorn

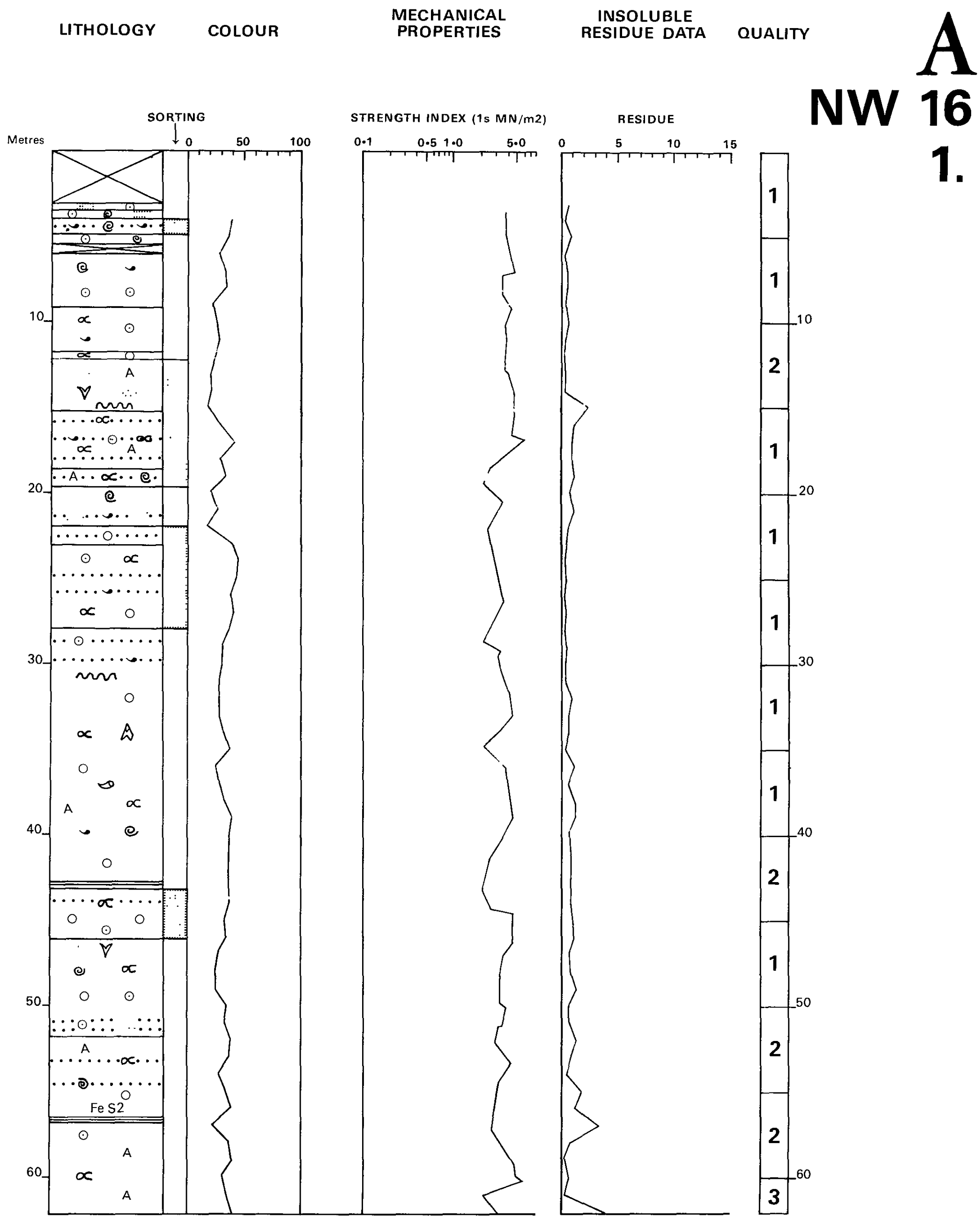
Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
1.10	320	15	30	0	0	0
3.90	215	10	20	0		0
5.85	100	10	10	0		0
9.00	95	25	20	30	5	0
11.00	85	15	10	0		0
12.00	110	10	10	0	0	0
14.00	105	10	10	0		0
16.00	105	10	10	30		0
19.00	140	10	10	0		0
21.00	175	60	30	0		0
22.00	180	5	10	0		0
24.00	170	5	10	10		0
26.00	265	10	10	0		0
27.00	400	5	10	160		0
28.90	850	5	10	50		0

RESOURCE BLOCK A
SK 16 NW 16 1135 6674 Hurdlow Town

Surface Level +388.3 m (1274 ft)
Edeco Stratadrill (waterflush) 76 and 94 mm diameter
January 1973

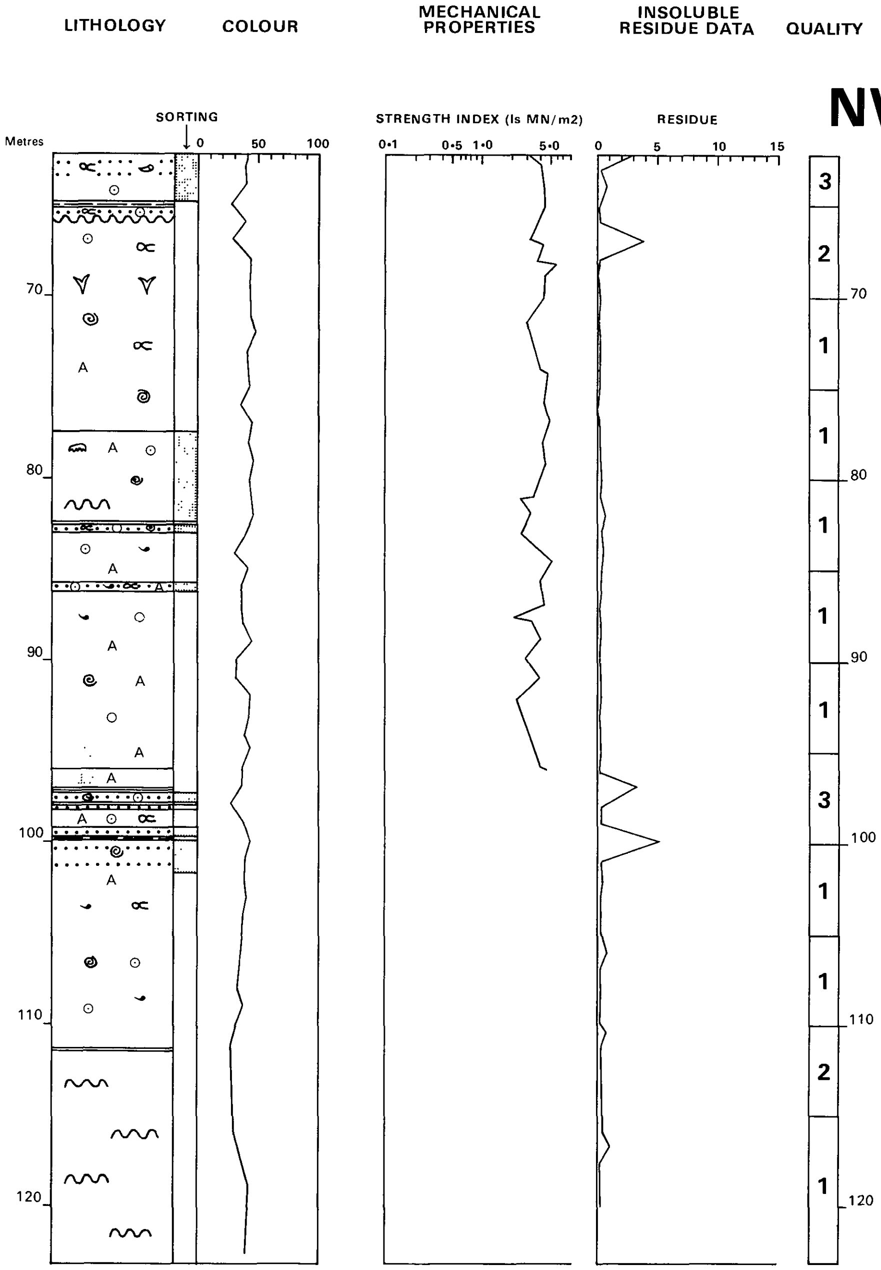
		Thickness (m)	Depth (m)
Topsoil and	Drift Openhole to 3.10 m	3.10	3.10
Limestone	Brachiopod Crinoid biomicrite, subordinate foraminifera and encrusting algae, local spar patches in mottled zones	0.37	3.47
	foraminiferal biosparite, scattered crinoid ossicles, mottled	0.48	3.95
	Pelsparite, subordinate foraminifera and rounded shell debris, laminated, well sorted	0.95	4.90
	Brachiopod Crinoidal biomicrite, subordinate foraminifera, bioturbated	4.28	9.18
	algal biosparite, common foraminifera and brachiopod debris, subordinate bryozoa and Girvanella	2.57	11.75
	algal Brachiopod Crinoidal biosparite, skeletal debris encrusted by algae	0.43	12.18
	Biomicrite, scattered shell fragments, subordinate bryozoa, foraminifera and crinoid debris, occasional Koninckopora; local spar patches in mottled zone	3.06	15.24
	algal biopelsparite, with crinoid and rounded shell debris, subordinate foraminifera; all debris coated with Girvanella, well sorted, laminated	3.36	18.60
	algal biosparite, occasional pellets and Koninckopora, Girvanella coatings	1.10	19.70
	Biomicrite, locally mottled; occasional fragments of encrusting algae especially at 21.80 m, pelletal at base	2.30	22.00
	Biopelsparite, subordinate rounded shell debris	1.10	23.10
	algal biomicrite, with brachiopod, crinoid debris and scattered foraminifera passing locally into pelsparite	4.77	27.87
	crinoid biomicrite, variation throughout division with much comminuted debris; occasional gastropods, rudite size crinoid ossicles, Girvanella and Koninckopora, rare colonial corals, bioturbated	14.86	42.73
Clay wayboard	Ochreous and green clay	0.42	43.15
Limestone	algal biopelsparite, well sorted, laminated at top	2.91	46.06
	foraminiferal bryozoa biosparite, mottled, passing to crinoidal pelsparite towards base	5.77	51.73
	Biosparite, locally pelletal, common foraminifera and crinoid debris with encrusting algae and Koninckopora; scatterd pyrite crystals	4.56	56.29
Clay wayboard	Green and red mudstone	0.19	56.48
Limestone	algal biosparite, common bryozoa, scattered crinoid ossicles, rare brachiopod debris and spines, some Girvanella and Koninckopora	5.42	61.90


A
NW 16
1.
LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
STRENGTH INDEX (1s MN/m2)
RESIDUE
Metres
Fe S2

RESOURCE BLOCK A
SK 16 NW 16 1135 6675 Hurdlow Town (continuation)

		Thickness (m)	Depth (m)
			61.90
Limestone	algal biopelsparite, occasional bryozoa; scattered euhedral quartz crystals	2.92	64.82
Wayboard	Greenish brown mudstone	0.25	65.07
Limestone	algal biopelsparite, subordinate foraminifera, crinoid and shell debris	0.51	65.58
	algal crinoidal biosparite, bryozoan colony at 69.06 m; common *Koninckopora*	11.95	77.53
	algal crinoidal biosparite, abundant *Koninckopora* and occasional intraclasts	4.90	82.43
Clay wayboard	Green and brown clay	0.15	82.58
Limestone	Biopelsparite, with *Girvanella* encrustations	0.39	82.97
	Biosparite, common *Koninckopora* and crinoid ossicles, scattered brachiopods	2.77	85.74
	algal biopelsparite, occasional *Koninckopora*	0.45	86.19
	algal Crinoidal biosparite, some mottling at base	9.81	96.00
	bryozoan biosparite, mottled, common *Koninckopora*	1.02	97.02
Clay wayboard	Green and brown clay	0.19	97.21
Limestone	foraminiferal crinoidal biopelsparite	0.69	97.92
Clay wayboard	Green and brown mudstone	0.12	98.04
Limestone	crinoidal biopelsparite, abundant *Koninckopora*; rare encrusting algae	1.21	99.25
	algal pelsparite, some *Koninckopora*	0.35	99.60
Clay wayboard	Green and brown clay	0.24	99.84
Limestone	algal crinoidal biosparite, pelletal near top, *Koninckopora* and *Girvanella* common	11.51	111.35
Wayboard	Brown mudstone	0.25	111.60
Limestone	crinoidal biopelsparite, broken and mineralised; fault breccia	11.65	123.25

Borehole completed at 123.25 m


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
Metres
0 50 100
STRENGTH INDEX (Is MN/m2)
0·1 0·5 1·0 5·0
RESIDUE
0 5 10 15
70
80
90
100
110
120
3
2
1
1
1
1
1
3
1
1
2
1

A
NW 16
2.

RESOURCE BLOCK A
SK 16 NW 16 1135 6674
Hurdlow Town

Chemical analyses, major elements
(results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050°C
3.10	0.02	0.30	0.15	0.40	0.04	0.19	0.03	55.3	0.13	43.89
5.00	0.01	0.30	0.05	0.65	0.02	0.40	0.02	55.2	0.07	43.75
10.00	0.02	0.30	0.03	0.50	0.02	0.76	0.01	55.5	0.03	43.48
15.00	0.02	0.50	0.21	0.70	0.04	0.84	0.01	54.4	0.19	43.43
20.00	0.01	0.30	0.00	0.58	0.05	1.37	0.00	55.3	0.07	43.58
25.00	0.01	0.10	0.00	0.21	0.02	0.81	0.00	55.6	0.04	43.74
30.00	0.00	0.20	0.00	0.28	0.02	0.56	0.00	55.8	0.06	43.96
35.00	0.01	0.20	0.00	0.24	0.02	0.78	0.01	55.8	0.04	43.90
40.00	0.00	0.20	0.05	0.70	0.02	0.86	0.02	55.4	0.05	43.62
45.00	0.01	0.20	0.13	0.53	0.03	0.90	0.03	55.4	0.15	43.68
50.00	0.00	0.20	0.02	0.20	0.02	0.57	0.01	55.7	0.00	43.49
55.00	0.00	0.20	0.13	0.94	0.00	0.55	0.03	54.4	0.05	43.27
60.00	0.00	0.10	0.02	0.33	0.02	0.79	0.00	55.8	0.02	43.37
65.07	0.00	0.10	0.00	0.08	0.00	0.73	0.00	55.9	0.02	43.55
70.00	0.00	0.10	0.00	0.13	0.00	0.68	0.00	55.8	0.02	43.64
75.00	0.00	0.10	0.00	0.07	0.00	0.63	0.00	55.9	0.00	43.77
80.00	0.01	0.10	0.00	0.34	0.02	0.81	0.01	56.0	0.00	43.70
85.00	0.00	0.10	0.03	0.42	0.03	0.59	0.02	55.9	0.02	43.80
90.00	0.02	0.20	0.03	0.24	0.00	0.71	0.02	55.6	0.02	43.86
95.07	0.00	0.10	0.00	0.20	0.02	0.58	0.00	55.5	0.02	43.66
100.00	0.00	0.10	0.04	0.73	0.00	0.58	0.01	55.1	0.10	43.42
105.00	0.00	0.20	0.00	0.36	0.00	0.71	0.00	55.7	0.00	43.57
110.00	0.01	0.10	0.03	0.27	0.00	0.71	0.01	55.5	0.04	43.74
116.05	0.01	0.20	0.93	1.69	0.02	0.89	0.09	54.1	0.38	42.79
120.00	0.00	0.10	0.09	0.17	0.00	0.35	0.02	55.4	0.02	43.69

SK 16 NW 16 1135 6674
Hurdlow Town

Trace elements (parts per million)

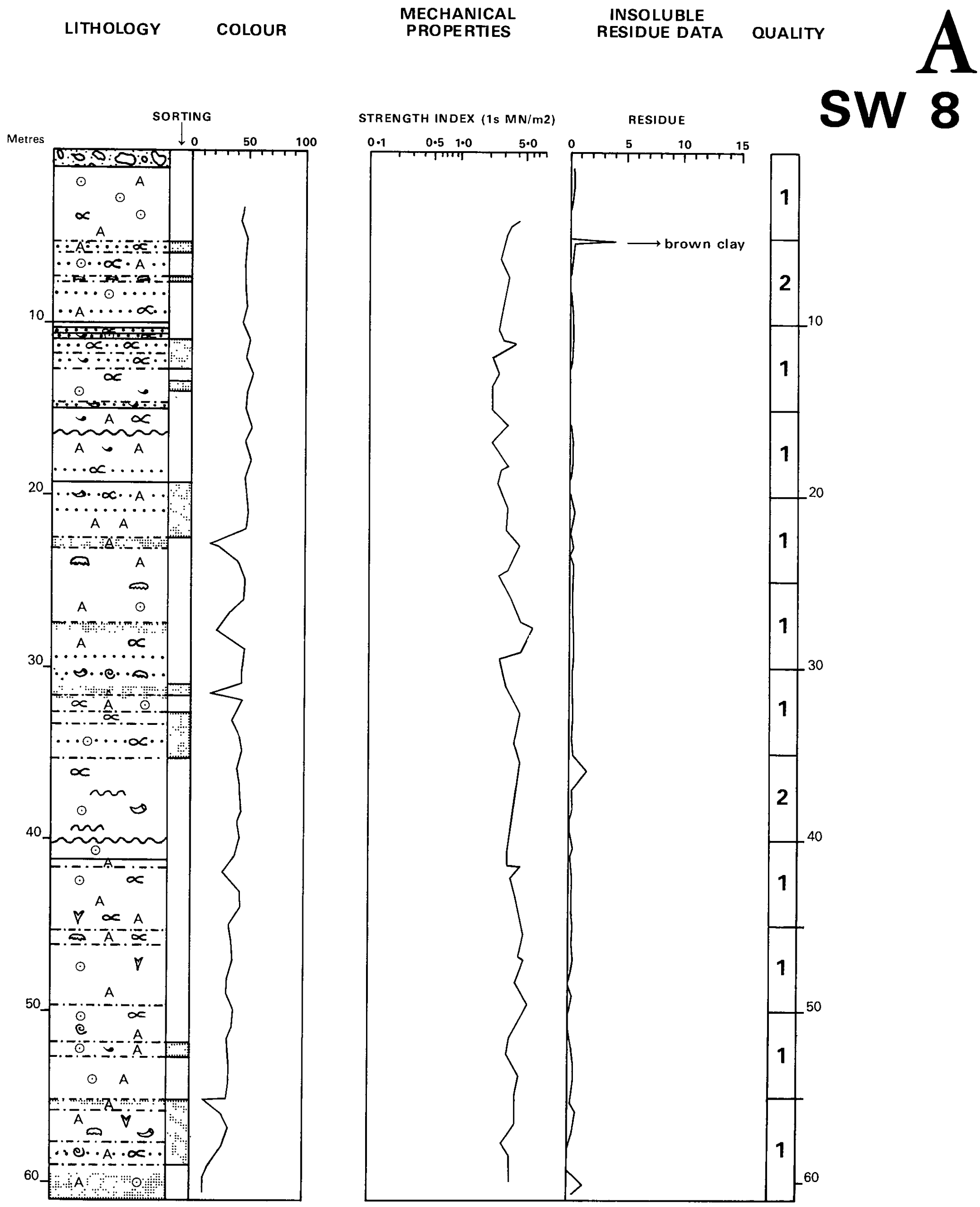
Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
3.10	140	5	25	5	0	0.01
5.00	130	5	15	5	0	0.02
10.00	220	5	15	5	3	0.01
15.00	260	5	15	10	0	0.01
20.00	220	5	10	0	0	0.01
25.00	170	5	20	10	0	0.00
30.00	170	5	20	15	0	0.00
35.00	150	5	15	0	0	0.00
40.00	170	5	20	5	0	0.00
45.00	210	10	50	15	2	0.01
50.00	110	5	15	0	0	0.00
55.00	100	5	20	0	1	0.00
60.00	90	5	15	0	0	0.01
65.07	110	5	10	0	0	0.03
70.00	110	5	10	0	0	0.04
75.00	60	5	10	0	0	0.02
80.00	50	5	10	0	0	0.01
85.00	90	5	10	5	0	0.00
90.00	90	5	10	5	4	0.02
95.07	70	5	10	0	0	0.01
100.00	130	5	25	10	3	0.00
105.00	80	5	15	0	0	0.02
110.00	150	5	20	10	0	0.02
116.05	380	10	100	75	0	0.02
120.00	80	5	15	5	0	0.00

RESOURCE BLOCK A
SK 16 SW 8 1365 6287 Vincent House

Surface level +285.2 m (+936 ft)
Edeco Stratadrill (waterflush), 95 mm reducing to 76 mm at 20 m
December 1972

		Thickness (m)	Depth (m)
Topsoil	Openhole to 0.40 m; broken limestone and clayey soil	0.82	0.82
Limestone	crinoid Algal biosparite, abundant Koninckopora and Girvanella, occasional shells and intraclasts, clay infilled joints, abundant brachiopods and intraclasts at 7.40 m	9.18	10.00
	Biomicrosparite	0.35	10.35
	crinoidal Algal biosparite, common Koninckopora and Girvanella, pellets occur between 10.85 m and 12.65 m, scattered shells, good	4.25	14.60
	sorting coral brachiopod biosparrudite	0.30	14.90
	crinoidal Algal biosparite, Koninckopora throughout, variable concentrations of shells and pellets, well sorted below 19.36 m	7.68	22.58
	Micrite, dark coloured	0.50	23.08
	algal crinoidal biosparite, rare bryozoa, local intraclasts, 'corroded' shells between 24.85 and 26.27 m	4.37	27.45
	Biomicrite, dark coloured, interbedded fine and medium calcarenites consisting of undifferentiated comminuted debris	0.50	27.95
	algal Crinoidal biosparite, locally dark coloured, Girvanella and Koninckopora throughout, scattered shells, foraminifera and pellets; calcirudite consisting of intraclasts and crinoid debris between 30.80 and 31.70 m	4.64	32.59
	Biosparite, finely comminuted, algal-encrusted debris, large shells at 33.30 m	0.81	33.40
	algal crinoidal biosparite, medium and coarse calcarenite to 35.27 m becoming finer grained towards base, laminated between 38.75 and 39.05 m, rubbly core between 39.30 and 40.00 m, jointing and associated iron staining throughout	7.75	41.15
	crinoidal Algal biosparite, local laminations	4.22	45.37
	algal intraclastic biosparite, masses of Koninckopora at 46.12 m	0.75	46.12
	Algal Crinoidal biosparite, masses of Koninckopora, subordinate shell debris, foraminifera and pellets, traces of bryozoa; Girvanella encrustations throughout, laminated fine calcarenite between 51..82 and 52.60 m	9.05	55.17
	foraminiferal algal Biomicrite, dark coloured, abundant Koninckopora but no encrusting algae	0.68	55.85
	foraminiferal Algal biosparite, locally laminated, well sorted, subordinate crinoid debris, pellets and bryozoa; corals and intraclasts at 57.21 m	3.03	58.88
	algal crinoidal biosparite, mid-grey, scattered fine shell debris	2.00	60.88

Borehole completed at 60.88 m



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
A
SW 8
SORTING
STRENGTH INDEX (1s MN/m2)
RESIDUE
Metres
0
50
100
0·1
0·5
1·0
5·0
0
5
10
15
brown clay
10
20
30
40
50
60
1
2
1
1
1
1
1
2
1
1
1
1

RESOURCE BLOCK A

SK 16 SW 8 1365 6287 Vincent House

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
7.00	0.02	0.21	0.02	0.18	0.01	0.18	0.01	55.65	0.02	43.88
11.00	0.02	0.23	0.02	0.16	0.01	0.18	0.01	55.88	0.01	44.01
15.00	0.02	0.21	0.02	0.15	0.02	0.18	0.01	54.65	0.00	43.87
20.00	0.01	0.21	0.02	0.14	0.01	0.19	0.01	55.75	0.01	43.91
22.20	0.02	0.21	0.01	0.12	0.01	0.19	0.00	55.75	0.02	43.88
22.65	0.01	0.23	0.01	0.13	0.01	0.19	0.00	55.55	0.01	43.93
25.00	0.01	0.24	0.02	0.16	0.01	0.20	0.01	55.55	0.01	43.93
31.00	0.02	0.23	0.02	0.16	0.01	0.21	0.01	54.74	0.01	43.91
36.00	0.02	0.24	0.04	0.20	0.01	0.20	0.01	55.45	0.04	44.00
45.00	0.02	0.25	0.03	0.16	0.01	0.23	0.01	55.31	0.07	43.89
51.00	0.02	0.22	0.02	0.17	0.01	0.19	0.00	55.22	0.02	43.96
55.40	0.01	0.42	0.02	0.14	0.01	0.22	0.00	55.28	0.01	44.05
56.00	0.01	0.27	0.05	0.21	0.01	0.19	0.01	55.61	0.01	43.84
60.60	0.02	0.44	0.05	0.19	0.01	0.20	0.01	55.02	0.01	44.03

SK 16 SW 8 1365 6287 Vincent House Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
7.00	60	25	10	10	0	0.06
11.00	60	20	10	10		0.07
15.00	60	10	10	10		0.04
20.00	70	5	10	15	0	0.06
22.20	60	5	10	15		0.05
22.65	70	5	10	15		0.06
25.00	70	5	10	15		0.05
31.00	80	5	10	15		0.02
36.00	100	10	20	15	0	0.05
45.00	130	5	30	15	0	0.05
51.00	120	10	10	15		0.05
55.40	80	5	10	20		0.04
56.00	120	10	10	15		0.05
60.60	120	10	10	20		0.04

RESOURCE BLOCK A
SK 16 NW 1S Street House

Section sampled from 1173 6724 (top) to 1133 6732 (base)
Surface level at top of section +365.7 m (+1270 ft)

		Thickness (m)	Depth (m)
Limestone	Biomicrite, dark, with comminuted shell debris, scattered crinoids and silicified brachiopods, ripple-drift bedding	2.00	2.00
	algal crinoidal biosparrudite passing into algal biomicrite; common Girvanella encrustations, scattered quartz euhedra	3.00	5.00
	crinoidal biopelsparite, dark at top but paler below 6.00 m; silicified fossil debris, common quartz grains	2.20	7.20
	crinoid brachiopod biomicrite, local algal encrusted skeletal debris, occasional foraminifera and spines, bioturbated, mottled with patchy spar from 12.80 m, euhedral quartz crystals present throughout	10.80	18.00

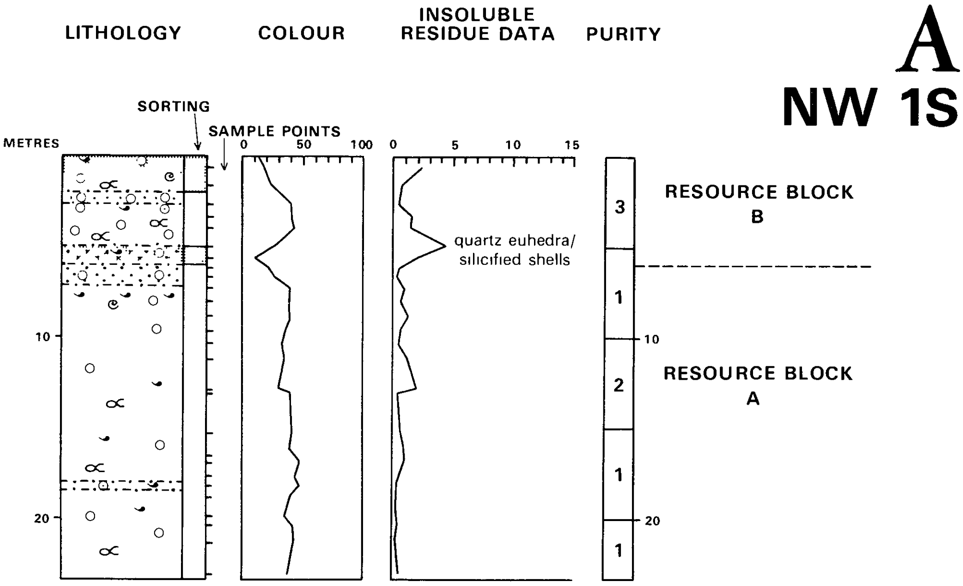
RESOURCE BLOCK A
SK 16 SW 1S 1474 6304 Parsley Hay Station

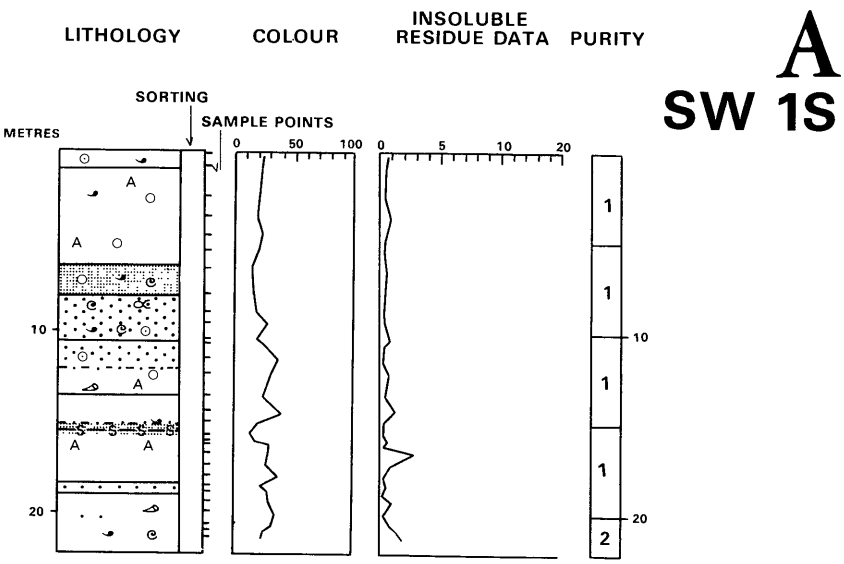
Surface level +354.7 m (+1164 ft)

		Thickness (m)	Depth (m)
Limestone	algal Crinoidal biomicrite, subordinate brachiopod debris, occasional foraminifera and bryozoan fragments, patchy spar	6.30	6.30
	Biosparite, darker coloured	1.70	8.00
	Pelsparite, grading locally to biopelsparite	4.00	12.00
	Biosparite, abundant comminuted debris; algal fragments, shell and crinoid debris, scattered foraminifera	3.20	15.20
	Biosparite, darker coloured throughout upper part of bed with Saccamminopsis and Coelosporella; towards base, limestone is paler with scattered Coelosporella fragments	3.00	18.20
	Biopelsparite	0.80	19.00
	Biosparite, scattered crinoid and shell debris; foraminifera and pellets	3.20	22.20

Section completed at 22.20 m

No chemical data available


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
NW 1S
SORTING
SAMPLE POINTS
METRES
0 50 100
0 5 10 15
10
20
3
1
2
1
1
quartz euhedra/ silicified shells
RESOURCE BLOCK B
RESOURCE BLOCK A


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
SW 1S
SORTING
SAMPLE POINTS
METRES
0 50 100
0 5 10 20
10
20
1
1
1
1
2

RESOURCE BLOCK A (and B)
SK 16 NW 1S 1173 6724 to 1133 6732
Street House

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
0.0	0.02	0.22	0.01	0.56	0.03	0.80	0.00	54.30	0.02	43.72
0.7	0.03	0.44	0.18	0.92	0.05	0.75	0.04	53.75	0.11	43.48
1.7	0.03	0.28	0.02	0.28	0.03	0.80	0.01	54.75	0.02	43.76
2.7	0.04	0.28	0.01	0.32	0.03	0.85	0.01	54.05	0.03	43.79
3.4	0.03	0.26	0.02	1.40	0.03	0.65	0.01	54.40	0.03	43.13
4.0	0.02	0.27	0.02	1.36	0.03	0.75	0.01	54.60	0.03	43.15
5.0	0.09	0.36	0.05	2.55	0.03	0.70	0.02	52.65	0.08	42.54
5.6	0.03	0.49	0.08	0.81	0.04	0.80	0.02	54.00	0.08	43.70
6.2	0.05	0.34	0.00	0.20	0.04	0.70	0.01	55.00	0.02	43.81
6.7	0.02	0.35	0.01	0.27	0.03	0.75	0.00	54.95	0.02	43.75
7.4	0.03	0.62	0.33	1.54	0.16	0.95	0.07	52.80	0.15	43.04
8.0	0.02	0.25	0.01	0.25	0.03	0.55	0.01	54.30	0.01	43.66
8.8	0.02	0.24	0.02	1.28	0.03	0.60	0.01	53.90	0.05	43.31
9.6	0.02	0.27	0.02	0.42	0.03	0.60	0.01	54.20	0.04	43.70
10.4	0.08	0.25	0.02	0.30	0.03	0.70	0.02	54.20	0.04	43.89
11.2	0.01	0.26	0.02	0.45	0.03	0.70	0.01	54.05	0.03	43.56
12.8	0.01	0.28	0.08	0.34	0.04	0.65	0.01	54.15	0.03	43.63
13.1	0.02	0.26	0.03	0.23	0.03	0.65	0.01	54.40	0.05	43.77
15.4	0.00	0.21	0.01	0.22	0.05	0.95	0.00	53.75	0.03	43.77
16.2	0.00	0.22	0.04	0.35	0.04	0.80	0.01	54.20	0.07	43.79
16.9	0.06	0.24	0.01	0.18	0.04	0.85	0.00	53.90	0.04	43.90
17.7	0.00	0.18	0.01	0.52	0.03	1.00	0.00	53.90	0.07	43.52
18.2	0.02	0.18	0.02	0.38	0.04	0.85	0.01	54.50	0.04	43.45
18.8	0.02	0.23	0.06	0.32	0.04	0.95	0.01	54.05	0.16	43.86
19.9	0.00	0.20	0.04	0.33	0.03	0.90	0.01	54.20	0.06	43.74
20.4	0.01	0.18	0.02	0.36	0.03	0.70	0.00	54.25	0.06	43.81
21.3	0.01	0.16	0.00	0.13	0.04	0.85	0.00	54.20	0.03	43.92
23.1	0.00	0.19	0.04	0.76	0.04	0.75	0.01	53.90	0.04	43.61

SK 16 NW 1S 1173 6724 to 1133 6732
Street House

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
0.0	135	20	20	30		0
0.7	135	20	20	0	0	0
1.7	85	25	20	0		0
2.7	100	15	20	0		0
3.4	125	15	20	10		0
4.0	145	20	20	10		0
5.0	290	20	30	30		0
5.6	185	15	20	40		0
6.2	90	20	20	0	0	0
6.7	115	20	20	0		0
7.4	80	25	50	0		0
8.0	100	10	20	0	0	0
8.8	150	15	20	0		0
9.6	85	15	20	0		0
10.4	85	15	20	0		0
11.2	70	10	20	0		0
12.8	95	15	30	0		0
13.1	85	15	20	0		0
15.4	105	20	20	0		0
16.2	190	15	20	0		0
16.9	95	10	20	0	0	0
17.7	105	20	30	0	0	0
18.2	95	15	10	0		0
18.8	105	15	30	0		0
19.9	115	20	30	0		0
20.4	130	15	20	0		0
21.3	105	20	30	0		0
23.1	130	10	30	0		0

RESOURCE BLOCK A
SK 16 SW 2S 1412 6229 Long Dale (north end)

Surface level +309.8 m (+1016 ft)

		Thickness (m)	Depth (m)
Limestone	Biomicrite, scattered foraminifera and spines, local patchy spar	0.80	0.80
	algal biopelsparite, tightly packed pellets, subordinate shell and crinoid debris, abundant Girvanella and Koninckopora passing into biomicrite towards base	1.40	2.20
	No exposure	1.90	4.10
	Biomicrite, scattered shell debris and pellets at top, minor calcite veining	2.70	6.80
	No exposure	1.60	8.40
	Biomicrite, becoming increasingly fossiliferous with spar cement towards base, common calcite veining	2.00	10.40
	No exposure	3.00	13.40
	Biomicrite, finely comminuted fossil debris, common algae and foraminifera, subordinate shell debris	0.60	14.00
	Pelsparite, coarse bioclastic band with large shells and corals at base of unit, scattered quartz euthedra	1.60	15.60
	No exposure	2.40	18.00
	Biomicrite; biopelsparite developed between 18.45 and 18.70 m	1.70	19.70
	No exposure	1.60	21.30
	Biomicrite, finely comminuted fossil debris, algae locally abundant at 22.70 m, calcite veined, slump structures at base of unit	2.30	23.60
	algal biosparite, common crinoid, spine and shell debris, occasional pellets; encrusting algae and Koninckopora; concentration of shells near base	1.20	24.80
	Biomicrite, fine calcarenite; tightly packed algal-encrusted allochems, passing into micrite towards base	2.00	26.80
	algal biopelsparite, scattered large shells, debris is tightly compacted locally, graded bedding at 28.80 m, calcite veined	3.20	31.00

No chemical data available

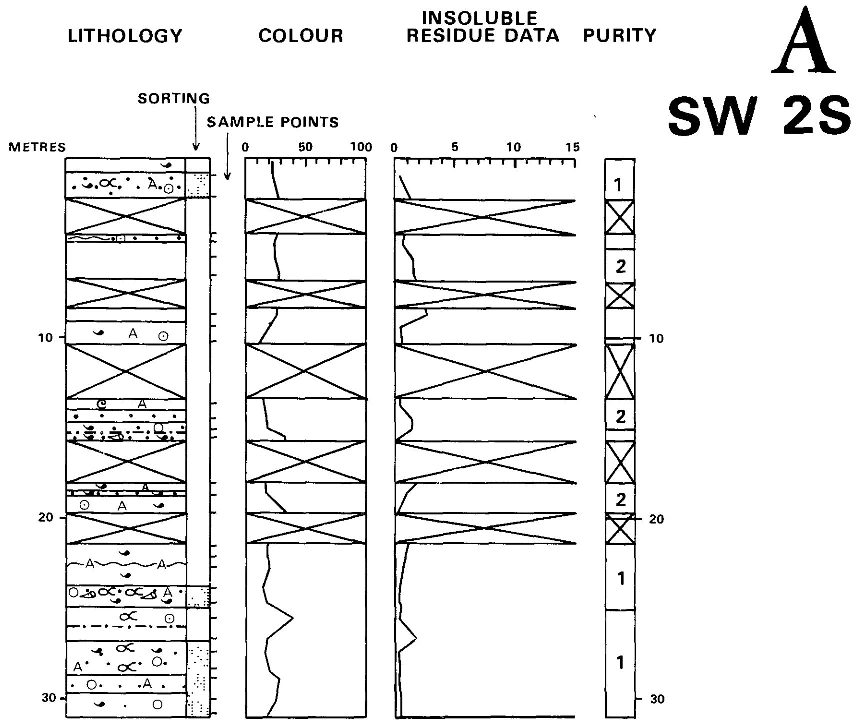
RESOURCE BLOCK A
SK 16 SW 3S 1395 6198 Long Dale, Hartington

Surface level +290.2 m (+952 ft)

		Thickness (m)	Depth (m)
Limestone	Algal biosparite; well sorted crinoid and shell debris; common Koninckopora and Girvanella, abundant shells on bedding plane at 1.00 m	1.30	1.30
No data	Inaccessible cliff face	8.40	9.70
Limestone	algal Pelsparite, laminated	0.30	10.00
	algal biosparite with brachiopod and crinoid debris passing at 10.40 m to a sparsely fossiliferous calcilutite, becoming pelletal at base	1.10	11.10
	Algal biosparite, Girvanella and Koninckopora present, remaining debris essentially comminuted foraminifera, crinoids and pelletal debris; medium rudite size shell cluster at 12.30 m	3.70	14.80
	crinoid algal biosparite, scattered foraminifera and pellets, Koninckopora present	1.70	16.50
Unexposed		3.60	20.10
Limestone	algal biosparite, subordinate crinoid and shell debris and occasional pellets, Koninckopora and Girvanella present	5.00	25.70

Section completed at 25.70 m

No chemical data available



LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
SW 2S
SORTING
SAMPLE POINTS
METRES
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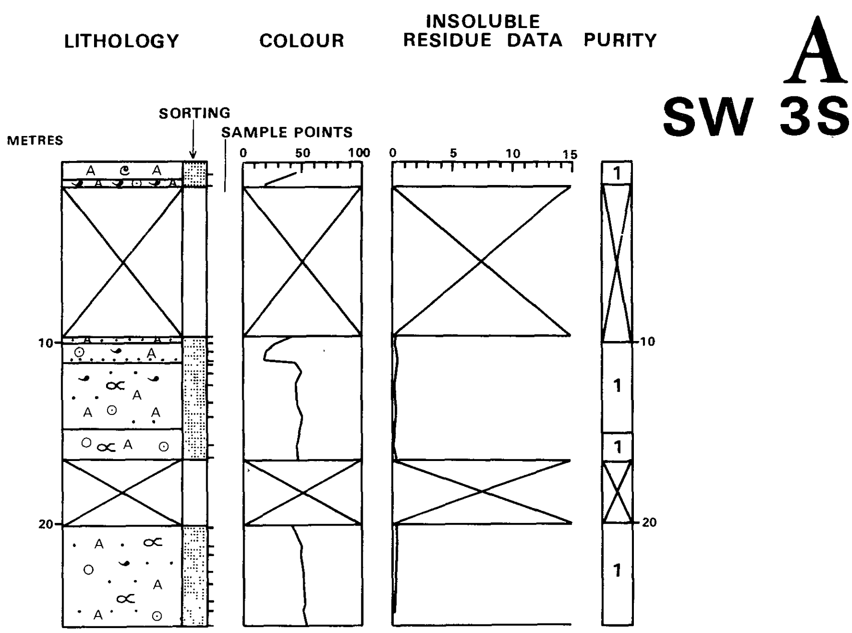
10
20
30
1
2
2
2
1
1



LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
SW 3S
SORTING
SAMPLE POINTS
METRES
0 50 100
0 5 10 15
10
20
1
1
1
1

RESOURCE BLOCK A

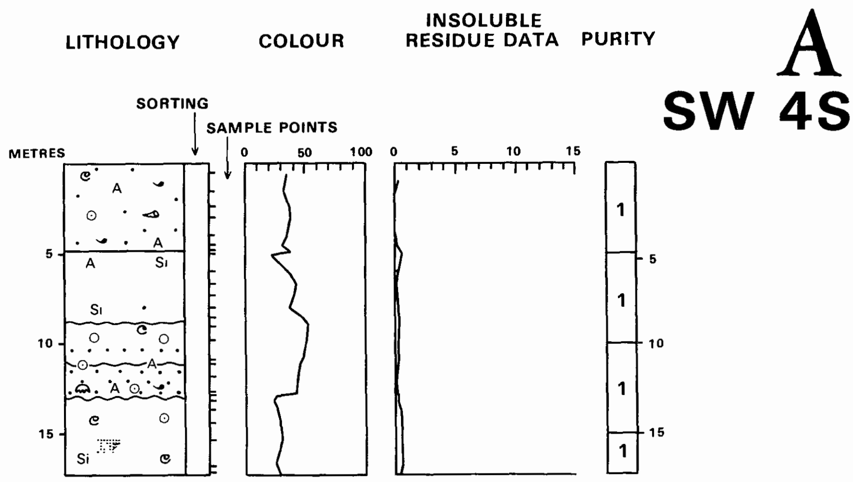
SK 16 SW 4S 1450 6153 Railway cutting, Hartington-moor Farm

Surface level +342.9 m (+1125 ft)

		Thickness (m)	Depth (m)
Limestone	Biosparrudite passing into biomicrite in the lower part of the unit, common crinoids, brachiopods, foraminifera and pelletal grains, abundant Koninckopora; minor silicification is associated with the biomicrite	8.80	8.80
	Crinoidal biosparite, local vuggy porosity	2.00	11.00
	Biopelsparite, fine calcarenite, common Koninckopora, subordinate crinoid debris, pellets and intraclasts; micrite developed towards erosion surface at base	2.00	13.00
	Biomicrite, coarse calcilutite, allochems are indeterminate, minor calcite veining, traces of silicification	4.20	17.20

Section completed at 17.20 m

No chemical data available


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
SW 4S
SORTING
SAMPLE POINTS
METRES
0 50 100
0 5 10 15
5
10
15
A
Si
1
1
1
1

RESOURCE BLOCK A

SK 16 SW 5S 1395 6049 Hartington Dale

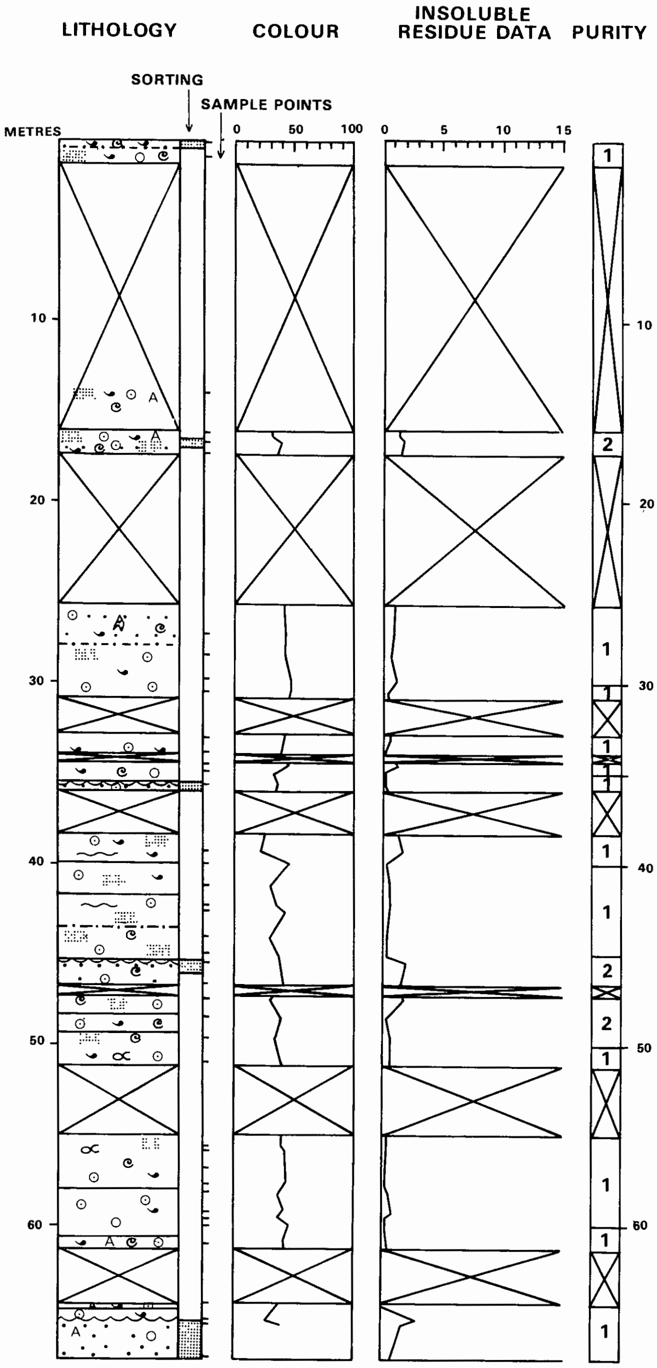
Surface level +342.9 m (+1125 ft)

		Thickness (m)	Depth (m)
Limestone	Biopelsparite, scattered foraminifera, algal coatings on bioclastic fragments; shell band at top of bed	0.50	0.50
	crinoid Brachiopod biosparite, mottled, subordinate forminifera and spines	0.80	1.30
Gap in data		12.70	14.00
Limestone	crinoid brachiopod biomicrite, mottled subordinate foraminifera and algae	0.80	14.80
Gap in data		1.30	16.10
Limestone	crinoid brachiopod biomicrite, mottled, scattered algae and foraminifera, alternating with crinoid biopelsparite	1.30	17.40
Gap in data		8.20	25.60
Limestone	Biopelsparite, scattered foraminifera, shells, gastropods and crinoids, becoming micritic towards base	2.30	27.90
	crinoid biomicrite, mottled near top	2.90	30.80
Gap in data		2.00	32.80
Limestone	Biomicrosparite, finely comminuted fossil debris, locally more abundant shell debris	1.10	33.90
Gap in data		0.50	34.40
Limestone	Biomicrite, scattered foraminifera, crinoids and shells; locally sparry patches	1.10	35.50
	crinoidal pelsparite, clay band at top	0.40	35.90
Gap in data		2.50	38.40
Limestone	crinoid Brachiopod biosparite, mottled, rubbly appearance	1.50	39.90
	crinoid Brachiopod biomicrite, local mottling, some sparry patches	1.75	41.65
	crinoid biomicrite, rubbly appearance, mottled at base	1.75	43.40
	Biomicrite, mottled, scattered foraminifera and comminuted bioclasts	1.90	45.30
	Biopelsparite, thin clay at top	1.50	46.80
Gap in data		0.50	47.30
Limestone	Biomicrosparite, mottled; finely comminuted fossil debris	1.00	48.30
	Biomicrosparite; allochems closely compacted	1.10	49.40
	Biomicrite, mottled, abundant foraminifera and finely comminuted debris at top; paler with shells, crinoids, foraminifera, algal coatings and patchy spar at base	1.80	51.20
Gap in data		3.80	55.00
Limestone	Biomicrosparite, scattered foraminifera, algae, crinoid debris	3.00	58.00
	Crinoidal biomicrite, local dolomitisation	2.60	60.60
	algal biosparite	0.70	61.30
Gap in data		3.10	64.40
Limestone	Biomicrosparite, scattered crinoid and algal debris	0.20	64.60
	Brachiopod Crinoidal biosparrudite, iron stained; 0.05 m clay wayboard at base	0.75	65.35
	algal Biopelsparite, scattered crinoids and spines	2.05	67.40

Section completed at 67.40 m

No chemical data available

A
SW 5S


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
SORTING
SAMPLE POINTS
METRES
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10
20
30
40
50
60
1
2
1
1
1
1
1
1
1
2
2
1
1
1
1

RESOURCE BLOCK A

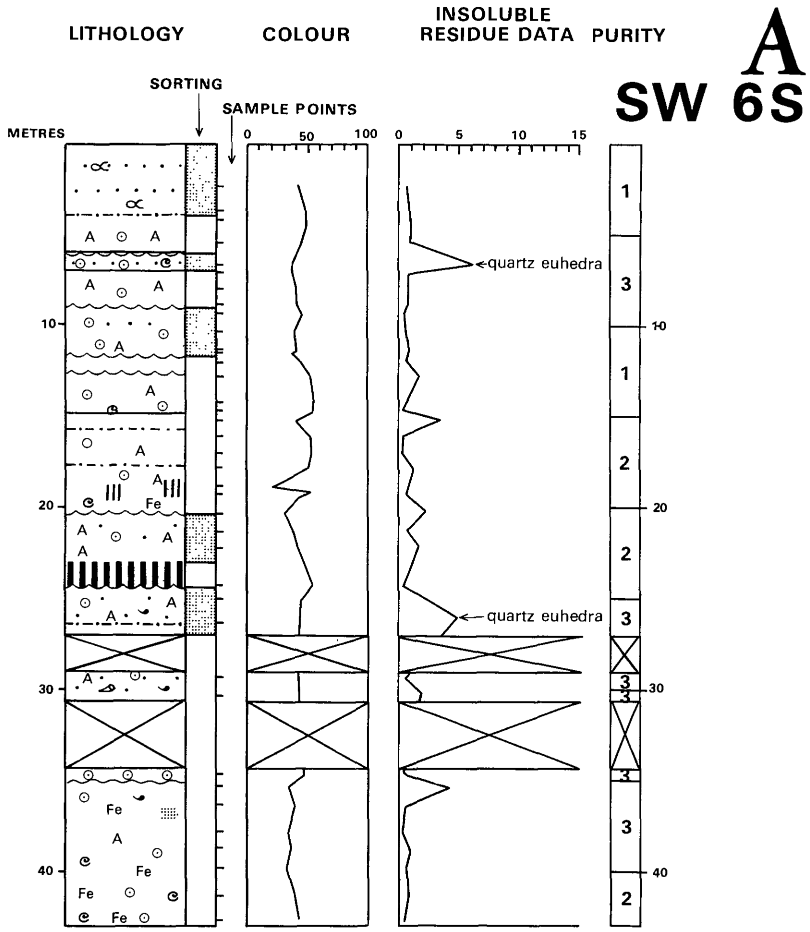
SK 16 SW 6S Heathcote Quarry and adjacent railway cutting
section sampled from 1490 6068 (top) to 1499 6099 (base)

Surface level +336.2 m (+1103 ft)

		Thickness (m)	Depth (m)
Limestone	algal pelsparite, occasional crinoid ossicles	4.00	4.00
	algal crinoidal biosparite; abundant *Koninckopora*	2.00	6.00
Clay wayboard		0.05	6.05
Limestone	Biopelsparite, common crinoid plates and foraminifera; many euthedral quartz crystals	0.95	7.00
	algal crinoidal biosparite, masses of *Koninckopora* near top of bed	2.00	9.00
Clay wayboard		0.05	9.05
Limestone	algal crinoidal biosparite, algal-encrusted crinoid debris and pellets common at top of unit, towards base *Koninckopora* increases, vuggy porosity at 11.50 m	2.75	11.80
Clay wayboard		0.03	11.83
Limestone	algal crinoidal biosparite; vuggy porosity at 15.20 m, traces of ferroan dolomite	3.67	15.50
	algal crinoidal biomicrite; *Girvanella* and *Koninckopora* present	2.00	17.50
	algal crinoidal biosparite, vuggy porosity at 19.00 m, locally dolomitised, micrite in part, iron stained at base	2.90	20.40
Clay wayboard		0.03	20.43
Limestone	algal biosparite, *Koninckopora* common, some pellets	1.77	22.20
Dolomite		2.20	24.40
Clay wayboard		0.03	24.43
Limestone	algal biosparite; many *Koninckopora*	1.57	26.00
	Biosparite; much fine shell debris, disseminated quartz	0.40	26.40
Gap in data		2.60	29.00
	algal biopelsparite, common Koninckopora and crinoid debris	1.30	30.30
Gap in data		4.20	34.50
	Crinoidal biosparite	0.60	35.10
	foraminiferal biosparite, partly recrystallised, red iron staining in patches	7.90	43.00

Section seen to 43.00 m

No chemical data available


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
SW 6S
SORTING
SAMPLE POINTS
METRES
0 50 100
0 5 10 15
quartz euhedra
quartz euhedra
Fe
1
3
1
2
2
3
3
3
3
3
2
10
20
30
40

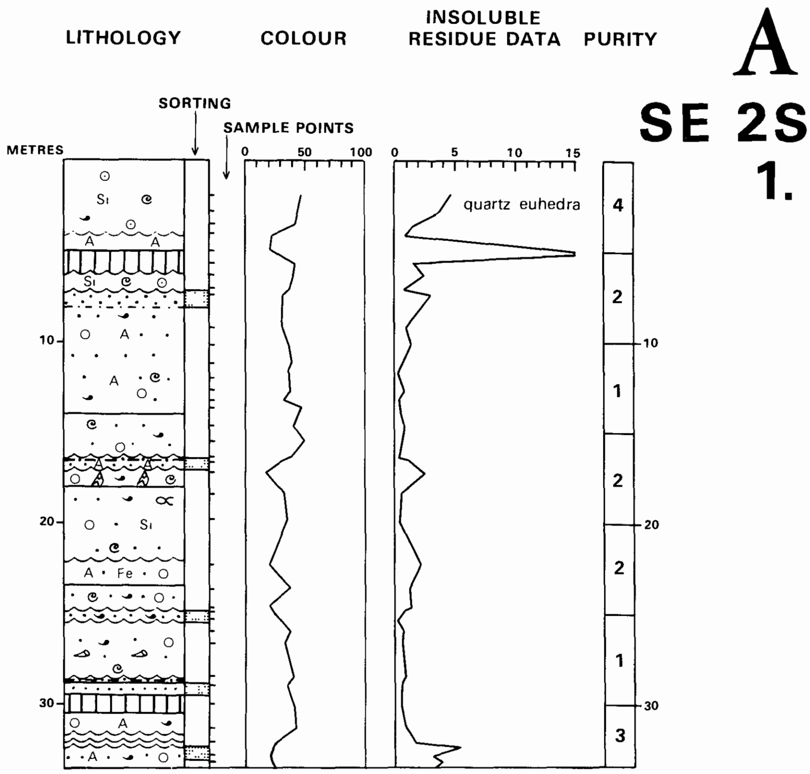
RESOURCE BLOCK A

SK 16 SE 2S Hartington Station Quarry

Section sampled from 1525 6122 (top) to 1500 6133 (base); uppermost 20 m of the quarry face are inaccessible

Surface level +338.5 m (+1111 ft)

		Thickness (m)	Depth (m)
Limestone	Biosparite, scattered crinoid ossicles and brachiopod shells, doubly terminating quartz crystals dispersed thoughout rock	4.00	4.00
Clay wayboard		0.05	4.05
Limestone	Algal? biomicrite, dark grey laminated rock	0.65	4.70
	Dolomitic limestone associated with small fault	1.50	6.20
Clay wayboard	10 cm-clay forming irregular wayboard	0.10	6.30
Limestone	crinoidal biosparite, common bioclasts becoming well sorted towards base	0.90	7.20
Clay wayboard		0.03	7.23
Limestone	Pelsparite, well sorted algal-encrusted grains	0.87	8.10
	Biosparite, massive bedded, varied bioclasts including crinoid ossicles, pellets, brachiopod shells, Dasycladaceaen algae (Koninckopora) and foraminifera; towards base gradation to biomicrite	8.40	16.50
Clay wayboard		0.12	16.62
Limestone	Biopelsparite, common pellets, foraminifera, crinoid ossicles, shell debris and algae (Koninckopora); localised hematite veining and associated silicification	0.48	17.10
Clay wayboard		0.04	17.14
Limestone	Biosparite, dark grey, partially recrystallised with mixed fauna including gastropod shells, below 18.00 m colour pales and allochems exhibit algal corrosion	4.96	22.10
Clay wayboard		0.05	22.15
Limestone	Biosparite, dark and pale grey, recrystallized with mixed fauna as above, local abundant Koninckopora; clay parting (4 cm) at 24.80 m	2.69	24.84
	Pelsparite, medium grey, dominant pellets, subordinate shell debris and foraminifera	0.36	25.20
Clay wayboard		0.04	25.24
Limestone	Biopelsparite, common pellets, shell debris and foraminifera; gradation to biosparite	3.36	28.60
Clay wayboard		0.20	28.80
Limestone	Pelsparite, well sorted grains, dominant pellets, subordinate crinoid ossicles, shell debris and foraminifera	0.70	29.50
	Dolomitic biosparite	1.00	30.50
	Thin micritic limestones interbedded with clay partings	1.80	32.30
	Biopelsparite, partially recrystallised, common pellets, crinoid and shell debris, local Koninckopora	1.00	33.30


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
A
SE 2S
1.
SORTING
SAMPLE POINTS
METRES
0
50
100
0
5
10
15
quartz euhedra
10
20
30
4
2
1
2
2
1
3
Si
A
Fe

SK 16 SE 2S Hartington Station Quarry (continuation)

		Thickness (m)	Depth (m)
			33.30
Clay wayboard	Varicoloured yellow and red-brown, finely bedded	0.30	33.60
Limestone	Biosparite, massive bedded, common varied bioclasts including coarse crinoid debris, brachiopods, pellets, foraminifera and algae; clay parting (2 cm) at base	3.90	37.50
	Pelsparite grading to well sorted biosparite, shell band at top of unit, throughout the lower part of the unit algal corroded, rounded debris predominates	1.20	38.70
	Biosparite, massive bedded, varied bioclasts, hematite veinlets	5.10	43.80
Clay wayboard		0.02	43.82
Limestone	Biosparite, massive bedded, fauna includes foraminifera, crinoid ossicles, brachiopod debris and pelletal grains	6.18	50.00
Clay wayboard	Tuffaceous clay, pale grey, green, red-yellow	0.10	50.10
Limestone	Shelly biosparite, dark grey with large productoids, some hematite staining		
	Biosparite, thick to massive bedded, common bioclastic debris with foraminifera, Dasycladaceaen algae (Koninckopora), pellets and brachiopod shells	13.00	63.80
	Shelly biosparite at 66.50 m continuing in crinoidal biosparite with subordinate pellets, algae, foraminifera and brachiopod debris	7.20	71.00
	Biosparite, as above but increased foraminifera and algae	1.50	72.50
	crinoidal biosparite	2.40	74.90

Additional Notes:

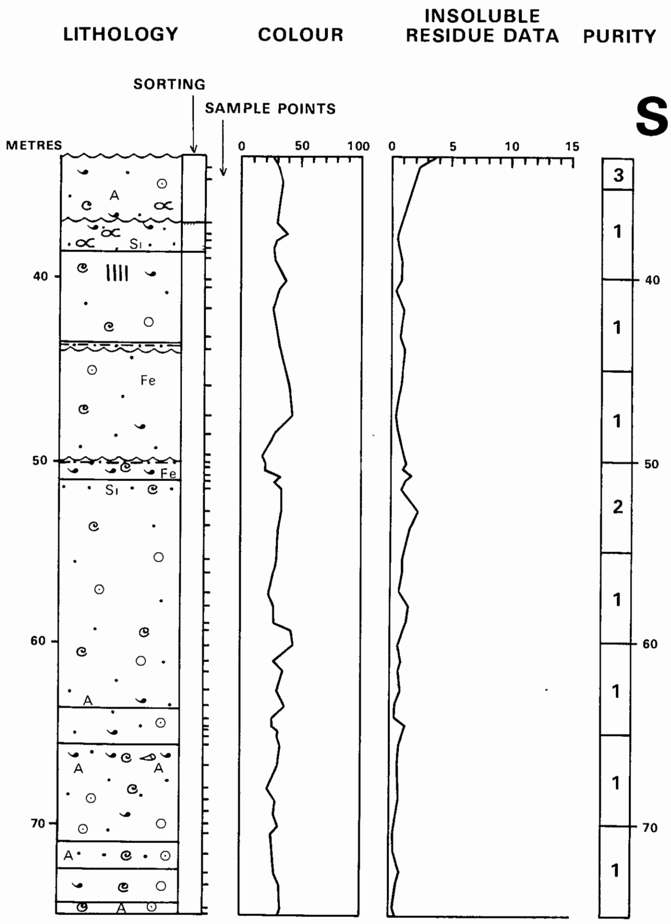
1. The dip of the strata ranges from 17° to 23° at a bearing of 149°.
2. A steeply dipping fault plane forms the sourthern face of the main quarry.
3. Localised dolomitisation is associated with minor faulting.
4. The calculated quality of the limestone takes no account of clay partings.

No chemical data available

A

SE 2S

2.



Resource Block B

Source of data	Registration number	Grid reference
MAU boreholes (drilled by contractor)	NW 8	1274 6956
	12	1476 6947
	14	1136 6765
Major sections used in the assessment	NW 1S*	1173 6724

*The log of section NW IS is given in resource block A

Logs of additional collected sections may be consulted at the appropriate office of the Institute.

RESOURCE BLOCK B

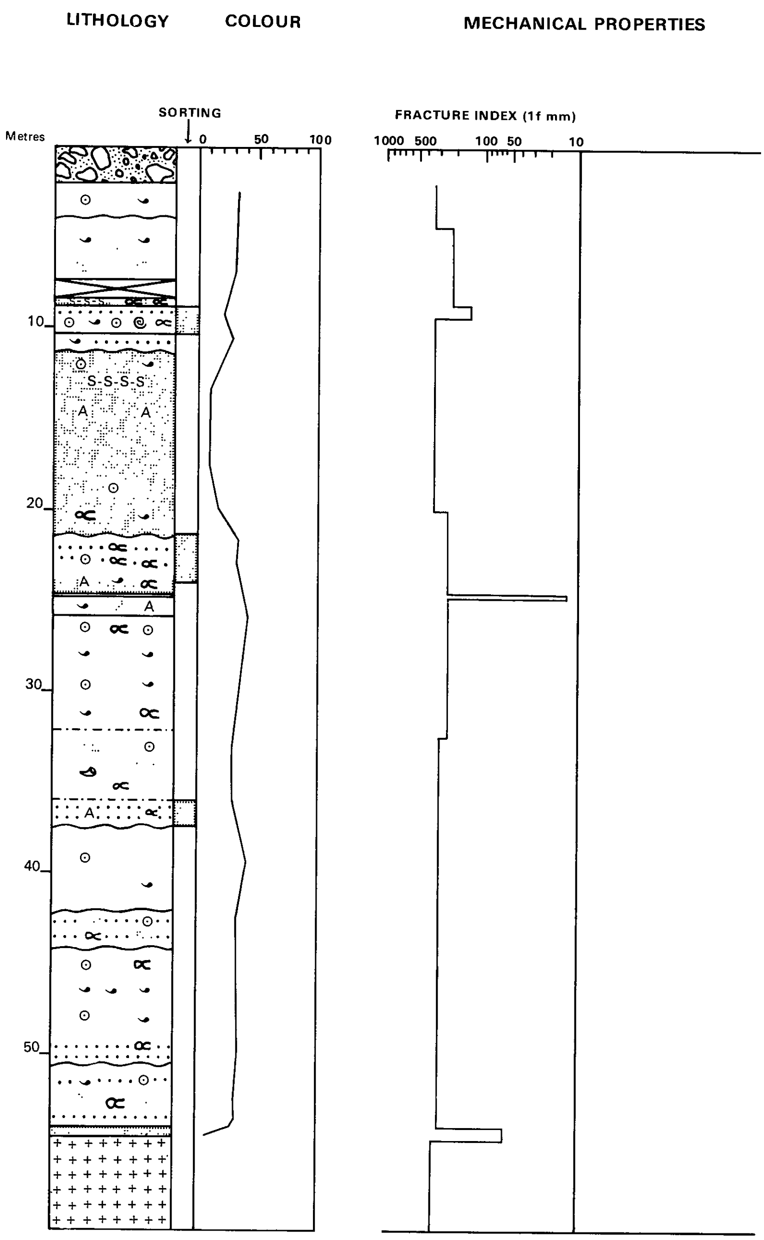
SK 16 NW 8 1274 6956 Town Head

Surface level +361.5 m (+1186 ft)
Reich (airflush), 74 mm diameter
March 1971

		Thickness (m)	Depth (m)
Openhole	Topsoil, brown clayey soil with fractured limestone at depth	2.00	2.00
Limestone	Biomicrite, frequent crinoid ossicles and small brachiopods	1.92	3.92
	Brachiopod biomicrite, mottled pale fawn to dark brown, occasional bioclasts as above with additional large shells, (>16 mm diameter); thin dark limestone (40 cm) developed at base, no recovery 7.30 to 8.30 m	4.78	8.70
	Biosparite, well sorted with graded bedding units; alternating fine calcarenite debris (pellets, foraminifera, algal grains) with coarse calcarenite crinoid and shell debris, local algal encrustations	2.80	11.50
	Biomicrite, medium to dark grey, frequent finely comminuted bioclastic debris, coarser allochems include foraminifera (Saccamminopsis band at 12.7 m), gastropod shells and Alga incerta; matrix is essentially micrite or microspar but coarsely crystalline spar mosaics occur locally	9.80	21.30
	algal biosparite, common encrusting and Dasycladaceaen algae (Girvanella, Coelosporella) associated well sorted pellets, crinoid and shell debris; below 22.40 m pellets disappear and colour darkens	3.30	24.60
Shale	Shale parting, dark grey, silty, slightly calcareous	0.10	24.70
Limestone	brachiopod crinoid biomicrite, mottled to 25.82 m frequent bioclasts; scattered algae include Dasycladaceaen and encrusting varieties, diverse foraminiferal fauna; matrix consists essentially of micrite or microspar but patchy spar occurs in bioturbations	7.40	32.10
	brachiopod crinoid biomicrite, mottled throughout, fauna as above, coral (Syringopora) at 34.30 m	3.88	35.98
	algal pelsparite, well sorted, very fine calcarenite, common bioclasts, essential pellets and subordinate large shells (>16 mm diameter) and crinoid debris	1.57	37.55
	brachiopod crinoid biomicrudite; traces of Girvanella	4.45	42.00
	brachiopod crinoid biomicrite, mottled	1.90	43.90
Clay wayboard	Pale grey-green parting	0.10	44.00
Limestone	brachiopod crinoid biosparite, frequent bioclasts; variable matrix	6.55	50.56
	algal biosparite, mottled, frequent bioclasts including crinoid, shell and pelletal debris, extensive encrusting algae (Girvanella), towards base of unit gradation to pelsparite	3.39	53.95
	Micrite, dark brown-black, pyritised at base	0.55	54.50
Basalt	Calcified basalt, pale grey-green, very friable with calcite amygdales and pyrite streaks	0.55	55.05
	Unaltered basalt, olive green, amygdaloidal at top	4.55+	59.60+

Borehole completed at 59.60 m

B
NW 8


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
SORTING
FRACTURE INDEX (1f mm)
Metres
0
50
100
1000
500
100
50
10
10
20
30
40
50

REOURCE BLOCK B

SK 16 NW 8 1274 6956 Town Head

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
2.50	0.02	0.29	0.06	0.52	0.05	0.29	0.02	54.30	0.03	43.66
6.80	0.03	0.37	0.07	1.39	0.04	0.36	0.02	54.05	0.03	43.31
9.30	0.03	0.42	0.14	1.36	0.04	0.43	0.01	53.65	0.08	43.40
10.50	0.03	0.44	0.05	0.51	0.04	0.42	0.01	54.70	0.02	43.76
13.30	0.03	0.57	0.07	0.42	0.04	0.49	0.02	54.00	0.03	43.88
17.50	0.02	0.56	0.13	0.51	0.05	0.45	0.02	54.25	0.05	43.82
19.80	0.01	0.38	0.16	1.31	0.08	0.48	0.03	54.00	0.08	43.20
21.60	0.01	0.25	0.02	0.48	0.03	0.38	0.01	54.50	0.05	43.73
22.80	0.05	0.24	0.06	0.80	0.04	0.42	0.02	54.65	0.07	43.62
26.00	0.01	0.20	0.04	0.78	0.03	0.39	0.01	54.60	0.04	43.76
28.00	0.02	0.17	0.02	0.55	0.03	0.40	0.01	55.00	0.04	43.71
32.00	0.01	0.19	0.07	1.16	0.05	0.35	0.01	54.50	0.07	43.37
33.00	0.02	0.20	0.08	1.52	0.05	0.37	0.02	54.10	0.05	43.00
36.00	0.01	0.19	0.02	1.36	0.04	0.50	0.02	54.25	0.04	43.12
39.30	0.02	0.14	0.01	0.60	0.04	0.39	0.01	54.75	0.03	43.62
42.30	0.00	0.23	0.03	0.93	0.03	0.37	0.01	55.30	0.06	43.19
49.60	0.00	0.24	0.04	0.56	0.03	0.46	0.01	55.30	0.01	43.66
52.45	0.00	0.26	0.05	0.45	0.03	0.36	0.01	55.00	0.03	43.75
53.45	0.00	0.24	0.07	0.68	0.03	0.36	0.01	54.40	0.03	43.50
54.10	0.02	0.72	1.69	11.20	0.05	4.10	0.30	45.10	2.02	33.48
54.50	0.02	0.66	1.29	12.20	0.05	10.00	0.23	43.75	5.28	24.98

SK 16 NW 8 1274 6956 Town Head Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
2.50	85	5	10	0	0	0
6.80	80	5	20	0		0
9.30	220	10	10	0		0
10.50	60	5	10	0		0
13.30	75	10	10	0	3	0
17.50	90	10	10	10		0
19.80	195	10	50	0		0
21.60	200	10	40	10		0
22.80	195	10	40	0		0
26.00	145	10	30	0		0
28.00	105	15	40	0		0.09
32.00	350	10	40	40		0
33.00	130	10	40	0		0
36.00	120	10	30	0		0
39.30	125	10	20	0	0	0
42.30	130	10	50	0		0.29
49.60	140	10	30	0		0
52.45	380	10	40	10		0
53.45	540	10	30	10		0
54.10	1130	20	20	0		0
54.50	1200	15	10	10		0

RESOURCE BLOCK B
SK 16 NW 12 1476 6947 The Jarnett

Surface level +331.8 m (+1089 ft)
Water encountered at approximately +250 m

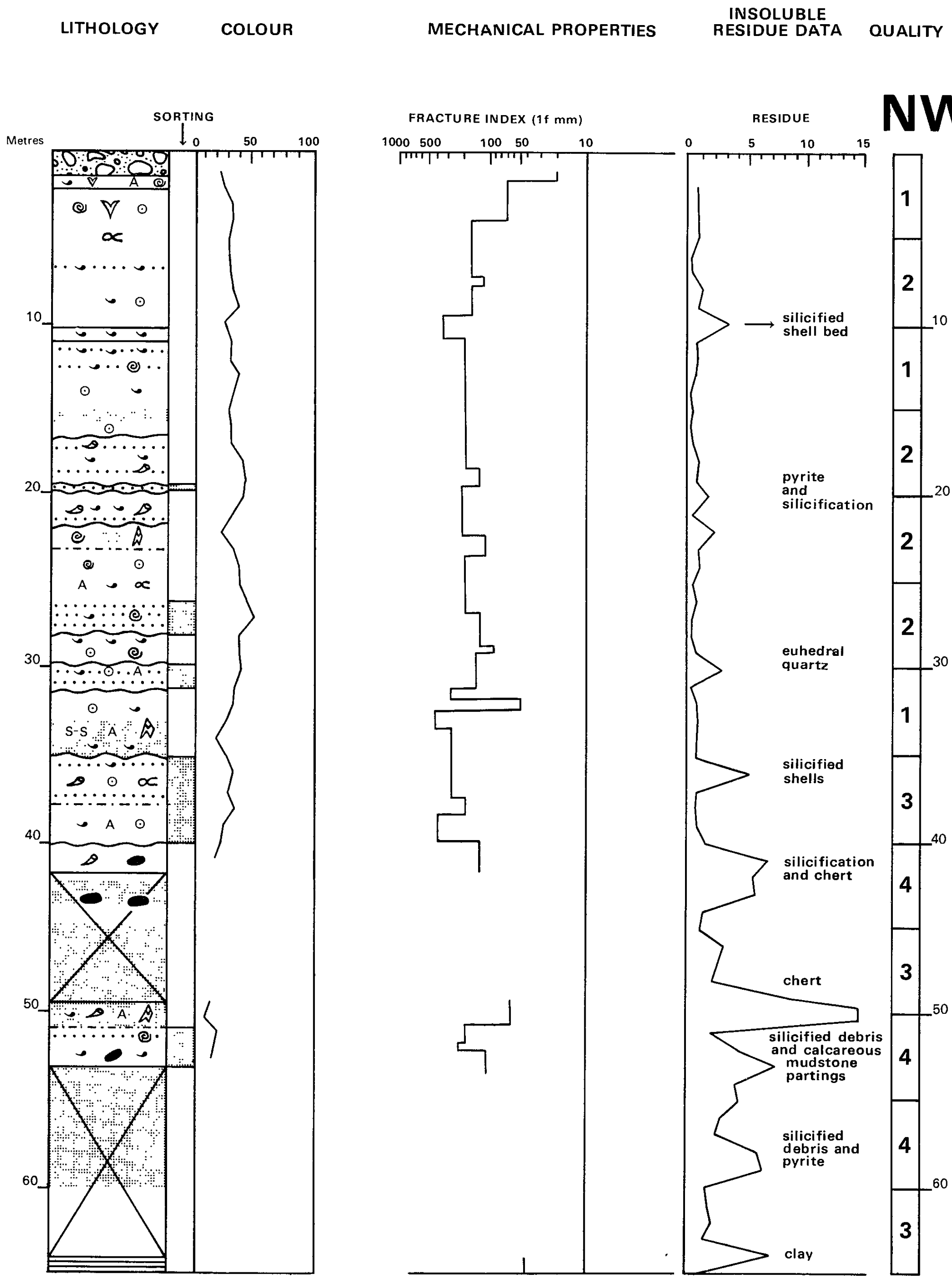
Reich (airflush), 74 mm diameter
April 1974

		Thickness (m)	Depth (m)
Topsoil	Openhole, brown clayey soil with rubbly limestone near base	1.20	1.20
Limestone	crinoid brachiopod biomicrite, alternating fine and medium calcarenites, subordinate debris includes foraminifera, bryozoa, algal tubes and encrustations	8.91	10.11
	Brachiopod biomicrudite composed essentially of silicified shells	0.77	10.88
	crinoid brachiopod biomicrite, darker bed at 15.00 m, varied comminuted fauna, subordinate foraminifera, corals, pellets, local patchy spar	8.46	19.34
	Biopelsparite, well sorted	0.30	19.64
	coral Brachiopod biomicrudite	1.86	21.50
	foraminiferal biosparite, darker lithology, common gastropod shells; accessory pyrite and altered iron ores	1.40	22.90
	foraminiferal biosparite; common brachiopod and crinoid debris, below 26.00 m pelletal grains increase to give a well sorted pelsparite	5.12	28.02
	foraminiferal biomicrite, scattered large shells	1.68	29.70
	Biopelsparite, well sorted	1.56	31.26
	Biomicrite, local rudite brachiopods, scattered algal tubes, darker limestone from 33.10 m with Saccamminopsis, Coelosporella and gastropod shells	3.64	34.90
	Crinoid biosparrudite, graded and current-bedded unit with extensively silicified and algal-encrusted shells, subordinate pellets and foraminifera, below 37.70 m allochems are finely comminuted	5.25	40.15
	Biomicrite with nodular cherts; openhole from 41.23 to 49.20 m, essentially dark limestones with scattered cherts; below 49.20 m biomicrosparite, abundant Coelosporella, gastropod shells, partially silicified brachiopods and corals, accessory pyrite, local shaly partings	10.58	50.73
	Biomicrite, mainly finely comminuted debris, extensively silicified, sporadic chert; openhole from 53.00 to 64.00 m, mid-grey limestone to 60.00 m, pale limestones from 60.00 to 64.00 m, clay recorded at base	14.27	65.00

B

NW 12

1.


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
Metres
0 50 100
FRACTURE INDEX (1f mm)
1000 500 100 50 10
RESIDUE
0 5 10 15
10
20
30
40
50
60
S-S
silicified shell bed
pyrite and silicification
euhedral quartz
silicified shells
silicification and chert
chert
silicified debris and calcareous mudstone partings
silicified debris and pyrite
clay
1
2
1
2
2
2
1
3
4
3
4
4
3

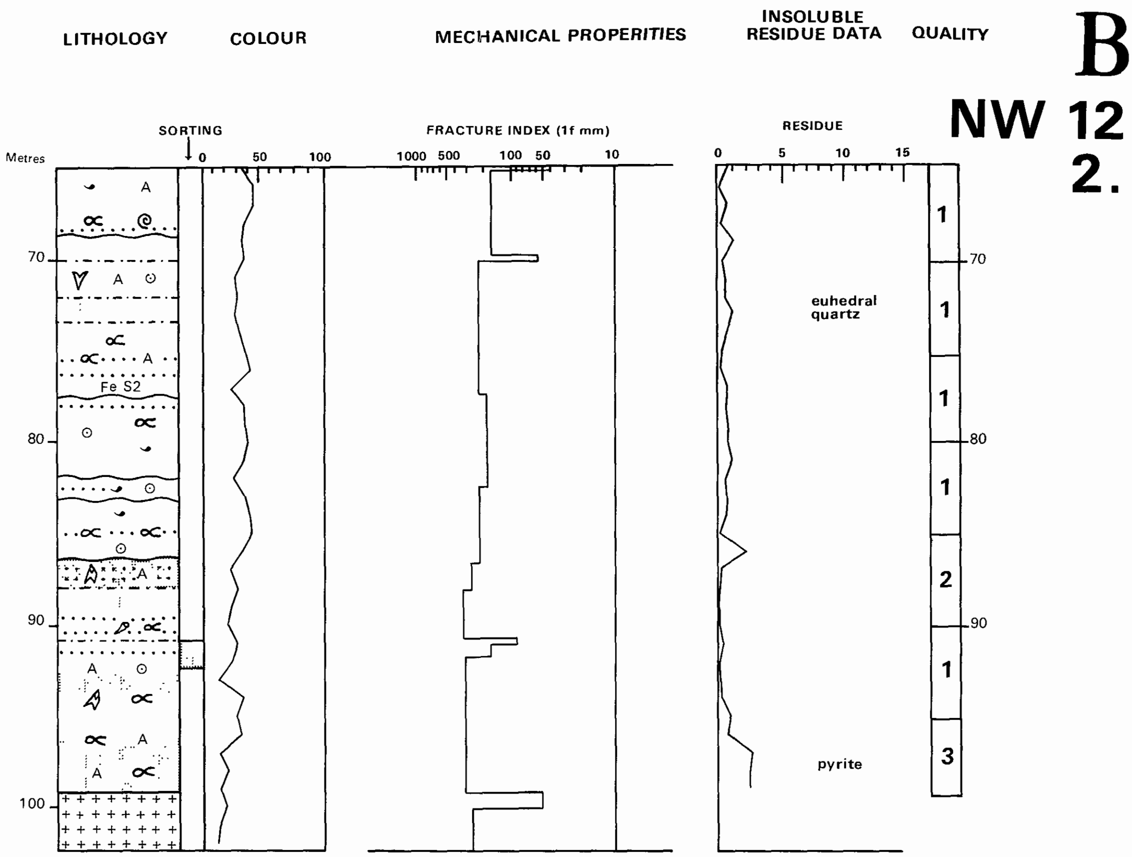
RESOURCE BLOCK B

SK 16 NW 12 1476 6947 The Jarnett

		Thickness (m)	Depth (m)
			65.00
Limestone	Biomicrite, essential shell and crinoid debris, local Coelosporella, mottling below 68.35 m	4.84	69.84
	Brachiopod Crinoid biomicrite, common bryozoa, mottling below 72.00 m	3.46	73.30
	crinoid brachiopod biomicrite with Girvanella to 75.00 m, continuing as a biopelsparite, abundant pyrite a base	3.90	77.20
Clay wayboard	Grey-green weathered volcanics	0.15	77.35
Limestone	brachiopod Crinoid biomicrite, pelletal grains at top of unit, bioturbated throughout, mottling towards base	4.95	82.30
	Biomicrite, very fine calcarenite	1.10	83.40
	brachiopod crinoid biomicrite, local Girvanella encrustations, patchy spar	3.11	86.51
	Biopelsparite, darker limestone with crinoid and brachiopod debris	1.35	87.86
	crinoid brachiopod biomicrite passing into pelsparite at 90.88 m, darker lithologies developed around 92.50 m and from 96.00 m to base of unit, local concentrations of Girvanella and Koninckopora are present throughout; accessory pyrite especially at base	11.25	99.11
Basalt	Friable, pyritised and amygdaloidal through uppermost 2.5 m, becoming less altered at depth, base not proved	3.15	102.26

Borehole completed at 102.26 m

No chemical data available


LITHOLOGY
COLOUR
MECHANICAL PROPERITIES
INSOLUBLE RESIDUE DATA
QUALITY
B
NW 12
2.
SORTING
FRACTURE INDEX (1f mm)
RESIDUE
Metres
0 50 100
1000 500 100 50 10
0 5 10 15
70
80
90
100
Fe S2
euhedral quartz
pyrite
1
1
1
1
2
1
3

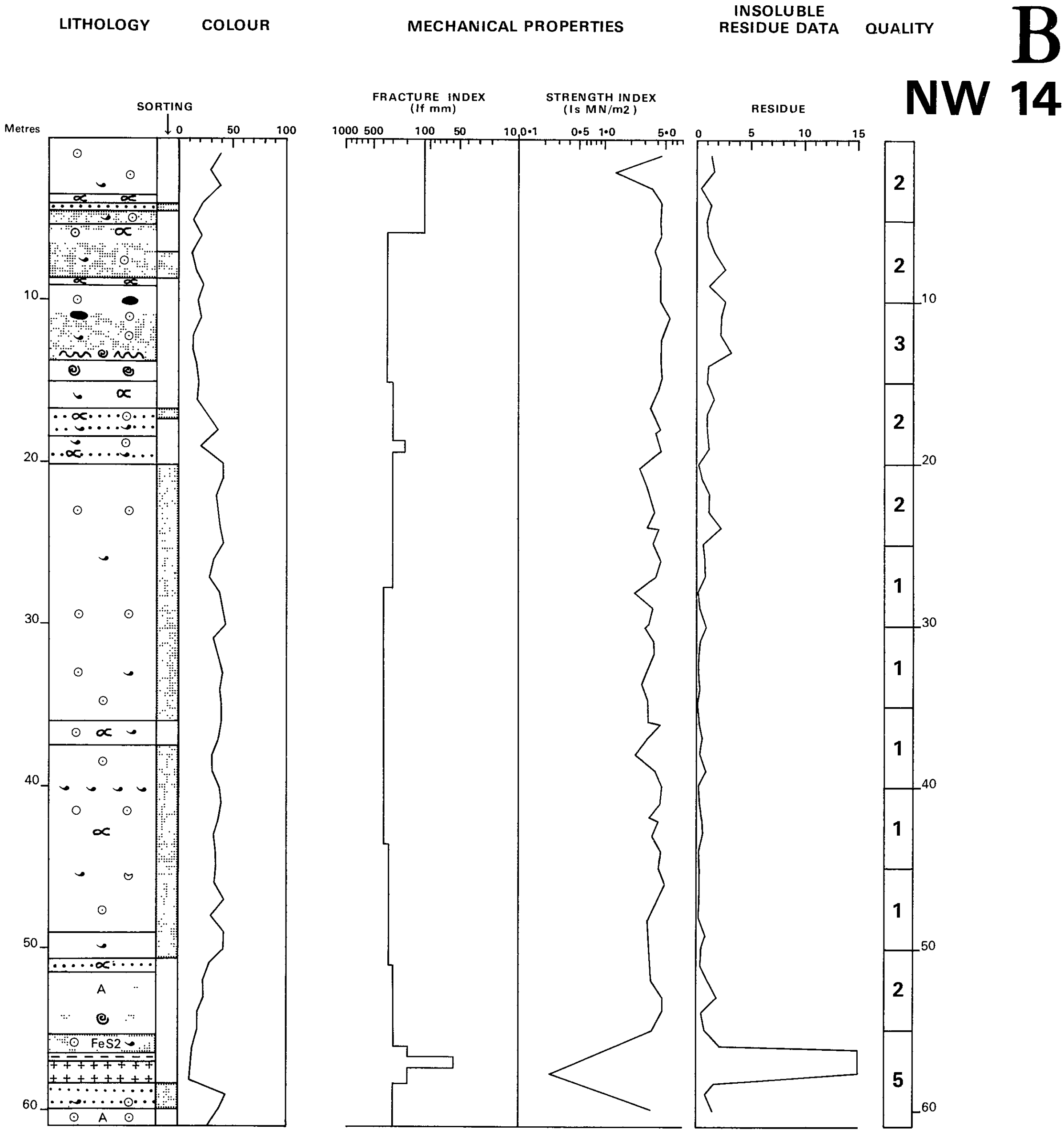
RESOURCE BLOCK B
SK 16 NW 14 1136 6765 Great Low

Surface level +387.1 m (+1270 ft)

Reich (airflush), 74 mm diameter
March 1971

		Thickness (m)	Depth (m)
Topsoil	Black soil on brown clay	0.75	0.75
	Brachiopod Crinoid biosparite, many large brachiopods at 3.00 m	2.75	3.50
	algal crinoid brachiopod biosparite, shells partially silicified and coated with Girvanella	0.60	4.10
	Pelsparite	0.40	4.50
	algal crinoidal brachiopod biosparite, dark coloured in upper part, silicified fossil debris	2.50	7.00
	algal crinoidal biomicrite, dark coloured, much Girvanella, scattered Saccamminopsis, very bioturbated	1.70	8.70
	algal Crinoidal biomicrite, much Girvanella, shells silicified	0.35	9.05
	brachiopod Crinoidal biomicrite, dark coloured from 12.30 m, chert nodules common, brachiopods exceed crinoids towards base; chert absent from 12.30 m	4.70	13.75
	foraminiferal biomicrite, mottled, with some Girvanella, endothyrids and palaeotextulariids, corals and gastropods also present	1.25	15.00
	algal brachiopod biomicrite, pelletal towards base accompanied by Girvanella	3.34	18.34
	brachiopod Crinoid biosparite, dark coloured, muddy, bioturbated	1.76	20.10
	algal crinoid Brachiopod biosparite, well sorted, iron stained from 33.58 m	15.90	36.00
	Crinoid biosparrudite, bioturbated, some Girvanella	1.50	37.50
	Biosparite well sorted, band of brachiopods at 40.30 m	10.20	48.95
	Biosparite, fine, well sorted shell debris	1.65	50.60
	algal Brachiopod biopelmicrite, mottled, bioturbated with Girvanella	0.90	51.50
	Algal biomicrite, mottled, bioturbated with Konickopora,	3.84	55.34
	muddy towards base, algal Crinoidal biomicrite, very muddy, fossils pyritised	1.56	56.90
Basalt	Deeply weathered amygdaloidal	1.40	58.30
Limestone	Crinoid Pelsparite, cross-laminated, very well sorted, coarsening downwards, pyrite veins at 58.40 m	1.60	59.90
	crinoid biosparite	1.01	60.91

Borehole completed at 60.91 m


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
B
NW 14
SORTING
FRACTURE INDEX (If mm)
STRENGTH INDEX (Is MN/m2)
RESIDUE
Metres
0 50 100
1000 500 100 50 10
0·1 0·5 1·0 5·0
0 5 10 15
10
20
30
40
50
60
FeS2
A
2
2
3
2
2
1
1
1
1
1
2
5

RESOURCE BLOCK B
SK 16 NW 14 1136 6765
Great Low

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
1.00	0.05	0.24	0.07	0.56	0.04	0.55	0.02	54.05	0.03	43.49
2.00	0.01	0.24	0.10	0.66	0.04	0.55	0.02	53.35	0.04	43.53
3.00	0.00	0.21	0.01	0.14	0.03	0.50	0.00	54.20	0.01	43.52
4.00	0.00	0.27	0.06	0.69	0.04	0.55	0.01	53.95	0.02	43.58
5.00	0.21	0.33	0.10	0.45	0.04	0.70	0.09	53.70	0.06	43.64
6.00	0.01	0.32	0.37	0.41	0.06	0.65	0.02	54.05	0.04	43.65
7.00	0.00	0.45	0.29	0.98	0.11	0.55	0.05	53.45	0.20	44.03
8.00	0.10	0.36	0.11	0.43	0.08	0.55	0.04	54.30	0.65	43.55
9.00	0.00	0.30	0.07	0.57	0.06	0.55	0.01	54.00	0.04	43.46
10.00	0.00	0.52	0.30	1.32	0.09	0.60	0.05	53.75	0.22	43.24
11.00	0.04	0.50	0.22	1.15	0.09	0.40	0.04	53.15	0.12	43.04
12.00	0.03	0.47	0.21	0.95	0.05	0.50	0.03	53.45	0.17	43.18
13.00	0.00	0.57	0.12	0.67	0.12	0.60	0.03	52.25	0.10	43.40
14.00	0.01	0.38	0.13	1.17	0.04	0.50	0.03	53.00	0.04	43.45
15.00	0.00	0.34	0.01	0.63	0.03	0.45	0.01	53.80	0.02	43.57
16.00	0.00	0.40	0.01	0.72	0.03	0.45	0.00	53.50	0.02	43.53
17.00	0.00	0.30	0.00	0.80	0.03	0.40	0.00	53.95	0.01	43.40
18.00	0.00	0.30	0.00	0.72	0.02	0.40	0.00	54.40	0.00	43.49
19.00	0.01	0.37	0.03	0.97	0.04	0.60	0.01	53.95	0.01	43.48
20.00	0.00	0.40	0.00	0.10	0.02	0.40	0.00	53.95	0.03	43.83
21.00	0.00	0.26	0.00	0.26	0.02	0.40	0.01	54.35	0.00	43.55
22.00	0.00	0.25	0.01	0.42	0.03	0.40	0.00	53.90	0.00	43.83
23.00	0.02	0.25	0.00	1.13	0.02	0.40	0.01	54.20	0.01	43.38
24.00	0.00	0.25	0.00	0.70	0.03	0.40	0.00	54.15	0.00	43.20
25.00	0.00	0.25	0.00	0.45	0.03	0.40	0.00	54.40	0.00	43.59
26.00	0.01	0.25	0.00	0.40	0.03	0.35	0.01	54.60	0.00	43.43
27.00	0.00	0.29	0.04	0.70	0.03	0.35	0.01	54.20	0.00	43.38
28.00	0.00	0.22	0.00	0.08	0.03	0.35	0.00	54.30	0.00	43.45
29.00	0.00	0.22	0.01	0.26	0.03	0.60	0.00	54.30	0.00	43.51
30.00	0.00	0.21	0.00	0.60	0.03	0.30	0.00	54.00	0.00	43.96
31.00	0.00	0.22	0.01	0.16	0.03	0.35	0.00	53.85	0.01	43.92
32.00	0.00	0.24	0.00	0.04	0.02	0.35	0.00	53.85	0.00	44.06
33.00	0.00	0.19	0.00	0.25	0.03	0.30	0.00	54.20	0.03	43.91
34.00	0.00	0.17	0.02	0.14	0.03	0.80	0.00	53.60	0.14	43.75
35.00	0.00	0.15	0.02	0.01	0.03	0.45	0.00	54.80	0.09	43.78
36.00	0.00	0.16	0.04	0.37	0.03	0.40	0.00	54.50	0.00	43.62
37.00	0.02	0.21	0.04	0.33	0.03	0.40	0.05	54.50	0.01	43.76
38.00	0.00	0.19	0.04	0.33	0.03	0.40	0.00	54.50	0.00	43.54
39.00	0.02	0.25	0.06	0.62	0.03	0.40	0.02	54.55	0.00	43.68
40.00	0.00	0.21	0.02	0.16	0.03	0.35	0.00	54.50	0.00	43.72
41.00	0.00	0.21	0.04	0.18	0.03	0.45	0.00	54.70	0.02	43.80
42.00	0.01	0.23	0.04	0.24	0.03	0.55	0.00	54.50	0.04	43.85
43.00	0.00	0.25	0.04	0.02	0.03	0.40	0.00	54.50	0.00	43.80
44.00	0.00	0.17	0.02	0.15	0.03	0.40	0.00	54.90	0.07	43.75
45.00	0.00	0.17	0.03	0.24	0.03	0.35	0.00	54.55	0.01	43.72
46.00	0.00	0.25	0.06	0.34	0.03	0.35	0.01	54.50	0.04	43.67
47.00	0.04	0.52	0.03	0.38	0.03	0.50	0.02	54.00	0.05	43.83
48.00	0.01	0.21	0.02	0.07	0.03	0.50	0.00	54.50	0.04	43.74
49.00	0.00	0.22	0.03	0.74	0.03	0.55	0.00	54.00	0.09	43.38
50.00	0.00	0.26	0.03	0.51	0.02	0.40	0.00	54.40	0.05	43.69
51.00	0.01	0.29	0.03	0.24	0.03	0.40	0.00	54.30	0.01	43.74
52.00	0.02	0.35	0.07	0.44	0.02	0.50	0.02	53.85	0.04	43.63
53.00	0.00	0.29	0.04	0.53	0.03	0.40	0.00	54.05	0.00	43.81
54.00	0.03	0.38	0.05	0.27	0.03	0.35	0.01	54.00	0.13	43.73
55.00	0.07	0.43	0.02	0.10	0.04	0.40	0.01	53.35	0.05	43.75
56.00	0.04	0.63	0.24	0.75	0.03	0.65	0.04	52.80	0.58	43.21
57.00	0.03	0.66	1.20	4.45	0.03	3.10	0.15	49.60	2.12	39.09
58.00	0.03	1.76	7.20	20.70	0.12	18.30	1.90	25.75	10.05	18.67
58.15	0.06	3.67	21.15	40.70	0.09	1.00	4.76	4.00	12.30	17.79
59.00	0.06	0.28	0.13	0.84	0.03	0.40	0.02	54.00	0.31	43.56
60.00	0.03	0.38	0.75	2.19	0.03	0.40	0.11	52.40	0.66	43.71
60.90	0.03	0.25	0.04	1.18	0.03	0.30	0.00	53.75	0.08	43.28

SK 16 NW 14 1136 6765
Great Low

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
1.00	70	5	10	0		0
2.00	70	10	20	0		0
3.00	55	20	10	0		0
4.00	65	10	10	0	6	0
5.00	90	5	10	0		0
6.00	55	10	10	0		0
7.00	60	15	50	0		0
8.00	75	10	20	0		0
9.00	90	10	30	0		0
10.00	90	10	50	0		0
11.00	160	10	90	0		0
12.00	100	10	30	0		0
13.00	140	15	10	0		0
14.00	145	5	10	0	3	0
15.00	95	10	10	0		0
16.00	100	10	10	0		0
17.00	105	5	10	0		0
18.00	155	10	10	0		0
19.00	105	10	20	0		0
20.00	70	10	20	10		0
21.00	80	10	20	0		0
22.00	100	5	10	0		0
23.00	105	10	10	0		0
24.00	85	10	10	0	7	0
25.00	80	10	10	0		0
26.00	75	10	10	0		0
27.00	100	10	10	0		0
28.00	70	15	10	0		0
29.00	75	10	10	0		0
30.00	75	15	20	0		0
31.00	70	10	10	0	5	0
32.00	85	15	20	0		0
33.00	150	20	30	0		0
34.00	205	5	40	0	0	0
35.00	185	10	30	0		0.06
36.00	80	10	20	0		0
37.00	100	10	20	0		0
38.00	120	10	10	0		0
39.00	115	10	20	0		0
40.00	105	5	20	0		0
41.00	115	10	20	0		0
42.00	110	10	20	0		0
43.00	100	5	20	0		0
44.00	150	10	30	0	0	0
45.00	105	5	20	0		0
46.00	105	10	20	0		0
47.00	145	5	20	0		0
48.00	130	10	20	0		0
49.00	215	20	40	0		0
50.00	170	20	30	0		0
51.00	105	5	10	0		0
52.00	120	10	30	0		0
53.00	125	5	10	0		0
54.00	170	10	40	0	7	0
55.00	195	5	20	0		0
56.00	350	10	40	0		0
57.00	520	25	20	0		0
58.00	1010	140	20	0		0.23
58.15	450	55	260	0		0.70
59.00	500	10	20	0		0
60.00	420	15	30	0		0
60.90	310	10	20	0		0

Resource Block C

Source of data	Registration number	Grid Reference
MAU Boreholes (drilled by contractor)	NW 6, 6B	1484 6895, 1485 6894
	10	1199 6704
	11	1284 6588
	SW 5	1471 6369
	6, 7	1279 6493, 1280 6493
	SE 4	1704 6254
	5	1826 6334
Other boreholes	NW 5*	1279 6656
Major sections used in the assessment	NE 4S	1645 6618
	5S	1645 6626
	6S**	1678 6601
	SE 1S	1665 6237

*Water borehole

**The log of section NE 6S is given in resource block D (see p.00).

Logs of borehole NW5 and additional collected sections may be consulted at the appropriate office of the Institute.

RESOURCE BLOCK C

SK 16 NW 6, 6B* 1484 6895; 1485 6894, Nether Wheal

Surface level +302.1 m (+991 ft)
Water encountered at +260 m
Boyles BBS, 20 Rig, 74 mm diameter

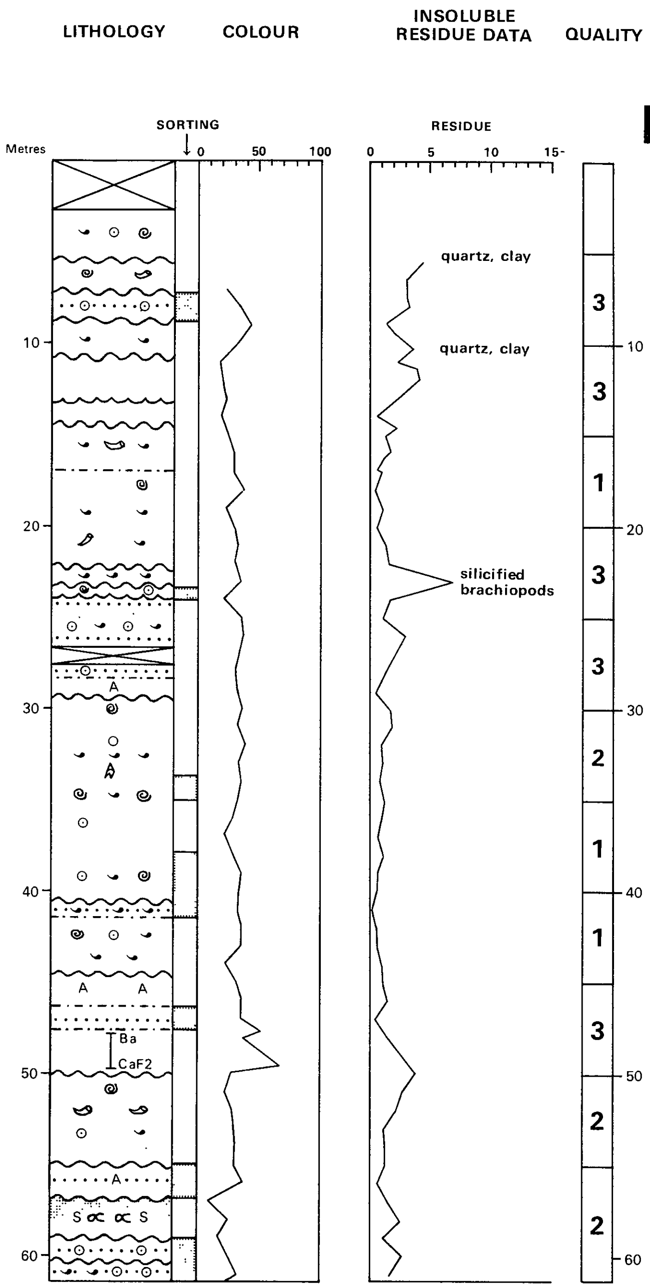
		Thickness (m)	Depth (m)
Topsoil	Brown clay and fractured limestone - open hole to 2.67 m	2.67	2.67
Limestone	foraminiferal biomicrite, shell and crinoid debris are common, Lithostrotion junceum (Fleming) at 6.60 m; gradation below 7.48 m to biopelsparite	6.09	8.76
	brachiopod biomicrudite	2.04	10.80
	Biomicrite, darker coloured, clay parting at 13.25 m; towards base limestone is mottled,and crinoid ossicles, shell debris and algal tubes are common	3.76	14.56
	coral brachiopod biomicrite, subordinate crinoid debris and foraminifera, patchy spar developed between 17 and 20 m	7.77	22.33
	Brachiopod biomicrudite, abundant productoids	0.92	23.25
	foraminiferal Crinoidal biosparite	0.62	23.82
Clay wayboard	Greenish grey clay with enclosed limestone fragments	0.05	23.87
Limestone	foraminiferal crinoidal biosparite, locally mottled, occasional rudite brachiopod clusters and corals (Lithostrotion pauciradiale (McCoy) at 30.38m), subordinate shell debris and turbid pelletal grains	7.73	31.60
	Brachiopod biosparite, darker coloured with recrystallised gastropod shells between 32.70 and 33.60 m	3.40	35.00
	foraminiferal crinoid brachiopod biosparite, mottled around 37.50 m, local pelletal development	5.66	40.66
	algal pelsparite	0.59	41.25
	foraminiferal brachiopod biomicrite, algal tubes are common between 44.67 and 46.25 m	5.00	46.25
	Biopelsparite grading to biomicrite below 46.75 m	1.22	47.47
	Mineral vein with calcite, fluorspar and baryte; possibly a fault plane	2.53	50.00
	Biomicrite, mottled at base	4.90	54.90
	algal biopelsparite, clusters of brachiopods between 55.00 and 55.50 m	2.02	56.92
	algal biomicrite, dark; Girvanella-encrusted shell and crinoid debris, Saccamminopsis also present	2.13	59.05
	Brachiopod Crinoid biosparites interbedded with pelsparites, graded and current-bedded	2.37	61.42

Borehole completed at 61.42 m

*Composite log

C

NW 6, 6B


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
Metres
0
50
100
RESIDUE
0
5
10
15-
quartz, clay
quartz, clay
silicified brachiopods
Ba
CaF2
3
3
1
3
3
2
1
1
3
2
2
10
20
30
40
50
60

RESOURCE BLOCK C
SK 16 NW 6B 1485 6894
Nether Wheal

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Loss on ignition at 1050° C
*1.00-2.00	0.02	0.31	0.14	1.62	0.03	0.25	0.02	53.70	43.28
2.00-3.00	0.02	0.33	0.10	1.36	0.03	0.50	0.02	54.00	43.31
3.00-4.00	0.02	0.32	0.10	1.22	0.03	0.50	0.02	54.90	43.33
4.00-5.00	0.03	0.34	0.21	1.83	0.03	0.45	0.03	54.35	43.10
5.00-6.00	0.04	0.36	0.19	1.45	0.04	0.45	0.03	54.80	43.20
6.00-7.00	0.03	0.34	0.20	1.91	0.03	0.35	0.03	54.25	43.01
7.00	0.01	0.31	0.10	0.66	0.03	0.30	0.02	55.00	43.62
8.00	0.02	0.24	0.02	0.89	0.03	0.25	0.01	55.20	43.53
9.00	0.02	0.20	0.03	0.65	0.04	0.35	0.01	55.20	43.57
10.00	0.02	0.27	0.07	1.50	0.02	0.40	0.01	54.65	43.33
11.00	0.03	0.31	0.12	1.73	0.02	0.55	0.02	54.45	43.27
12.00	0.02	0.40	0.29	1.44	0.07	0.45	0.05	54.50	43.23
13.00	0.03	0.41	0.24	1.20	0.07	0.55	0.04	54.80	43.56
14.00	0.02	0.36	0.07	0.60	0.02	0.45	0.02	55.40	43.88
15.00	0.02	0.23	0.37	1.94	0.03	0.60	0.04	54.25	43.45
16.00	0.04	0.30	0.07	1.60	0.02	0.70	0.02	55.10	43.39
17.00	0.01	0.20	0.05	0.45	0.02	0.40	0.01	55.60	43.67
18.00	0.03	0.27	0.03	0.91	0.02	0.40	0.01	55.60	43.66
19.00	0.02	0.34	0.03	0.83	0.01	0.35	0.01	54.90	43.66
20.00	0.01	0.27	0.03	1.02	0.03	0.40	0.01	53.50	43.58
21.00	0.03	0.24	0.03	1.28	0.02	0.30	0.01	54.25	43.39
22.00	0.00	0.23	0.01	1.22	0.02	0.30	0.01	54.45	43.34
23.00	0.05	0.23	0.03	5.63	0.04	0.30	0.02	52.50	41.01
24.00	0.03	0.33	0.21	1.28	0.02	0.40	0.03	54.35	43.31
25.00	0.02	0.28	0.62	2.42	0.01	0.30	0.13	53.80	43.32
26.00	0.01	0.26	0.04	1.10	0.01	0.55	0.02	54.35	43.21
27.00	0.04	0.24	0.03	0.53	0.02	0.50	0.02	54.60	43.29
28.00	0.01	0.27	0.04	1.63	0.02	0.75	0.01	54.65	42.72
29.00	0.01	0.21	0.01	0.48	0.01	0.40	0.01	55.10	43.68
30.00	0.01	0.26	0.04	1.46	0.02	0.35	0.01	54.95	42.61
31.00	0.02	0.26	0.13	2.70	0.01	0.40	0.03	54.05	42.07
32.00	0.03	0.24	0.01	0.93	0.02	0.55	0.02	55.05	43.44
33.00	0.01	0.17	0.00	0.75	0.01	0.45	0.01	54.85	43.51
34.00	0.02	0.24	0.02	0.70	0.02	0.60	0.01	55.35	43.56
35.00	0.05	0.26	0.10	1.26	0.02	0.65	0.03	55.20	43.18
36.00	0.05	0.28	0.08	0.78	0.02	0.50	0.04	54.80	43.24
37.00	0.04	0.24	0.07	0.90	0.04	0.55	0.02	54.45	43.52
38.00	0.08	0.23	0.04	0.88	0.03	0.55	0.04	55.20	43.47
39.00	0.02	0.22	0.01	0.65	0.02	0.25	0.00	55.50	43.36
40.00	0.01	0.23	0.04	1.00	0.02	0.30	0.01	55.30	43.49
41.00	0.02	0.26	0.01	0.22	0.02	0.25	0.00	55.75	43.71
42.00	0.03	0.24	0.06	1.05	0.02	0.25	0.01	55.25	43.45
43.00	0.03	0.31	0.00	0.66	0.01	0.30	0.00	55.55	43.68
44.00	0.01	0.27	0.02	1.10	0.02	0.25	0.01	55.25	43.17
45.00	0.01	0.36	0.02	0.91	0.02	0.20	0.01	55.55	43.48
46.00	0.02	0.24	0.00	0.48	0.02	0.85	0.00	55.60	43.27
47.00	0.02	0.25	0.06	1.23	0.05	1.10	0.01	55.00	43.73
47.50	0.03	0.16	0.02	2.12	0.02	2.20	0.01	53.70	41.23
48.50	0.04	0.18	0.02	2.74	0.02	0.60	0.01	54.55	42.48
49.50	0.02	0.16	0.03	2.10	0.02	1.45	0.01	54.20	41.44
50.00	0.01	0.25	0.05	2.25	0.01	1.05	0.01	54.75	42.76
51.00	0.02	0.25	0.01	1.21	0.02	0.30	0.01	55.20	43.29
52.00	0.01	0.26	0.05	1.50	0.02	0.30	0.01	55.00	43.20
53.00	0.03	0.28	0.03	0.82	0.04	0.35	0.01	55.50	43.24
54.00	0.01	0.29	0.04	1.34	0.04	0.30	0.01	55.05	43.20
55.00	0.03	0.28	0.00	0.55	0.01	0.45	0.01	55.35	42.98
56.00	0.02	0.25	0.00	0.70	0.01	0.30	0.00	55.40	43.27
57.00	0.03	0.51	0.03	2.47	0.02	0.30	0.02	54.20	42.79
58.00	0.03	0.24	0.01	2.80	0.02	0.30	0.00	54.75	42.66
59.00	0.04	0.27	0.00	0.79	0.02	0.40	0.00	55.80	43.59
60.00	0.04	0.22	0.00	1.46	0.01	0.35	0.00	55.25	43.12
61.00	0.04	0.29	0.00	1.79	0.01	0.45	0.00	54.85	42.58
61.40	0.03	0.00	0.00	0.99	0.01	0.60	0.00	55.50	43.43

*analyses of chip samples

SK 16 NW 6B 1485 6894
Nether Wheal

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	Fe_2O_3	As
1.00-2.00	135	20	35	25	970	
2.00-3.00	125	10	30	20	750	
3.00-4.00	120	5	25	15	710	
4.00-5.00	135	5	30	20	1100	
5.00-6.00	150	5	50	40	1600	
6.00-7.00	170	10	50	40	2200	
7.00	100	20	40	5	280	
8.00	110	10	20	5	200	
9.00	135	5	20	5	115	
10.00	165	10	35	5	235	0
11.00	150	5	45	5	280	
12.00	185	5	35	5	440	
13.00	200	5	45	10	445	
13.30	1000	85	1750	685	79000	
14.00	140	5	20	10	185	
15.00	90	0	25	10	160	
16.00	220	5	35	5	250	
17.00	210	5	25	30	420	
18.00	100	0	20	20	190	
19.00	110	5	20	15	250	0
20.00	130	5	20	0	190	
21.00	140	0	25	0	285	
22.00	120	0	20	0	190	
23.00	125	0	25	0	240	
23.85	185	0	1100	0		
24.00	160	0	40	0	770	
25.00	90	0	20	0	155	
26.00	90	0	10	0	130	
27.00	65	0	10	0	85	
28.00	75	0	15	0	125	0
29.00	95	5	10	0	155	
30.00	250	0	20	0	410	
31.00	90	0	30	0	300	
32.00	115	5	20	0	335	
33.00	205	5	15	0	200	
34.00	90	0	10	0	125	
35.00	90	0	25	0	320	
36.00	95	0	20	0	215	
37.00	100	0	15	0	155	
38.00	100	0	20	0	140	
39.00	120	0	20	0	135	0
40.00	135	0	25	0	160	
41.00	110	0	25	0	130	
42.00	105	0	20	0	210	
43.00	100	0	20	0	130	
44.00	70	0	20	0	120	
45.00	100	0	15	0	160	
46.00	130	0	20	0	280	
47.00	265	0	20	0	320	
47.50	1000	5	45	0	2350	
48.50	750	0	20	0	1050	
49.50	850	0	60	0	2000	
50.00	435	0	35	0	480	
51.00	135	0	25	0	150	
52.00	80	0	30	0	200	
53.00	65	0	20	0	120	
54.00	55	0	20	0	130	
55.00	160	0	15	0	150	0
56.00	120	0	20	0	100	
57.00	75	0	15	0	155	
58.00	100	0	20	0	175	
59.00	75	0	25	0	110	
60.00	140	0	20	0	220	
61.00	575	0	20	0	360	
61.40	175	0	15	0	135	

RESOURCE BLOCK C
SK 16 NW 10   1199 6704   Sparklow Station

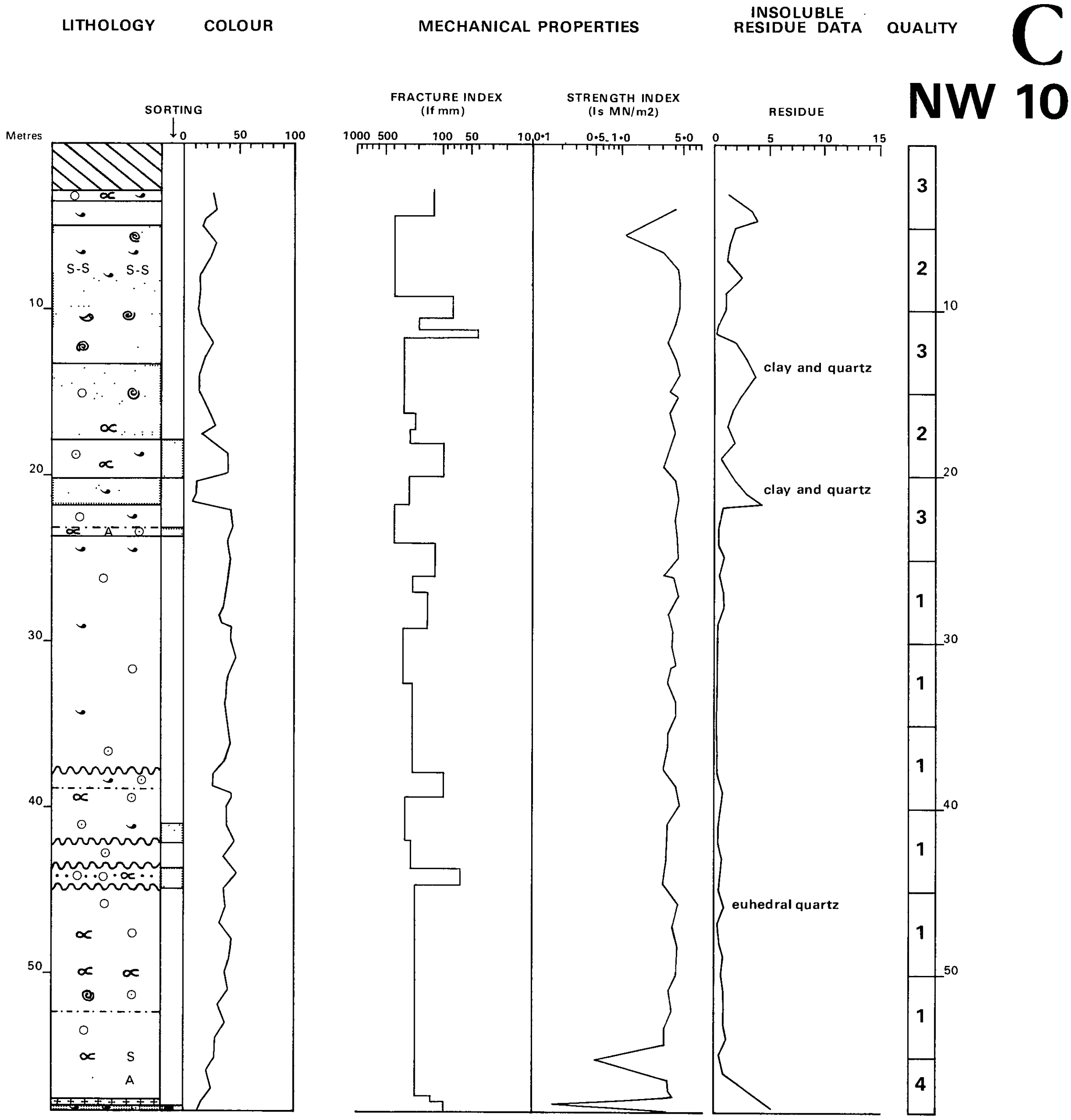
Surface level +359.1 m (+1178 ft)
Reich (airflush), 74 mm diameter
March 1971

		Thickness (m)	Depth (m)
Made Ground		2.80	2.80
Limestone	Crinoid Brachiopod biomicrudite, traces of encrusting algae (Girvanella), bryozoa and foraminifera	0.70	3.50
	Brachiopod biomicrudite, darkening towards base; occasional corals	1.43	4.93
	foraminiferal brachiopod biomicrosparite, large and small small scale mottling, local silicified brachiopod clusters, abundant diverse foraminifera (including Saccamminopsis) and rare gastropods, bryozoa and corals	8.27	13.20
	Biosparite, dark to 15.75 m; then passing into crinoidal biosparite with subordinate shell debris, bryozoa fragments and foraminifera, traces of Girvanella near base; pyrite and alteration products concentrated between 13.68 and 14.50 m	4.60	17.80
	algal Crinoid Brachiopod biosparite; bioclasts grade from coarse calcarenite to fine calcirudite size and all are Girvanella encrusted	2.35	20.15
	crinoidal biomicrite, dark with occasional rudite size, silicified brachiopods	1.65	21.80
	brachiopod Crinoid biosparite, subordinate foraminifera, pelletal debris, and Girvanella, allochems tightly compacted	1.32	23.12
	algal crinoidal biosparite; current sorted; Girvanella encrusted shell and crinoid debris	0.59	23.71
	brachiopod Crinoid biosparite, frequent bioclasts including rudite shell clusters and crinoid stems; shell fragments are silicified in upper part of unit, traces of encrusting algae	14.26	37.97
	Brachiopod Crinoid biomicrosparite, mottled	0.89	38.86
	Crinoid biosparite, coarse calcarenite, well sorted	3.33	42.19
	Brachiopod Crinoid biosparite, rudite crinoid and shell fragments and finer comminuted debris	1.56	43.75
	Crinoidal biopelsparite, subordinate brachiopods, foraminifera, bryozoa and Girvanella	1.15	44.90
	algal Crinoid biosparite, subordinate shell fragments, foraminifera and bryozoa; algae include Koninckopora and Girvanella; patchy micrite, common euhedral quartz crystals	7.50	52.40
	crinoidal biomicrosparite, mottled subordinate foraminifera (including Saccaminopsis), shell fragments (encrusting Girvanella), and traces of Koninckopora; matrix extensively recrystallised, pyritised below 56 m	5.19	57.59
Basalt	Altered Basalt, pale green,amygdaloidal	0.41	58.00
Limestone	Biosparite, current sorted, laminated; local traces of pyrite	0.31	58.31

Borehole completed at 58.31 m

No chemical data available

C
NW 10



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
FRACTURE INDEX (If mm)
STRENGTH INDEX (Is MN/m2)
RESIDUE
Metres
0 50 100
1000 500 100 50 10
0·1 0·5 1·0 5·0
0 5 10 15
10
20
30
40
50
S-S
S
A
clay and quartz
clay and quartz
euhedral quartz
3
2
3
2
3
1
1
1
1
1
1
4

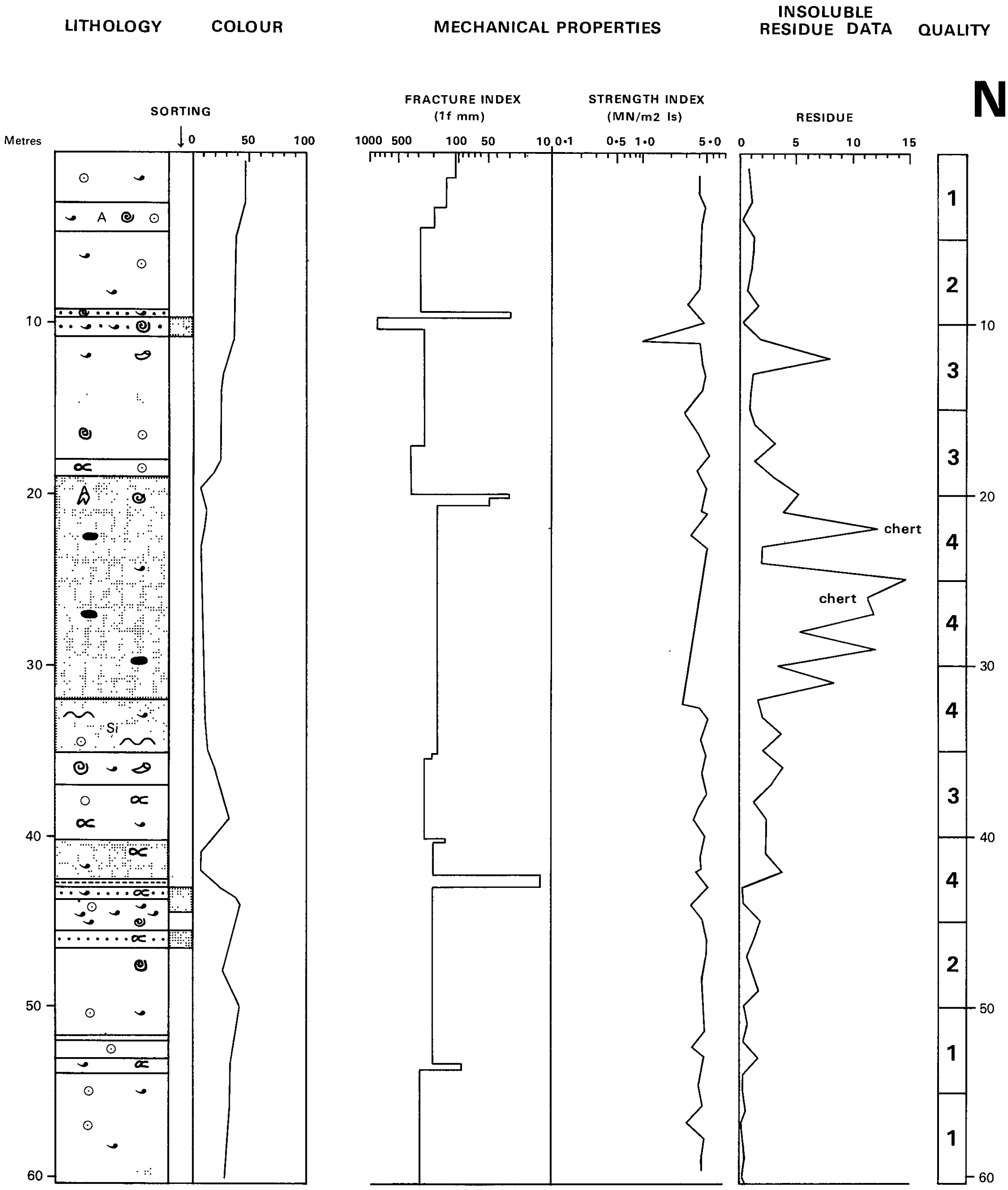
Resource Block C
SK 16 NW 11   1284 6588   Sparklow Station

Surface level +336.8 m (+1106 ft)
Reich (airflush), 74 mm diameter
March 1971

		Thickness (m)	Depth (m)
Limestone	foraminiferal Brachiopod biosparite becoming laminated at base	3.08	3.08
	algal foraminiferal biosparite, very fine grained, brachiopods and crinoids common at base	1.60	4.68
	algal crinoid Brachiopod biomicrite, some silicification at 9.10 m	4.52	9.20
	brachiopod biomicrite	0.45	9.65
	foraminiferal Brachiopod pelsparite, cross-bedded	1.10	10.75
	crinoid Brachiopod biomicrite, occasional small solitary corals, mottled at 12.40 and 15.60 m	7.25	18.00
	algal crinoid biomicrite, mottled	0.95	18.95
	algal foraminiferal biomicrite, dark coloured, fossils silicified, scattered chert nodules	13.05	32.00
	Brachiopod Crinoid biomicrite, dark coloured; many stylolites, band of silification at 32.22 m, bioturbated	3.09	35.09
	coral brachiopod foraminiferal biomicrite, mottled and bioturbated	1.91	37.00
	algal crinoid Brachiopod biomicrite with Girvanella	3.25	40.25
	ostracod crinoid algal Brachiopod biomicrite, dark coloured, muddy towards base	2.23	42.48
Mudstone	Mudstone with bryozoa and brachiopods	0.42	42.90
Limestone	brachiopod Algal pelsparite, rare quartz crystals, laminated	1.40	44.30
	algal Brachiopod biosparite, ripple-drifted at 44.40 m	1.12	45.42
	crinoid brachiopod Algal pelsparite	1.06	46.48
	foraminiferal crinoid Brachiopod biosparite, mottled, many foraminifera from 49.05 m	5.12	51.60
	foraminiferal Brachiopod biosparite	0.29	51.89
	brachiopod Crinoidal biosparite	1.13	53.02
	Algal Brachiopod biosparite	0.83	53.85
	Crinoid Brachiopod biosparite, increase in shell debris from 55.80 m	6.66	60.51

Borehole completed at 60.51 m

C
NW 11



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
FRACTURE INDEX (1f mm)
STRENGTH INDEX (MN/m2 Is)
RESIDUE
Metres
0 50 100
1000 500 100 50 10
0·1 0·5 1·0 5·0
0 5 10 15
10
20
30
40
50
60
A
Si
chert
chert
1
2
3
3
4
4
4
3
4
2
1
1

RESOURCE BLOCK C

SK 16 NW 11   1284 6588   Sparklow Station

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
0.50	0.04	0.17	0.07	0.66	0.03	0.57	0.01	54.30	0.06	43.60
3.00	0.03	0.25	0.13	0.53	0.03	0.54	0.01	54.55	0.04	43.63
5.00	0.03	0.19	0.04	0.14	0.02	0.52	0.00	54.90	0.02	43.86
10.00	0.01	0.20	0.03	0.13	0.03	0.54	0.00	55.10	0.00	43.83
11.00	0.04	0.24	0.03	0.81	0.03	0.61	0.01	54.40	0.00	43.58
13.00	0.01	0.27	0.04	0.33	0.03	0.61	0.00	54.55	0.00	44.11
14.00	0.02	0.28	0.10	0.58	0.04	0.61	0.02	54.55	0.03	43.68
18.00	0.16	0.32	0.07	0.36	0.05	0.61	0.04	54.90	0.03	43.76
18.90	0.03	0.54	0.10	2.10	0.03	0.57	0.01	52.90	0.02	42.99
19.60	0.08	0.53	0.22	1.82	0.03	0.86	0.04	53.45	0.08	43.35
21.00	0.02	0.48	0.05	0.47	0.02	0.63	0.01	54.40	0.02	43.88
22.00	0.02	0.40	0.10	0.86	0.03	0.57	0.01	54.10	0.06	43.61
23.73	0.03	0.48	0.13	1.99	0.04	0.76	0.02	53.30	0.05	43.19
26.00	0.05	0.54	1.21	6.15	0.07	0.68	0.09	50.10	0.52	40.43
28.00	0.03	0.45	1.19	2.74	0.05	0.61	0.11	52.25	0.28	42.45
30.00	0.02	0.51	0.79	1.59	0.04	0.58	0.06	53.45	0.23	43.06
33.00	0.03	0.51	0.20	0.80	0.04	0.51	0.01	54.00	0.05	43.54
35.00	0.02	0.61	0.35	1.17	0.08	0.58	0.05	53.30	0.06	43.39
36.00	0.01	0.38	0.16	1.06	0.05	0.51	0.02	53.95	0.03	43.38
39.00	0.02	0.33	0.05	1.95	0.03	0.43	0.01	53.90	0.01	43.02
41.00	0.02	0.43	0.08	0.45	0.04	0.60	0.01	54.00	0.05	43.92
42.00	0.07	0.53	0.17	0.78	0.04	0.63	0.04	54.15	0.11	43.53
43.10	0.02	0.27	0.03	0.03	0.02	0.45	0.00	54.70	0.04	43.31
43.60	0.01	0.21	0.02	0.04	0.02	0.39	0.00	55.15	0.04	43.87
44.00	0.02	0.21	0.02	0.32	0.04	0.46	0.01	54.05	0.06	43.73
48.00	0.03	0.30	0.06	0.62	0.05	0.49	0.02	54.00	0.04	43.71
50.00	0.02	0.21	0.02	0.38	0.05	0.42	0.01	57.30	0.04	43.73
53.35	0.02	0.38	1.81	6.32	0.04	1.11	0.10	48.65	0.34	39.46
56.00	0.02	0.21	0.02	0.42	0.04	0.45	0.01	54.40	0.03	43.69
60.00	0.02	0.27	0.04	0.30	0.03	0.40	0.01	54.55	0.02	43.71

SK 16 NW 11 1284 6588 Sparklow Station

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F(%)
0.50	90	15	20	20		0
3.00	70	10	20	10		0
5.00	65	10	10	20		0
10.00	80	10	10	0	0	0
11.00	65	10	10	0		0
13.00	75	15	20	0		0.05
14.00	65	10	10	0		0
18.00	85	10	10	0		0
18.90	50	5	10	20		0.10
19.60	50	10	60	0		0
21.00	55	10	10	0		0.05
22.00	310	10	30	40		0.03
23.73	65	10	40	0	7	0.05
26.00	130	20	90	100		0.06
28.00	120	10	70	50		0.07
30.00	85	10	20	0		0.12
33.00	90	10	10	0		0
35.00	130	10	20	0		0
36.00	100	5	10	0		0
39.00	60	10	10	0		0
41.00	75	10	10	0		0
42.00	65	10	10	0		0
43.10	90	5	10	0		0
43.60	55	10	10	0	0	0
44.00	170	10	20	0		0.09
48.00	75	10	20	0		0
50.00	55	10	10	0		0
53.35	95	10	30	60	0	0
56.00	65	20	10	0		0
60.00	55	10	10	0		0

RESOURCE BLOCK C
SK 16 SW 5 1471 6369 Parsley Hay Station

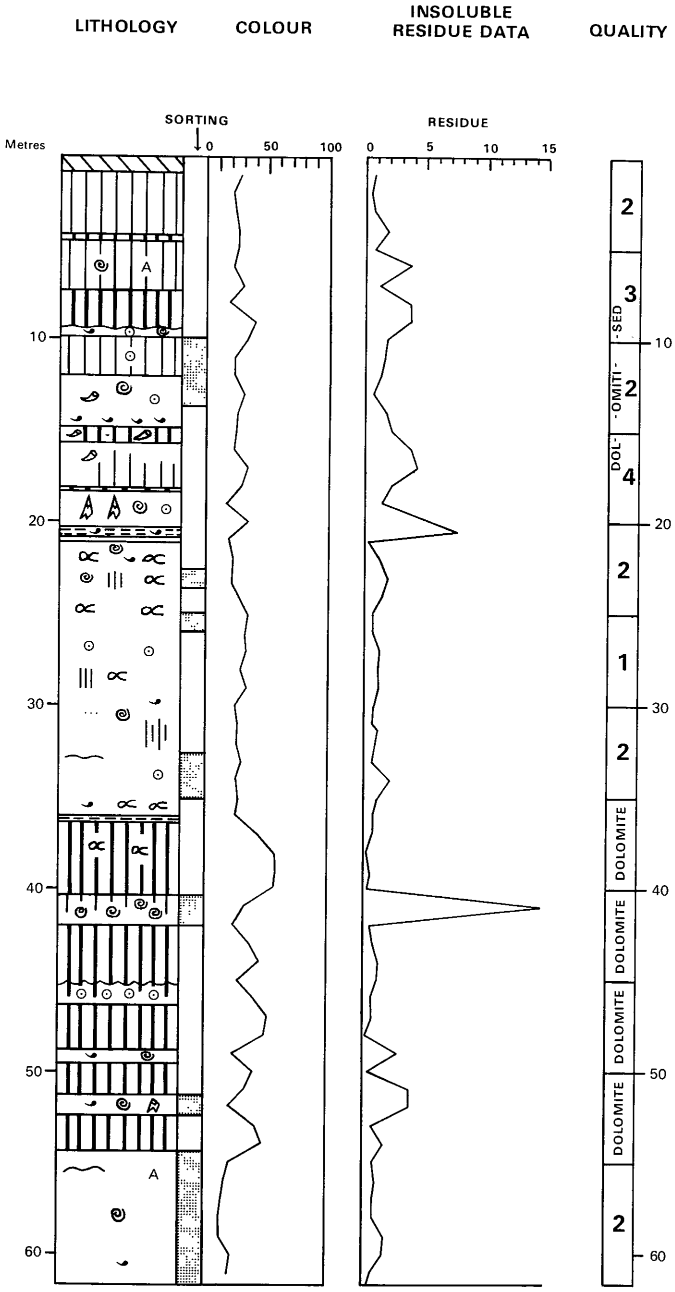
Surface level +334.7 m (+1098 ft)
Reich (airflush), 74 mm diameter

		Thickness (m)	Depth (m)
Made ground		0.80	0.80
Limestone	Biomicrite, slightly dolomitised at 2.60 m	3.50	4.30
Sideritic dolomite	Almost completely recrystallised, very iron stained	0.35	4.65
Dolomitic limestone	Dolomitic biomicrite	2.65	7.30
Dolomite	Very porous with patchy iron staining	2.20	9.50
Dolomitic limestone	Dolomitic biomicrite, few allochems visible, but scattered crinoid and fine shell debris around 9.88 m	2.84	12.34
Limestone	Biomicrite; stained with hematite; Carcinophyllum vaughani Salee at 13.70 m, Lithostrotion pauciradiale (McCoy) at 13.70 m, scattered Saccamminopsis	2.56	14.90
Sideritic dolomite	Colonial corals at 15.20 m	0.80	15.70
Limestone	Biomicrite, calcite vein from 16.75 m to 17.20 m, slight dolomitisation at 17.85 m	2.45	18.15
Dolomite		0.05	18.20
Limestone	Biomicrite, darker from 18.36 m with common gastropods; hematite stained veins, disseminated pyrite at 20.00 m	2.05	20.25
Mudstone	Included brachiopod and other shell fragments	0.07	20.95
Limestone	Micrite, some hematite present	0.17	21.12
	Biomicrite, fine lamination at 22.25 m, slightly dolomitised at 23.00 m, some silicified and Girvanella encrusted fragments at 23.68 m; common hematite veining, bioturbated from 26.08 m; locally dolomitised at 28.50 m, finely laminated at 32.36 m, shells silicified at 32.50 m; towards base, an algal biopelsparite is developed, pyrite is common at 35.60 m to base	14.88	36.00
Clay wayboard	Greenish grey clay	0.30	36.30
Dolomite		4.00	40.30
Limestone	foraminiferal biomicrite, locally dolomitised in uppermost 1.00 m	1.73	42.03
Dolomite	Hematite stained stylolite at 45.18 m	3.15	45.18
Dolomitic limestone	Dolomitic biomicrite, scattered crinoid and brachiopod 'ghosts'	1.20	46.25
Dolomite		2.61	48.86
Limestone	Biomicrite, dolomitic at base Syringopora common	1.61	49.47
Dolomite	Vuggy	0.76	51.23
Limestone	Biomicrite, laminated towards base	2.17	52.40
Dolomite	Iron stained, some corals present	2.06	54.46
Limestone	Biomicrite, bioturbated from 54.60 m; haematite stained	7.16	61.62

Borehole completed at 61.62 m

No chemical data available

C
SW 5


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
RESIDUE
Metres
0
50
100
0
5
10
15
10
20
30
40
50
60
2
3
SED
DOL- OMITI-
2
4
2
1
2
DOLOMITE
DOLOMITE
DOLOMITE
DOLOMITE
2
A
A

RESOURCE BLOCK C

SK 16 SW 6, 7* 1279 6493, 1280 6493 Cronkstone Grange

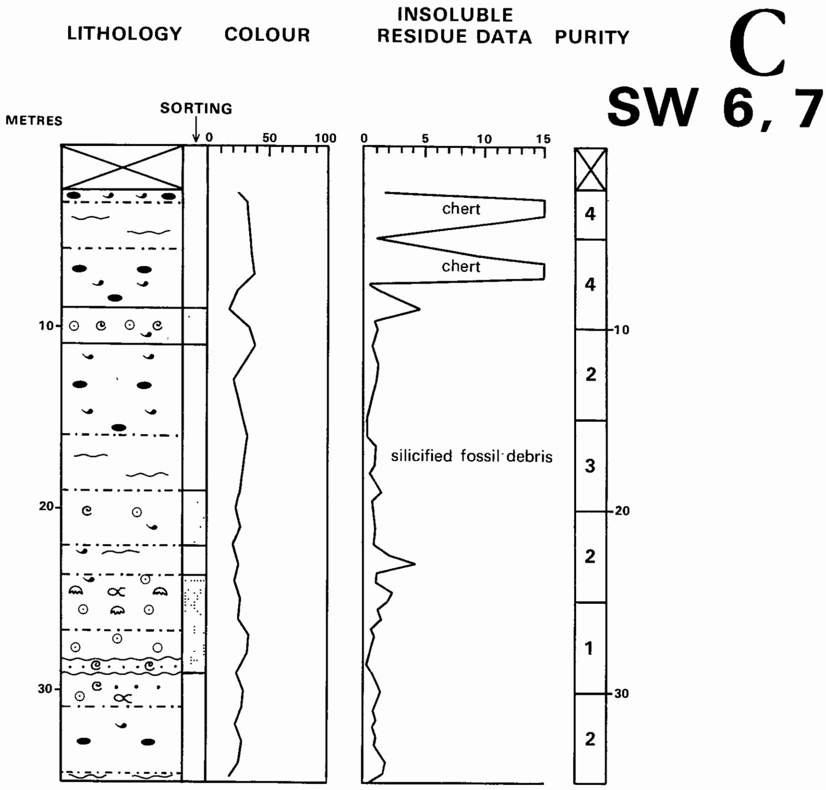
Surface level +317.9 m (+1043 ft), +318.2 m (+1044 ft)
Water seepage at 270 m
Boyles BBS 20 (airflush), 74 mm diameter
January 1971

		Thickness (m)	Depth (m)
Topsoil	Black soil on sandy soil; openhole to 2.44 m	2.44	2.44
Limestone	Biomicrite, with coarse rudite silicified shells and crinoid ossicles, rubbly core between 3.10 m and 5.66 m, grading to biosparite from 5.66 m; fine laminations occur towards base; chert nodules throughout	6.36	8.80
	crinoidal foraminiferal biosparite; subordinate shell debris, well sorted	2.10	10.90
	brachiopod biomicrite, subordinate crinoid and finely comminuted debris; scattered nodular cherts; rubbly core from 15.90 to 18.94 m	8.04	18.94
	Biosparite, fine to medium calcarenite with well sorted crinoid ossicles, foraminifera and fine shell debris; local rubbly horizons	3.06	22.00
	brachiopod biomicrite, rubbly core from 22.20 m	0.90	22.90
	crinoid brachiopod biomicrite	0.60	23.50
	intraclastic biosparrudite, well sorted crinoid, shell and bryozoa debris	3.15	26.75
	Crinoidal biosparite, well sorted below 27.56 m, subordinate silicified shells, foraminifera and bryozoa	1.62	28.37
	foraminiferal biopelsparite, essential finely comminuted debris	0.70	29.07
	brachiopod crinoid biosparite, common Girvanella	1.83	30.90
	brachiopod biomicrite, corals at 31.00, 32.60 m; local crinoid concentrations (30.60 m); nodular chert occurs between 32.70 and 34.00 m, traces of pyrite at base; at 34.52 m the borehole intersects a major fault	4.11	35.01

Borehole abandoned at 35.01 m

*Composite log

No chemical data available


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
C
SW 6, 7
METRES
SORTING
0
50
100
0
5
10
15
chert
chert
silicified fossil debris
10
20
30
4
4
2
3
2
1
2
10
20
30

RESOURCE BLOCK C
SK 16 SE 4 1704 6254 Oldhams Farm

Surface level +344.4 m (+1130 ft)
Reich (airflush), 74 mm

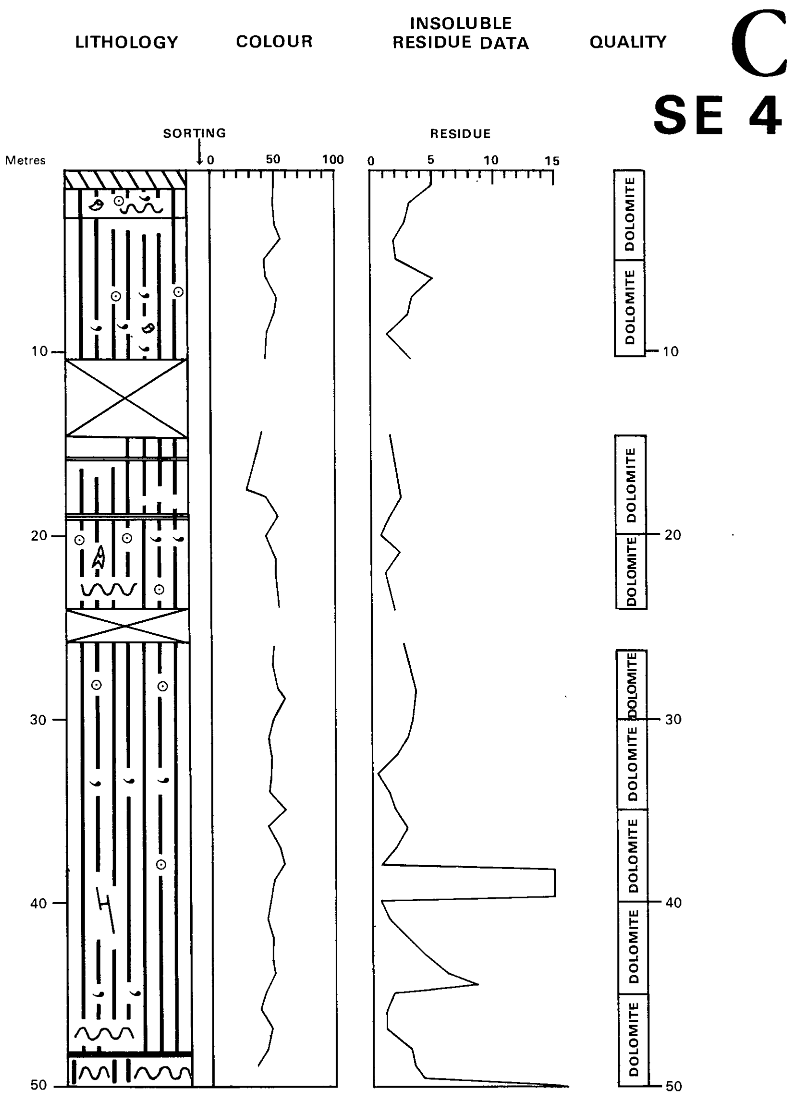
		Thickness (m)	Depth (m)
Topsoil	Topsoil and weathered dolomite	1.00	1.00
Sideritic calcitic dolomite	Very vuggy, recrystallised; traces of crinoid and shell debris, locally silicified	1.45	2.45
Dolomite	Locally calcitic, very powdery; bed of brachiopods at 8.05 m	7.91	10.36
Core loss	No data	3.25	13.61
Dolomite	Medium grained, recrystallised, clay wayboards at 16.70 and 18.80 m	9.12	22.73
Core loss	No data	2.27	25.00
Sideritic dolomite	Limonite stained veins infilled with dolomite around 28.50 m, very vuggy from 32.09 m; open horizontal voids with secondary calcite crystals at 35.25 m; becoming more iron stained at 40.36 m; large coral colony at 46.40 m	23.20	48.20
Clay wayboard		0.10	48.30
Limestone	Biomicrite, recrystallised in places, slightly dolomitised; scattered chert nodules, poor recovery; openhole from 49.66 to 61.00 m; dolomite and limestone chippings recovered	12.70	61.00

Borehole completed at 61.00 m

RESOURCE BLOCK C
SK 16 SE 4 1704 6254
Oldhams Farm

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050°C
1.50	0.06	19.37	0.22	3.82	0.03	0.31	0.07	31.16	0.47	45.65
5.00	0.06	19.96	0.04	2.06	0.01	0.42	0.02	31.91	0.37	46.50
9.00	0.06	19.25	0.12	0.89	0.06	0.50	0.05	31.99	0.25	47.23
18.00	0.06	20.88	0.06	0.82	0.02	0.42	0.04	31.04	0.24	47.75
22.00	0.04	20.44	0.04	1.43	0.01	0.40	0.02	31.33	0.28	47.02
27.00	0.04	21.34	0.06	1.15	0.02	0.41	0.02	30.65	0.26	47.10
30.00	0.06	20.40	0.05	0.74	0.03	0.39	0.03	31.12	0.34	46.96
32.00	0.05	20.95	0.04	1.00	0.02	0.33	0.03	31.16	0.25	47.51
37.00	0.05	20.61	0.03	0.37	0.02	0.34	0.02	31.55	0.29	47.61
40.00	0.04	21.07	0.04	0.32	0.01	0.33	0.02	30.98	0.47	47.34
42.00	0.05	21.28	0.02	1.24	0.00	0.43	0.02	31.07	0.21	47.23
45.00	0.06	20.50	0.05	1.48	0.01	0.44	0.03	31.26	0.31	46.91
47.00	0.05	20.85	0.06	2.28	0.01	0.47	0.02	31.11	0.25	46.50
49.00	0.04	4.10	0.18	84.57	0.04	0.23	0.02	6.68	0.13	9.32
49.66	0.06	15.54	0.06	1.13	0.05	0.68	0.04	36.52	0.82	46.37



RESOURCE BLOCK C
SK 16 SE 4 1704 6254 Oldhams Farm

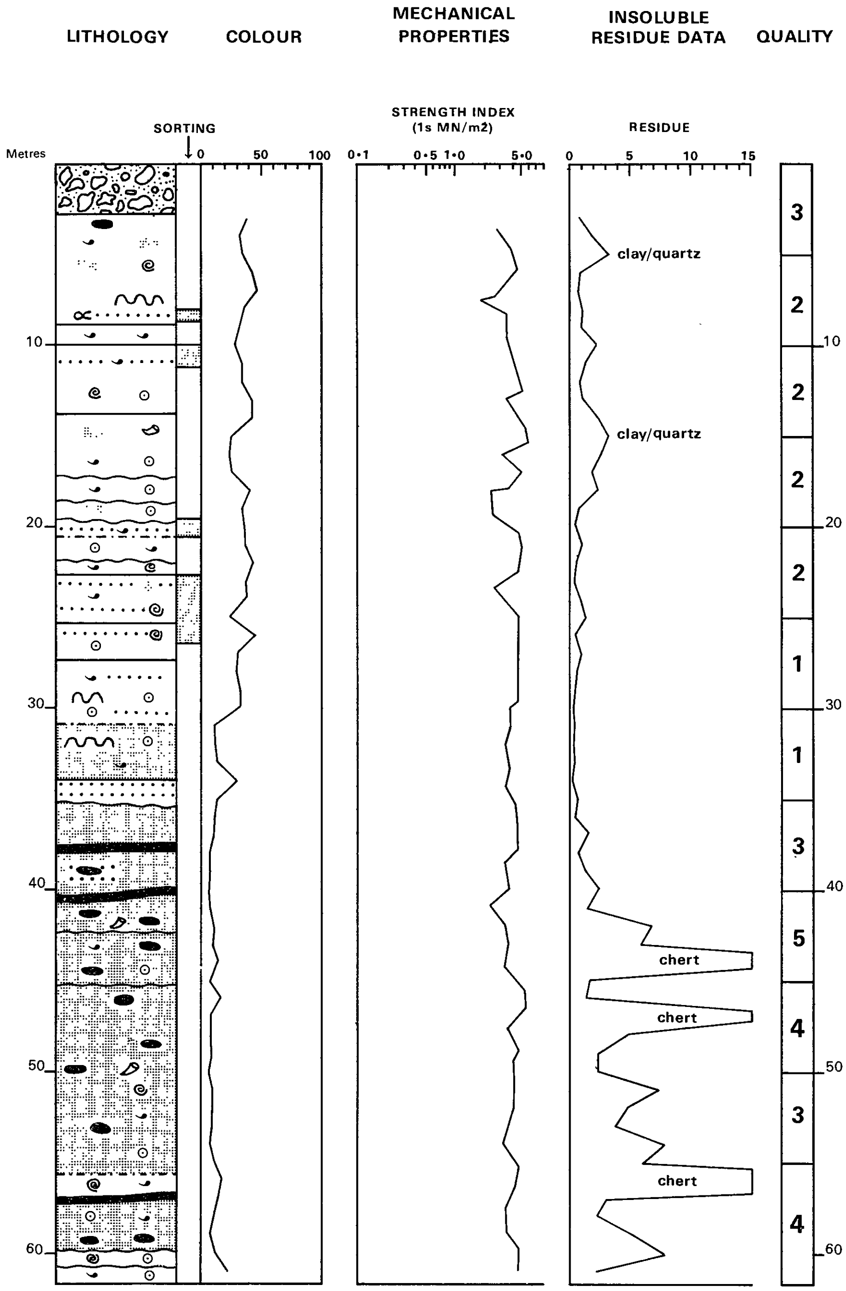
Depth (m)	Mn	Cu	Zn	Pb	As	F(%)
					Trace elements (parts per million)	
1.50	950	20	360	0	0	0.13
5.00	670	20	320	0		0.02
9.00	1200	10	240	10		0.03
18.00	950	10	170	20		0.02
22.00	1150	60	270	10	0	0.02
27.00	490	30	100	50		0.01
30.00	850	20	300	30		0.03
32.00	820	10	130	0		0.01
37.00	620	30	100	20		0.00
40.00	850	20	170	20	0	0.00
42.00	560	15	60	0		0.04
45.00	950	40	230	0		0.02
47.00	900	40	130	10		0.03
49.00	150	10	70	10		0.11
49.66	1250	15	350	10	3	0.09

RESOURCE BLOCK C
SK 16 SE 5 1826 6334 Thorntree
Surface level +324.5 m (+1065 ft)
Joy Sullivan (waterflush), 94 and 76 mm diameter
February 1972

		Thickness (m)	Depth (m)
Topsoil	Red-brown soil, clay and limestone fragments	2.73	2.73
Limestone	foraminiferal biosparite, mottled, occasional chert nodules and silicified fossil debris, pelletal at 5.50 m and at base, Girvanella also present at base	6.01	8.74
	foraminiferal Brachiopod biomicrite, patchy silicification of shell debris, iron stained at base	0.96	9.70
	foraminiferal biopelsparite, passing into foraminiferal Crinoidal biosparite at about 11.00 m; encrusting algae at base; thin clay 13.76 to 13.77 m	4.07	13.77
	foraminiferal brachiopod biomicrite; local rudite sized shell debris, corals at 15.70 and 17.20 m, common crinoid bryozoa and gastropod fragments around 16.50 m; local mottling with associated spar development, pyrite and hematite staining throughout, frequent stylolites	5.71	19.48
	foraminiferal Brachiopod biopelsparite	1.04	20.52
	crinoid Brachiopod biomicrosparite; bands of silicified shells	1.76	22.28
	foraminiferal Brachiopod biomicrosparite; silicified shells at base and traces of black clay	0.28	22.56
	brachiopod biopelsparite; close packed shell debris, patchy mottling at top with occasional rudite sized shell band (patchily silicified), traces of Girvanella and Coelosporella occur throughout, allochems are less closely packed towards base of bed (marked by a 3cm clay band)	2.71	25.27
	algal biopelsparite; Girvanella and Coelosporella traces, crinoid and shell debris increasing towards base	2.23	27.50
	Biopelsparite	3.42	30.92
	Biomicrosparite, dark, finely comminuted fossil debris, occasional pelletal bands	3.10	34.02
	Pelsparite, finely comminuted fossil debris	0.63	34.65
	Biomicrite, dark with chert bands and nodules, minor dolomitisation, occasional crinoid and shell debris and corals, numerous stylolites and some thin shale partings	20.99	55.64
	Biomicrite, local bioclastic bands with foraminifera, crinoid debris, algae and bryozoa fragments, occasional chert nodules	1.26	56.90
	Crinoid biomicrite, dark, cherty	3.10	60.00
	algal biomicrite, Girvanella encrushed shell, foraminifera and crinoid debris, local silicification	1.68	61.68

Borehole completed at 61.68 m

C
SE 5



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
QUALITY
SORTING
STRENGTH INDEX (1s MN/m2)
RESIDUE
Metres
0 50 100
0·1 0·5 1·0 5·0
0 5 10 15
10
20
30
40
50
60
clay/quartz
clay/quartz
chert
chert
chert
3
2
2
2
2
1
1
3
5
4
3
4

RESOURCE BLOCK C
SK 16 SE 5 1826 6334
Thorntree

Chemical analyses, major elements (results as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss of ignition at 1050° C
4.00	0.01	0.35	0.11	0.90	0.01	0.08	0.01	54.89	0.06	43.51
6.00	0.00	0.25	0.08	0.33	0.01	0.17	0.00	55.63	0.10	43.73
8.00	0.01	0.30	0.13	0.76	0.01	0.17	0.01	55.13	0.06	43.62
11.00	0.00	0.26	0.07	0.33	0.01	0.18	0.00	55.14	0.06	43.74
13.00	0.01	0.25	0.10	0.58	0.01	0.14	0.00	55.14	0.05	43.78
15.00	0.01	0.36	0.35	1.47	0.02	0.27	0.03	54.41	0.30	43.08
17.00	0.01	0.39	0.10	0.65	0.01	0.24	0.00	54.02	0.27	40.00
18.00	0.01	0.31	0.13	0.60	0.01	0.16	0.01	54.88	0.07	43.55
20.00	0.01	0.35	0.30	0.60	0.01	0.14	0.00	55.30	0.04	43.69
23.00	0.00	0.32	0.06	0.12	0.01	0.19	0.00	55.68	0.03	43.94
26.00	0.02	0.30	0.06	0.29	0.01	0.15	0.01	55.21	0.02	43.77
30.00	0.00	0.33	0.05	0.21	0.01	0.14	0.00	55.21	0.05	43.85
32.00	0.00	0.45	0.06	0.09	0.01	0.21	0.00	54.91	0.02	43.93
34.00	0.01	0.78	0.06	0.13	0.00	0.24	0.00	54.71	0.13	44.04
40.00	0.01	0.50	0.11	0.33	0.02	0.38	0.01	54.73	0.04	44.11
43.00	0.02	0.63	0.60	2.59	0.03	1.05	0.09	52.59	0.26	42.03
45.00	0.01	0.75	0.09	0.83	0.02	0.31	0.00	54.58	0.05	43.64
50.00	0.01	0.75	0.19	1.26	0.06	0.48	0.02	54.22	0.10	43.47
55.00	0.02	0.80	0.34	2.15	0.06	0.68	0.05	53.64	0.13	42.79
58.00	0.01	0.57	0.28	0.98	0.03	0.44	0.04	54.37	0.14	43.00
60.00	0.01	0.59	0.91	2.32	0.55	1.45	0.13	52.00	1.32	40.38
60.85	0.01	0.55	0.16	0.47	0.00	0.39	0.01	54.06	0.11	43.87

SE 16 SE 5 1826 6334
Thorntree

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
4.00	80	10	10	15		0.03
6.00	60	10	10	15		0.03
8.00	60	10	0	15		0.03
11.00	60	10	10	15		0.04
13.00	90	5	0	15		0.05
15.00	100	5	0	15	0	0.06
17.00	600	5	0	15	0	0.03
18.00	140	5	0	15		0.03
20.00	70	0	0	15		0.04
23.00	90	0	0	15		0.04
26.00	70	0	0	15		0.03
30.00	80	5	10	15		0.04
32.00	40	0	0	20		0.04
34.00	350	0	0	15		0.04
40.00	40	5	30	20		0.09
43.00	80	10	90	40	0	0.11
45.00	40	10	0	15		0.17
50.00	70	10	60	15		0.07
55.00	90	5	50	20		0.08
58.00	120	10	60	20		0.12
60.00	200	10	130	15	25	0.14
60.85	160	5	70	25		0.05

RESOURCE BLOCK C
SK 16 NE 4S   1645 6618   Lathkill Dale
Surface level +259.0m (+850 ft)

		Thickness (m)	Depth (m)
Limestone	crinoid Brachiopod biosparite; abundant productoids, subordinate large biserial foraminifera and bryozoa fragments; chert nodules throughout; no exposure from 2.10 to 4.00 m	5.00	5.00
	crinoid Brachiopod biomicrite, dark, mottled, abundant productoids, crinoid debris concentrated near top of bed, corals at 7.30 m [*Lithostrotion junceum* (Fleming) and *Diphyphyllum fasciculatum* (Fleming)], common recrystallised gastropod fragments, patchy spar	3.00	8.00
	gastropod biomicrite, dark, subordinate foraminifera and bryozoa, occasional productoids, rare crinoid debris, cherty to 13.00 m	7.00	15.00
	bryozoa Crinoidal biosparite, rudite size crinoid debris, occasional brachiopod fragments	7.50	22.50

Section completed at 22.50 m

No chemical data available

RESOURCE BLOCK C
SK 16 NE 5 S   1645 6626   'Patch-reef', Ricklow Quarry
Surface level +264.5 m (+868 ft)

		Thickness (m)	Depth (m)
Limestone	Bryozoa brachiopod biomicrite, calcirudite debris, chiefly shells and crinoid stems intermixed with finer grained pellets and indeterminate debris, coarse vuggy porosity developed with coarsely crystalline spar occurring commonly as infillings within the vugs; the lithology is extremely rubbly and is characterised by numerous stylolitic seams	22.00	22.00

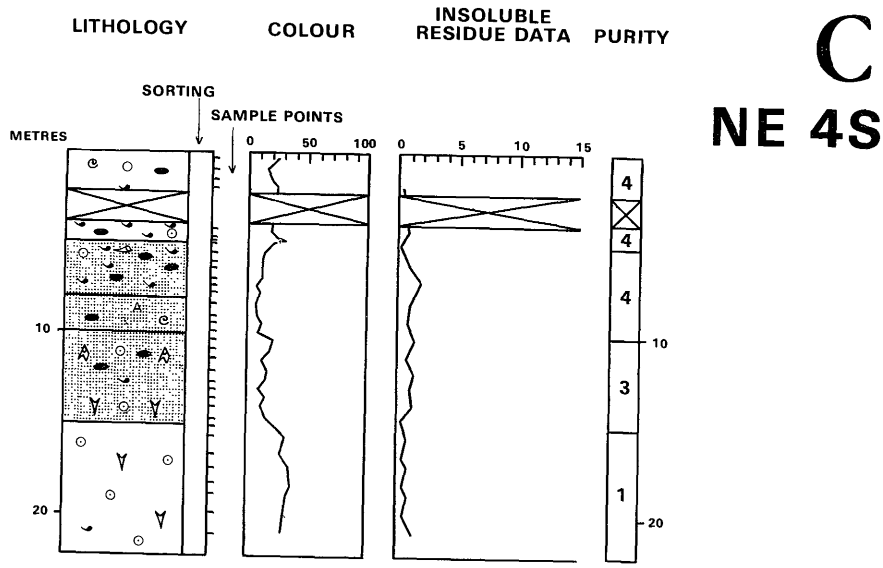
Section seen to 22.00 m

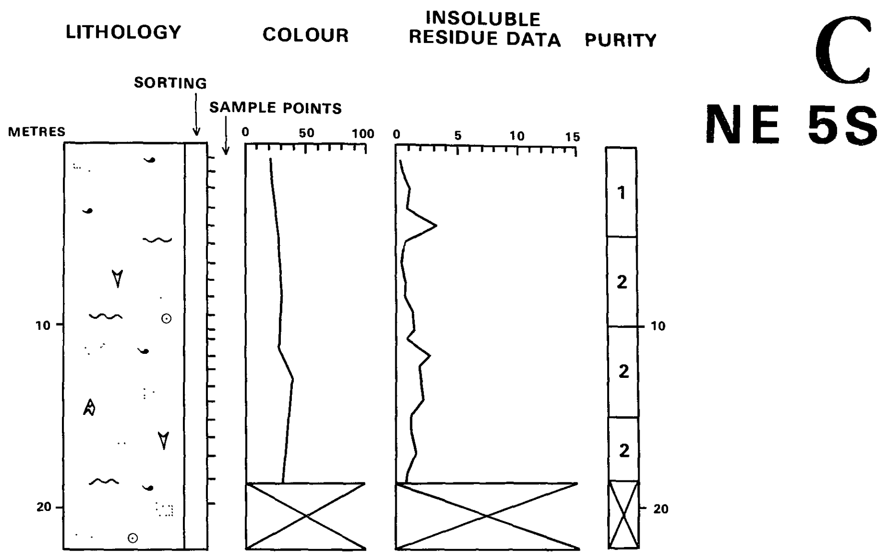
No chemical data available

RESOURCE BLOCK C
SK 16 SE 1S   1665 6237   Silica pit (worked-out) at Green Lane
Surface level +339 m (+1111 ft)

		Thickness (m)	Depth (m)
Dolomite	Buff-yellow rock, primary fabric largely destroyed by dolomitisation, rare poorly preserved macrofauna, friable and porous, traces of fluorite and baryte mineralisation	18.00	18.00

No chemical data available


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
SORTING
SAMPLE POINTS
METRES
C
NE 4S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COLOUR
INSOLUBLE RESIDUE DATA
PURITY
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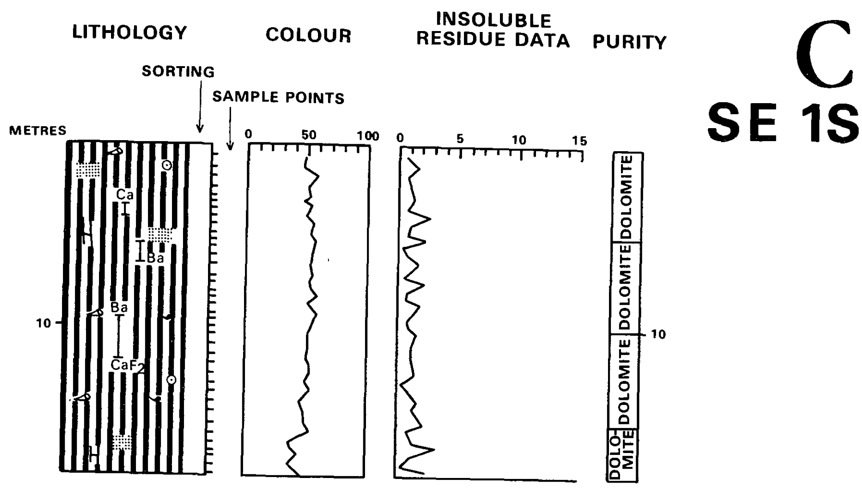
SAMPLE POINTS
METRES
C
NE 5S

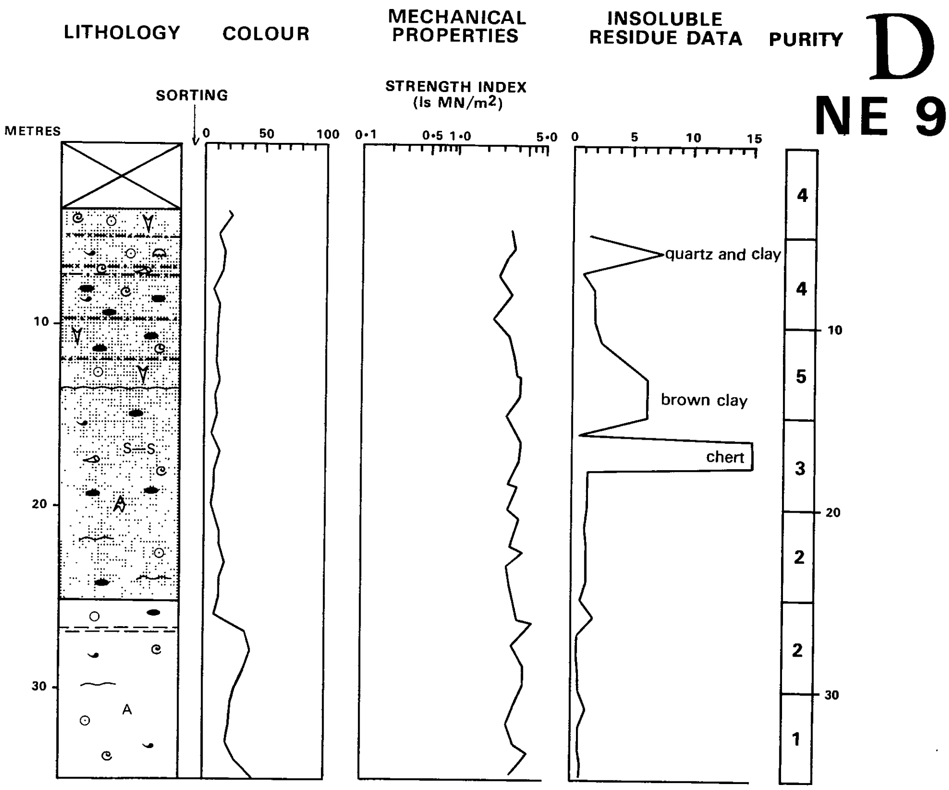

LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
SORTING
SAMPLE POINTS
METRES
Ca
Ba
Ba
CaF_2
DOLOMITE
DOLOMITE
DOLOMITE
DOLOMITE
DOLO-MITE
C
SE 1S

Source of data	Registration number	Grid reference
MAU borehole (drilled by contractor)	NE 9	1552 6817
	NE 10	1728 6946
MAU shallow boreholes drilled with a 'Pack Sack''	NE 11	1753 6676
	12	1840 6675
	13	1884 6650
	14	1927 6644
	15	1910 6738
Major sections used in the assessment	NE 3S	1574 6803
	6S	1678 6601
	7S	1805 6589

RESOURCE BLOCK D
SK 16 NE 9 1552 6817 High Low
Surface level +312.7 m (+1026 ft)

Joy Sullivan (waterflush), 94 and 76 mm diameter
January 1973

		Thickness (m)	Depth (m)
Openhole	Topsoil to 1.22 m	3.60	3.60
Limestone	bryozoa Crinoidal biosparite, coarse calcarenite and medium calcirudite interbedded units, rare shell debris and foraminifera, numerous thin clay bands	1.65	5.25
	Crinoidal biomicrite, dark, occasional micritic intraclasts, traces of bryozoa, local sparry cavity fillings, common shaly partings	1.58	6.88
	foraminiferal biomicrite, dark; finely comminuted fossil debris, coral colony at 7.14 m	0.37	7.25
	brachiopod biomicrosparite, dark, cherty; finely comminuted fossil debris to 8.93 m below coarser debris up to fine calcirudite size, large shells coated with Girvanella	2.40	9.65
	Brachiopod Crinoid biosparite, dark coarse calcarenites and fine calcirudites interbedded with chert, local bands of large brachiopods and crinoids, scattered foraminifera and bryozoa fragments, abundant thin dark shaly bands	2.39	12.04
	bryozoan Crinoid biomicrite, dark, thin shaly partings, locally abundant	1.66	13.70
	foraminiferal biomicrite, dark, cherty, finely comminuted fossil debris including brachiopods, crinoids, bryozoa, and gastropods; Saccamminopsis present at 17.00 m; colonial coral at 17.74 m, thin dark shaly partings locally abundant, stylolitic towards the base	11.50	25.20
	foraminiferal Crinoidal biomicrosparite, dark, numerous thin shaly partings	1.24	26.44
Mudstone	Mudstone, unconsolidated at top	0.10	26.54
Limestone	foraminiferal biosparite, finely comminuted fossil debris with local bands of crinoids, brachiopods and foraminifera	10.27	36.81



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
D
NE 9
SORTING
STRENGTH INDEX (Is MN/m2)
METRES
0
50
100
0·1
0·5 1·0
5·0
0
5
10
15
quartz and clay
brown clay
chert
10
20
30
4
4
5
3
2
2
1

RESOURCE BLOCK D
SK 16 NE 9 1552 6817
High Low

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
5.00	0.03	0.39	0.35	1.37	0.01	0.27	0.03	53.46	0.12	42.55
6.00	0.04	0.56	1.44	4.47	0.10	0.25	0.19	51.25	0.24	41.24
8.00	0.04	0.51	0.54	1.62	0.06	0.42	0.07	52.75	0.05	43.96
13.00	0.02	0.49	1.03	2.63	0.04	0.65	0.12	52.32	0.26	42.88
18.00	0.03	0.55	0.17	0.59	0.02	0.26	0.03	54.45	0.02	43.14
23.00	0.02	0.50	0.06	0.69	0.00	0.18	0.01	54.30	0.01	43.60
26.00	0.02	0.56	0.09	0.50	0.02	0.29	0.01	53.63	0.01	44.28
28.00	0.01	0.16	0.04	1.60	0.00	0.11	0.01	53.86	0.01	42.79
33.00	0.01	0.34	0.09	0.45	0.00	0.11	0.02	54.71	0.01	43.84

SK 16 NE 9 1552 6817
High Low

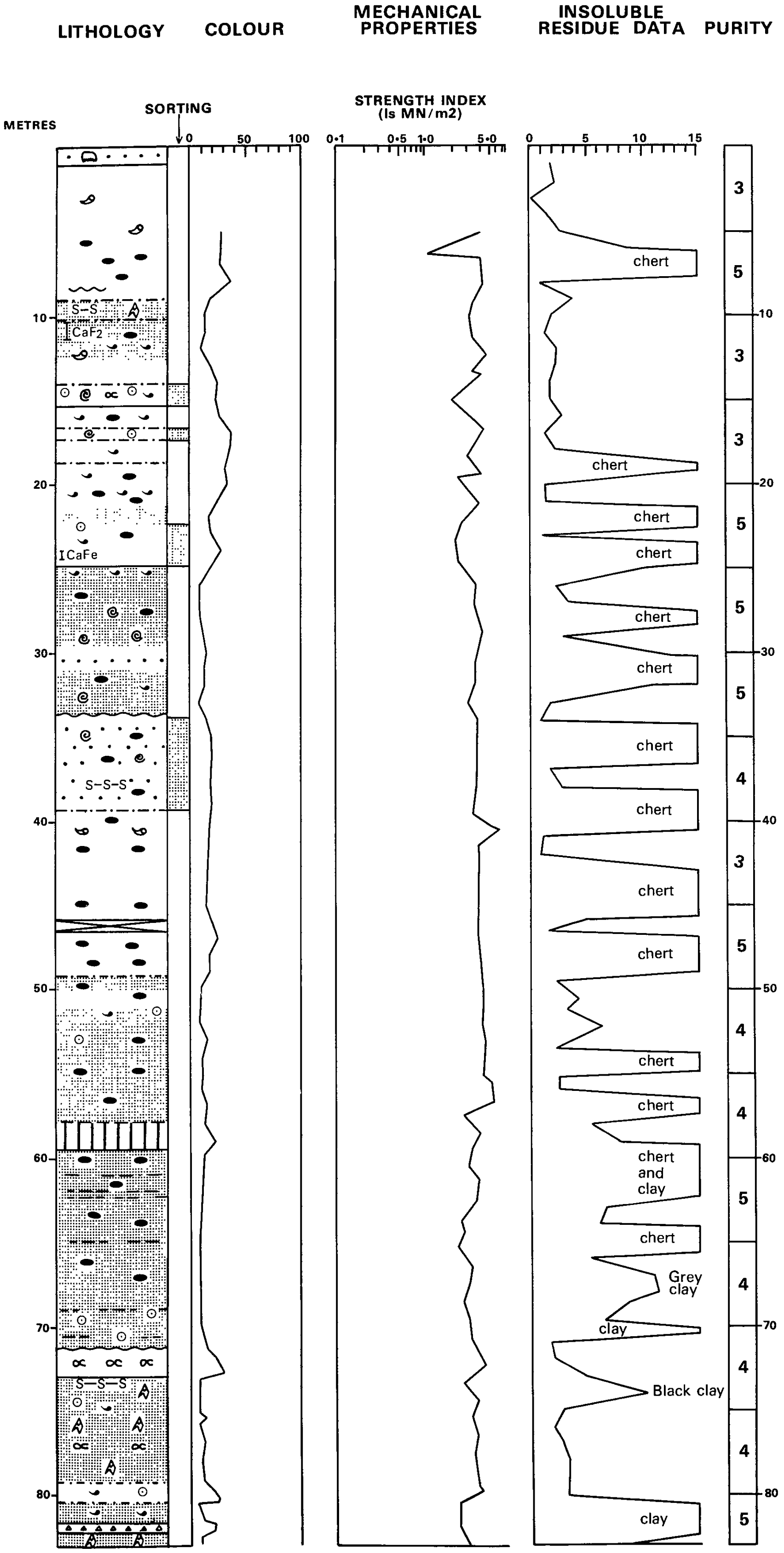
Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
5.00	450	5	0	10		0.18
6.00	430	0	10	15		0.14
8.00	100	75	70	130	0	0.07
13.00	530	15	10	15	0	0.05
18.00	90	10	10	15		0.16
23.00	60	5	10	15		0.02
26.00	140	0	0	15		0.03
28.00	140	0	0	15		0.06
33.00	70	0	0	15		0.02

RESOURCE BLOCK D
SK 16 NE 10 1728 6946 Sheldon
Surface level + 290.3 m (+952 ft)
Edeco Stratadrill (waterflush), 94, 76, 70 mm diameter

		Thickness (m)	Depth (m)
Topsoil		0.91	0.91
Limestone	Biomicrite, sporadic dark chert nodules, essential comminuted debris with scattered coarser crinoid ossicles, shells, spines and corals, all partially silicified, accessory pyrite at 6.50 m	8.01	8.92
	Biosparite, dark coloured, abundant comminuted debris including Saccamminopsis, continuing from 11.50 m in paler biosparite with coarse crinoid, shell and bryozoa debris; local nodular chert and fluorite mineralisation	5.03	13.95
	crinoid brachiopod biosparite, well sorted, fauna affected by algal corrosion, thin shell bed 15.40 to 16.63 m with associated nodular chert	4.65	18.60
	brachiopod biomicrite, many coarse rudite shell clusters interspersed with beds of finer comminuted debris in a microspar or spar matrix; towards base crinoid brachiopod biosparites occur; scattered chert nodules throughout, mineralised vein 24.10 to 24.50 m	6.19	24.79
	foraminiferal brachiopod biosparite, mainly dark coloured, tightly packed shells to 25.37 m, local concentrations of foraminifera, rudite crinoid debris, and pelletal grains, chert nodules occur throughout	8.94	33.73
	Biosparite, well sorted very fine calcarenite with dominant foraminifera and pelletal grains; scattered chert nodules	5.67	39.40
	Biomicrosparite, very fine calcarenite, patchy development of dolomite crystals, local chert nodules; continuing from 49.14 m as a dark coloured limestone with bands of coarser crinoid and shell debris at 51.36 m, 52.00 m and 52.68 m, thin mudstone at 53.36 m; shale parting at base of unit, scattered chert nodules throughout	18.45	57.85
	Micrite, laminated with dolomite rhombs preferentially developed along laminae (Rosewood Marble)	1.69	59.54
	Biomicrite, dark coloured, very fine calcarenite, crinoid debris near base; thin shale partings and nodular chert throughout; mineralised vein (calcite, fluorite) from 61.30 to 61.80 m	11.76	71.30
	algal biomicrosparite, subordinate crinoid and shell debris, common Girvanella	1.70	73.00
	Biomicrosparite, mainly dark coloured, abundant finely comminuted debris, local coarse silicified shell and crinoid fragments; Girvanella and Coelosporella are diagnostic algae; Saccamminopsis band at 73.30 m	8.70	81.70
	Tuffaceous biomicrite, limestone fragments embedded in a pyritic pale grey-green clay matrix	0.55	82.25
	Biomicrosparite, dark, common gastropod debris	0.83	83.08

D
NE 10
1.



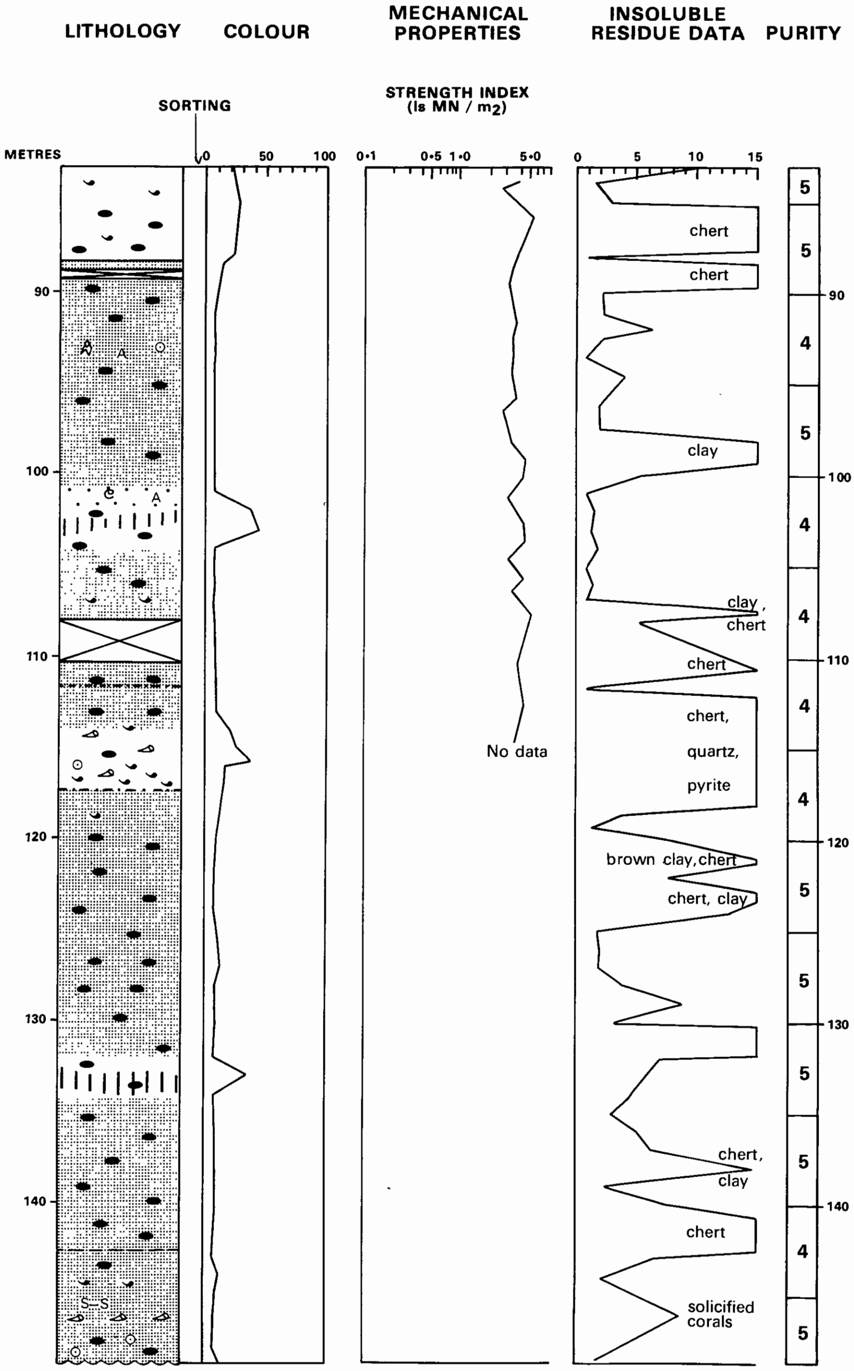
LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
METRES
SORTING
0
50
100
STRENGTH INDEX (Is MN/m2)
0·1
0·5
1·0
5·0
0
5
10
15
S–S
CaF2
CaFe
S–S–S
S—S—S
chert
chert and clay
Grey clay
clay
Black clay
10
20
30
40
50
60
70
80
3
5
3
3
5
5
5
4
3
5
4
4
5
4
4
4
5

		Thickness (m)	Depth (m)
			148.81
Limestone	Biomicrite, algal nodules in upper part of unit, also sporadic concentrations of Saccamminopsis; between 155.00 and 157.53 m colour darkens and gastropods are common; several very thin wayboards occur at around 157.53 m; below this depth crinoid and shell debris increases; local patchy spar	11.19	160.00
	Biosparite, common crinoids, foraminifera, pellets and small shells, moderately sorted except for the interval 162.00 to 166.38 m; accessory pyrite	9.04	169.04
	Biomicrosparite, local concentrations of crinoid debris with gastropods and brachiopod shells, subordinate bryozoa and foraminifera; patchy spar	8.76	177.80
	Biosparite, very fine calcarenite, well sorted tightly packed debris	0.81	178.61
	Biomicrosparite, varied fauna, composed chiefly of crinoids, gastropods and foraminifera, occasional rudite shells	3.02	181.63
	algal crinoidal biosparite, sorted crinoid, foraminifera and shell debris, common encrusting algae	1.60	183.23
	crinoidal biosparite, locally dark with rudite crinoid debris at 200.72 m, scattered rudite brachiopods, several coral bands developed e.g. at 197.60 to 198.50 m; Saccamminopsis band at 191.48 m; clay wayboard at 202.53 m	19.30	202.53
	algal biosparite, foraminifera and chambered algal tubes are common, subordinate crinoid and shell debris; pyrite traces	4.77	207.30

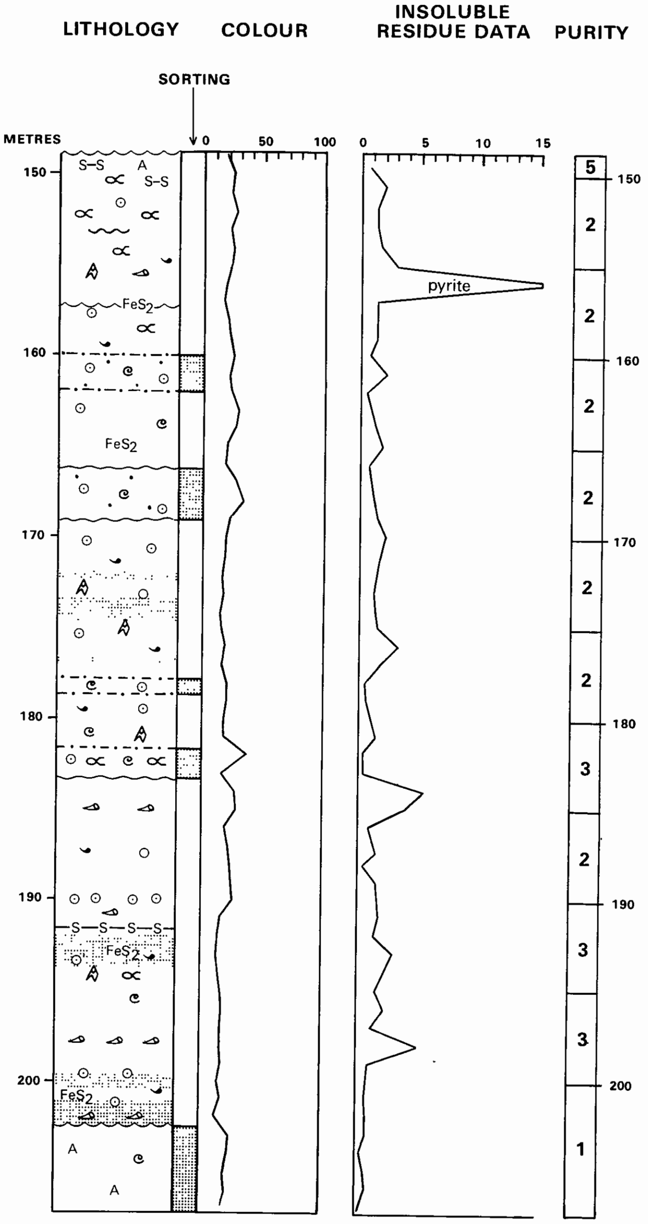
Borehole completed at 207.30 m

D

NE 10 2.


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
SORTING
STRENGTH INDEX (Is MN / m2)
METRES
0
50
100
0·1
0·5
1·0
5·0
0
5
10
15
90
100
110
120
130
140
chert
chert
clay
clay, chert
chert
chert, quartz, pyrite
brown clay, chert
chert, clay
chert, clay
chert
solicified corals
No data
5
5
4
5
4
4
4
4
5
5
5
5
4
5

		Thickness (m)	Depth (m)
			83.08
Limestone	Biomicrite, laminated, very fine calcarenite, rare rudite shells, scattered chert nodules	5.27	88.35
	Biomicrosparite, predominantly dark, abundant finely comminuted debris; between 93.25 and 93.85 m, gastropods, crinoid debris and Coelosporella are common; local paling from 101.00 to 192.00 m is associated with pellet/algal fauna; influx of coarse shell debris between 107.1 and 108.01 m; secondary dolomite rhombs are developed at 94.66 and 95.50 m and intermittently between 101.00 and 106.00 m, scattered chert nodules throughout	23.28	111.63
	coral brachiopod biomicrite, some nodular chert	5.66	117.29
	Biomicrosparite, predominantly dark, very fine grained indeterminate fossil debris; dolomite rhombs developed from 125.00 to 125.84 m, complete dolomitisation has occurred between 132.95 and 133.35 m; abundant chert nodules throughout, rare shale partings	25.40	142.70
	coral biomicrite, dark, rudite shells occur about 144.04 m, silicified corals are present between 145.50 and 146.00 m - Lithostrotion junceum (Fleming), Dibunophyllum bipartitum konincki (Milne, Edwards and Haime) and Diphyphyllum lateseptatum McCoy; secondary dolomite rhombs at 143.80 m; sporadic cherts throughout; at base of unit traces of grey-green clay suggest the presence of a wayboard	6.11	148.81


LITHOLOGY
COLOUR
INSOLUBLE RESIDUE DATA
PURITY
SORTING
METRES
0 50 100
0 5 10 15
150
160
170
180
190
200
S–S
A
S–S
FeS2
FeS2
FeS2
S—S—S—S
FeS2
FeS2
A
A
pyrite
5
2
2
2
2
2
2
3
2
3
3
1

D

NE 10
3.

RESOURCE BLOCK D
SK 16 NE 10 1728 6946
Sheldon

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
6.00	0.02	0.42	0.42	5.66	0.06	0.32	0.09	52.18	0.11	40.94
10.00	0.02	0.52	0.15	1.10	0.04	0.37	0.04	54.43	0.11	43.57
11.00	0.02	0.48	0.11	1.03	0.03	0.37	0.03	54.22	0.09	43.53
13.00	0.02		0.08	1.32	0.03	0.41	0.03	54.47	0.10	43.29
16.00	0.03	0.39	0.08	2.46	0.02	0.34	0.03	52.69	0.10	42.62
17.10	0.05	0.44	0.06	0.97	0.02	0.34	0.03	54.96	0.11	42.98
19.00	0.02	0.43	0.07	8.66	0.01	0.40	0.02	51.88	0.11	39.14
21.00	0.03	0.45	0.04	1.81	0.02	0.41	0.02	55.87	0.10	43.23
23.00	0.02	0.50	0.05	0.83	0.02	0.30	0.02	55.64	0.11	43.56
26.00	0.04	0.60	0.17	0.97	0.04	0.56	0.06	52.34	0.09	43.87
28.00	0.02	0.58	0.08	14.22	0.00	0.30	0.02	47.95	0.08	36.59
31.00	0.02	0.12	0.17	70.96	0.04	0.17	0.03	17.87	0.05	13.07
34.00	0.02	0.62	0.03	1.15	0.01	0.29	0.02	52.60	0.09	43.54
37.00	0.02	0.54	0.04	0.47	0.03	0.35	0.02	55.89	0.11	43.88
39.00	0.11	0.06	0.17	89.71	0.07	0.11	0.07	8.13	0.09	7.17
42.00	0.03	0.46	0.08	1.20	0.02	0.37	0.04	58.63	0.13	43.43
49.00	0.02	0.64	0.09	0.68	0.03	0.42	0.03	55.60	0.13	43.56
52.00	0.03	0.04	0.75	80.43	0.05	0.22	0.09	10.93	0.08	9.68
54.35	0.02	0.49	0.31	19.21	0.01	0.41	0.07	44.47	0.18	34.02
58.00	0.02	0.83	0.07	1.39	0.04	0.39	0.03	55.97	0.13	43.44
60.00	0.04	0.35	1.06	50.76	0.02	0.52	0.19	28.75	0.14	22.47
61.00	0.02	0.85	0.73	4.23	0.27	0.27	0.14	51.22	0.15	41.50
65.00	0.03	0.31	0.50	35.19	0.00	0.60	0.06	34.45	0.18	26.09
70.30	1.16	0.61	1.54	11.55	0.03	1.39	0.27	46.33	0.70	36.66
72.00	0.01	0.38	0.11	1.65	0.08	0.12	0.02	56.06	0.07	42.94
76.00	0.01	0.52	0.09	0.97	0.06	0.13	0.01	56.24	0.06	43.53
80.10	0.01	0.43	0.39	1.77	0.04	0.56	0.05	54.15	0.31	42.57
84.00	0.02	0.33	0.15	1.50	0.05	0.19	0.02	54.26	0.10	43.02
88.00	0.02	0.37	0.13	0.70	0.05	0.05	0.01	53.98	0.08	43.44
92.00	0.02	0.64	0.13	0.52	0.03	0.19	0.01	53.83	0.09	43.96
95.50	0.01	1.36	0.17	8.40	0.14	0.10	0.02	51.74	0.13	38.09
99.00	0.03	0.56	0.23	9.91	0.04	0.36	0.02	49.35	0.08	38.94
101.00	0.03	0.96	0.07	0.47	0.02	0.12	0.00	54.04	0.09	43.92
104.00	0.04	7.08	0.16	52.84	0.17	0.10	0.01	21.90	0.02	18.76
111.63	0.04	0.46	0.17	11.84	0.03	0.17	0.02	48.01	0.07	37.57
115.50	0.05	0.30	0.09	2.42	0.13	0.07	0.02	54.11	0.03	42.18
116.50	0.01	0.25	0.05	0.31	0.08	0.06	0.00	55.69	0.03	43.71
120.00	0.01	0.74	0.13	0.28	0.07	0.16	0.02	55.52	0.04	44.05
125.00	0.02	0.82	0.10	0.23	0.03	0.19	0.01	54.13	0.07	44.09
130.13	0.03	0.94	0.18	14.62	0.04	0.97	0.03	45.82	0.12	35.88
135.00	0.03	0.65	0.24	0.83	0.07	0.37	0.05	55.65	0.10	43.82
140.00	0.01	0.62	0.55	1.40	0.12	0.69	0.09	52.62	0.25	42.96
149.65	0.14	0.43	0.20	0.70	0.04	0.10	0.08	54.51	0.17	43.46
155.00	0.01	0.28	0.21	0.88	0.06	0.09	0.05	56.56	0.11	43.27
161.00	0.01	0.34	0.30	0.63	0.06	0.12	0.06	56.26	0.08	43.46
165.00	0.15	0.45	0.28	1.05	0.02	0.38	0.10	54.22	0.24	43.24
168.00	0.01	0.23	0.08	0.47	0.06	0.22	0.01	54.38	0.08	43.30
171.00	0.01	0.51	0.23	1.06	0.07	0.16	0.05	54.68	0.03	43.33
177.00	0.06	0.53	0.23	0.79	0.05	0.13	0.06	54.03	0.03	43.50
183.00	0.01	0.38	0.08	0.30	0.07	0.09	0.01	56.37	0.04	43.79
187.30	0.00	0.68	0.09	0.24	0.05	0.10	0.02	54.36	0.06	43.04
193.00	0.01	0.44	0.16	0.63	0.04	0.09	0.03	54.40	0.25	42.87
199.00	0.02	0.43	0.15	0.50	0.10	0.07	0.03	55.94	0.08	43.64
205.00	0.03	0.27	0.12	0.45	0.02	0.17	0.02	55.24	0.11	42.06

SK 16 NE 10 1728 6946 Trace elements (parts per million)
Sheldon

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
6.00	80	5	10	0	0	0.02
10.00	150	5	10	10		0.03
11.00	110	10	10	10		0.05
13.00	75	20	10	10		0.14
16.00	160	20	20	0		0.01
17.10	90	45	30	0	17	0.02
19.00	70	95	50	0		0.07
21.00	40	100	50	0	0	0.07
23.00	115	70	40	0		0.10
26.00	45	65	30	10		0.07
28.00	45	65	30	0	0	0.04
31.00	45	70	30	0		0.00
34.00	40	45	30	0		0.18
37.00	60	30	20	0		0.08
39.00	70	35	20	10		0.05
42.00	195	5	10	20	0	0.11
49.00	80	10	10	0		0.19
52.00	35	35	20	10		0.02
54.35	210	10	10	0		0.07
58.00	310	15	10	10		0.15
60.00	115	40	30	10	0	0.11
61.00	250	20	20	0	4	0.16
65.00	120	55	30	0		0.10
70.30	140	40	15	0		0.08
72.00	190	5	5	0		0.06
76.00	100	10	5	0	0	0.04
80.10	80	10	10	0		0.06
84.00	80	15	10	0		0.07
88.00	60	10	10	0		0.03
92.00	50	5	5	0		0.04
95.50	230	15	10	0	0	0.15
99.00	50	15	10	0		0.08
101.00	120	15	10	0	0	0.07
104.00	100	40	15	0		0.01
111.63	60	15	10	0		0.05
115.50	110	10	10	0		0.04
116.50	80	15	15	0	0	0.05
120.00	60	5	5	0		0.07
125.00	90	15	10	0		0.07
130.13	70	30	15	0	4	0.11
135.00	90	10	15	0		0.06
140.00	110	20	20	0	4	0.05
149.65	160	5	5	0		0.04
155.00	100	10	10	0		0.07
161.00	60	10	10	0		0.06
165.00	100	15	10	0		0.03
168.00	90	25	15	0	0	0.04
171.00	90	20	15	0		0.07
177.00	70	20	10	0		0.07
183.00	70	25	15	0		0.06
187.30	170	20	10	0		0.54
193.00	210	30	25	0		0.14
199.00	160	15	10	0		0.08
205.00	70	10	5	0	0	0.07

RESOURCE BLOCK D

Shallow boreholes drilled with the MAU 'Pack Sack' drill

SK 16 NE 11   1734 6676   over Haddon

Surface level +296.2 m (+972 ft)

		Thickness (m)	Depth (m)
Topsoil	Limestone fragments in brown clay	0.30	0.30
Limestone	Brachiopod biosparite medium grey shells silicified, chert at 0.50 m. *Saccamminopsis* at 1.15	1.84	2.14
	Biosparite, pale grey	0.62	2.76
	Brachiopod biomicrite, medium grey, chert between 2.97 and 3.00, 4.10 and 4.23 and at 4.34 m, patchy silicification	1.74	4.50

Borehole completed at 4.50 m

No chemical data available

SK 16 NE 12   1839 6677   Over Haddon

Surface level +287.9 m (+945 ft)

		Thickness (m)	Depth (m)
Topsoil		0.60	0.60
Limestone	Brachiopod biomicrite, pale grey, shells patchily silicified, some *Girvanella,* foraminifera common, local pellets, darker coloured from 2.32 to 4.42 m; chert nodules at 2.68 and 4.76 m, calcite veined, traces of malachite at 4.41 m	4.36	4.96
	Brachiopod biopelmicrite, chert nodules at 5.36 and 5.70 m, local patchy silicification of shells	1.55	6.51
	Brachiopod biomicrite, grey, common foraminifera, shells show patchy silicification, spar developed locally, chert at 7.11 m	1.10	7.61

Borehole completed at 7.61 m

No chemical data available

RESOURCE BLOCK D

Shallow boreholes drilled with the MAU 'Pack Sack' drill

SK 16 NE 13 1886 6650 Over Haddon

Surface level +265.9 m (+872 ft)

		Thickness (m)	Depth (m)
Topsoil	Red clay	0.95	0.95
Limestone	Brachiopod biomicrite, subordinate crinoid debris, patchy silicification of shells, flecks of limonite below 1.60 m	0.90	1.85
	Bryozoa biosparite, shells slightly silicified, crinoids and foraminifera common	1.85	3.70
	Brachiopod biomicrite, grey becoming dark grey at 4.13 m, patchy silicification; much calcite veining, becoming very dark towards base with clay coated stylolites	3.60	7.30

Borehole completed at 7.30 m

No chemical data available

SK 16 NE 14 1926 6646 Over Haddon

Surface level +252.9 m (+830 ft)

		Thickness (m)	Depth (m)
Limestone	Rubbly weathered grey limestone	0.88	0.88
	Brachiopod biosparite; Saccamminopsis at 2.15 m, many silicified shells, common clay partings, fragmented limestone at base	1.48	2.36
	foraminiferal algal biosparite, some pellets, rare bryozoa, calcite veining, patchy silicification below 5.45 m, cherty between 6.08 and 6.38 m	4.02	6.38

Borehole completed at 6.38 m

No chemical data available

SK 16 NE 15 1908 6737

Surface level +308.4 m (+1012 ft)

		Thickness (m)	Depth (m)
Topsoil	Brown clay with chert and limestone fragments	1.42	1.42
	Brachiopod biomicrite, dark grey, some foraminifera, pyrolusite flecks common, clay partings common, some shells silicified	0.90	2.32

Borehole completed at 2.32 m

No chemical data available

Boreholes NE 11 - NE 15 all encountered limestone of low purity

RESOURCE BLOCK D
SK 16 NE 3S 1574 6803 'Patch-reef' at High Low
Surface level +320.4 m (+1051 ft)

		Thickness (m)	Depth (m)
Limestone	Inaccessible cliff	1.20	1.20
	bryozoa brachiopod Crinoid biosparrudite, locally well sorted with graded bedding structures, scattered foraminifera and occasional corals, shell debris is patchily silicified, variable micrite plugging gaps in the allochem frameworks, interbedded clay seams	8.67	9.77

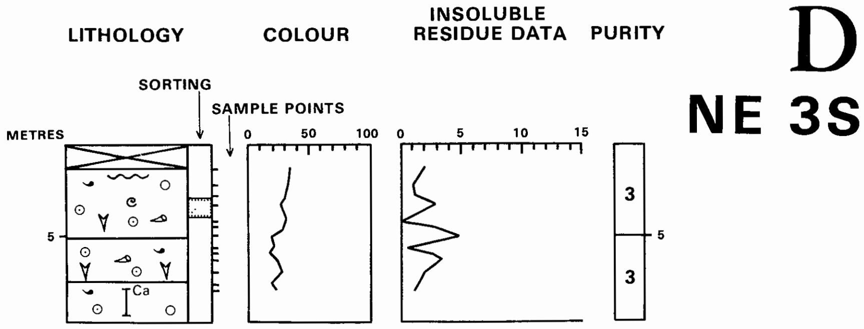
No chemical data available

RESOURCE BLOCK D
SK 16 NE 6S 1678 6601 Lathkill Dale
Surface level +246.6 m (+809 ft)

		Thickness (m)	Depth (m)
Limestone	Biomicrite, finely comminuted bioclasts include crinoid ossicles, shell debris and rare bryozoa, coral band at 3.90 m	12.50	12.50
	Biopelmicrite, finely comminuted shell and crinoid debris	2.50	15.00
	brachiopod biomicrite, cherts throughout, scattered productoids, crinoids, bryozoa and foraminiferal debris	4.50	19.50
	brachiopod biomicrosparite, dark, coral band at 21.0 m, traces of algae	3.50	23.00
	algal Brachiopod biopelsparite; rudite size brachiopods; common <u>Girvanella.</u>	0.60	23.60
	crinoid Brachiopod biosparite, coarse calcarenite size compacted debris, partially silicified; scattered foraminifera and bryozoan fragments	3.50	27.10
	Brachiopod biosparrudite; bed containing abundant silicified productoids, chert nodules throughout	6.40	33.50
	foraminiferal brachiopod biosparite, mottled with fossil debris concentrated in pockets which are spar cemented	2.90	36.40
	Biomicrosparite, scattered shell and crinoid debris; quartz and chert present in small amounts	2.00	38.40

Section completed at 38.40 m

No chemical data available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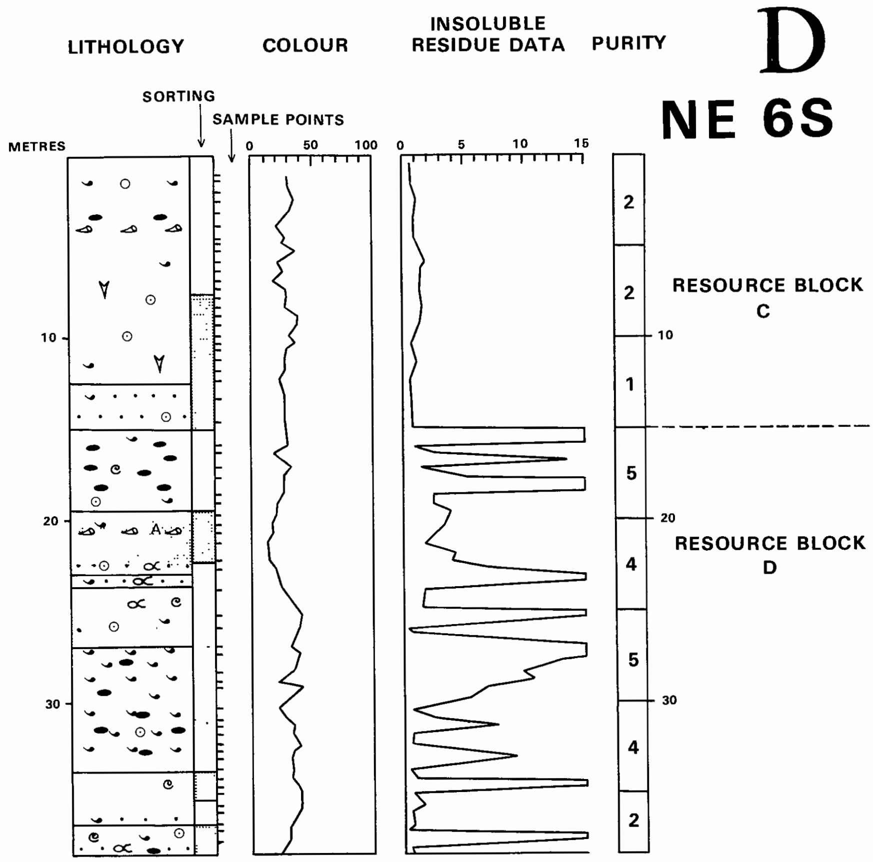
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RESOURCE BLOCK C
RESOURCE BLOCK D

RESOURCE BLOCK D

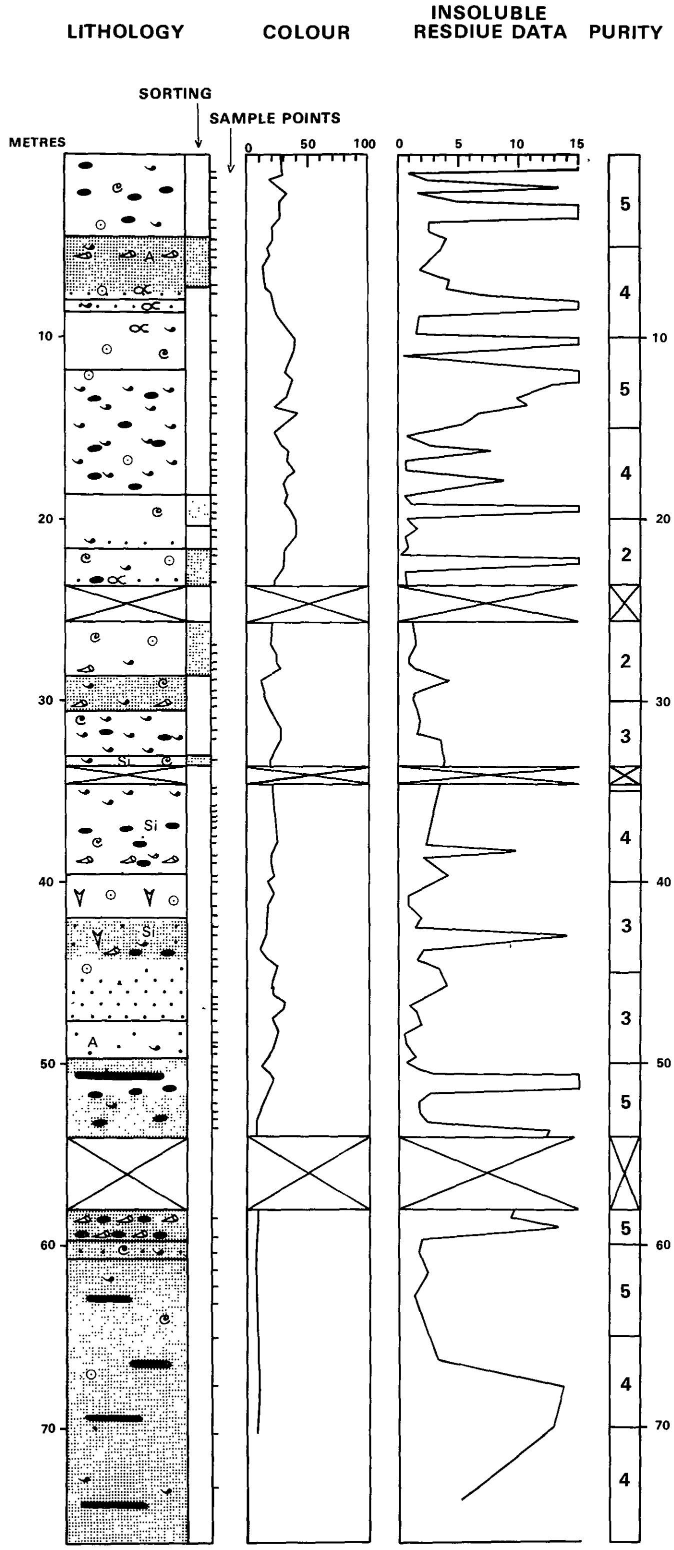
SK 16 NE 7S 1805 6589 Lathkill Dale

Surface level +263.2 m (+864 ft)

		Thickness (m)	Depth (m)
Limestone	brachiopod biomicrite, cherts throughout, scattered productoids, crinoids, bryozoa foraminiferal debris	4.50	4.50
	brachiopod biomicrosparite, dark, coral band at 6.30 m, traces of algae	3.50	8.00
	algal Brachiopod biopelsparite, rudite size brachiopods; common Girvanella	0.60	8.60
	crinoid Brachiopod biosparite, coarse calcarenite size compacted debris, partially silicified, scattered foraminifera and bryozoa fragments	3.50	12.10
	Brachiopod biosparrudite; bed containing abundant silicified productoids, chert nodules throughout	6.40	18.50
	foraminiferal brachiopod biosparite, mottled with fossil debris concentrated in pockets which are spar cemented	2.90	21.40
	Biomicrosparite, scattered shell and crinoid debris, quartz and chert present in small amounts; gap in data from 23.4 to 25.4 m	7.00	28.40
	foraminiferal Brachiopod biomicrite, dark, corals at 30.00 m	1.90	30.30
	Brachiopod biomicrosparite, productoid bed, scattered foraminifera; chert nodules	2.50	32.80
	Brachiopod biosparite, silicified, scattered foraminifera; no exposure from 33.50 to 34.60 m	1.80	34.60
	foraminiferal Brachiopod biomicrosparite, bioclasts silicified	4.90	39.50
	foraminiferal bryozoa Crinoid biosparite, silicified bioclasts	2.50	42.00
	Pelsparite, dark at top of unit, with scattered bryozoa, silicified shells, foraminifera, crinoid debris and corals; fewer bioclasts below, chiefly pellets	5.60	47.60
	algal pelsparite, rare brachiopods and traces of Coelosporella	2.00	49.60
	Biomicrite, dark; bedded and nodular chert present, rare brachiopods, crinoids and foraminifera, Diphyphyllum and Lithostrotion junceum (Fleming) at 59.0 m	10.00	59.60
	brachiopod biopelmicrite, dark, scattered foraminifera	1.00	60.60
	brachiopod biomicrite, dark, few allochems, cherty throughout	15.90	76.50

Section completed at 76.59 m

D
NE 7S



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RESOURCE BLOCK D
SK 16 NE 7S
Lathkill Dale

Chemical analyses, major elements (results expressed as percentage oxides)

Depth (m)	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_3	K_2O	CaO	Fe_2O_3	Loss on ignition at 1050° C
0.60	0.03	0.24	0.19	77.99	0.05	0.04	0.03	15.09	0.13	11.30
1.60	0.01	0.54	0.18	1.12	0.06	0.26	0.05	54.82	0.09	43.56
2.00	0.01	0.44	0.09	1.74	0.05	0.22	0.02	54.66	0.07	43.04
3.80	0.01	0.54	0.12	0.73	0.08	0.23	0.04	55.06	0.09	43.69
4.90	0.02	0.58	0.19	1.12	0.08	0.24	0.05	54.81	0.11	43.42
7.10	0.01	0.56	0.08	0.45	0.05	0.24	0.02	55.13	0.11	43.77
9.10	0.02	0.46	0.05	0.37	0.04	0.21	0.02	55.31	0.11	43.85
11.20	0.01	0.30	0.14	0.54	0.10	0.08	0.02	56.36	0.07	43.82
14.10	0.01	0.51	0.11	0.37	0.05	0.21	0.02	55.99	0.11	43.81
15.10	0.01	0.38	0.04	3.66	0.05	0.21	0.01	54.73	0.09	42.33
16.60	0.01	0.38	0.07	5.92	0.05	0.19	0.02	52.73	0.11	41.02
18.40	0.01	0.43	0.04	1.84	0.04	0.22	0.01	55.95	0.12	43.21
19.00	0.01	0.42	0.08	0.62	0.03	0.19	0.02	56.38	0.11	43.75
20.90	0.01	0.42	0.12	0.63	0.03	0.35	0.03	56.14	0.13	43.63
21.90	0.01	0.45	0.14	0.36	0.03	0.28	0.02	55.99	0.11	43.82
23.80	0.04	0.46	0.03	0.08	0.03	0.22	0.02	56.17	0.11	43.92
27.80	0.02	0.51	0.05	0.42	0.03	0.19	0.02	54.98	0.10	43.80
28.60	0.01	0.48	0.04	0.56	0.03	0.23	0.02	56.23	0.12	43.63
30.70	0.02	0.67	0.15	1.00	0.03	0.26	0.04	55.69	0.12	43.59
32.00	0.00	0.35	0.11	0.83	0.09	0.13	0.02	56.13	0.05	43.62
35.80	0.03	0.61	0.34	1.86	0.03	0.35	0.08	54.19	0.20	43.03
39.20	0.02	0.62	0.24	1.43	1.15	0.25	0.07	55.52	0.18	43.19
40.30	0.02	0.59	0.12	0.65	0.12	0.25	0.04	56.09	0.16	43.38
41.60	0.02	0.59	0.10	0.76	0.07	0.23	0.03	55.95	0.12	43.63
42.70	0.02	0.56	0.04	1.14	0.03	0.21	0.02	54.89	0.12	43.51
43.90	0.03	0.70	0.09	1.61	0.04	0.32	0.03	54.99	0.11	42.96
46.60	0.02	0.66	0.03	2.04	0.03	0.29	0.02	54.23	0.17	43.09
47.30	0.01	0.51	0.03	0.52	0.03	0.26	0.01	55.60	0.11	43.79
50.20	0.01	0.66	0.05	0.32	0.03	0.30	0.02	55.67	0.10	43.90
51.80	0.02	0.76	0.08	0.27	0.04	0.34	0.02	54.80	0.11	44.04
53.80	0.02	0.77	0.64	9.92	0.04	0.44	0.11	49.53	0.17	39.97
59.80	0.02	0.87	0.08	1.13	0.05	0.35	0.02	54.33	0.11	43;75
60.60	0.02	0.86	0.08	0.63	0.05	0.33	0.02	55.07	0.12	43.54
66.50	0.02	0.85	0.17	2.40	0.05	0.32	0.04	53.50	0.10	42.83
68.00	0.02	0.77	0.19	2.85	0.07	0.43	0.04	53.08	0.19	42.85
70.60	0.02	0.82	0.39	5.18	0.08	0.52	0.08	51.71	0.24	41.88

SK 16 NE 7 S
Lathkill Dale

Trace elements (parts per million)

Depth (m)	Mn	Cu	Zn	Pb	As	F (%)
0.60	110	40	60	30	0	0.01
1.60	125	15	20	0		0.06
2.00	165	10	10	0		0.09
3.80	90	15	20	10		0.05
4.90	115	15	10	0	0	0.08
7.10	145	15	20	0		0.06
9.10	190	10	20	0		0.00
11.20	70	10	20	0		0.01
14.10	195	10	20	0	0	0.06
15.10	80	10	10	0		0.07
16.60	90	10	20	0		0.18
18.40	120	10	20	0		0.06
19.00	65	10	20	0	0	0.05
20.90	125	20	30	0		0.04
21.90	65	10	10	0		0.05
23.80	60	15	10	0		0.06
27.80	60	15	10	0		0.03
28.60	60	10	10	0	0	0.13
30.70	50	15	10	0		0.06
32.00	85	20	20	0		0.02
35.80	60	20	20	0		0.04
39.20	110	20	20	0	0	0.08
40.30	95	15	20	0		0.17
41.60	55	25	20	0		0.04
42.70	45	15	20	0		0.07
43.90	30	30	20	0		0.04
46.60	175	15	10	0	0	0.03
47.30	110	15	20	0		0.04
50.20	35	15	10	0		0.03
51.80	50	25	20	0		0.06
53.80	115	15	10	0	0	0.12
59.80	45	15	20	0		0.05
60.60	75	15	20	0		0.24
66.50	100	20	20	0		0.15
68.00	95	20	30	0		0.06
70.60	110	25	125	20	4	0.06

Resource Block E

Source of data	Registration number	Grid reference
Major sections used in the assessment	NE 1S	1910 6937
	2S	1939 6957

Logs of additional collected sections may be consulted at the appropriate office of the Institute.

RESOURCE BLOCK E

NE 1S

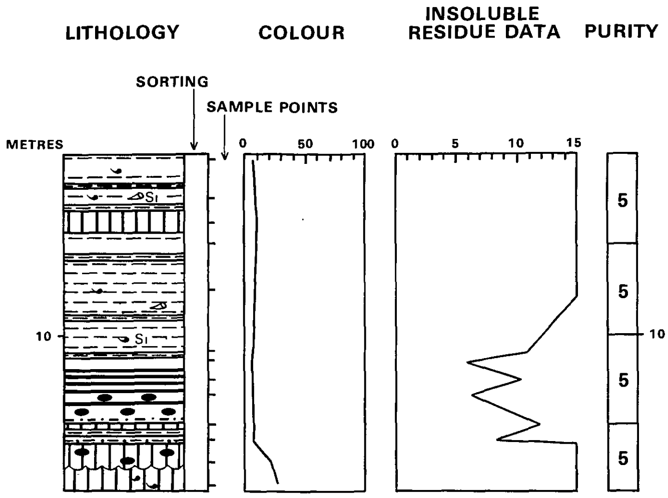
SK 16 1910 6937 Ashford Quarry

		Thickness (m)	Depth (m)
Limestone	Biomicrite, very muddy with shale partings at 0.20 and 1.20 m, some quartz and pyrite crystals	1.60	1.60
Shale	Shale	0.20	1.80
Limestone	Biomicrite, silicified and slightly dolomitised, pyrite crystals, muddy shale parting at 2.30 m	0.95	2.75
Shale	Shale	0.35	3.10
Dolomitic limestone	Dolomitic biomicrite; shale parting at 4.05 m, less dolomitic towards base	1.25	4.35
Limestone	Biomicrite, muddy with quartz crystals; shale parting at 4.70 m	1.15	5.50
Shale	Shale	0.30	5.80
Limestone	Biomicrite, very muddy; shale partings at 6.50, 6.90, 7.50 7.60, 7.90, 8.20, 8.50 and 8.75 m	3.10	8.90
Shale	Shale	0.25	9.15
Limestone	Biomicrite, some quartz crystals, muddy lenses; fossil debris is silicified; shale partings at 10.10, 10.30 and 10.50 m	1.85	11.00
Shale	Shale	0.20	11.20
Limestone	Biomicrite; bedded and nodular cherts are present between 12.00 and 14.00 m, fossil debris is silicified between chert bands; thin shale at 14.40 and shale partings around 14.80 m	3.70	14.90
Dolomitic limestone	Dolomitic biomicrite	0.40	15.30
Mudstone	Mudstone, very calcareous, flaggy	0.20	15.50
Limestone	Biomicrite, patchy mud developed, scattered quartz crystals	0.40	15.90
Mudstone	Mudstone, laminated, cross-bedded with thin cherts	0.10	16.00
Dolomitic limestone	Dolomitic biomicrite; chert nodules present	1.30	17.30
Clay wayboard		0.05	17.35
Dolomitic limestone	Dolomitic biomicrite, banded texture	1.25	18.60

Section seen to 18.60 m

No chemical data available

E
NE 1S



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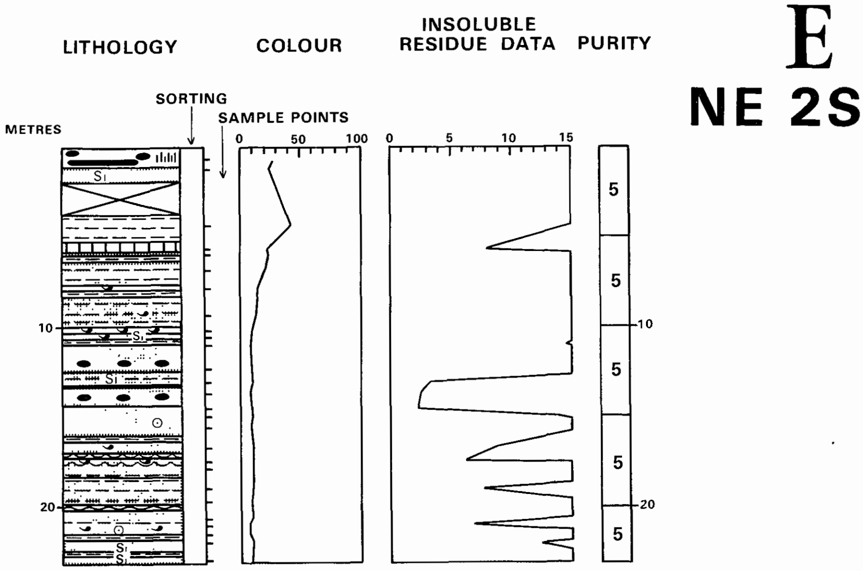
RESOURCE BLOCK E

SK 16 NE 2S 1939 6957 Ashford Road Cutting

		Thickness (m)	Depth (m)
Dolomitised Limestone	Biomicrite, silicified with bands of chert and chert nodules; quartz veins also present	1.10	1.10
Limestone	Biomicrite, highly silicified; also traces of dolomite	0.85	1.95
	Gap	1.80	3.75
	Biomicrite ('Ashford Marble') finely laminated	1.45	5.20
Dolomitised Limestone	Biomicrite, slightly silicified	0.60	5.80
Limestone	Biomicrite, scattered quartz crystals	0.30	6.10
Shale	Shale	0.20	6.30
Limestone	Biomicrite, scattered pyrite and quartz thin shale partings laminated to 7.70 m	1.70	8.00
Shale	Shale, very calcareous	0.20	8.00
Limestone	Biomicrite, laminated with shale partings. Scattered pyrite and quartz thin shale parting at 10.75 m. Chert nodules at 12.00 becoming very dark at 12.50 m. Chert band at 13.20 to 13.30 m	5.10	13.30
	Biomicrite. Many chert nodules. Band of nodules at 13.90 m, chert ceases at 14.40 m	2.85	16.15
Mudstone	Shaly mudstone	0.15	17.04
Limestone	Biomicrite, fossil debris silicified. Clay wayboard parting at 17.00 m	0.56	17.60
Wayboard	Clay wayboard	0.10	17.70
Limestone	Biomicrite, thin shale band at 18.27 m. Many shale partings. Scattered quartz crystals	2.20	19.90
Wayboard	Clay wayboard	0.20	20.10
Limestone	Crinoidal Biomicrite. Many quartz crystals. Shelly towards base	1.45	21.55
Mudstone	Flaggy mudstone	0.25	21.80
Limestone	Biomicrite, scattered quartz crystals	0.65	22.45
Mudstone	Shaly mudstone	0.15	22.60
Limestone	Biomicrite, scattered quartz crystals		

Section seen to 23.20 m

No chemical data available



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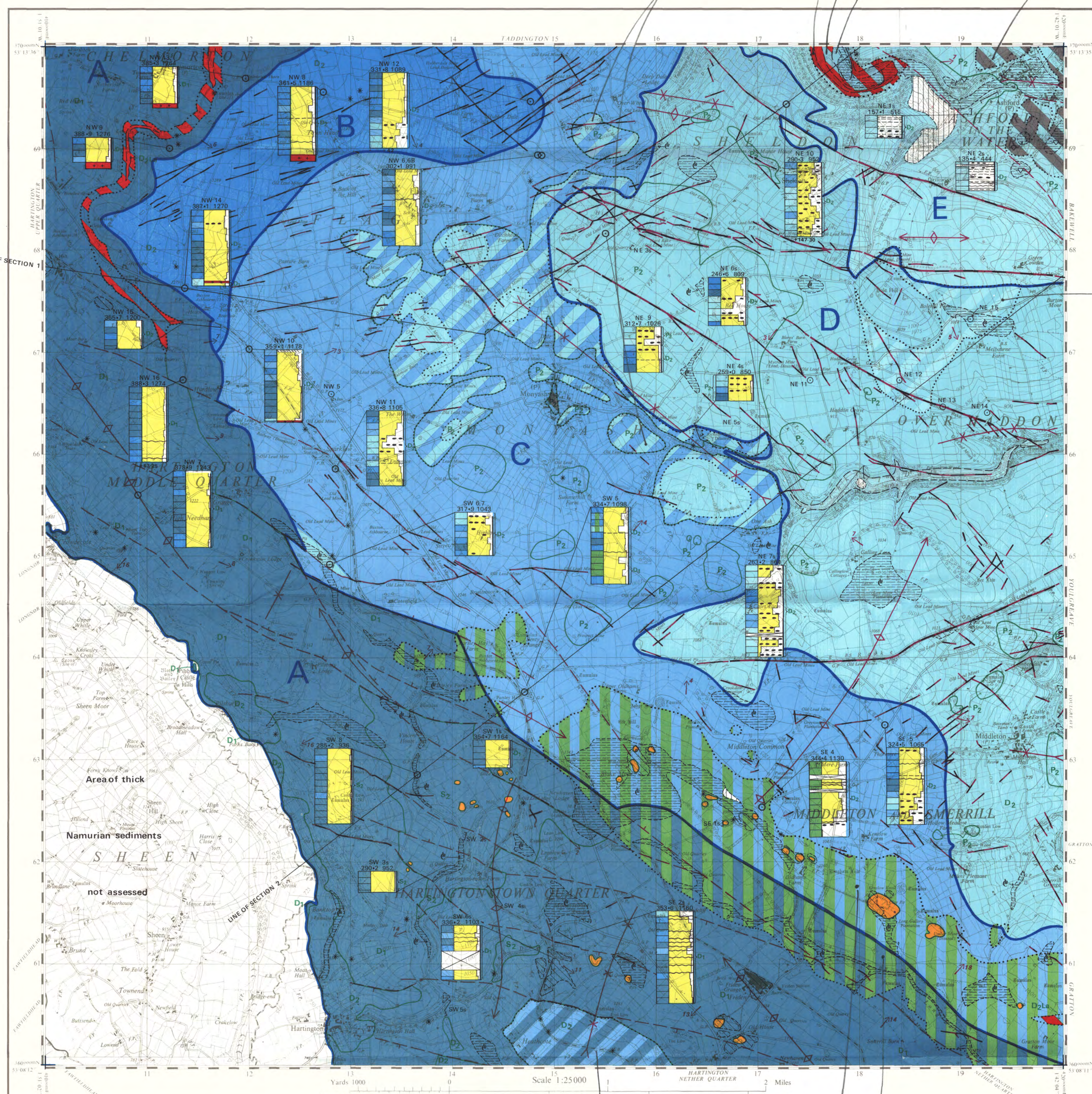
INSTITUTE OF GEOLOGICAL SCIENCES

MINERAL ASSESSMENT UNIT

THE LIMESTONE AND DOLOMITE RESOURCES OF SHEET SK 16 (MONYASH, DERBYSHIRE)



Limestone and Dolomite Survey by F.C.Cox and D.McC.Bridge 1972-73
J.H.Hull, officer-in-charge, sub-unit Northern England
R.G.Thurrell, Head, Mineral Assessment Unit

Geological Survey by J.I.Chisholm, N.Aitkenhead and D.Price 1968-72,
W.B.Evans, District Geologist
Published in 1976 as 1:25 000 sheet SK 16 (Monyash)

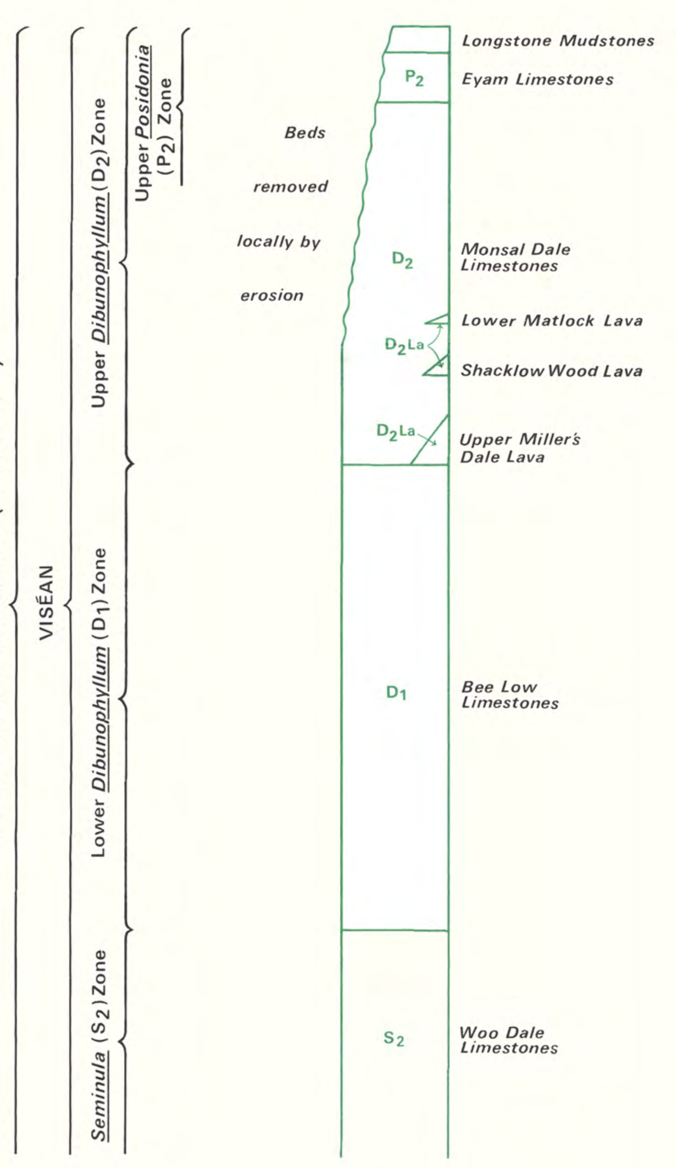
1:25 000 Limestone and Dolomite Resource sheet published 1977
Austin W. Woodland C.B.E., Director Institute of Geological Sciences

2050/77

Based on the Provisional Edition 1:25 000 Map, Sheet SK 16.
Compiled from 6" sheets last fully revised 1919-20.
Other partial systematic revision 1938-49 has been incorporated.
The Grid lines on this sheet are at 1 Kilometre interval.
Heights are in feet above Mean Sea Level at Newlyn.
1 square inch on this map represents 99.639 acres on the ground.
The representation on this map of a road, track, or footpath
is no evidence of the existence of a right of way.

GENERALIZED VERTICAL SECTION AND EXPLANATION OF STRATIGRAPHICAL SYMBOLS

Scale 1:2500



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

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Colours are used to indicate limestone purity which is averaged over 5 metre intervals for data points. Regional variation is shown averaged to a depth of 10 metres

CATEGORIES OF ROCK

LIMESTONES

	Composition (% CaCO3)
Very high purity	> 98·5
High purity	97·0-98·5
Medium purity	93·5-97·0
Low purity	85·0-93·5
Impure	< 85·0

Extensive zones of intermixing within uppermost 10 metres: colours indicate limestone categories involved

LIMESTONES LIKELY TO BE AFFECTED BY DOLOMITIZATION

DOLOMITE

AREAS OF LIMESTONE AFFECTED BY OTHER ROCKS (within uppermost 10 metres)
- Mudstone
- Basalt lava

DRIFT
- Alluvium
- Head
- Boulder Clay

NON-CARBONATE SEDIMENTS
- 'Pocket' deposits (sands and clays)
- Mudstone

IGNEOUS ROCKS (thickness > 10 metres)
- Basalt lava

MADE GROUND

LANDSLIP

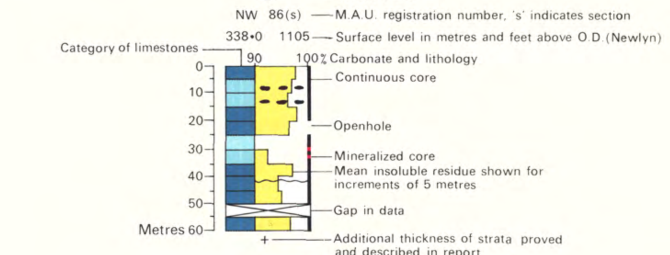
BOUNDARY LINES
- Boundary between categories
- Boundary of zone of intermixing
- Resource block boundary (blocks designated by letters A to E)
- Geological boundary, Drift
- Geological boundary, Solid

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 pipe-vein
- Mineral vein; where veins are also faults crossmark indicates downthrow side

BOREHOLE AND SECTION DATA

SITE LOCATIONS
- Mineral Assessment Unit (M.A.U.) Boreholes
- Other boreholes
- Collected section (bracket indicates limits)
- Additional collected section

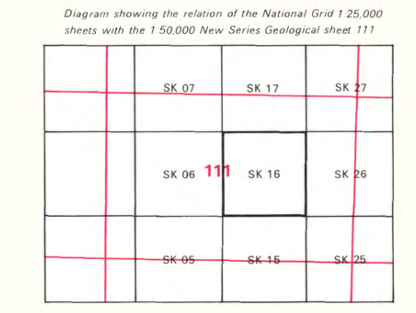
FORMAT



LITHOLOGICAL SYMBOLS
- Chert
- Clay wayboard
- Shale/mudstone
- Basalt lava

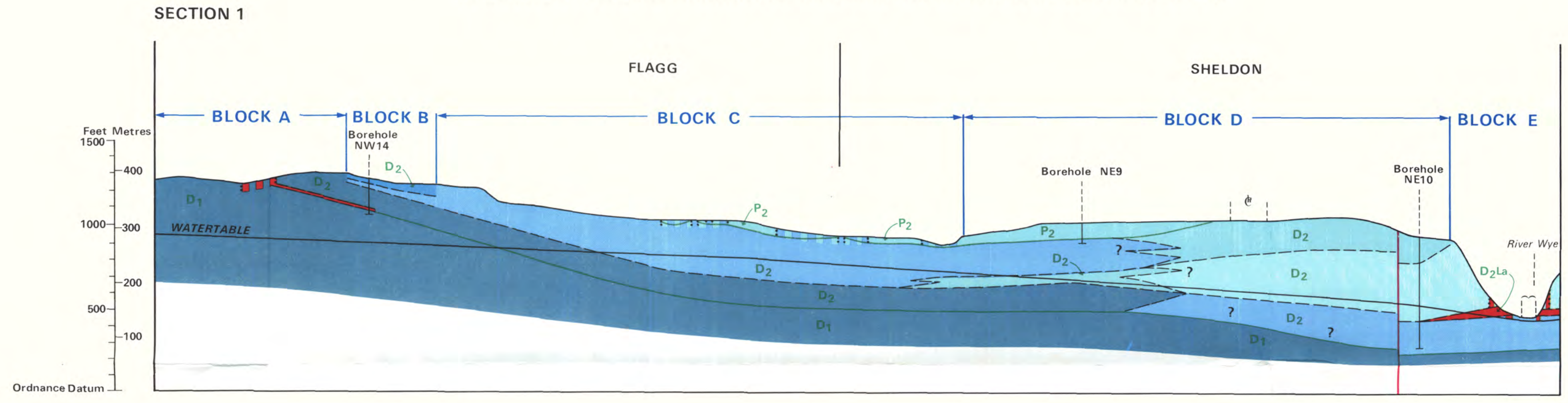
Detailed records may be consulted on application to the Head of the Mineral Assessment Unit, at the appropriate offices of the Institute of Geological Sciences.

Diagram showing the relation of the National Grid 1:25 000 sheets with the 1:50 000 New Series Geological sheet 111

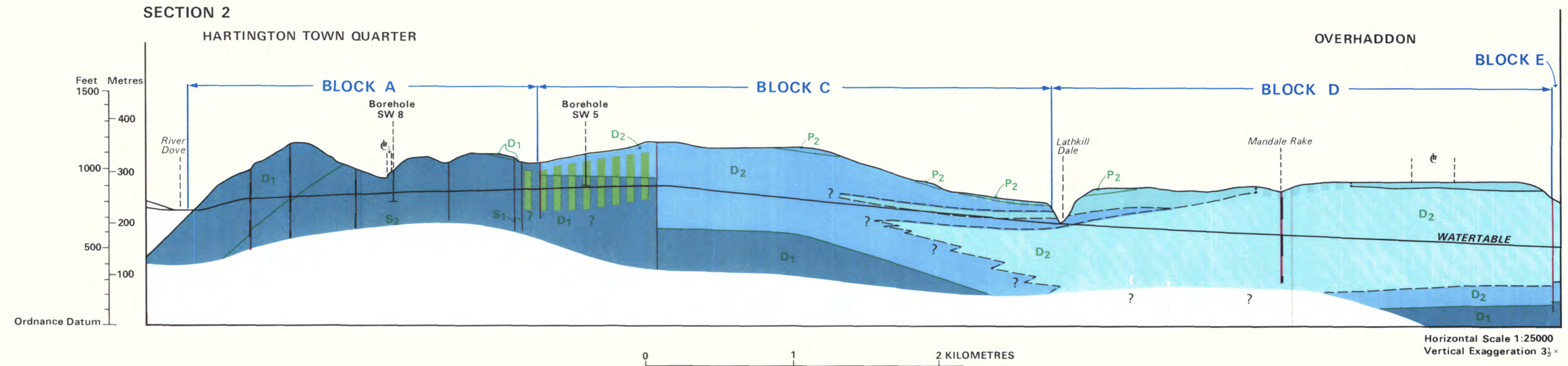


HORIZONTAL SECTIONS SHOWING GENERALIZED LIMESTONE CATEGORIES AT DEPTH

SECTION 1



SECTION 2



Horizontal Scale 1:25000
Vertical Exaggeration 3⅓ ×