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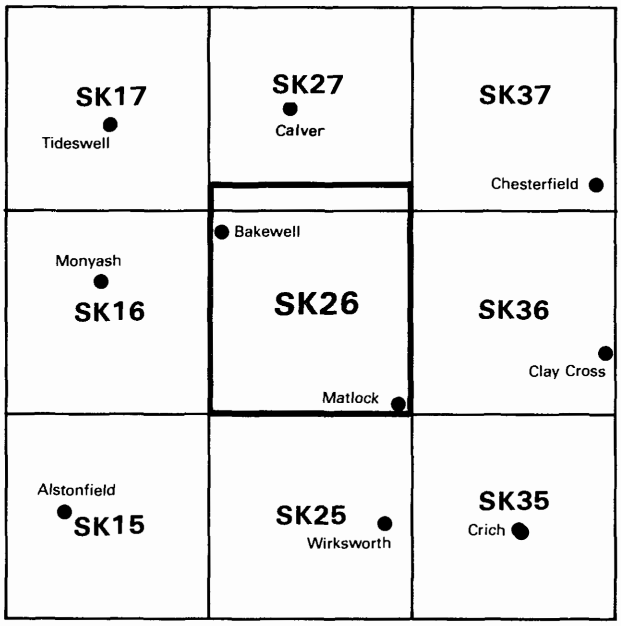

The limestone and dolomite resources of the country around Bakewell, Derbyshire

Description of 1:25 000 sheet SK 26 and part of SK 27

D. McC. Bridge and J. R. Gozzard

Contributor
J. I. Chisholm

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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 Industrial Minerals 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 27 km^2 of country around Bakewell, Derbyshire, shown on the accompanying 1:25 000 resource map. The survey was conducted by Mr J. R. Gozzard under the supervision of Dr F. C. Cox; Mr D. McC. Bridge has been mainly responsible for the preparation of the report. Messrs D. J. Harrison, J. T. Dove, H. Mathers, T. Waterhouse and Mrs A. J. Stewart were also involved with the collection of basic data.

The assessment was based on a geological survey at the 1:10 560 scale by Messrs J. I. Chisholm, I. P. Stevenson, E. G. Smith, D. Price and R. A. Eden; dates of surveys are given on the resource map which is folded into the pocket at the end of this report. Mr Chisholm also contributed the account of the geology of the district.

Chemical analyses were determined by Mr A. E. Davis and Mr A. N. Morigi of the Institute's Analytical Chemistry Unit. Mr K. S. Siddiqui provided X-ray diffraction analyses of the insoluble residues and petrographic slides were prepared by Mr M. Beasant.

Palaeontological determinations were made by Messrs I. C. Burgess, M. Mitchell and J. Pattison.

The G-EXEC data-base management system was used to provide statistical analyses and additional new programs were developed to aid the assessment; this work was carried out by Mrs S. Strachan and Mr J. Wheeler. Dr G. G. Baxter acted as systems analyst for the project.

Mr C. L. Reeves, ARICS, (Land Agent) was responsible for negotiating access to land for drilling. The ready cooperation of landowners, tenants, quarrying and mining companies in the work is gratefully acknowledged.

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24 March 1981

The first twelve reports on the assessment of British sand and gravel resources appeared in the Report series of the Institute of Geological Sciences as a subseries. Report 13 and subsequent reports appear as Mineral Assessment Reports of the Institute.

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

Any enquiries concerning this report may be addressed to Head, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Keyworth, Nottingham NG12 5GG

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SUMMARY

The study of samples from 11 cored boreholes, 19 major sections and 131 small exposures, together with information from the records and geological maps of the Institute, form the basis of the assessment of limestone and dolomite resources in the Bakewell area, Derbyshire. Five of the boreholes were drilled under contract for the Industrial Minerals Assessment Unit; the remainder were made available by industry.

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 constructed from the borehole data and from knowledge of the regional geology, indicate the categories likely to be encountered below this depth.

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

Bibliographic reference

BRIDGE, D. McC. and GOZZARD, J. R. 1981. The limestone and dolomite resources of the country around Bakewell, Derbyshire. Description of 1:25 000 sheet SK 26 and part of SK 27. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 79.

If it is desired to refer to the part of this report written by the contributor, the bibliographical reference shown above should appear in the list of references, and the citation in the text should take the form 'Chisholm *in* Gozzard and Bridge (1981, pp 4–11)'.

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INTRODUCTION

In recent years concern for environmental planning has made it clear that more detailed and comprehensive information on limestone resources is required. This information is needed to facilitate land-use and mineral planning by central and local government and to assist in the formulation of national policies to ensure continuing supplies to all industries for which limestone is an essential raw material. Ideally the information should relate to all the uses of this commodity ranging, for example, from crushing strength which relates to its use as aggregate, to trace-element composition, important in more specialised uses, for example, glass and steel manufacture. The provision of information on limestone resources is particularly important in regions such as Derbyshire and north Staffordshire which contribute significantly to the country's production of raw materials and are noted also for their high scenic and amenity value. In 1978 the two counties produced 17 million tonnes of limestone from the Lower Carboniferous outcrop, representing 20% of national production (Institute of Geological Sciences, 1979); the cement, steel and chemical industries accounted for 41% of this tonnage, the remainder being used for constructional purposes. This report describes the resources along the eastern margin of the limestone crop, between Bakewell and Matlock and is one of a series of reports covering the region.

The methods of assessment embody the most cost-effective procedures for assessing limestone resources on a regional scale (Cox and others, 1977). The material for study has been obtained from cored boreholes, natural sections and quarry faces. 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 purity and possible end-use may be deduced. Whilst detailed results are set out in the report and its appendices the accompanying map is more generalised. Regional variation in limestone purity is shown averaged to a depth of 10 m. In the horizontal sections, the purity of the limestone to greater depths is inferred from knowledge of the local geology, augmented by the results from the boreholes and sections. The more detailed assessment of limestone within 10 m of the surface reflects the relative abundance and widespread distribution of data for this interval compared with a paucity for the more deeply buried strata.

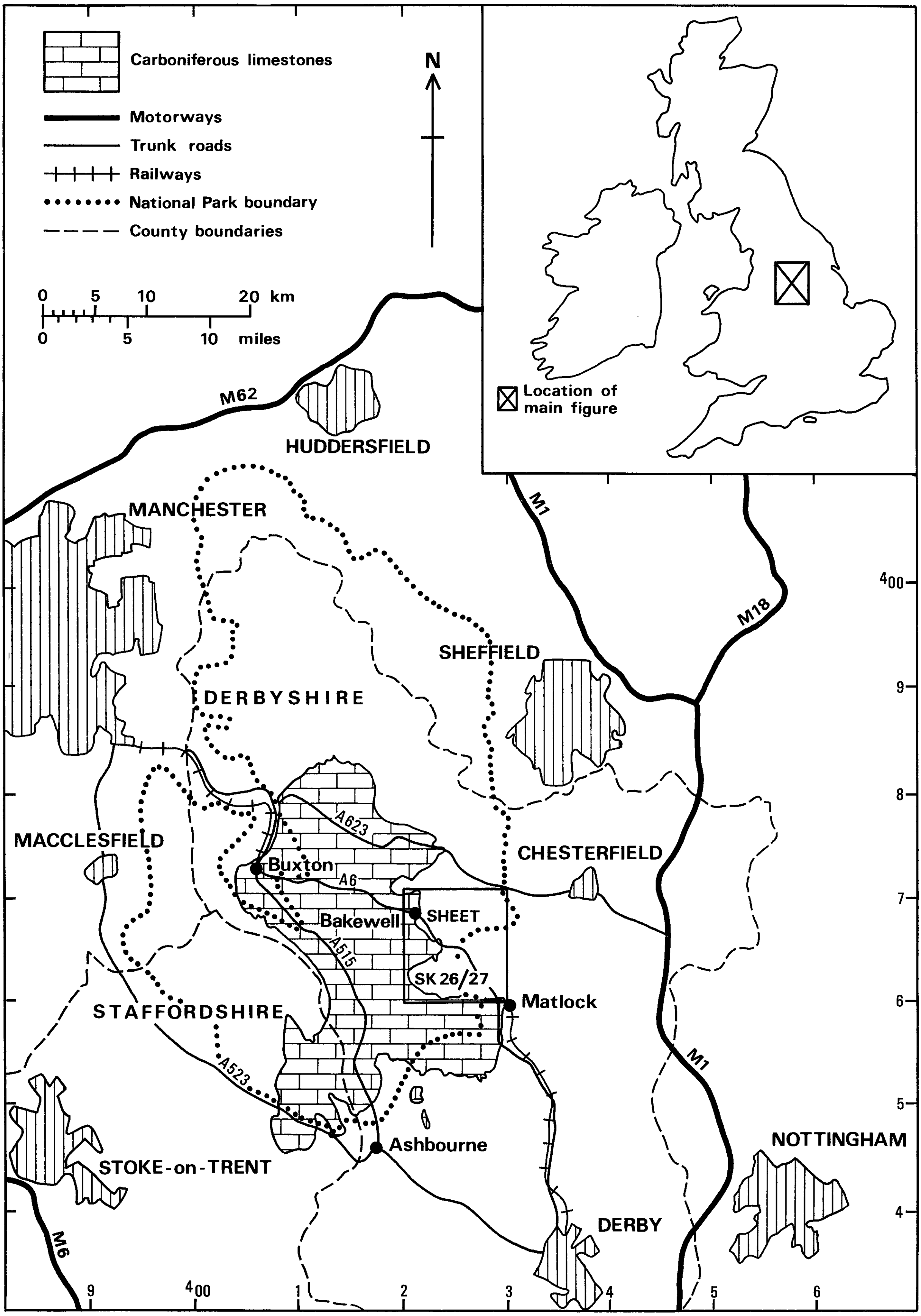


Figure 1 Sketch map showing the location of the resource sheet area.

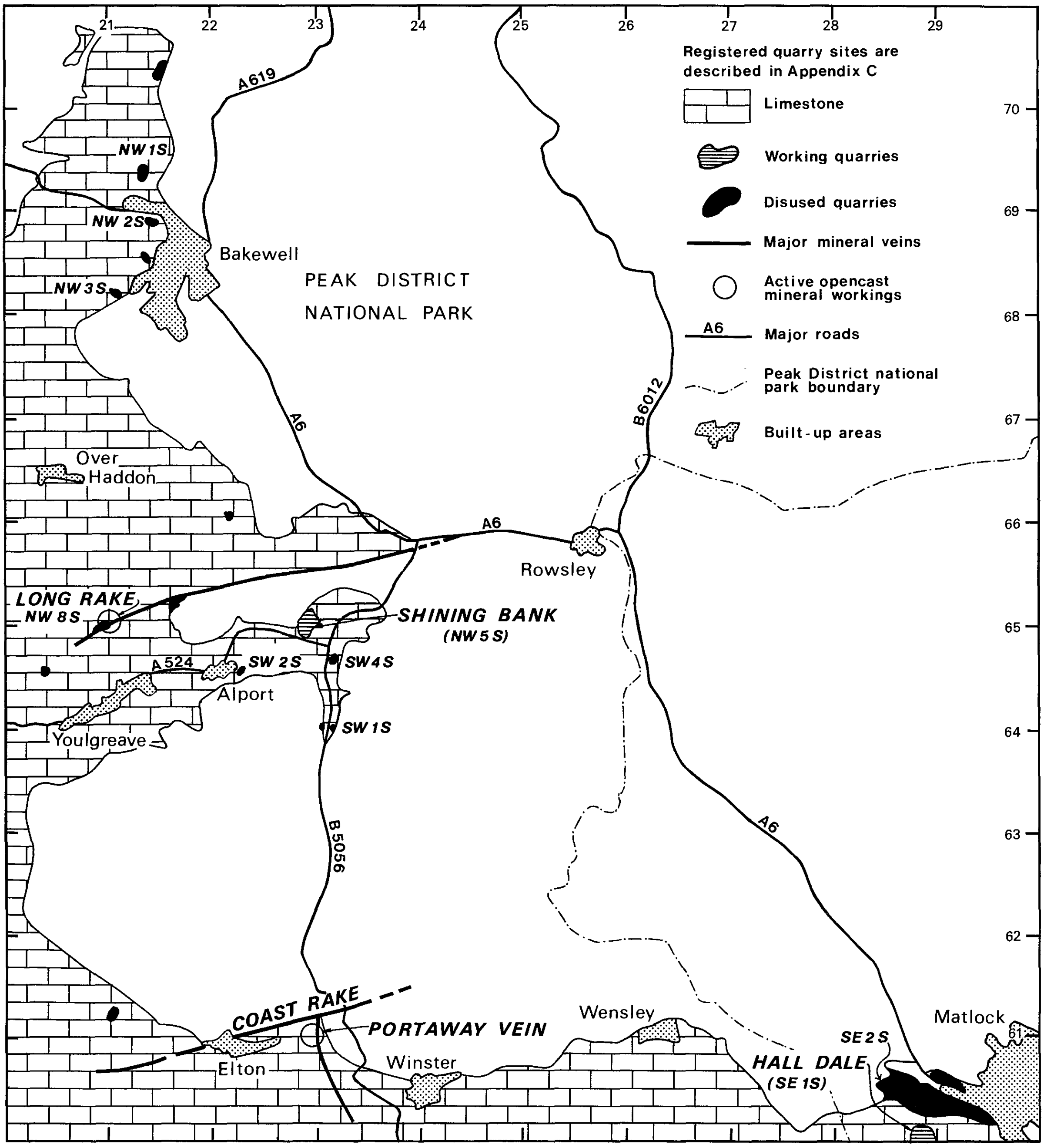


Figure 2 Distribution of quarries and opencast mineral workings in the district.

DESCRIPTION OF THE DISTRICT

Lying largely within the Peak District National Park (Figure 1), the district is predominantly rural and is served by the towns of Bakewell and Matlock. The local economy is largely based on the agricultural and mineral extractive industries with tourism playing a subordinate role. In the past, lead mining was a major industry but activity is now confined to relatively small opencast operations for fluorite, calcite and barytes in Long Rake [210 650] and Portaway Vein [230 610]. Limestone is exploited in two large quarries (Hall Dale and Shining Bank; Figure 2) and is of major importance in the building and road-making industries. Formerly a number of small quarries were worked for building stone and lime burning. The district is crossed by several main roads including the A6.

TOPOGRAPHY

The Carboniferous limestones give rise to undulating topography which rises to 282 m (925 ft) near Over Haddon [204 665] and 330 m (1083 ft) at Blake Low [221 603] near Elton. It is dissected by the steep-sided wooded valleys of Lathkill Dale and Bradford Dale (Figure 3). Between Elton [223 610] and Winster [240 605] the district is characterised by prominent dolomite tors in the form of isolated pinnacles and castellated escarpments. Here and in the neighbourhood of Alport [220 645] spoil heaps from earlier lead and fluorite workings have further contributed to the scenery. Quarrying has also modified the topography in the central and eastern part of the limestone crop.

Elsewhere in the district Namurian sandstones and shales form scarp- and dip-slope features. The scarps rise to 323 m (1060 ft) on Stanton Moor and 366 m (1200 ft) on Beeley Moor. The rivers Wye and Derwent, which have their confluence near Rowsley [260 655], flow through broad valleys.

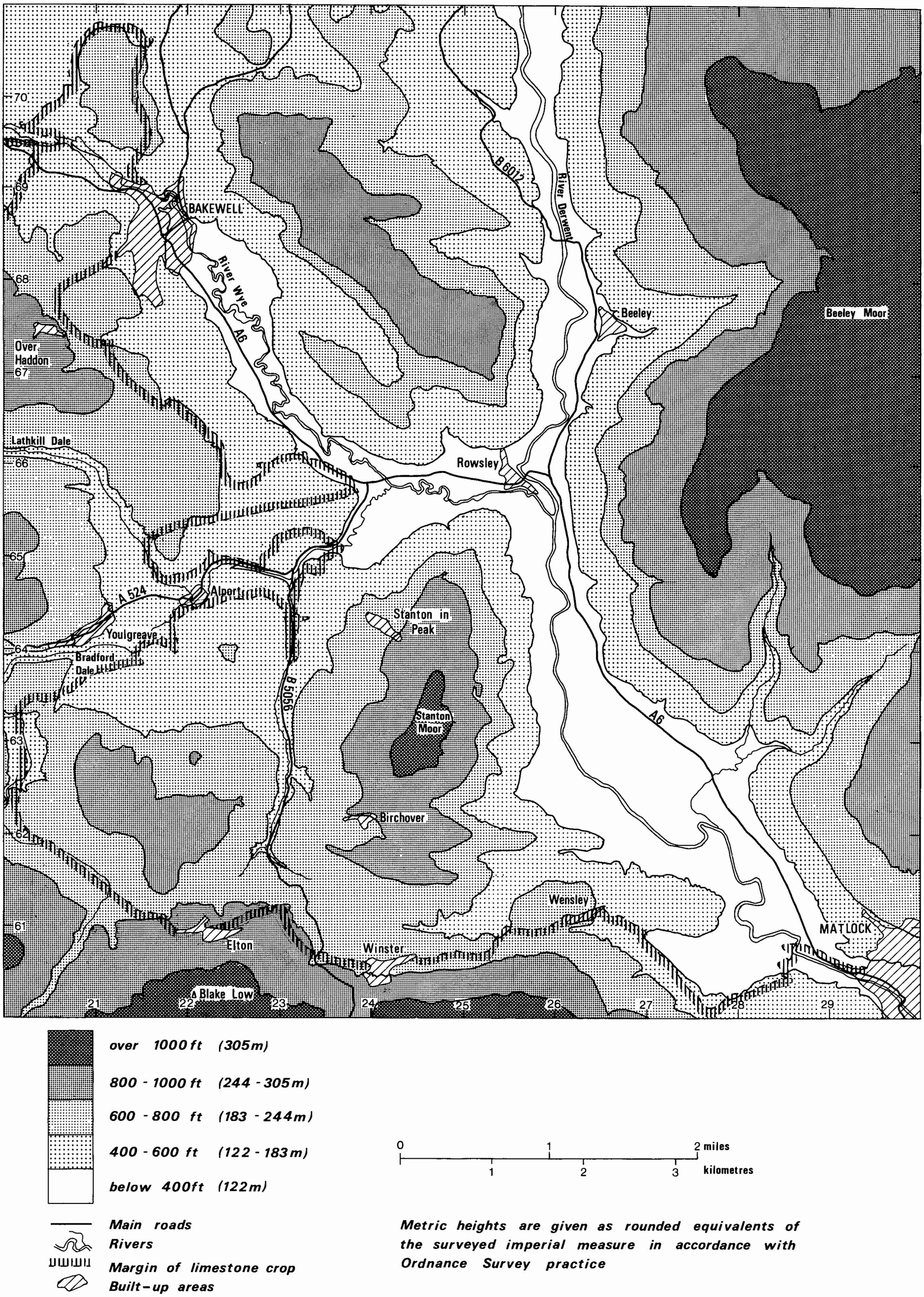


Figure 3 Topography.

GEOLOGY

This general account is based mainly on geological investigations which are to be detailed in the forthcoming Buxton memoir (Aitkenhead and others, *in preparation*). The district is underlain by sedimentary and volcanic rocks of Carboniferous age. Limestones with interbedded volcanics form the lower part of the sequence and are succeeded upwards by mudstones and sandstones. The limestones were deposited in a shallow sea over a slowly subsiding 'block' of much older rocks, the gradual accumulation of sediment being interrupted at intervals by the eruption of basaltic lava with associated falls of tuffaceous material. Marked variations occur in the type of limestone, and in the proportion of limestone to volcanic rocks, within the district. Towards the end of Lower Carboniferous (Dinantian) times the deposition of limestones and volcanic rocks ceased and was succeeded by that of mudstones and sandstones, the outcrop of which now lies north and east of that of the limestones. For the most part these terrigenous sediments belong to the Upper Carboniferous (Namurian) Series, but the basal few metres are of Dinantian age and are termed the Longstone Mudstones.

Spreads of superficial deposits, dating from the Pleistocene ice age and later, cover parts of the district. On the limestone outcrops the main deposits are head, a reddish brown silt with chert fragments that attains a thickness of a few metres in hollows, and boulder clay. Along the major river valleys post-Glacial spreads of alluvium are commonly developed.

Dinantian rocks

The stratigraphy of the Dinantian rocks of the district has been described by Traill (1940), Shirley (1950; 1959), Smith, Rhys and Eden (1967), and Butcher and Ford (1973). Additions and revisions to the sequences given by these authors have become necessary in the light of new information from borehole and surface surveys. A summary of the stratigraphical relationships as they are at present understood is given in the form of a generalised vertical section (see resource map folded into the pocket at the end of this report).

The Dinantian rocks are divided into five formations (Table 1), mainly on the basis of lithology but also on the evidence of contained fossils. The formational names apply throughout the shelf province of the region and are based on the Wye valley section (Cope, 1933; Stevenson and Gaunt, 1971). In the south-eastern part of the district the formations are also known by local names (Table 1, column 5) and these have been used in Institute maps and memoirs (for example, Smith and others, 1967, p. 8). A generalised geological map of the Dinantian outcrop is incorporated in the resource map.

Woo Dale Limestones This formation does not crop out in the district and is not proved with certainty in boreholes. However, in adjacent areas, it consists of pale, chert-free calcarenites with bands of calcisiltite and calcilutite at the top, and it is assumed that these lithologies exist at depth beneath the district.

Bee Low Limestones Apart from a single small outcrop in Gratton Dale [202 600] which is dolomitised, these limestones are known only from boreholes and mine workings.

Boreholes in the Gratton Dale area have proved 132 m of chert-free calcarenite beneath the Monsal Dale Limestones. The beds have not yielded any diagnostic fossils but they are assigned to the Bee Low Limestones on lithological grounds. The top of the sequence is marked by a calcarenite, rich in dasycladacean algal fragments, below which is a monotonous sequence of mid-grey and buff coloured thickly bedded calcarenites. Greenish grey and ochreous mudstone bands and clay wayboards occur at intervals throughout the succession and range in thickness from a few millimetres to over 0.5 m.

The upper part of the formation is also seen in Millclose Mine where limestones similar to those proved in the Gratton Dale boreholes have yielded Asbian faunas. One basaltic lava, the 144 Pumpstation Toadstone, has been proved in the upper part of this succession but is not seen to the south and west. Evidence from surrounding areas suggests that the proportion of volcanic rocks increases towards the east (Ramsbottom and others, 1962, pp. 138–140).

Monsal Dale Limestones This formation consists of interbedded limestones, lavas and tuffs, and ranges in thickness from 150 to 190 m (Figure 4). Beds high in the sequence crop out over the northern and central parts of the district and are worked currently in Shining Bank Quarry; lower stratigraphical levels are exposed only on the southern limb of the Stanton Syncline.

The limestones are laterally variable but are mainly pale and medium grey coloured calcarenites with some calcirudites and calcilutites. A darker lithofacies forms the major part of the exposed sequence in the north-west of the district and is sufficiently well defined to be mapped as a separate unit. In the south, dolomitisation has destroyed much of the textural detail in the limestones close to the surface. However, there is evidence from borehole and mine workings for a thin, persistent dark grey limestone immediately above the Lower Matlock Lava and for a wedge of dark coloured limestone at the horizon of the Upper Matlock Lava where the latter is absent. Chert is common throughout the sequence, particularly in the darker lithofacies.

Table 1 Classification of Dinantian rocks

Stages	Coral-brachiopod zones	Goniatite-bivalve zones	Standard formational names	Local names (Matlock area)
			Longstone Mudstones	Cawdor Group
Brigantian	D_2	P_2 ?	Eyam Limestones	
			Monsal Dale Limestones	Matlock Group
Asbian	D_1		Bee Low Limestones	Hoptonwood Group
early Asbian or Holkerian	S_2–D_1		Woo Dale Limestones	Griffe Grange Bed

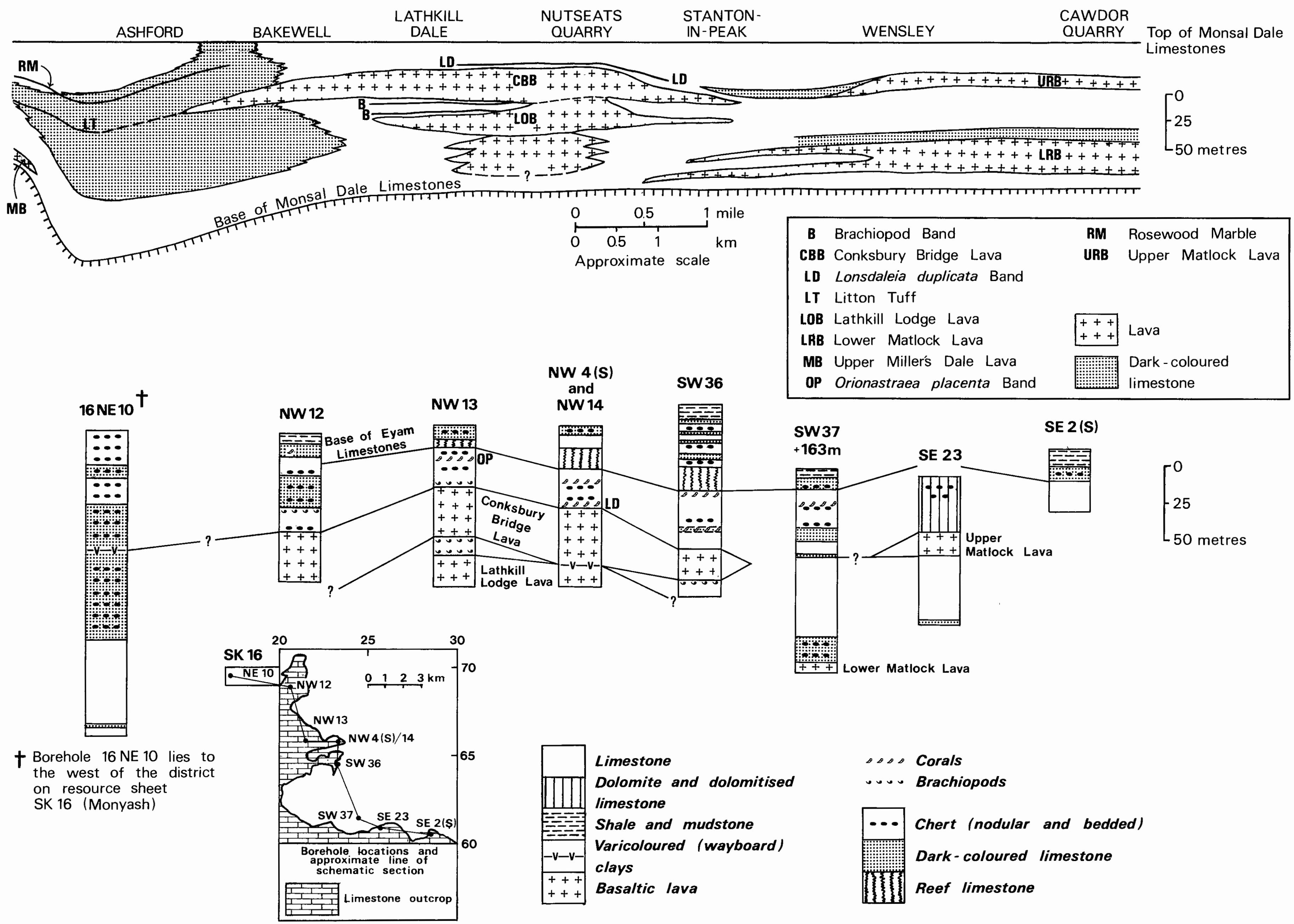


Figure 4 Schematic section of the Monsal Dale Limestones based on borehole and section data.

Volcanic products may exceed 50% of the total thickness of the sequence, particularly near the centres of eruption, the most important of which appears to extend from Alport [220 645] eastwards towards Ashover beyond the sheet margin. Beds of lava and tuff related to this centre underlie the central and northern parts of the crop and are also recorded in Millclose Mine workings, where they interdigitate with the limestones before dying out southwards (Traill, 1940, pp. 198–203, 205–207). The lavas also thin northwards and westwards, and there is an excellent example of this at an outcrop [204 664] near Over Haddon. A second volcanic centre lies south of the district in the Matlock–Bonsall area, and its principal flows (the Upper and Lower Matlock lavas) extend northwards into the district. Both flows die out northwards in the Millclose Mine workings (Traill, 1940, pp. 194–198, 203–207).

Eyam Limestones These rocks are preserved around the margin of the Dinantian crop where they form a thin but distinctive veneer which rests disconformably on the Monsal Dale Limestones. They are mainly dark to medium grey, thinly bedded, cherty limestones with local developments of paler, unbedded or poorly bedded, knoll-reef limestone.

The knolls are found mainly in the lower parts of the sequence and occur scattered across the district, with the exception of the south-west. The largest knoll is known from the Millclose Mine workings and is 60 m thick and about 1 km across, but most are much smaller. The reef lithologies consist partly of pale, fine-grained limestone and partly of coarse-grained limestone, rich in crinoids and bryozoan debris.

The darker coloured limestones that surround the knolls and overlie all but the largest are generally between

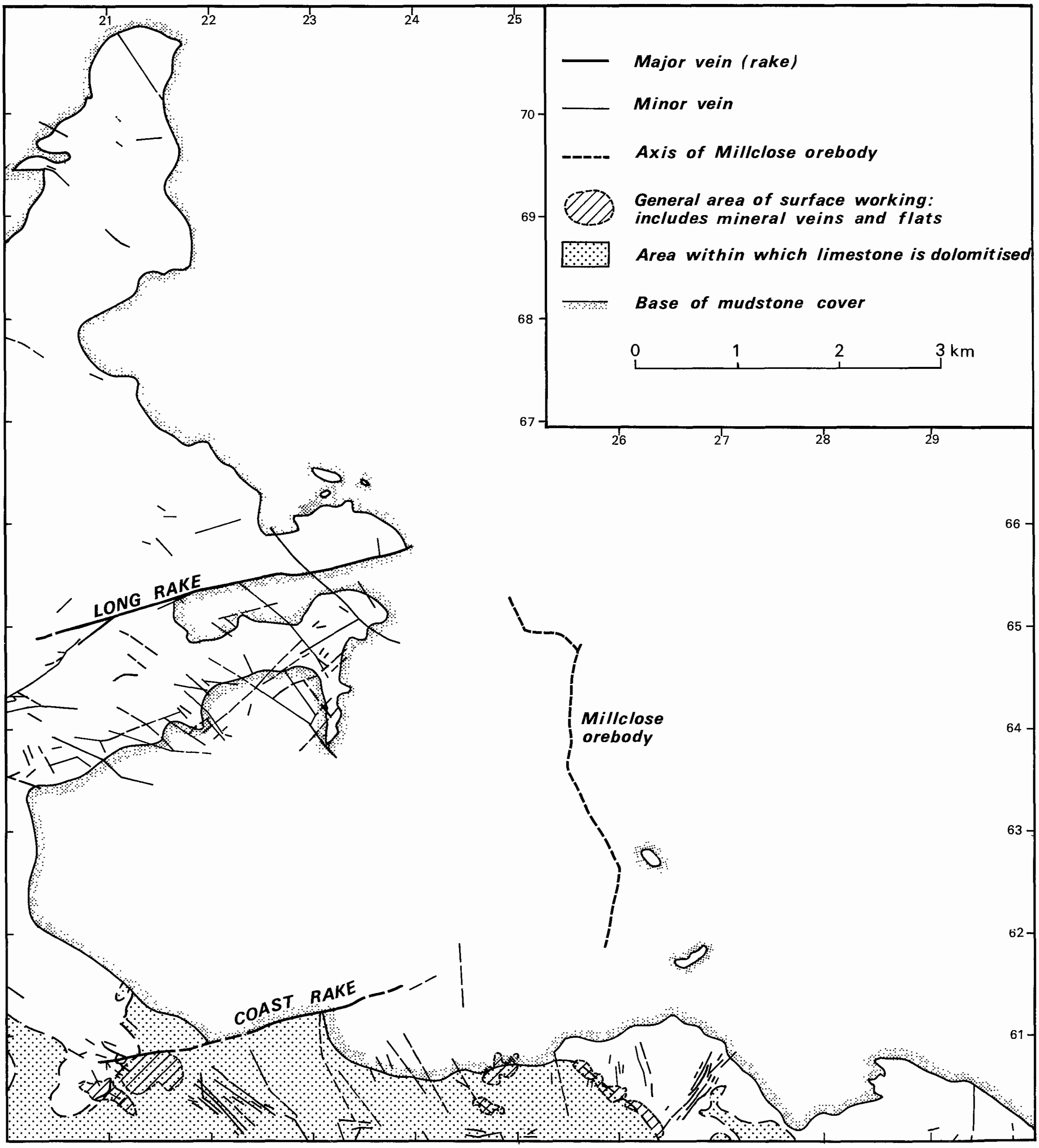


Figure 5 Dolomitisation and lead-zinc mineralisation within Dinantian rocks.

10 and 20 m thick, but they exceed 40 m in thickness locally, as for example near Alport [220 645] and Snitterton [278 603]. Nodular and tabular cherts occur throughout the darker coloured lithofacies and are often associated with silicified shell debris.

Longstone Mudstones The Eyam Limestones are overlain by a thick sequence of fossiliferous mudstones. The basal 10 to 20 m contain a Dinantian fauna and are distinguished by the name Longstone Mudstones. The remainder, up to 150 m thick, contain Namurian faunas.

Dolomitisation

The limestones at outcrop have been altered to dolomite along the southern margin of the district (Figure 5). Parsons (1922) provided the first comprehensive account of the extent and nature of the dolomitisation; more recently papers by Ford (1969) and Ford and King (1965; 1967) have described aspects of the dolomitisation relating to mineralisation and the development of silica sand pockets. The intensity of the dolomitisation varies locally and partially dolomitised limestones have generally been included with more completely altered rock for mapping purposes. In detail, the margins of the alteration are irregular, and may be sharp or gradational. They commonly cut across bedding planes, showing that the dolomitisation took place after the lithification of the limestone. The alteration is a surface effect, as unaltered limestone has been proved to lie beneath the dolomite in several places. Recorded thicknesses of dolomite range up to 90 m.

Mineralisation

The carbonate rocks in the district have been mineralised by fluids migrating from an inferred source at depth to the east. Most of the deposits are in near-vertical veins occupying joints or fault fissures, but there are also various less well-defined forms, including flats, pipes and irregular replacements, which are approximately horizontal or lie parallel to bedding.

The orebodies are composed mainly of calcite, barytes and fluorite with subordinate quantities of lead-zinc minerals, particularly galena and sphalerite. The largest veins, known as Long Rake and Coast Rake, trend east-north-eastwards across the district. Minor mineral veins are relatively abundant in the areas south of each rake, where they can be grouped into a dominant set trending approximately north-westwards and a subordinate set trending approximately north-eastwards (Figure 5). Stratiform deposits mapped at the surface are virtually restricted to the dolomite crop and probably consist mainly of flats, with some veins.

The most important single orebody in the district was that formerly exploited at Millclose Mine (Traill, 1939). It consisted of a complex of veins with linked flats, pipes and cavern deposits, arranged in a series of layers beneath impervious beds (lavas, clay wayboards and the mudstone cover) through the top 180 m of the limestone sequence. The overall shape of the orebody was linear along an approximately north–south axis.

Structure

The Carboniferous rocks have been deformed by earth movements, mainly during late Carboniferous and early Permian times, but also probably during the Tertiary; the folds and faults that resulted are shown in Figure 6. The dominant structure is the regional north-eastward dip away from the Derbyshire 'Dome', which takes the limestones beneath the mudstone cover in the east of the district. Superimposed on the regional dip are small periclinal and basinal structures with various axial trends. The largest of these is the Stanton Syncline, an asymmetrical downfold, aligned approximately west–east, which has a relatively steep southern limb with dips exceeding 30° locally. The only other well-defined structures are the Magshaw and Bakewell anticlines.

The main faults are the pair of east-north-eastward-trending rakes, which have throws of up to 20 m; a number of other fractures showing no preferred orientation and, with no significant associated mineralisation, occur in the north of the district.

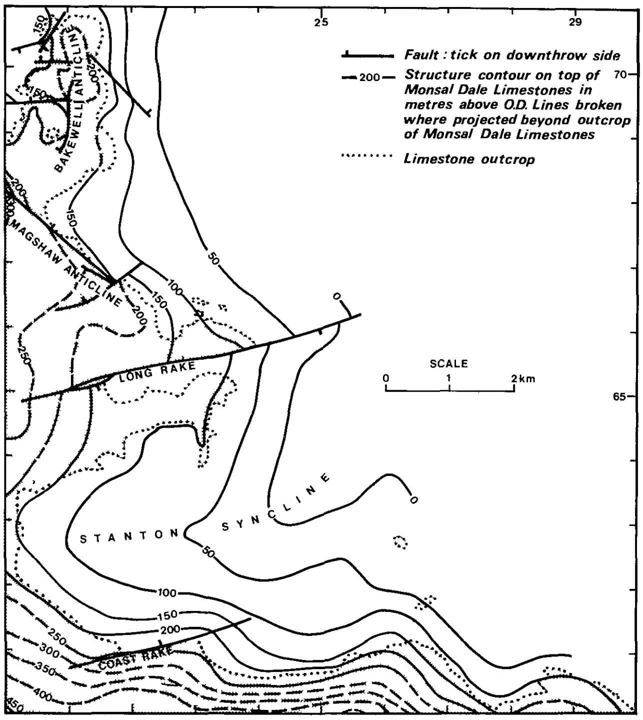


Figure 6 Structure.

ASSESSMENT OF RESOURCES

PROCEDURES

The various techniques and procedures adopted for the assessment survey evolved from a feasibility study which was carried out in an adjacent district (Cox and others, 1977).

Field programme The sampling programme was planned on the basis of modern 1:10 560-scale geological maps. Four boreholes were drilled to a depth of 100 m using a wireline system for core recovery and water-flush circulation; a fifth was drilled using airflush and terminated at 34 m depth. Continuous cores with a minimum diameter of 47 mm were obtained. In general, core recovery exceeded 90% but some difficulties were encountered with cherty limestone, dolomite and clay bands. Cores from six commercial boreholes were also made available. All major quarries and natural sections in the area were sampled at one-metre intervals and supplementary spot-samples were collected from smaller exposures.

Laboratory programme All the cores and face-sampled material were sawn, acid-etched and then logged with the aid of a binocular microscope. The purity of limestone

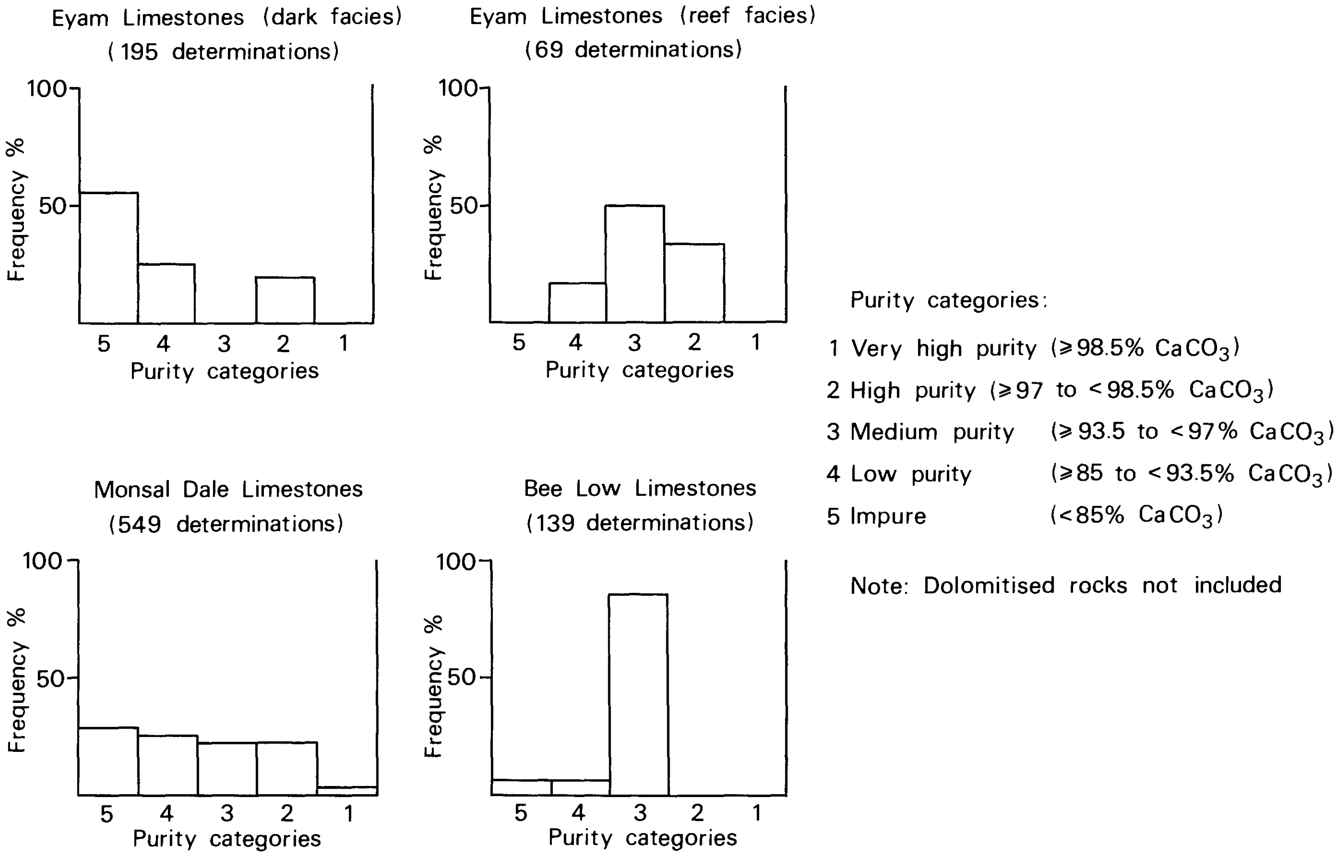


Figure 7 Summary of the purity of each formation determined from insoluble residue data. Dolomitised rocks are not included.

The purity categories are:

1 Very high purity (≥98.5% $CaCO_3$)
2 High purity (≥97.0 to <98.5% $CaCO_3$)
3 Medium purity (≥93.5 to <97.0% $CaCO_3$)
4 Low purity (≥85.0 to <93.5% $CaCO_3$)
5 Impure (<85.0%)

Table 2 Classification of limestones by purity

Category	$CaCO_3$ percentage	Equivalent CaO	Possible uses
1 Very high purity	≥98.5	≥55.2	Steel, glass, rubber, plastics, paint, whiting
2 High purity	≥97 to <98.5	≥54.3 to <55.2	Iron, ceramics, Portland cement, sugar
3 Medium purity	≥93.5 to <97	≥52.4 to <54.3	Paper, animal feeding stuffs, agriculture
4 Low purity	≥85 to <93.5	≥47.6 to <52.4	Aggregates
5 Impure	<85	<47.6	Natural cement, mineral wool

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

was determined by measuring the quantity of acid-insoluble residue. Determinations were carried out at one-metre intervals using a rapid but accurate filtration method (Molinia, 1974) and the chief constituents in the residues were identified by semiquantitative X-ray diffractometry. Chemical analyses for major and trace elements were performed on selected samples by the Analytical Chemistry Unit of the Institute using methods previously described (Roberts and Davis, 1977). Tests were also performed to monitor colour variation and the mechanical properties of the rock.

CLASSIFICATION

Limestones may be classified in a variety of ways (Ham, 1962), but the two methods chosen for use in this report are based on petrology (see Appendix A) and on $CaCO_3$ content. The former is used to describe the rocks in lithological terms, but the latter is preferred for demonstrating the variation in chemical grade of the resource. The relationship between the five chemical grades adopted, their $CaCO_3$ contents and possible end-uses is shown in Table 2.

PURITY

The grades of mineral present throughout the district were determined by grouping the insoluble residue results at each sample site into sets covering successive 10-m intervals and then calculating an average purity for each interval (see section on 'Carbonate resource information' for details of calculation). This value then determined the category of the limestone according to the classification in Table 2.

Figure 7 shows the frequency with which these different categories occur within each of the mapped divisions and is based on 952 residue determinations.

The Bee Low Limestones Information on the purity of these rocks is derived from two boreholes (SW 18 and 19) in the south-west of the district. Those parts of the sequence that are undolomitised are of medium purity and have a fairly uniform composition but minor developments of chert are recorded towards the top of the sequence which downgrade the quality of the mineral locally. Anomalously high residue values ($>20\%$) recorded at a number of horizons may be attributed to the inadvertent sampling of wayboard material.

The Monsal Dale Limestones Although the formation is more varied in its carbonate content than the Bee Low Limestones, the limestone categories are usually stratigraphically controlled and their occurrence is therefore predictable on a regional scale (Figure 8), both at the surface and at depth.

North of the Stanton Syncline, the chief resources are the limestones overlying the Conksbury Bridge Lava. These are predominantly of low or impure grade although some improvement in purity is observed in paler coloured lithologies which are more common over the central parts of the district. Here the absence of chert and argillaceous impurities from parts of the sequence gives rise to localised bands (<10 m thick) of medium or high purity mineral. A thin development of high purity mineral also separates the Conksbury Bridge Lava from the underlying Lathkill Lodge Lava.

On the southern flank of the Stanton Syncline, the Monsal Dale Limestones are extensively dolomitised and data on limestones are more restricted. Nevertheless, the variation in purity has been established from boreholes drilled through and around the zone of alteration. The sequence is split into three by the Upper and Lower Matlock lavas. Above the upper lava (or the dark limestone which is its lateral equivalent), the limestones average about 40 m in thickness and fall mainly within the low purity bracket. The sequence between the upper and lower lava beds is some 55 to 60 m thick and comprises a basal unit of dark, cherty and chemically impure limestone, overlain by pale-coloured high purity limestones. The basal unit, which is 10 to 20 m thick in the west, thickens eastwards gradually at the expense of the purer limestones until at Wensley the whole sequence consists of impure limestone. The beds below the Lower Matlock Lava are chiefly of medium purity but a band of impure limestone is known in the Gratton Dale area. Impurity levels are broadly maintained through the zone affected by dolomitisation.

Eyam Limestones The reef facies results are based on a small sample population drawn from only six sites, two of which produced residues containing anomalously high concentrations of fluorite (NE 15) and pyrite (NW 14). The results are therefore rather inconclusive. However, overall the knolls appear to consist of mineral ranging between medium and high purity. The dark facies limestones surrounding and covering the knolls are generally impure.

ROCK CHEMISTRY

Chemical analyses of selected borehole and surface material are given in full in Appendix C and the results are summarised in Table 3. In the case of section material selected for analysis, only chert-free samples were processed and consequently the mean silica values quoted for the Eyam Limestones (dark facies) and the Monsal Dale Limestones are slightly too low. This results in some discrepancies between the $CaCO_3$ contents calculated from analysis and purity categories defined on the basis of insoluble residue determinations which make allowance for the presence of chert.

In the *Bee Low Limestones* and *Eyam Limestones* (reef facies), the mean carbonate contents calculated from CaO values are 95.2% and 96.0% respectively, which are in good agreement with the overall purity levels predicted by the insoluble residue results. Accessory elements are combined in trace amounts to form clay minerals and iron ores; in addition there are variable amounts of free silica.

The chemistry of the *Monsal Dale Limestones* and of the dark facies of the *Eyam Limestones* is more varied and reflects the influx of cherty and argillaceous lithologies. The clay-forming oxides are present in higher concentrations, silica varies according to the amount of chert in the rock, and iron and sulphur, where present, are combined in pyrite. The various elemental associations are demonstrated in a correlation matrix prepared for the Monsal Dale Limestones dataset (Table 4). The degree of correlation between variables is shown on a scale ranging from 0.20 (implying low levels of correlation) to >0.90 (indicating very high correlation); constituents with a negative correlation are enclosed in brackets. The matrix confirms the close interdependence of the clay-mineral-forming constituents (soda, potash and alumina) and also shows their common association with iron sulphides (represented as Fe_2O_3 and SO_3). Moreover, the correlation between alumina and magnesia supports the presence of the latter in, and its preference for, the clay minerals. The positive correlation between P_2O_5 and F may indicate the presence of fluor-apatite ($Ca_5(PO_4)_3F$) as an accessory mineral. Broadly similar elemental associations were identified in the chemistry of the Bee Low and the Eyam limestones.

The extent to which the major-element chemistry can be predicted from a knowledge of the stratigraphy has been investigated using 'R'-mode cluster analysis. This technique gives a measure of the mutual correlation between samples which can be shown graphically by means of a dendrogram (Figure 9). Chemically similar samples are linked on the dendrogram by horizontal tie-lines located close to the x-axis, while chemical divergence between samples or groups of samples is indicated by linkages in the upper part of the diagram where similarity values approach zero. Bar graphs beneath the dendrogram show the constitution of each of the six clusters identified and the accompanying table illustrates the salient chemical differences between them. The largest grouping, and the most important economically, is Cluster E, which represents the purest rocks in the district (mean normative $CaCO_3 = 96.25\%$) and is characterised by comparatively low levels of silica and clay. Three lithostratigraphic units are well represented in the group; they are the Bee Low Limestones, the reef facies within the Eyam Limestones and the limestone sequence between the Upper and Lower Matlock lavas (designated Mo< URB on Figure 9). Samples from the first two units are restricted mainly to Subset E′ and these appear to be more uniform in composition than those from the Monsal Dale sequence. The presence of Eyam Limestones (dark facies) material in the group is anomalous and stems from selective sampling of chert-free surface material, a problem alluded to earlier.

Clusters A to C comprise low purity and impure limestones suitable only for aggregate. Cluster C contains the more siliceous lithologies and is consequently dominated by samples from the dark facies of the Eyam

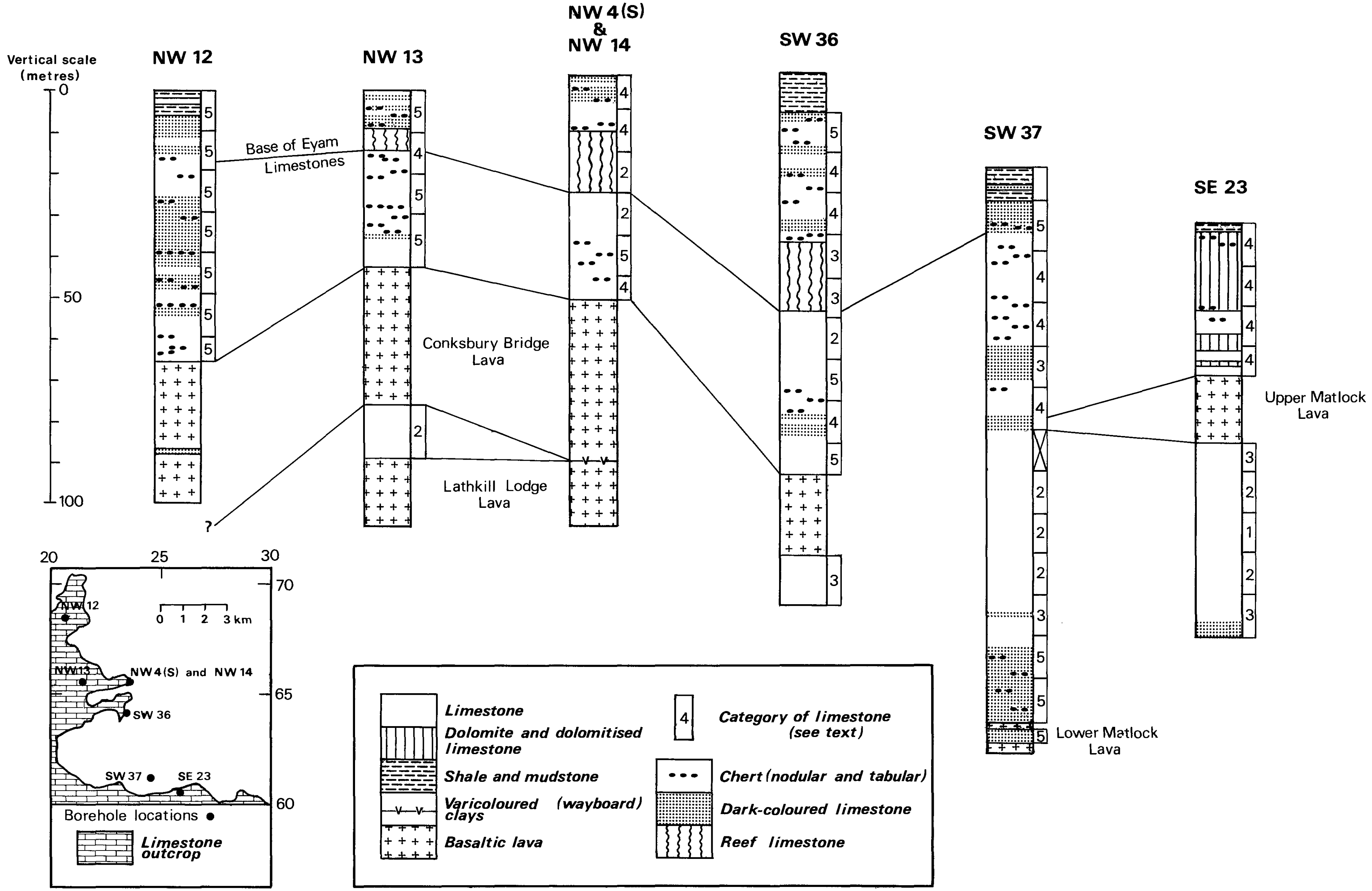


Figure 8 Purity variations within the Monsal Dale and Eyam limestones.

Table 3 Summary of the chemistry of the main lithostratigraphical divisions

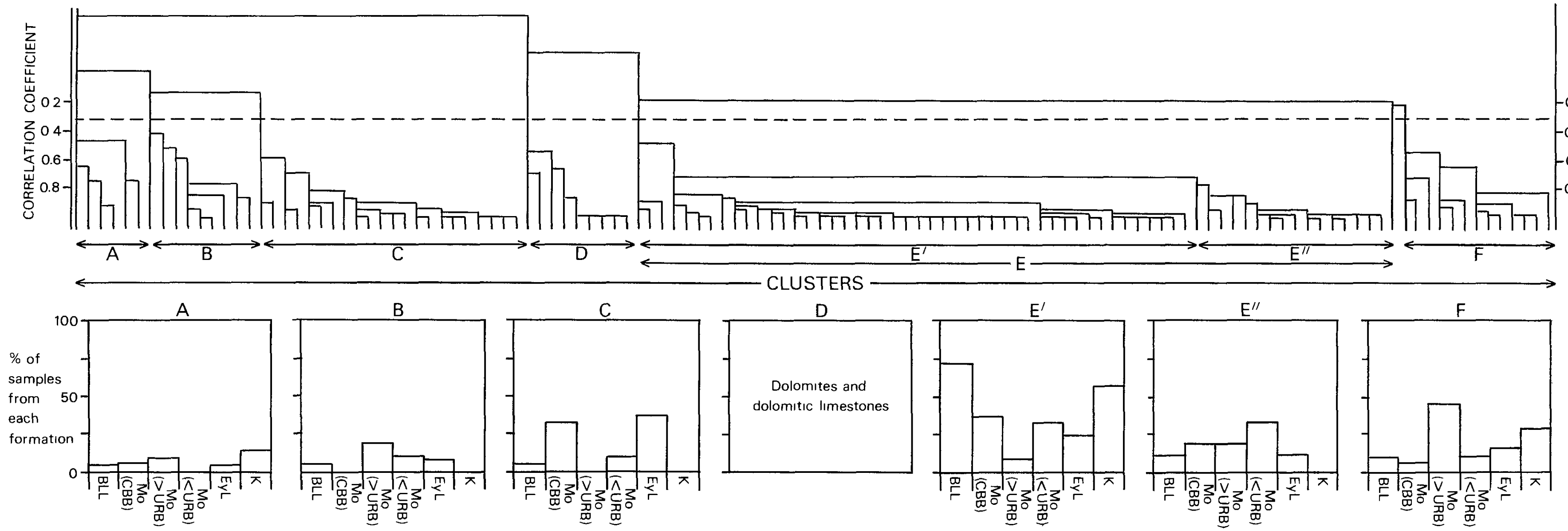
Lithostratigraphical divisions (with number of analyses)		*percentages*										*parts per million*						
		CaO	MgO	Loss on ignition	SiO_2	Al_2O_3	Na_2O	K_2O	SO_3	P_2O_5	F	Fe_2O_3	MnO		Pb	Zn	Cu	As*
EYAM	Mean	53.80	0.26	41.61	0.39	0.21	0.03	0.06	0.39	0.06	0.67	1223	325	Mean	53	53	5	–
LIMESTONES†	S.D.	1.39	0.08	2.84	0.68	0.19	0.01	0.03	0.68	0.03	1.60	961	143	Maximum	270	190	5	4
Reef facies	±%‡	2.7	32.3	7.2	183.0	95.0	35.0	52.5	183.0	52.5	250.7	8.2	46.2					
(6; 1)§	±‡	1.46	0.08	2.98	0.71	0.20	0.01	0.03	0.71	0.03	1.68	101	150					
Dark facies	Mean	46.89	0.51	36.62	16.19	0.70	0.04	0.13	0.37	0.09	0.04	3006	372	Background	< 3	60	5	–
(25; 4)§	S.D.	10.39	0.40	8.01	18.69	2.31	0.02	0.34	0.81	0.10	0.06	7239	500	Maximum	480	460	30	3
	±%‡	8.7	30.7	8.6	45.3	129.4	19.6	102.5	85.8	43.6	58.8	94.4	52.7					
	%‡	4.07	0.15	3.14	7.32	0.91	0.01	0.13	0.32	0.03	0.02	2838	196					
MONSAL	Mean	51.00	0.41	39.83	8.04	0.38	0.04	0.09	0.23	0.05	0.05	2447	231	Background	< 3	40	5	–
DALE	S.D.	4.59	0.19	4.70	10.03	0.79	0.01	0.14	0.26	0.04	0.09	3595	177	Maximum	2000	1000	35	4
LIMESTONES†	±%‡	2.2	11.5	2.9	31.1	51.7	6.2	38.7	28.1	19.9	44.8	36.6	19.1					
(62; 18)§	±‡	1.14	0.05	1.17	2.50	0.20	0.00	0.03	0.06	0.01	0.02	895	44					
BEE LOW	Mean	53.35	0.49	42.40	2.91	0.13	0.03	0.05	0.12	0.01	0.01	1078	260	Background	< 3	20	5	–
LIMESTONES†	S.D.	1.32	0.37	1.14	1.91	0.09	0.00	0.02	0.15	0.01	0.02	1023	178	Maximum	170	140	10	7
(16; 5)§	±%‡	1.3	40.2	1.4	35.0	36.9	–	21.3	66.6	53.3	106.6	50.6	36.5					
	±‡	0.70	0.20	0.61	1.0	0.04	–	0.01	0.08	0.01	0.01	545	948					
DOLOMITES ‖	Mean	31.72	19.82	46.37	1.70	0.05	0.05	0.03	0.04	0.04	0.17	2925	875	Mean	47	272	11	–
(4; O)§	S.D.	1.09	0.10	1.05	1.59	0.08	0.01	0.01	0.05	0.01	0.20	917	88	Maximum	160	430	15	–
	±%‡	5.5	0.8	3.6	148.8	254.6	31.8	53.0	198.9	39.8	18.7	49.9	16.0					
	±‡	1.73	0.16	1.67	2.53	0.13	0.02	0.02	0.08	0.02	0.03	1459	140					

* The background value of As, determined for the complete data set is < 2 parts per million.
† Excluding dolomitised samples.
‡ Confidence limits at the 95% probability level.
§ The first figure denotes the number of samples analysed for all constituents other than As; the second figure denotes the number of samples analysed for As.
‖ Rocks containing over 90% dolomite mineral.

S.D. denotes 'standard deviation'.

Table 4 Correlation matrix for selected samples from the Monsal Dale Limestones

Element/ oxide	Correlation coefficients (based on a dataset of 62 samples; constituents in brackets have a negative correlation)							
	0.20–0.30	0.30–0.40	0.40–0.50	0.50–0.60	0.60–0.70	0.70–0.80	0.80–0.90	> 0.90
CaO	(SO_3)	MnO, (Al_2O_3, K_2O, P_2O_5)						(SiO_2)
SiO_2	SO_3, K_2O, P_2O_5, (MnO)	Al_2O_3						(CaO)
Al_2O_3	P_2O_5	SiO_2, (CaO), Cu, Zn, F	MgO		Na_2O, Fe_2O_3	SO_3		K_2O
K_2O	SiO_2, (CaO), Cu, Zn	F	MgO	Fe_2O_3		SO_3, Na_2O		Al_2O_3
Na_2O	Cu	P_2O_5	Zn, F	MgO, Fe_2O_3	SO_3, Al_2O_3	K_2O		
Fe_2O_3	Pb	P_2O_5, Cu	F	SO_3, Na_2O, MgO, Al_2O_3, K_2O, Zn				
SO_3	SiO_2, Al_2O_3, (CaO)	MgO	Zn, F	Fe_2O_3	Na_2O	Al_2O_3, K_2O		
MgO	Zn, MnO	SO_3, F	Fe_2O_3, Al_2O_3, K_2O	Na_2O				
P_2O_5	SiO_2, AL_2O_3, Fe_2O_3, MnO	Na_2O, (CaO), Cu, Zn		F				
Cu	Na_2O, K_2O, SO_3, Zn, Pb	Al_2O_3, Fe_2O_3, P_2O_5, MnO						
Pb	SO_3, Fe_2O_3, Cu		F					
Zn		F, K_2O, P_2O_5	SO_3, Na_2O, Al_2O_3	Fe_2O_3, Pb				
MnO	CaO, P_2O_5, (MgO)	(SO_3, Na_2O, K_2O, Cu)	(Al_2O_3)					
F		SO_3, MnO, K_2O, Al_2O_3, Cu, Zn	Na_2O, Fe_2O_3, Pb	P_2O_5				



Clusters		CaO	SiO_2	Fe_2O_3 (ppm)	Al_2O_3	MgO	P_2O_5	Number of samples	Diagnostic Features
A	mean ($\bar{x}$)	50 52	6.11	3680	0.31	0.75	0 04	6	
	standard deviation (σ)	2.49	4.18	2600	0.34	1.01	0.01		
B	$\bar{x}$	41.71	18.09	18170	4 43	1.10	0.10	9	High levels of silica, clay and pyrite
	σ	9.86	13.48	8850	3.58	0.89	0.09		
C	$\bar{x}$	41.85	27.98	1510	0.26	0 51	0.07	22	High levels of silica
	σ	6.10	12.60	1470	0.24	0 60	0.04		
D	$\bar{x}$	36.96	4 40	3880	0.10	14.07	0.03	9	Magnesium-rich rocks
	σ	7.50	8.16	3680	0.11	6.78	0.02		
E / E′	$\bar{x}$	53.89	2.38	900	0 12	0.41	0 03	63	Low levels of silica and clay
	σ	1.34	2.37	670	0.12	0.24	0.02		
F	$\bar{x}$	49.60	3.81	1860	0.29	0.47	0.14	13	High levels of P_2O_5
	σ	1.62	2.88	1260	0 18	0.14	0.09		

BLL	Bee Low Limestones
Mo (CBB)	Monsal Dale Limestones (north of Stanton Syncline)
Mo (>URB)	Monsal Dale Limestones (overlying Upper Matlock Lava)
Mo (<URB)	Monsal Dale Limestones (underlying Upper Matlock Lava)
EyL	Eyam Limestones (dark facies)
K	Eyam Limestones (reef facies)

Figure 9 Cluster analysis of chemical data.

Limestones and from the more northerly outcrops of the Monsal Dale Limestones. It is significant that stratigraphically equivalent Monsal Dale Limestones material (designated >URB on Figure 9) from the south of the district is not included in this cluster but occurs in the purer clusters E″ and F, thus supporting the view expressed earlier that silica levels decrease towards the south. Clusters A and B are distinguished primarily on account of their high Fe_2O_3 contents while Cluster D is made up of the various dolomitised samples.

It is evident from the distribution of the samples within the dendrogram that the clusters have both stratigraphical and economic significance and the analysis confirms that the exploration targets for medium or high purity mineral are those identified by the insoluble residue study.

Boreholes were sited away from known mineral veins so that trace element concentrations would be likely to approximate to background levels. Nevertheless anomalously high levels of lead (up to 2000 ppm) were detected in some of the samples analysed. Frequency distribution curves were plotted for copper, lead, zinc and arsenic where there were sufficient data and in each case, the modal value was selected as the best estimate of background concentration (Table 3). Most of the trace elements show no consistent regional pattern, but there is some evidence that in the Monsal Dale Limestones, the metals copper, lead and zinc have a strong affinity for the clay-forming elements (Table 4).

A detailed study of the chemical variation along the dolomite belt has not been undertaken because of the restricted geographical and subsurface occurrence of dolomite within the resource sheet area. Evaluation of the dolomites is further complicated because the rocks are chemically varied and have been affected by several phases of silicification and calcification. Of the 9 samples analysed, 4 contain more than 90% dolomite mineral (MgO >19.68%), the remainder range from calcitic dolomites (MgO 10.93 to 19.68%) through to dolomitic limestones (MgO 2.19 to 10.93%). The chemistry of the 'commercial grade' dolomites is summarised in Table 3.

Analytical data on the dolomitised rocks in adjacent areas have already been published (Cox and Bridge, 1977; Cox and Harrison, *in press*) and, since this report concludes the assessment of these rocks, it is appropriate to review the chemistry of the *Matlock–Monyash–Brassington dolomite belt* as a whole (Table 5).

The majority of the samples analysed are dolomites or calcitic dolomites with dolomitic limestones only poorly represented towards the margins of the alteration zone. Chemical variation across the belt reflects, in part, compositional differences inherited from the parent rocks. Thus the Eyam and Monsal Dale limestones, which are typically more siliceous and argillaceous than the Bee Low Limestones, give rise to dolomites containing higher levels of silica, potash, alumina and soda. The main elements introduced during dolomitisation in addition to magnesium, are iron and manganese whose abundances are increased to four times and twice their original abundances respectively. Both elements substitute in the calcite and dolomite lattices. Manganese also occurs as the oxide, pyrolusite. Trace-element levels of copper, lead and zinc are comparable with background levels recorded in unaltered limestones.

NON-CARBONATE MINERALOGY

The non-carbonate fractions of the rocks were examined microscopically in reflected light and representative samples were selected for X-ray diffraction analysis. This examination showed that silica and clay minerals account for more than 90 per cent of all residues with pyrite, limonite, barytes, fluorite, unidentified ore minerals and hydrocarbon recorded in minor or trace amounts. The proportions of the three most commonly occurring non-carbonate minerals in each formation are shown in Figure 10.

Silica is present in the form of euhedral quartz crystals, as cryptocrystalline replacements of shell structures, and as chert. Crystals are scattered throughout the sequence, but, where concentrated locally, they may increase the insoluble residue by between 2 and 3 per cent. Fossil debris may be partially or completely replaced by silica giving rise to abundant insoluble residues. Brachiopods are most susceptible to replacement, but silicification of all the main fossil groups has been recorded. Chert is mainly restricted to certain parts of the Monsal Dale and Eyam Limestones; its surface distribution based on field and borehole observations is shown on the resource map. Rocks containing combinations of the various forms of silica are common.

Clay occurs in stratified deposits, in joints, and as mineral disseminations within limestone. The stratified deposits, termed wayboards, are ochreous grey and may exceed 0.3 m in thickness. A full discussion of their composition and mode of origin is given by Walkden (1972; 1974). Disseminated clay minerals are most widely developed within the darker coloured limestones of the Monsal Dale and Eyam limestones. The various clay mineral groups that have been identified are listed in Table 6. Kaolinite and illite appear to be more common in the Monsal Dale Limestones, possibly as a result of

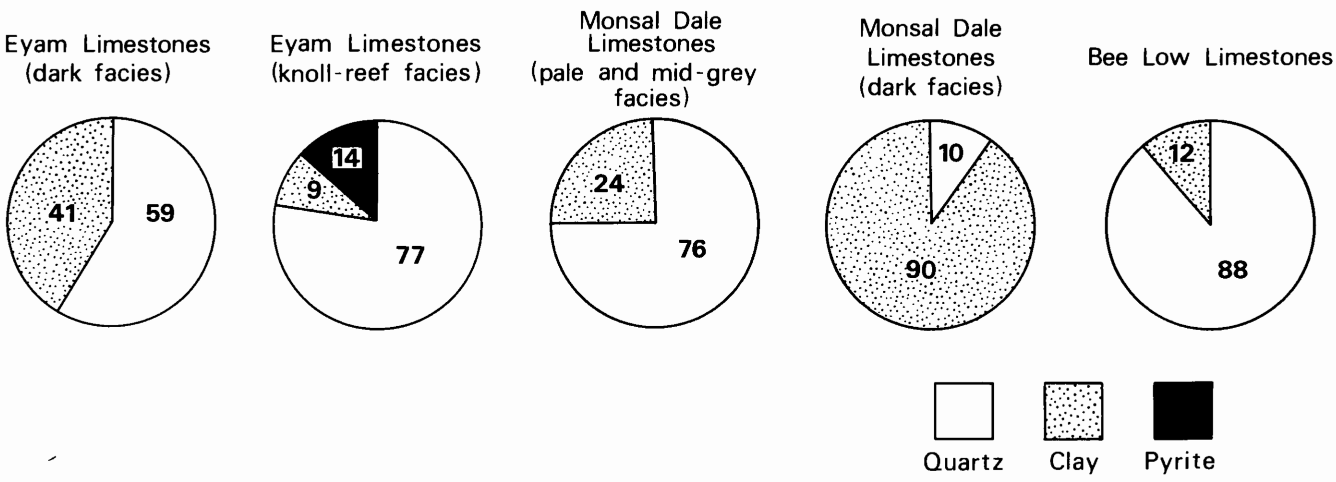


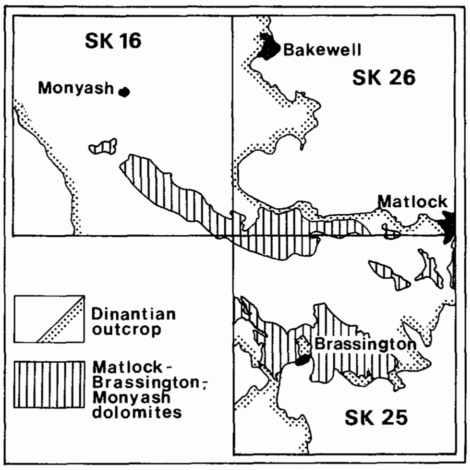
Figure 10 Variation of non-carbonate mineralogy with formation (percentages from optical examination of insoluble residues).

Table 5 Summary of the chemistry of the Monyash-Matlock-Brassington dolomites

Lithostratigraphical divisions (with number of analyses)		*percentages by weight*											*parts per million*				
		MgO	CaO	Fe_2O_3	Al_2O_3	SiO_2	NA_2O	K_2O	SO_3	P_2O_5	F	Loss at 1050° C	Cu	Pb	Zn	MnO	As
DOLOMITISED	Mean	19.72	31.47	0.31	0.10	2.75	0.05	0.03	0.02	0.04	0.16	46.00	15	35	250	860	1
MONSAL DALE	S.D.	1.52	1.70	0.11	0.19	4.21	0.02	0.02	0.02	0.04	0.33	2.39	15	55	180	200	1
LIMESTONES	Maximum	21.34	34.10	0.63	1.01	19.70	0.06	0.11	0.05	0.17	1.30	47.75	60	180	580	1270	3
(29) *	Minimum	15.60	27.00	0.18	0.00	0.19	0.01	0.01	0.00	0.00	0.00	37.03	5	0	20	490	0
DOLOMITISED	Mean	18.74	32.62	0.35	0.03	0.19	0.03	0.02	0.06	0.60	0.04	47.32	5	490	260	1250	1
BEE LOW	S.D.	2.57	2.94	0.16	0.05	0.24	0.02	0.02	0.21	0.05	0.18	0.81	5	2100	780	510	1
LIMESTONES	Maximum	21.10	42.10	0.68	0.20	1.04	0.05	0.05	1.00	0.22	0.85	48.21	15	10100	3800	2800	2
(23) †	Minimum	10.50	29.30	0.13	0.00	0.00	0.00	0.00	0.00	0.01	0.00	45.12	0	0	20	620	0

* The numbers of analyses for SO_3 and As were 13 and 7 respectively.
† The number of analyses for As was 6.

S.D. denotes standard deviation.



Location of main dolomitised zones

Table 6 Non-carbonate mineralogy determined by X-ray diffraction.

Minerals identified	Eyam Limestones		Monsal Dale Limestones	Bee Low Limestones
	Dark facies	Knoll-reef facies		
Quartz	X	X	X	X
Kaolinite	X	X	X	X
Illite	X	X	X	X
Montmorillonite	X			
Chlorite			X	
Muscovite		X		
Mixed-layer clay		X	X	
Pyrite	X	X	X	X
Siderite	X	X	X	
Hematite		X		
Geothite			X	
Marcasite		X		
Fluorite			X	
Barytes			X	
Ankerite	X		X	
Number of samples analysed	10	4	35	8

increased volcanic activity. Clay minerals also form as residual deposits infilling stylolitic sutures.

Finely divided pyrite is scattered throughout the limestone sequence but is more common in the darker limestones and in those associated with igneous rocks. An apparent concentration in knoll-reef limestones (Figure 10) is due to an abundance of pyrite recorded at one locality (NW 14). Iron oxides occur as alteration and weathering products after pyrite, commonly staining fissures and fractures. Barytes, fluorite and hydrocarbon are recorded in residues from rocks adjacent to hydrothermal veins.

COLOUR

Quantitative colour determinations are important for limestones which are intended for use in the production of whiting, glass and paper. Measurements of tri-colour reflectance (Cox and others, 1977) were made using an EEL reflectance spectrophotometer calibrated against a white standard (magnesium carbonate). The measurements were taken on sawn, acid-etched rock surfaces and on powder discs. The etched surface colour gives an objective value which can be used in correlating boreholes and sections. Additionally, it is a general guide to the likely category of the limestone, although some spar-cemented rocks with high carbonate contents may give low reflectance readings.

Table 7 Distribution of rock colour

Formations and subdivisions		percentages		
		Pale grey*	Mid-grey†	Dark grey‡
EYAM LIMESTONES	Dark lithofacies	8	51	41
	Reef facies	24	72	4
MONSAL DALE LIMESTONES	Dark lithofacies	14	46	40
	Normal lithofacies	21	73	6
BEE LOW LIMESTONES		11	87	2

* Reflectance > 35% at 660 nm, > 26% at 520 nm, > 24% at 470 nm.
† Reflectance 35–15% at 660 nm, 26–12% at 520 nm, 24–11% at 470 nm.
‡ Reflectance < 15% at 660 nm, < 12% at 520 nm, < 11% at 470 nm.

Table 8 Summary of powder reflectance results for very high purity ($CaCO_3 \geqslant 98.5\%$) rocks

Borehole/ Section number (with number of samples determined)	Formation* (and stratigraphical subdivision sampled	Maximum continuous thickness of very high purity mineral	Mean reflectance percentage (and standard deviation)		
			660 nm	520 nm	470 nm
SE 1s (26)	EyL, K, Mo (> URB)	7	78 (5)	72 (5)	69 (5)
SE 3s (15)	EyL, K	5	75 (9)	70 (10)	68 (10)
NW 14 (18)	K, Mo (> CBB)	8	80 (3)	76 (4)	74 (4)
NW 5s (7)	Mo (> CBB)	3	80 (6)	69 (3)	67 (4)
SW 36 (15)	Mo (> CBB)	5	82 (2)	76 (2)	74 (2)
NW 13 (10)	Mo (< CBB > LOB)	6	80 (2)	73 (3)	72 (4)
SW 18 (17)	Mo (< LRB)	6	68 (4)	60 (5)	57 (4)
SW 37 (11)	Mo (< URB)	6	80 (1)	76 (2)	74 (2)
SE 23 (21)	Mo (< URB)	11	79 (3)	73 (3)	71 (3)

* EyL = Eyam Limestones (dark facies)
K = Eyam Limestones (reef facies)
Mo = Monsal Dale Limestones
 > CBB = Beds above the Conksbury Bridge Lava
 < CBB > LOB = Beds between the Conksbury Bridge and Lathkill Lodge lavas
 > URB = Beds above the Upper Matlock Lava
 < URB = Beds between the Upper and Lower Matlock lavas
 < LRB = Beds below the Lower Matlock Lava

The limestones exhibit various shades of grey which are defined by reference to three filters with wavelengths of 660, 520 and 470 nm respectively (Cox and others, 1977, p.7), the percentage distribution of these shades based on over 1100 etched-surface measurements is given in Table 7. Dark grey limestones are mainly restricted to the thin-bedded Eyam Limestones and to the dark facies of the Monsal Dale Limestones; a dark grey limestone also occurs directly above the Lower Matlock Lava. The dark coloration of the rocks may be related to volcanic events outside the district. Mid-grey limestones are represented in each formation but are best developed in the Bee Low Limestones, which show a high degree of uniformity of colour. In contrast, pale grey colours typify the reef-Knolls and purer parts of the Monsal Dale Limestones.

Powder discs (Cox and others, 1977) were prepared for all samples falling within the very high purity category. The reflectance results (Table 8) show that the whitest powders come from thin, very high purity bands within the upper part of the Monsal Dale Limestones. A maximum value for the dataset of 88% is recorded in SE 3s but, in general, the limestones are less white when powdered than stratigraphically equivalent beds outcropping west of the district (Cox and Bridge, 1977).

PHYSICAL PROPERTIES

Fracture spacing

One of the most important properties which determine the engineering quality of a rock is its continuity; rock masses transected by faults, joints and bedding planes are inherently weaker and less stable than larger blocks with few fractures. One method of quantifying fracture and joint spacing, which is particularly applicabie in dealing with borehole core is to use the Fracture Spacing Index (Franklin and others, 1971). This index, denoted by the symbol 'If', is defined as the length of a unit, divided by the number of fractures within the unit. The index has been used to assess the rock quality of some of the cores drilled for the assessment study and results are shown graphically in Appendix C. Fracture indices for all the limestones commonly fall between 200 and 1000 mm. The mean value for the Monsal Dale Limestones is 740 mm, which is consistent with the thickly bedded nature of these rocks. The mean indices for the other formations are 370 mm for the Eyam Limestones, dark facies and 700 mm for the Eyam Limestones, reef facies.

Aggregate Impact Value testing

In order to assess the performance of the rocks as aggregates, 10-m lengths of halved core were crushed, sub-sampled and tested. Following the work of Ramsay and others (1973), who showed that an unknown component of additional energy is introduced by the rebound of the hammer when the test machine is mounted on a concrete base, the Institute substituted a wooden base, in an attempt to eliminate this potential source of error. Although the results obtained using this modified procedure are internally consistent, the values are not directly comparable with results from other laboratories. Consequently, the procedure laid down in British Standard 812 (British Standards Institution, 1975) has been re-adopted. Aggregate impact values (AIV) obtained with the machine mounted on a wooden base have been corrected in this report to equivalent 'British Standard values' using an experimentally determined conversion factor. The corrected results are shown graphically for individual boreholes in Appendix C and are summarised in Table 9. Reef-facies and dolomitised limestones are the least durable of the samples tested and are therefore less suitable for use as aggregate. Samples from the other lithostratigraphic units give consistently lower aggregate impact values.

AIV measurements were also performed on surface material collected from a working quarry at Shining Bank (NW 5s). This quarry straddles the junction between the Eyam Limestones and Monsal Dale Limestones and produces a mixed aggregate containing constituents from both formations. Blocks from the quarry face and crushed aggregate from stockpiles were sampled separately and AIV determinations were carried out on the component fractions. The results (Table 10) are in broad agreement with the values obtained from testing borehole core but there are some inconsistencies. On the basis of

Table 9 Summary of AIV results

Lithostratigraphical divisions		Mean AIV	Standard deviation	Number of determinations
EYAM LIMESTONES	Dark facies	22	1	5
	Reef facies	24	2	5
MONSAL DALE LIMESTONES		21	2	38
BEE LOW LIMESTONES		22	1	18
DOLOMITISED LIMESTONES		26	3	9

the stockpiled aggregate, the Monsal Dale Limestones prove to be the stronger of the two formations, whereas if face-sampled material is used, the Eyam Limestones appear to be more durable. These discrepancies may be due to differences in particle shape (aggregate produced by the plant crusher is less flaky than that produced in the laboratory), or they may reflect petrographical differences between samples.

AIV testing was also carried out on core material from the main volcanic members. During the primary crushing process to produce 10–14 mm grade chips for testing, a high proportion of the material disintegrated into dust or very fine aggregate leaving only a small fraction consisting of the more durable components for testing. Consequently, the results (Table 11) reflect the strength of the more competent parts of the rock only and should not be taken as indicative of the overall strength of the lavas.

THE RESOURCE MAP

The limestone and dolomite resource map is folded into the pocket at the end of this report. The base map is the Ordnance Survey 1:25 000 outline edition 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 red, and major geological boundaries in green. For clarity, the positions of the outcropping formations are also identified on a small-scale solid-geology map which is printed alongside the main assessment map.

Carbonate resource information

On the face of the resource map, shades of blue are used to indicate the average purity of the limestones to a depth of 10 m from surface. Additionally the same shades are used on the various tablets and on the horizontal sections to show variations in purity at depth. Purity values were determined at sample points as follows: the measurements of insoluble residue (that is, the non-carbonate fraction) were grouped into sets covering successive 10-m intervals. For each group the mean, the standard deviation and the confidence limits were calculated for the 95% probability level, assuming the Student's t distribution. The mean and the 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. Where selective sampling has excluded chert and mudstone partings from insoluble residue determinations, their percentage contribution was obtained by direct measurement in the field and the insoluble residue value adjusted by calculation.

Dolomitisation at the surface is indicated by green stripes, and the same pattern is also used on the tablets to indicate the presence of dolomite or partly dolomitised rocks at depth.

Where non-carbonate rocks form part of the uppermost 10 m, zones of intermixing are developed. In earlier reports, these zones were depicted on the resource map, but because of the relatively steep dips which prevail throughout this district the zones are generally too narrow to show satisfactorily and they have therefore been omitted.

Table 10 AIV results for material from Shining Bank Quarry

Material	Eyam Limestones component			Monsal Dale Limestones component		
	Mean AIV	Elongation Index	Flakiness Index	Mean AIV	Elongation Index	Flakiness Index
Stockpiled aggregate (10–14 mm)	23	37	16	20	33	12
Face-sampled material (10–14 mm)	20	38	25	24	37	25

Table 11 AIV results for volcanic rocks

Borehole number	Depth interval tested	Volcanic Member	Mean AIV	Percentage of sample* grading between 10 and 14 mm
NW 12	90–100 m	Conksbury Bridge Lava	16	9.9
NW 13	90–100 m	Lathkill Lodge Lava	17	7.5
NW 14	90–100 m	Lathkill Lodge Lava	10	8.9
SW 36	110–120 m	Conksbury Bridge Lava	11	9.5
SE 23	45–55 m	Upper Matlock Lava	15	7.5

*BS 812 recommends a minimum acceptable value of 15 per cent.

Structural and mineralisation data
This information is largely abstracted from the 1:10 560-scale geological maps based on surveys by the Land Survey staff of the Institute. The structural interpretation has been augmented by information obtained from the assessment boreholes.

Drift geology
Locally the limestone is covered by boulder clay, head or alluvium. Areas where these are thicker than 1.5 m are indicated by black ornament, with the appropriate symbol. These deposits are ignored when calculating limestone quality.

IMAU 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 insoluble residue value for each metre of strata up to a maximum of 15%. Where natural sections are recorded, the elevation above 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 constructed from borehole information, the

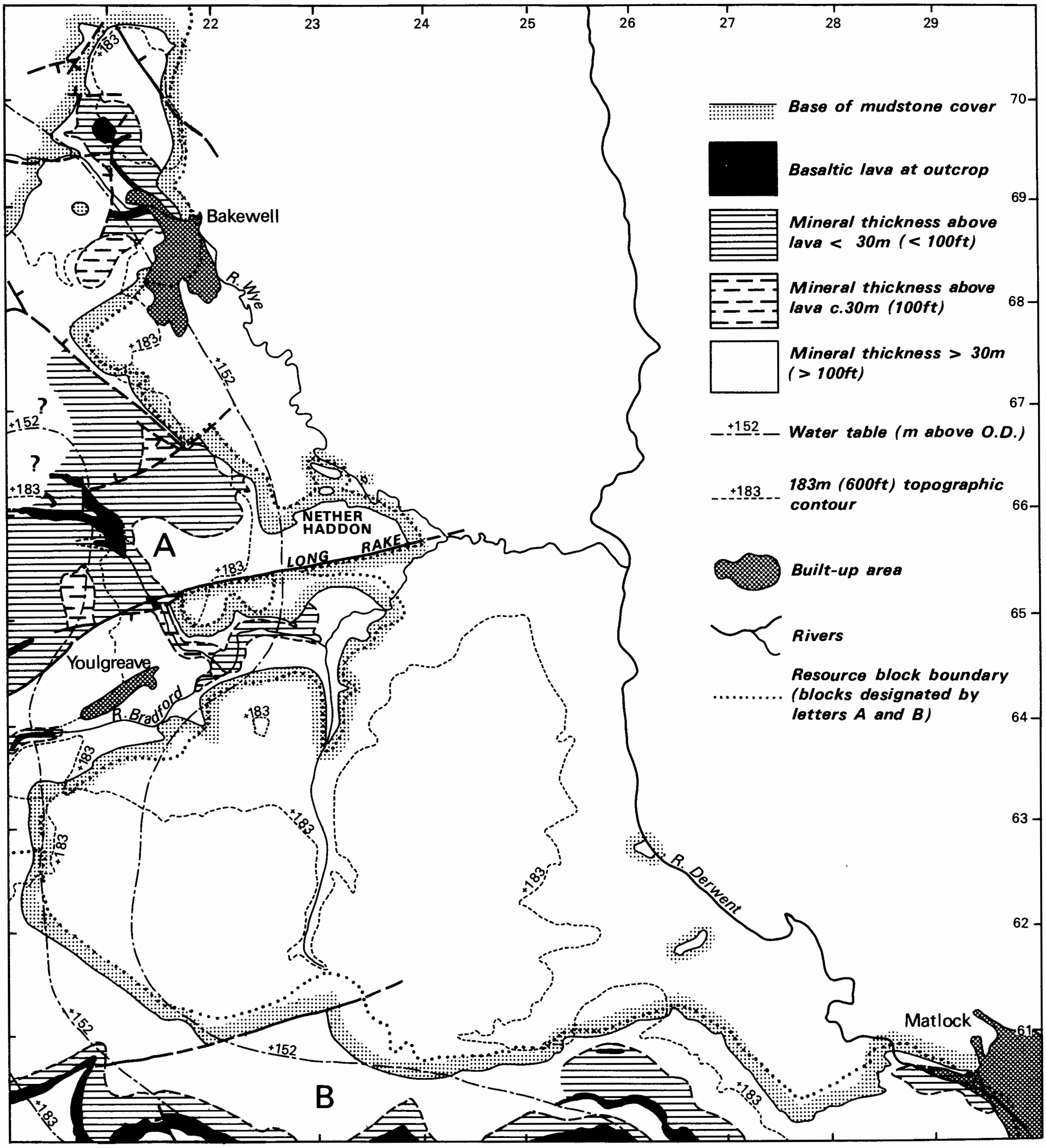


Figure 11 Variation in mineral thickness across the district.

structure as determined from field evidence, and the interrelationships of the various categories and stratigraphy. 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 an illustration of the depth of dolomitisation. Zigzag lines have been used diagrammatically to indicate a change in limestone category related to a facies change; the lines do not indicate the precise boundaries between categories.

SUMMARY OF RESOURCES

By dividing the district into two resource blocks, one on either side of the Stanton Syncline, resources with broadly similar characteristics are grouped together and their description is simplified.

BLOCK A

This block covers an area of 16 km² and extends from the northern extremity of the crop to just south of Bradford Dale. The formations at outcrop are the Eyam and Monsal Dale limestones which together comprise a potentially workable thickness of mineral of about 60 m. Both formations are currently worked for aggregate at Shining Bank Quarry [228 650]. The base of the resource for open-pit exploitation is set at the first major volcanic member which over most of the area is the Conksbury Bridge Lava. The variations in mineral thickness above this member are shown in Figure 11. It is apparent from the diagram that the areas where the mineral is sufficiently thick to accommodate a working face 30 m high are limited; the largest tract of potentially workable ground lies on the downfaulted block to the south of Long Rake, and there are less extensive zones along the western margin of the crop and in the vicinity of Nether Haddon.

Edmunds (1971) has published tentative watertable contours for the Carboniferous Limestone crop based on data from mine-shafts, cave systems and sough levels and these are reproduced in Figure 11. Edmunds stresses that the contours must be regarded as approximate as data on seasonal fluctuations are lacking. Over most of the district the watertable is thought to lie at approximately 152 m (500 ft) which sets the lower limit for dry quarry operations. The 183 m (600 ft) topographic contour is included on Figure 11 to show areas which might be at risk from flooding if operations were instituted below this height.

Mineral The block contains very limited resources of high purity chemical grade limestone, either at surface or sufficiently close to the surface to be worked by open-pit methods. Reef-knolls within the Eyam Limestones offer the best targets but they tend to be deeply buried or too small to be worth exploiting; thicknesses of the more accessible knolls range from 5 m in Lathkill Dale to 15 m at Nutseats Quarry. High purity mineral is also exposed below the Conksbury Bridge Lava; near Over Haddon the section is some 25 m thick but as the beds are traced up Lathkill Dale the band thins to approximately 10 m. Because of this rapid attenuation westwards, the band is not delineated on the adjacent resource assessment map (SK 16). To the east the band occupies a position between the Conksbury Bridge and Lathkill Lodge lavas and has no economic potential.

Over the remainder of the block, the rocks are classified as impure or low grade and these categories are maintained at depth except where subsurface knolls are encountered.

The most impure grades occur north of the Magshaw Anticline within the darker lithofacies of the Monsal Dale and Eyam limestones. The mineral in this area is dark coloured, thinly bedded and cherty, and contains waste partings of shale and mudstone. Over the central and southern parts of the block, the Monsal Dale Limestones are paler, more massively bedded and contain thin chert-free bands of better quality stone (see, for example, NW 5s).

Dips throughout the block range between 10° and 20° and are related to three main fold structures, namely the Stanton Syncline and the Magshaw and Bakewell anticlines.

Mineralisation is largely restricted to the Alport-by-Youlgreave mining field, located on the south side of Long Rake, and some contamination of the resources by ore or gangue minerals must be anticipated immediately adjacent to the veins which form this field.

Overburden The limestone crop is largely free from overburden except for patches of boulder clay to the north of Alport and in the Bakewell area. The deposit is locally quite thick (9 m at Shining Bank Quarry) and its removal could pose a problem. Elsewhere the drift cover is restricted to thin patches of head and alluvium along the major valleys. Namurian mudstones also occur as overburden to the limestones in outliers near Alport and west of Bakewell.

BLOCK B

The southern limb of the Stanton Syncline comprises an assemblage of carbonates interbedded with substantial thicknesses of volcanic rock which constitute waste. The principal volcanic members are the Upper and Lower Matlock lavas which have maximum thicknesses of 35 m and 36 m, respectively. The Upper Matlock Lava dies out west of Wensley but its horizon is marked by a persistent band of dark limestone and clay wayboard. Similarly the Lower Matlock Lava is absent west of Gratton Moor.

The lavas are important hydrogeologically since they can give rise to temporary perched watertables; this effect is illustrated in Gratton Dale where springs emerge from the limestone–lava junction. However, over most of the block, the regional watertable is generally well below the ground surface and is unlikely to be intersected in quarrying operations, except on the low ground in the extreme north-west of the block and in the Derwent valley, near Matlock (see Figure 11).

Down-dip from the lava outcrops resources are negligible in a zone which varies in width between 100 and 600 m where the mineral is probably too thin to support a working face. The zone is widest on the escarpment south of Wensley where the ground surface dips at approximately the same angle as the underlying strata.

Mineral The limestones in the central and western parts of the block are extensively dolomitised. The dolomitisation is irregular, particularly towards the margins of the affected area and individual beds or lenses of unaltered limestone lie within the mapped limits of the dolomite crop. The dolomitisation cuts across the boundaries of the limestone formations but is confined locally by impermeable wayboards and lavas. The depth of alteration varies and is unpredictable because of the controls exerted by joint and fracture systems in channelling the magnesium-bearing solutions. The depth of dolomitisation on Gratton Moor has been proved to 55 m in borehole SW 19. Elsewhere, dolomitisation was found to penetrate 34.5 m (SE 23) and 16.0 m (SW 18) below surface. The purest dolomites are found in the Monsal Dale Limestones in the west of the block. Analyses of material from this district and from adjacent areas compare favourably with published analyses (Industrial Minerals, 1976) of dolomites used as fluxes, clay conditioners and as a refractory material in the iron and steel industry. However, a more detailed investigation would be required to establish whether or not the deposits have any commercial value.

The mechanical strength of the dolomitised rocks, measured using the AIV test, is appreciably less than that of the limestones in the district.

Limestones unaffected by dolomitisation are restricted to the escarpment between Wensley and Matlock and to the ground around Gratton Moor. In the former area, the mineral has a maximum thickness of about 50 m and is composed of beds lying between the top of the Eyam Limestones and the Upper Matlock Lava. The mineral is predominantly of low purity but medium and high purity beds are developed locally within the upper part of the Monsal Dale Limestones. The limestones are currently quarried at Hall Dale (SE 1s) and have been worked in the past at Cawdor Quarry, near Matlock (SE 2s).

The sequence in the Gratton Moor area is thicker due to the absence of the Upper Matlock Lava. On the north-east-facing slopes of the moor, the Eyam Limestones and the upper beds of the Monsal Dale Limestones contain chert and are of low purity. High purity mineral, representing the interlava sequence, is present on top of the moor but its maximum thickness of about 60 m is only likely to be realised close to the junction with the overlying low-grade limestones. The recognition of high purity mineral in this area is based on borehole information which was unavailable at the time when the report on the adjacent Monyash district (Cox and Bridge, 1977) was compiled; consequently the band does not appear on the resource map (SK 16) accompanying that report.

Lead ore has been worked extensively in the past, and over much of the block the ground bears evidence of mineral workings. Enhanced trace-metal concentrations must, therefore, be anticipated throughout the area.

Regional dips throughout the block range up to 20° with the majority of beds inclined towards the axis of the Stanton Syncline. In the Wensley–Darley Bridge area, north–south-trending flexures locally complicate the regional pattern.

Overburden The resources are generally free of overburden apart from small patches of head in the bottom of some of the dry valleys. A narrow deposit of alluvium forms the flood plain of the River Derwent at Matlock and also floors Rowlow Brook. Along the northern margin of the block the resources are concealed by the mudstone cover.

Limestone inliers and subsurface resources within the Stanton Syncline

The resources concealed within the Stanton Syncline have not been sampled but the grades which might be anticipated are shown on the horizontal sections beneath the resource map. The limestones are generally too deeply buried to be exploited in open-pit workings, and in the inliers where they crop out, the high level of the watertable would pose an additional problem.

APPENDIX A

CLASSIFICATION AND GLOSSARY

CLASSIFICATION

The petrographic classification of limestones proposed by Folk (1959) is widely accepted and is used in this report. The classification is summarised in Table 12.

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

Limestones are also classified by reference to the mean grain size of the allochems into calcirudites (greater than 1 mm), calcarenites (1 to 0.062 mm) and calcilutites (less than 0.062 mm). A grain size term may be incorporated into the main rock as a suffix, for example, biosparrudite. Where the limestones contain significant amounts of other allochems, these may be specified, for example, crinoidal biosparite.

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

10 to 50% dolomite mineral	Dolomitic limestone
50 to 90% dolomite mineral	Calcitic dolomite
more than 90% dolomite mineral	Dolomite

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

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.
Argillaceous rocks Detrital sedimentary rocks which contain clay or silt-grade material.
Bioclasts Broken fragments of organic skeletal material.
Calcarenite A limestone consisting predominantly (more than 50%) of detrital calcite particles of sand size (0.062 to 1 mm).
Calcilutite A limestone consisting predominantly (more than 50%) of detrital particles of clay size.
Calcirudite A limestone consisting predominantly (more than 50%) of detrital calcite particles larger than sand size (greater than 1 mm).
Calcisiltite A limestone consisting predominantly (more than 50%) of detrital calcite particles of silt size.
Euhedral A term applied to grains displaying fully developed crystal form.
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.
Gangue A mineral in a vein other than an ore mineral.
Hydrothermal Pertaining to heated water, to the action of heated water or to the products of the action of heated water.
Inlier A limited area of older rocks completely surrounded by younger rocks.
Intraclast Material created by penecontemporaneous erosion within a basin of deposition.
Lithofacies A mappable subdivision of a stratigraphic unit of any kind distinguished from other adjacent subdivisions on the basis of noteworthy lithological characters.
Pericline A general term for a fold in which the dip of the bed has a central orientation; beds dipping away from a centre form a dome, and beds dipping towards a centre form a basin.
Rake A body of ore and gangue minerals disposed vertically between two walls of rock; the main type of mineral vein in the Peak District.
Sough An adit or tunnel driven specifically to drain a mine.
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 that are separated from underlying rocks by a surface that represents a significant break in sedimentation.
Vug A cavity in a rock.
Wayboard An old mining term used commonly in Derbyshire to describe a discrete and deleterious thin rock bed, usually of clay.

	LIMESTONES			
	>10% Allochems Allochemical Rocks		<10% Allochems Microcrystalline Rocks	
	Sparry calcite cement> microcrystalline ooze	Microcrystalline ooze> sparry calcite cement	1-10% allochems (Most abundant allochem)	<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% Intraclasts: <25% oolites: Volume ratio of Fossils: Pellets >3:1	Biosparite	Biomicrite	Fossils: Fossiliferous Micrite	
<25% Intraclasts: <25% oolites: Volume ratio of Fossils: Pellets 3:1 to 1:3	Biopelsparite	Biopelmicrite	Pellets: Pelletiferous Micrite	
<25% Intraclasts: <25% oolites: Volume ratio of Fossils: Pellets <1:3	Pelsparite	Pelmicrite		

Table 12 Classification of limestones (based on Folk, 1959)

APPENDIX B

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

1 The Registration Number

This consists of two statements:

1 The number of the 1:25 000 sheet on which the borehole lies, for example SK 26.

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 9. Thus the full Registration Number is SK 26 NW 9. This is abbreviated to NW 9 in the text.

Collected sections are registered in a similar manner using a separate series of numbers, suffixed by the letter S, for example, SK 26 NW 1s. This is abbreviated to NW 1s in the text.

2 The National Grid reference

All National Grid references on 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.

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*
Water	Edeco Stratadrill 36
	Dando 250
Air	Reich JO 82

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

Descriptive borehole log

6 The limestone formational names are listed.

7 Each major rock type is subdivided, 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 the lithologies described in the log.

Graphical borehole log

9 Major rock types are represented on a graphical log and diagnostic lithologies are shown using an ornamental overprint. A complete list of symbols is given in Figure 12.

10 Energy (sorting) index (Plumley and others, 1962)

In the column representing energy (sorting) index 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 (solid line) and from powder pellet samples (broken line) are shown graphically. A white magnesium carbonate standard with a reflectance value of 100 per cent was used to calibrate the spectrophotometer.

Mechanical properties

12 For most boreholes and sections, the fracture spacing index (If) is measured in millimetres and plotted on a logarithmic scale.

13 For certain boreholes the point-load strength index (Is) is measured in mega newtons per square metre (MN/m^2) and is plotted on a logarithmic scale.

14 For most boreholes, the aggregate impact value (AIV) is determined for 10-m aggregated samples, and plotted on a linear scale.

Insoluble residue data

15 Residue values are expressed as weight percentages.

Classification into categories by carbonate content

16 The overall purity of a limestone, averaged over consecutive 10-m intervals of depth, is stated using the following system (see also Table 2).

Category		*Composition* (%$CaCO_3$)
1	Very high purity	$\geq$98.5
2	High purity	$\geq$97.0 to $<$98.5
3	Medium purity	$\geq$93.5 to $<$97.0
4	Low purity	$\geq$85.0 to $<$93.5
5	Impure	$<$85.0

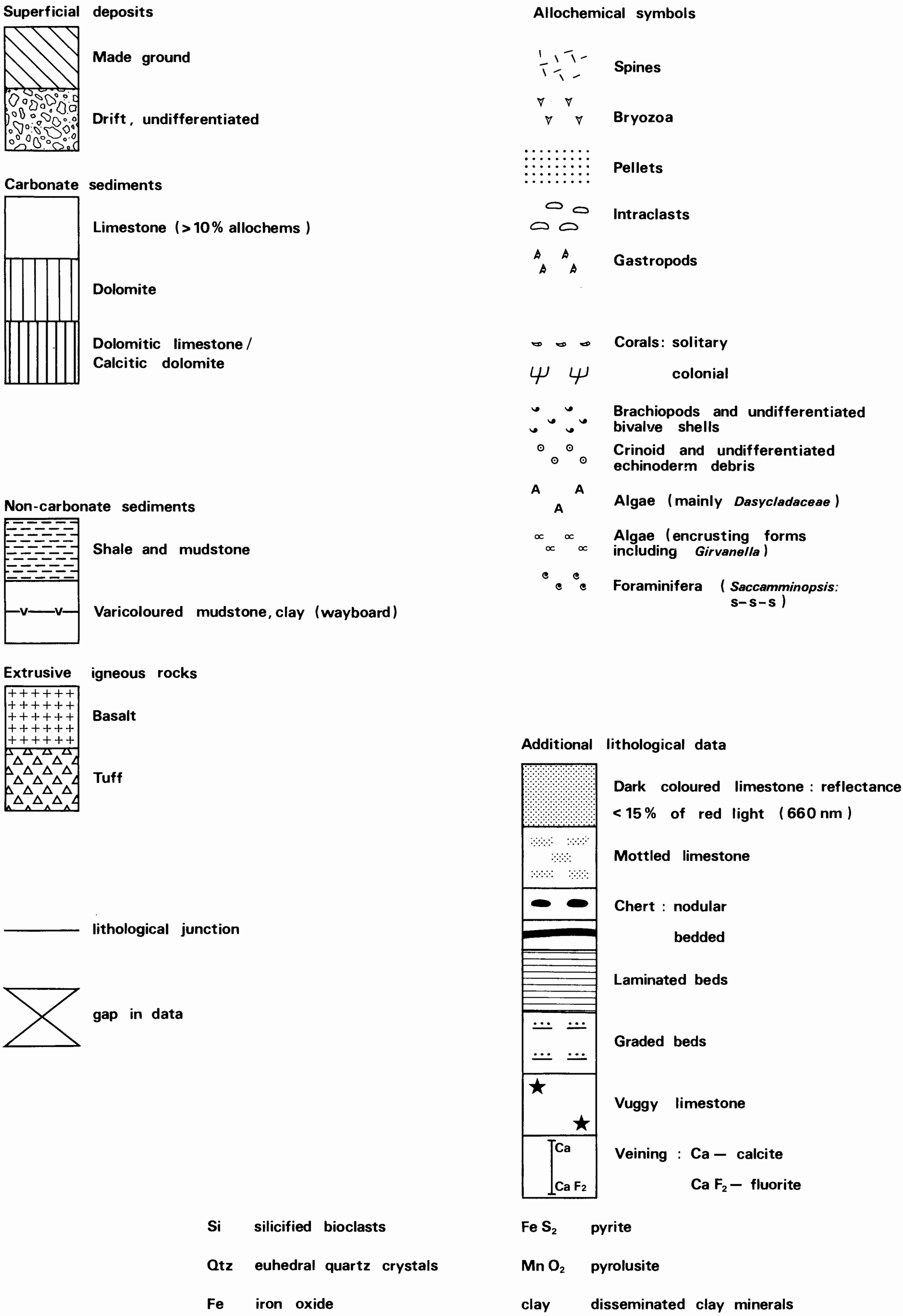
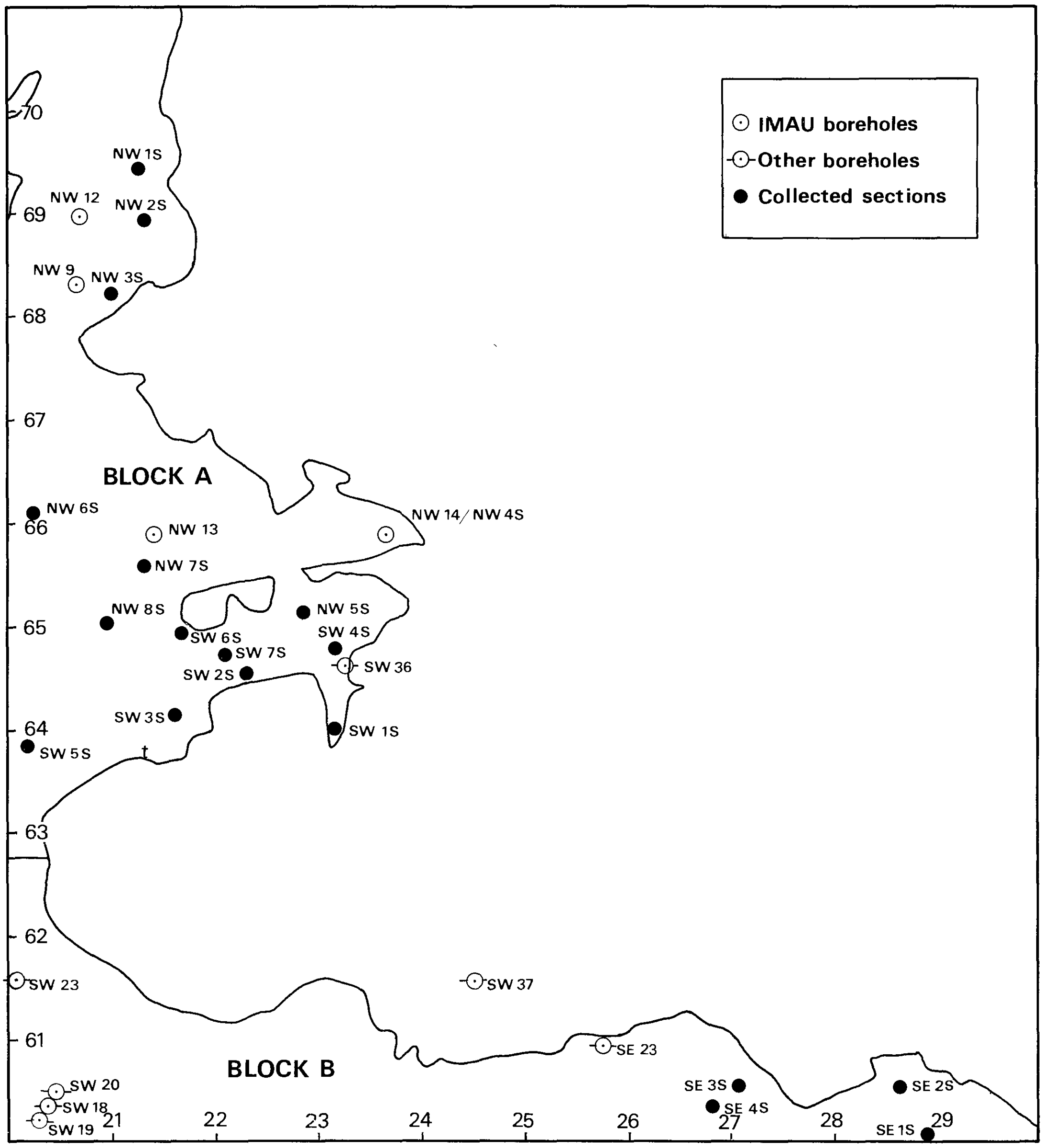


Figure 12 Explanation of symbols used on graphical logs.

APPENDIX C

RECORDS OF BOREHOLES AND SECTIONS

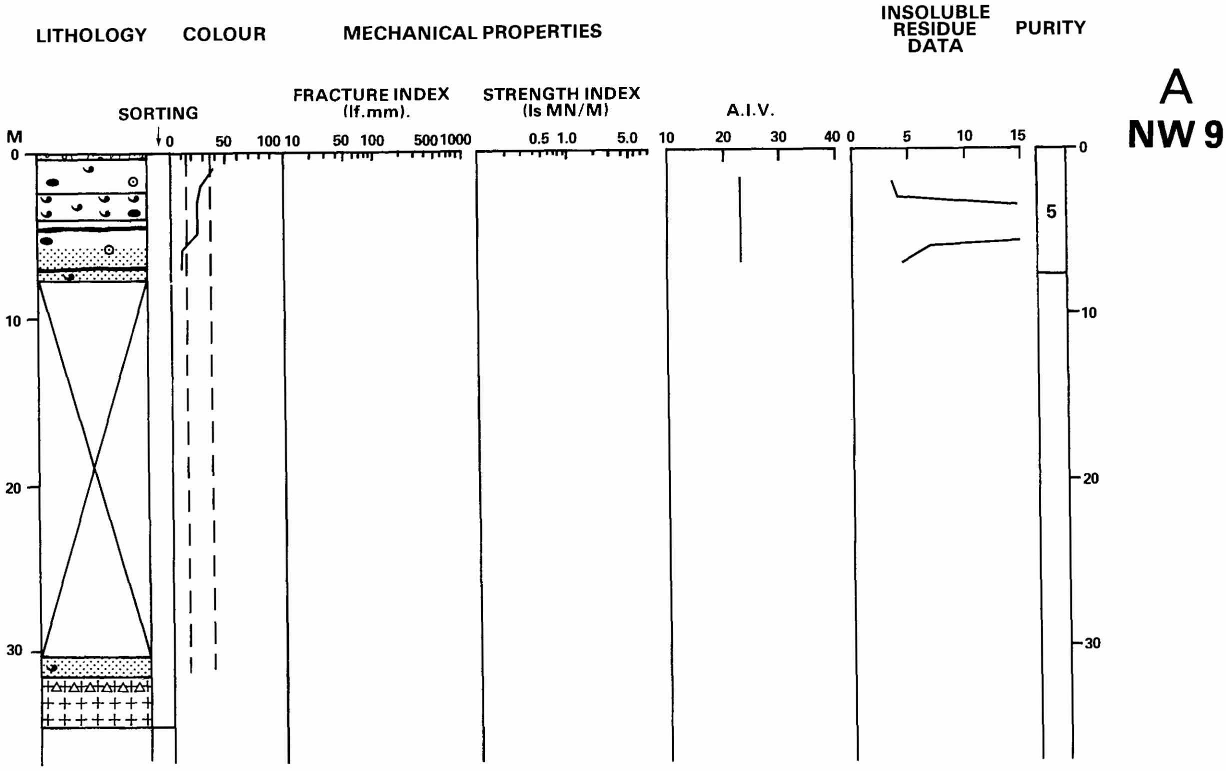


RESOURCE BLOCK A

Source of data	*Registration number*	*Grid reference*
IMAU boreholes (drilled by contractor)	NW 9	2074 6826
	NW 12	2077 6897
	NW 13	2142 6587
	NW 14	2369 6585
Commercial borehole	SW 36	2325 6458
Major sections used in the assessment	NW 1s	2133 6945
	NW 2s	2136 6894
	NW 3s	2111 6819
	NW 4s	2382 6577
	NW 5s	2283 6505
	NW 6s	2034 6608
	NW 7s	2134 6556
	NW 8s	2093 6498
	SW 1s	2341 6397
	SW 2s	2287 6460
	SW 3s	2164 6416
	SW 4s	2318 6473
	SW 5s	2015 6381
	SW 6s	2169 6494
	SW 7s	2197 6479

RESOURCE BLOCK B

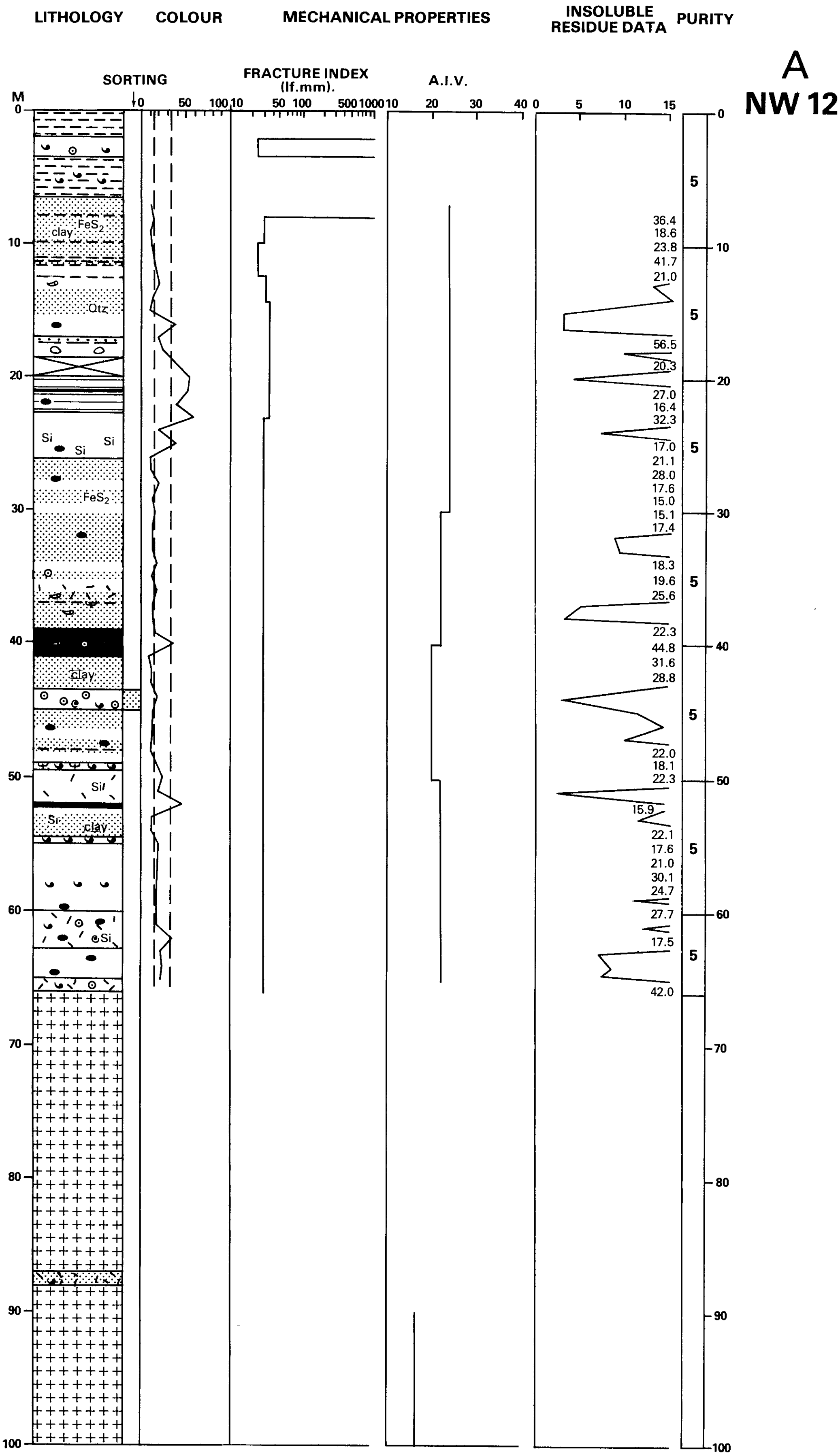
Source of data	*Registration number*	*Grid reference*
IMAU borehole (drilled by contractor)	SE 23	2571 6095
Commercial boreholes	SW 18	2035 6034
	SW 19	2027 6025
	SW 20	2045 6048
	SW 23	2003 6155
	SW 37	2444 6154
Major sections used in the assessment	SE 1s	2889 5986
	SE 2s	2865 6064
	SE 3s	2677 6033
	SE 4s	2701 6060



SK 26 NW 9[1] **2074 6826**[2] **Stonedge Lane**[3] **Block A**
Surface level + 193.2 m (+ 634 ft)[4]
Reich (airflush) 74 mm diameter[5]

	Thickness m	*Depth*[8] m
Topsoil	0.40	0.40
Monsal Dale Limestones[6]		
Biomicrosparite,[7] medium to coarse calcarenite; some thin-shelled, partly silicified brachiopods	1.09	1.49
Crinoidal biosparite, moderate to well-sorted	0.05	1.54
Biomicrosparite, sporadic chert nodules	0.81	2.35
Biomicrosparrudite, with abundant brachiopods—some partly silicified, sporadic chert nodules	1.65	4.00
Biomicrite, grey to 5.23 m, continuing dark grey to base, sporadic nodular and tabular cherts from 4.42 m to 4.60 m and from 6.96 to 7.06 m	3.06	7.06
Biomicrosparite	0.64	7.70
Gap	22.65	30.35
Biomicrite, grey to dark grey, medium calcarenite; abundant clay in matrix	1.05	31.40
Tuffaceous clay, brown and yellow	0.18	31.58
Conksbury Bridge Lava		
Basalt, amygdaloidal; contained blocks of pyritised calcilutite	3.07	34.65

Borehole completed at 34.65 m
The annotations are explained in Appendix B



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
A
NW 12
SORTING
FRACTURE INDEX (If.mm).
A.I.V.
M
clay
FeS_2
Qtz
Si
36.4
18.6
23.8
41.7
21.0
56.5
20.3
27.0
16.4
32.3
17.0
21.1
28.0
17.6
15.0
15.1
17.4
18.3
19.6
25.6
22.3
44.8
31.6
28.8
22.0
18.1
22.3
15.9
22.1
17.6
21.0
30.1
24.7
27.7
17.5
42.0

SK 26 NW 12 2077 6897 Field House **Block A**

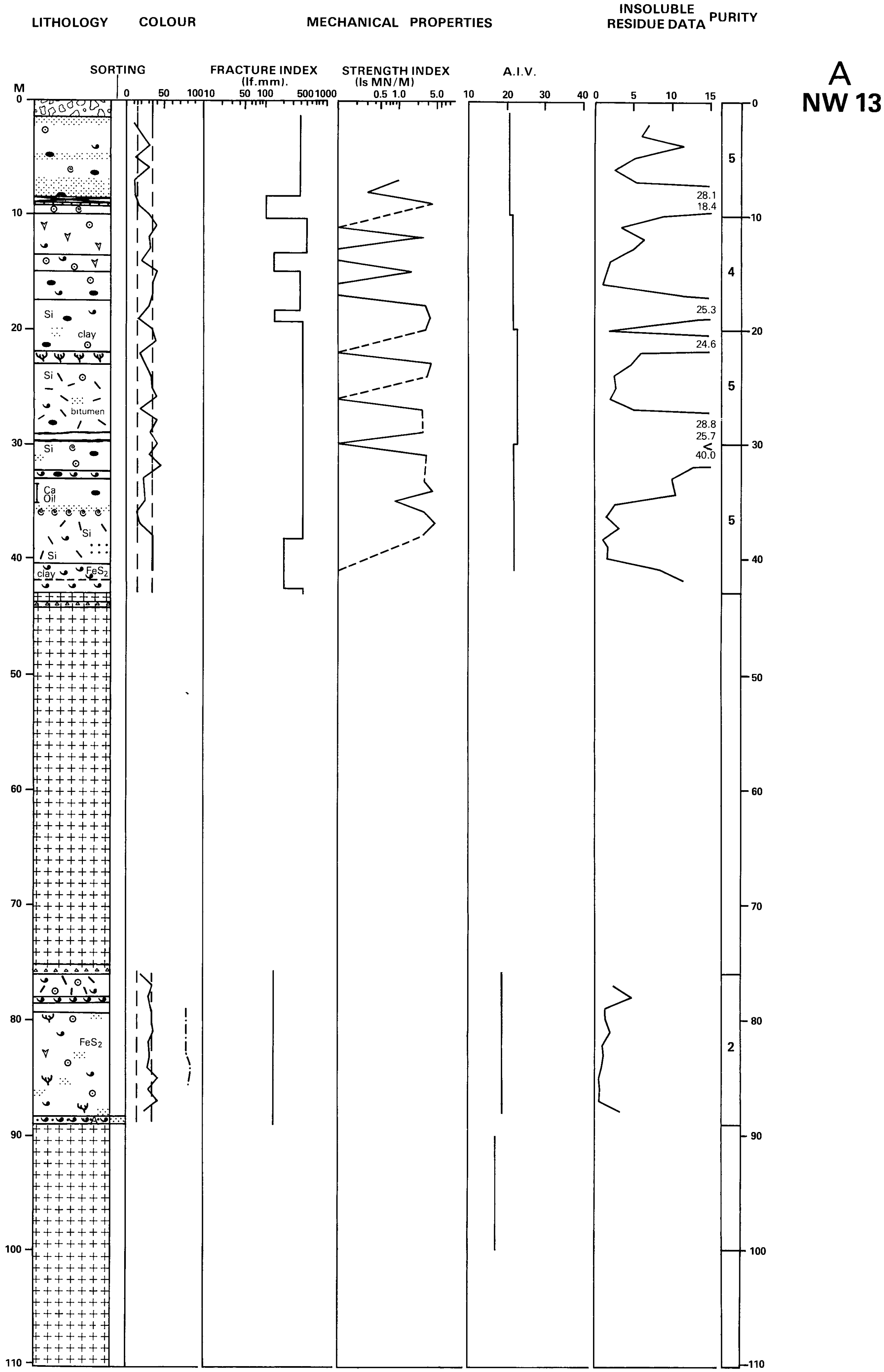
Surface level +154.6 m (+507 ft) : water table 25.00 m below surface

Edeco Stratadrill (waterflush) 47 mm diameter

February 1976

	Thickness m	*Depth* m
Topsoil	0.35	0.35
Longstone Mudstones		
Mudstone, non-calcareous	1.80	2.20
Biomicrite, locally dark grey; scattered brachiopods, argillaceous, laminated toward base	1.30	3.50
Mudstone, calcareous, with *Martinia sp., Rugosochonetes sp.* and ostracods	2.97	6.47
Eyam Limestones		
Biomicrite, dark grey, argillaceous, locally pyritised; intercalations of mudstone, medium to dark grey, calcareous, limonitic	6.23	12.70
Biomicrite, predominantly dark grey, argillaceous, fine to medium calcarenite, corals including *Amplexizaphrentis derbiensis* (Lewis) at 12.85 m; dolomitisation at 12.80 m, patchy silicification	1.46	14.16
Mudstone, dark grey, calcareous	0.04	14.20
Biomicrite, mid-grey becoming brownish grey below 15.50 m, argillaceous, with fine arenitic bioclastic debris. Many thin clay stringers, scattered euhedral quartz crystals, local nodular and tabular cherts	2.65	16.85
Intrasparite, five graded units (turbidites), locally bioturbated; scattered pyrite crystals and rare chert nodules	1.91	18.76
Gap	1.12	19.88
Monsal Dale Limestones		
Micrite, finely laminated, (*Rosewood Marble?*), some slumping, microfaulting, brecciation. Locally cherty	4.56	24.44
Micrite, mid to dark grey, unfossiliferous, argillaceous, highly siliceous to 25.76 m, pale and dark cherts to 27.80 m, some pyrite. *Passes into*	9.56	34.00
Biomicrite, argillaceous, with comminuted fine arenite shell debris, silicified corals including *Fasciculophyllum sp.* at 37.00 m	4.68	38.68
Gap	0.39	39.07
Chert, pale grey, laminated	1.70	40.77
Gap	0.23	41.00
Micrite, dark grey, argillaceous, chert nodules common	2.28	43.28
Crinoidal biomicrite, dark grey; abundant medium arenite crinoid debris, subordinate brachiopods, spines and foraminifera. Sporadic chert. Very well sorted.	0.96	44.24
Micrite, dark grey, argillaceous, unfossiliferous, chert common. Thin calcareous mudstone at 48.26 m	4.79	49.03
Biomicrudite, abundant thick-shelled brachiopods, some partly silicified, and coral colony	0.47	49.50
Biomicrosparite, mid to dark grey, medium arenite size brachiopod and crinoid debris partly silicified	2.12	51.62
Chert, pale grey, bedded	0.42	52.04
Biomicrite, mid to dark grey, argillaceous to 54.43 m, abundant silicified brachiopods between 54.43 and 54.80 m and at 58.00 m	7.90	59.94
Biomicrosparite, alternating mid and dark grey, fine to medium arenite size bioclastic debris, sporadic chert nodules and some silicification of shells	6.02	65.96
Conksbury Bridge Lava		
Basalt, amygdaloidal. Biomicrite with contained fragments of basalt from 86.95 to 87.91 m	34.04	100.00

Borehole completed at 100.00 m


A
NW 13
LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
SORTING
FRACTURE INDEX (If.mm).
STRENGTH INDEX (Is MN/M)
A.I.V.
M
Si
clay
bitumen
Ca
Oil
FeS_2
28.1
18.4
25.3
24.6
28.8
25.7
40.0

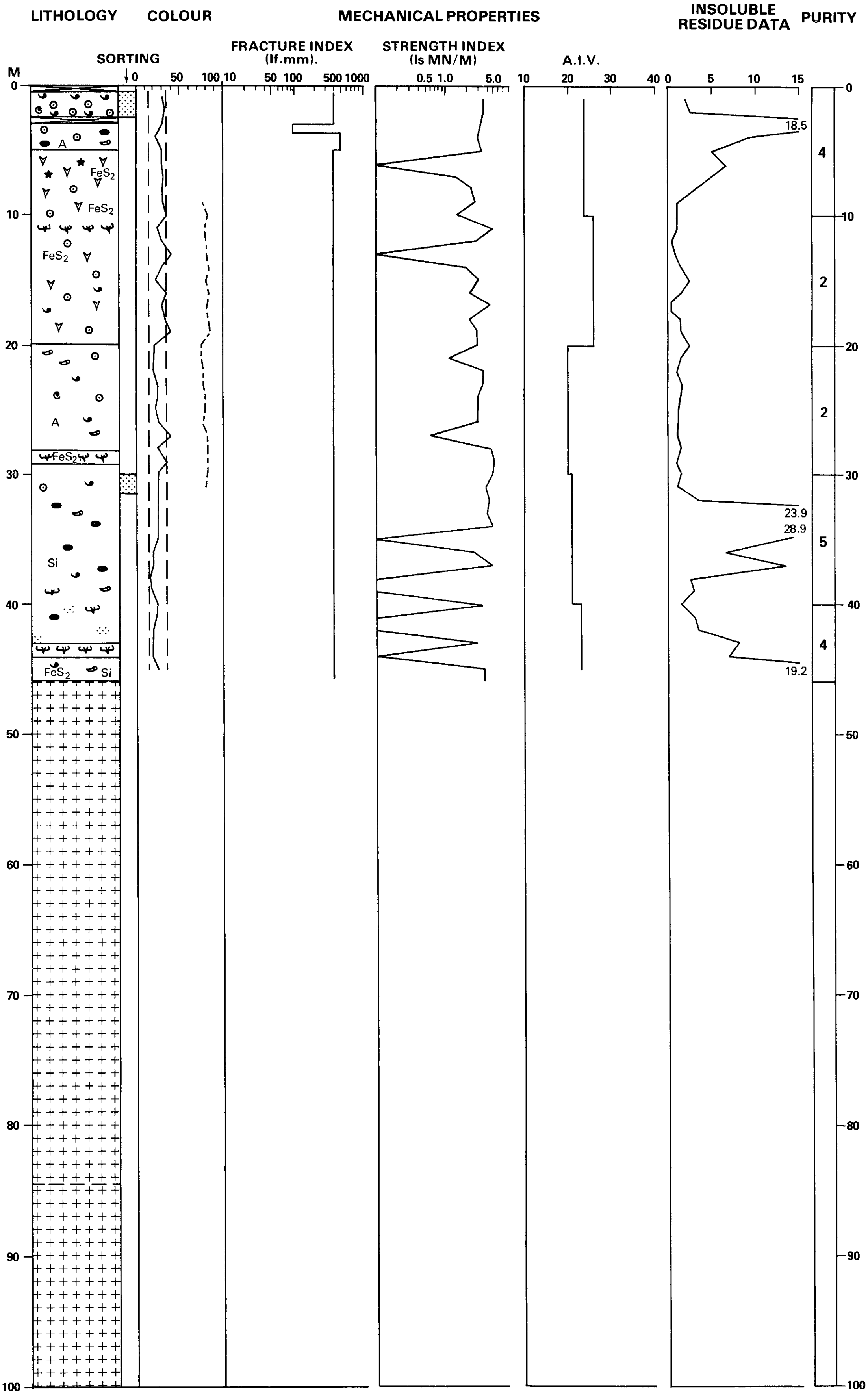
SK 26 NW 13 2142 6587 Conksbury Bridge **Block A**

Surface level + 196.2 m (+ 644 ft)
Edeco Stratadrill (waterflush) 47 mm diameter
February 1976

	Thickness m	*Depth* m
Pleistocene and Recent		
Boulder clay, red and brown with limestone, chert and sandstone fragments	1.20	1.20
Eyam Limestones		
Biomicrite, dark grey	0.25	1.45
Biomicrosparite; sporadic shell debris. *Passes into*	0.15	1.60
Biosparite, rare bryozoa	0.39	1.99
Biomicrite, dark grey, moderate sorting	0.11	2.10
Biosparite, medium calcarenite, containing moderately sorted crinoid and brachiopod debris. *Passes into*	1.00	3.10
Biomicrosparite, pale and mottled grey; orientated brachiopods, sporadic chert below 4.00 m	1.25	4.35
Biomicrite, argillaceous below 5.00 m, large bryozoa at 4.80 m	1.95	6.30
Biomicrosparite, dark grey, argillaceous below 7.00 m; tabular cherts between 6.70 and 6.75 m, rock totally silicified from 7.61 to 7.75 m	2.06	8.36
Gap	0.54	8.90
Dolomitic micrite, dark grey, unfossiliferous, with abundant disseminated dolomite rhombs	0.21	9.11
Biomicrosparite	0.76	9.87
Eyam Limestones (reef facies)		
Biomicrite, medium calcarenite; crinoid and bryozoan debris in partly silicified matrix; brachiopods and foraminifera increase below 13.30 m	5.09	14.96
Monsal Dale Limestones		
Biomicrosparite, mottled between 17.65 and 19.33 m and between 21.35 and 21.60 m; alternations of fine and coarse bioclastic shell debris to 17.65 m, corals including *Lithostrotion junceum* (Fleming) between 21.65 and 21.80 m, sporadic chert nodules	6.94	21.90
Coral band containing *Diphyphyllum lateseptatum* (McCoy), *Lithostrotion junceum*, *Lithostrotion portlocki* (Brown) and *Orionastraea sp.*	0.97	22.87
Biomicrite, pale buff, much fine arenite grade bioclastic debris	1.66	24.53
Biomicrosparite, pale buff, sporadically mottled, chert nodules common, bituminous from 27.41 to 27.61 m	7.99	32.52
Biomicrudite, buff-grey; abundant silicified brachiopods, sporadic chert nodules	0.68	33.20
Biomicrosparite; clay-filled stylolites common, patchy silicification throughout, quartz crystals common below 37.16 m. Oil-filled calcite veins from 35.10 to 35.23 m	4.62	37.82
Biosparite, pale buff, locally pelletal	2.78	40.60
Biomicrudite; abundant thick-shelled brachiopods, argillaceous and limonitic matrix	1.30	41.90
Clay, blue-grey	0.06	41.96
Brachiopod biomicrudite	0.82	42.78
Clay, blue-grey, pyritous. Weathered amygdaloidal basalt	0.47	43.25
Tuff, grey, pyritous; common patches of silica	0.62	43.87
Conksbury Bridge Lava		
Basalt, amygdaloidal, sporadic pyrite, rare autobrecciation	31.58	75.45
Tuff	0.45	75.90
Monsal Dale Limestones		
Biomicrosparite, patchy mottling, local abundant brachiopods—some partly silicified at 77.80 m	2.22	78.12
Brachiopod biosparrudite; most shells silicified	0.36	78.48
Biosparite, patchily mottled; *Lithostrotion junceum* at 83.50 m and *Palaeosmilia regia* (Phillips) at 87.37 m. Pyrite common. Base marked by layer of orientated brachiopods	7.77	88.25
Brachiopod biopelsparite, well-sorted bioclasts heavily encrusted with algal-coatings	0.59	88.84
Coral band, massive *Chaetetes* colony	0.09	88.93
Lathkill Lodge Lava		
Basalt, amygdaloidal, partly scoriaceous	21.42	110.35

Borehole completed at 110.35 m

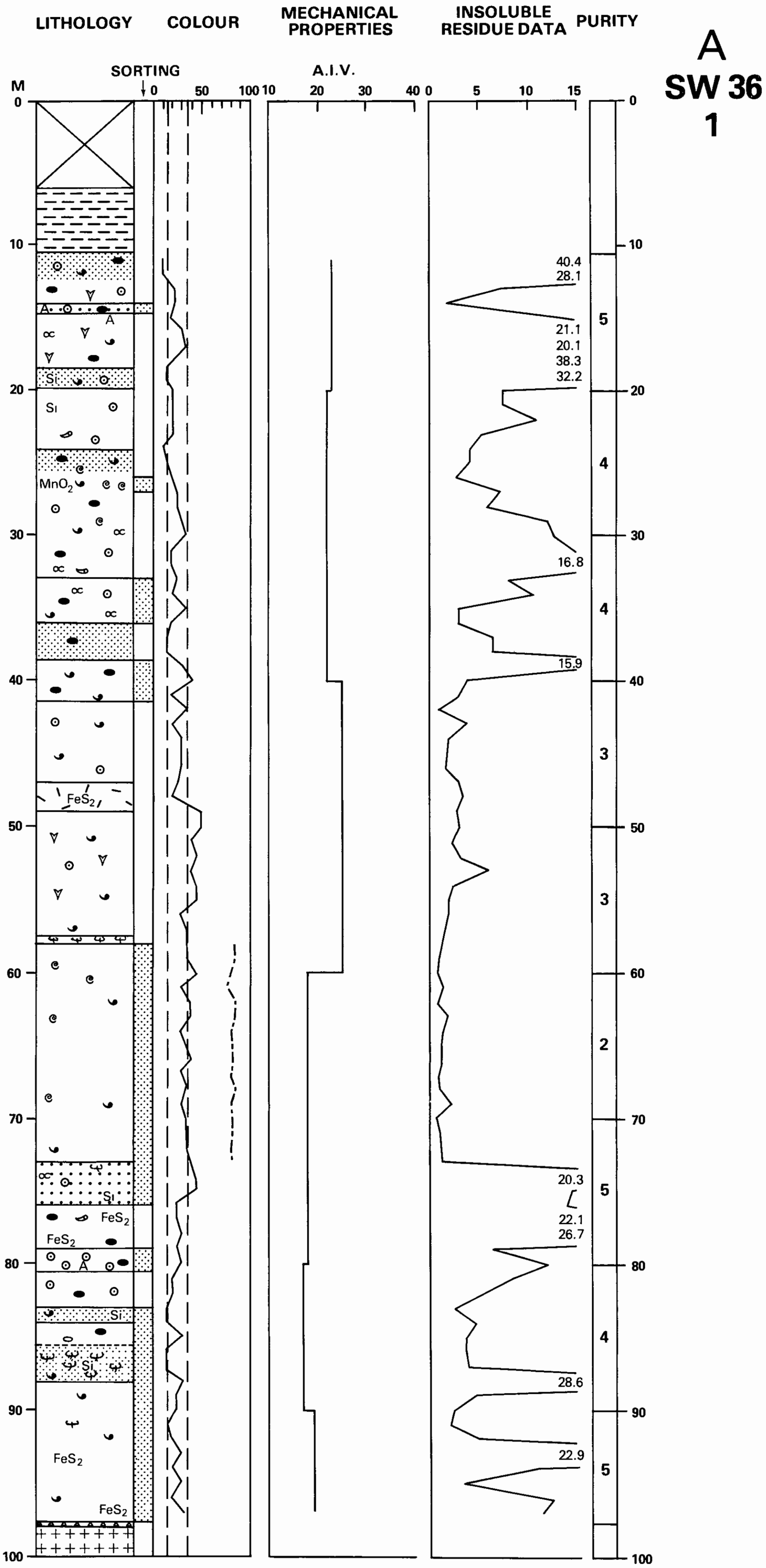
A NW 14



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
SORTING
FRACTURE INDEX (If.mm).
STRENGTH INDEX (Is MN/M)
A.I.V.
M
FeS2
Si
A
18.5
23.9
28.9
19.2

SK 26 NW 14 2369 6585 Nutseats Quarry **Block A**
Surface level +113.1 m (+371 ft)
Edeco Stratadrill (waterflush) 47 m diameter
January 1976

	Thickness m	*Depth* m
Made ground	0.30	0.30
Eyam Limestones		
Crinoidal brachiopod biosparite, medium to coarse calcarenite, shells partly silicified, foraminifera common below 1.50 m. Well-sorted assemblage	2.16	2.46
Gap	0.59	3.05
Biomicrite	0.62	3.67
Crinoidal biosparite, coarse calcarenite to fine calcirudite; solitary coral *Dibunophyllum sp.* at 4.15 m, sporadic small chert nodules	1.28	4.95
Eyam Limestones (reef facies)		
Bryozoan biomicrite, vuggy, with pyrite and carbonaceous material	3.08	8.03
Bryozoan crinoidal biosparrudite, solitary coral *Koninckopyllum sp.* at 9.85 m	2.71	10.74
Coral band with large specimens of *Koninckophyllum sp.* and *Rotiphyllum costatum* (McCoy). Calcite and pyrite veining from 12.88 to 12.97 m	2.23	12.97
Crinoidal biosparrudite, some bryozoa; mixed spar and micrite matrix. Locally pyritous	6.85	19.82
Monsal Dale Limestones		
Biomicrite; fine silicified bioclastic debris. Solitary coral *Amplexizaphrentis derbiensis* at 21.92 m. Influx of coarse arenite crinoid debris between 22.60 and 22.80 m. *Passes into*	3.49	23.31
Biomicrosparite, mid-grey, mottled	2.99	26.30
Biosparite, pale grey-buff, fine to medium calcarenite; algal-encrusted brachiopods throughout, corals at 26.72 m- *Diphyphyllum lateseptatum* and 27.80 m- *Koninckophyllum sp.* Small clusters of pyrite crystals at 27.56 m	1.51	27.81
Coral biomicrosparite; *Dibunophyllum sp., Diphyphyllum lateseptatum* and *Syringopora sp. Passes into*	1.99	29.80
Biosparite, pale grey-buff, mottled below 30.70 m	1.43	31.23
Biomicrosparite, mottled; coral (*Caninia sp.* (cornucopiae Michelin group)) at 33.20 m. Shells silicified below 35.00 m. Chert nodules common below 32.25 m	4.77	36.00
Biomicrite; chert nodules to 37.40 m. Many clay-filled stylolites	3.40	39.40
Biomicrosparite, mottled, with corals between 39.65 and 39.85 m—*Dibunophyllum bipartitum* (McCoy), *Diphyphyllum lateseptatum* and *Lithostrotion pauciradiale* (McCoy)	3.68	43.08
Coral biomicrosparite; large colonies of *Dibunophyllum bipartitum, Diphyphyllum lateseptatum, Lithostrotion junceum, L. pauciradiale* and *Nemistium edmondsi* (Smith). Much pyrites at base	2.76	45.84
Conksbury Bridge Lava		
Basalt, amygdaloidal, much pyrite, some lapilli, local calcite veining	38.81	84.65
Clay, grey	0.02	84.67
Lathkill Lodge Lava		
Basalt, dark green, locally amygdaloidal	15.38	100.05
Borehole completed at 100.05 m		



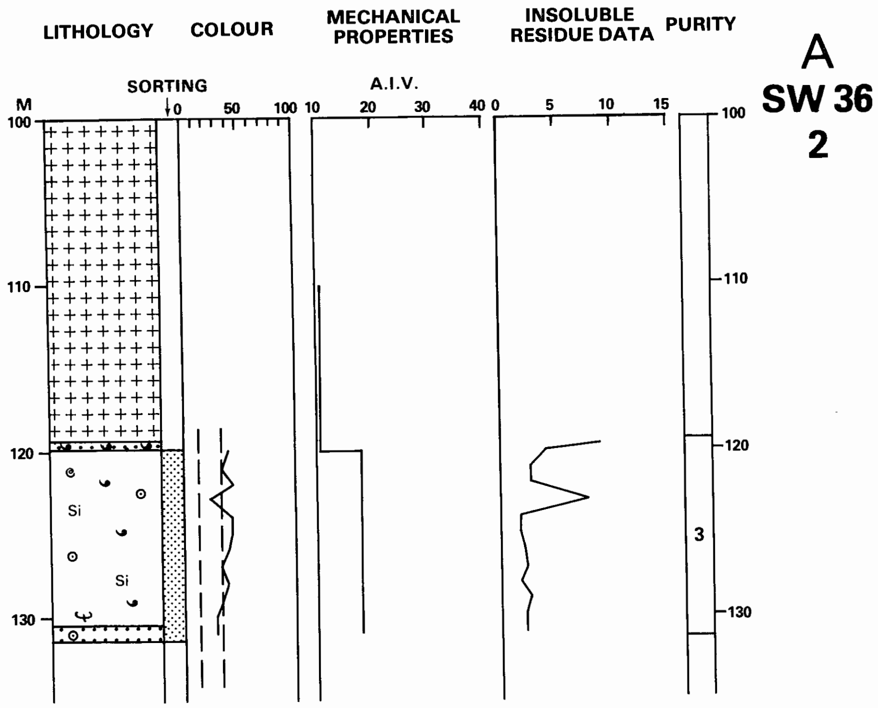
LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
SORTING
A.I.V.
M
A
SW 36
1
40.4
28.1
21.1
20.1
38.3
32.2
16.8
15.9
20.3
22.1
26.7
28.6
22.9

(*Contd*)

SK 26 SW 36 2325 6458 Bowers Hall **Block A**
Surface level c + 137 m (+ 450 ft)
1974

	Thickness m	Depth m
Gap	6.00	6.00
Longstone Mudstones		
Mudstone, dark grey	4.55	10.55
Eyam Limestones		
Crinoidal brachiopod biosparite, mid to dark grey, laminated, shells commonly silicified, sporadic chert	3.31	13.86
Pelsparite; algal-corroded shell debris. Some silicification	0.74	14.60
Biosparite; abundant dasycladacean algae at top and scattered bryozoa near base, matrix becomes more micritic towards base. Common chert	3.80	18.40
Biomicrite, dark grey; some silicification	1.30	19.70
Crinoidal biosparite, locally pelletal; scattered traces of green volcanic(?) detritus. Minor silicification. Oil present in cavities	4.00	23.70
Biomicrite, dark grey, cherty to 26.40 m, from 27.15 to 27.92 m and between 32.40 and 33.00 m. Alternating with biosparite, mid-grey, with algal-encrusted, calcarenite-grade bioclasts. Allochems well-sorted below 33.00 m	12.45	36.15
Crinoidal biomicrite, dark grey, cherty. Passing at 38.65 m into biosparite, pale grey, with well-sorted, fine arenite grade comminuted shell debris	5.27	41.42
Eyam Limestones (reef facies)		
Crinoidal biosparite; rudite crinoid debris common to 45.30 m, influx of bryozoa from 48.90 m to base. *Diphyphyllum* at 57.40 m. Well-developed vugs containing traces of oil between 47.00 and 48.84 m. Pyrite present along joints	16.58	58.00
Monsal Dale Limestones		
Biosparite; well-sorted bioclasts	14.70	72.70
Crinoidal biopelsparite; algal-corroded shell debris, partly silicified. Corals including *Palaeosmilia regia* and *Koninckophyllum magnificum* (Thomson and Nicholson) at 73.10 m. Sporadic small chert nodules	2.80	75.50
Biomicrite, cherty and pyritous	3.35	78.85
Crinoidal biosparite; well-sorted comminuted bioclasts. Traces of green volcanic (?) detritus. Minor silicification, sporadic cherts	1.74	80.59
Crinoidal biomicrite. Mudstone wisps. Local chert	2.41	83.00
Biopelsparite, quartz crystals throughout	1.00	84.00
Biomicrite, dark grey; coral band with *Lonsdaleia duplicata* (Martin) and *Nemistium edmondsi* from 85.50 to 87.79 m. Lithology is increasingly argillaceous and pyritous towards base	13.82	97.82
Tuff, green, pyritous	0.20	98.02

(Contd)



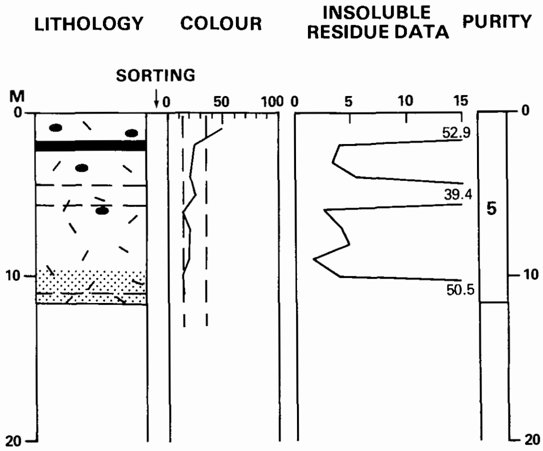
SK 26 SW 36 2325 6458 Bowers Hall Block A

Conksbury Bridge Lava		
Basalt, amygdaloidal to 107.00 m	21.13	119.15
Monsal Dale Limestones		
Brachiopod biomicrite, pale grey, locally pelletal	0.75	119.90
Biosparite, pale grey, medium to fine calcarenite with well-sorted bioclasts, local silicification	10.75	130.65
Pelsparite	0.75	131.40

Borehole completed at 131.40 m

A

NW 1S



SK 26 NW 1s 2133 6945 Holmebank Chert Quarry Block A

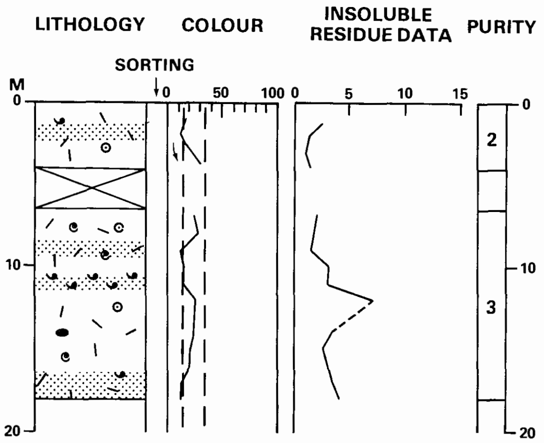
Surface level +180.8 m (+593 ft)

	Thickness	*Depth*
Monsal Dale Limestones	m	m
Biomicrite, scattered bioclastic debris, variable silicification, some chert nodules	8.00	8.00
Biomicrosparite, medium calcarenite. Brachiopod, crinoid and spine debris patchily silicified. Finely laminated towards base	2.00	10.00
Biomicrite, mid to dark grey, sparsely fossiliferous. Quartz crystals abundant in matrix	1.70	11.70

Section completed at 11.70 m

A

NW 2S

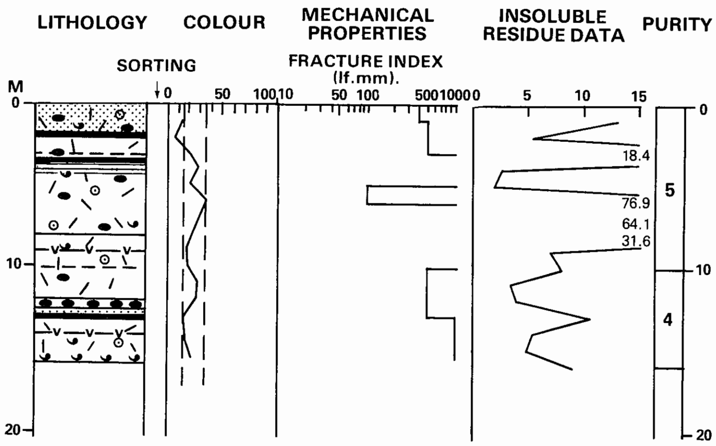


SK 26 NW 2s 2136 6894 Endcliff Wood Block A

Surface level +152.4 m (+506 ft)

	Thickness	*Depth*
Monsal Dale Limestones	m	m
Biomicrosparite, mid to dark grey, fine to medium calcarenite, with abundant brachiopod, crinoid and foraminiferal debris. Locally argillaceous. Shells partly silicified	4.00	4.00
Gap	2.50	6.50
Biosparite; well-sorted bioclasts showing selective silicification	1.50	8.00
Biomicrosparite, mid to dark grey, with abundant brachiopods between 10.80 and 11.00 m. Local patchy silicification	6.00	14.00
Biosparite; abundant bioclastic debris. Moderate to good sorting. Shells partly silicified	2.00	16.00
Biomicrosparite, mid to dark grey argillaceous towards base	2.00	18.00

Section completed at 18.00 m



A

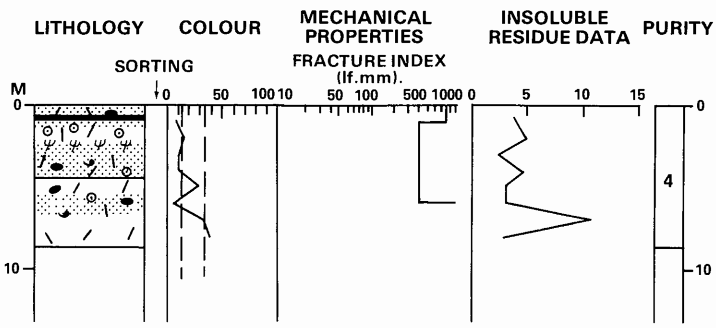
NW 3S

SK 26 NW 3s 2111 6819 Bank Top House **Block A**

Surface level + 179.3 m (+ 588 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, argillaceous, with tabular and nodular chert. Thin mudstone partings	2.75	2.75
Calcareous mudstone	0.15	2.90
Monsal Dale Limestones		
Biomicrite, laminated and bioturbated from 2.00 to 5.00 m. Cherty throughout. Clay wayboards at 8.90 and 14.00 m	11.10	14.00
Biosparite, medium to coarse calcarenite, with brachiopod, crinoid, foraminifera and spine debris. Moderate to good sorting. Silicified brachiopods common at base of unit	1.50	15.50

Section completed at 15.50 m



A

NW 4S

SK 26 NW 4s 2382 6577 Nutseats Quarry **Block A**

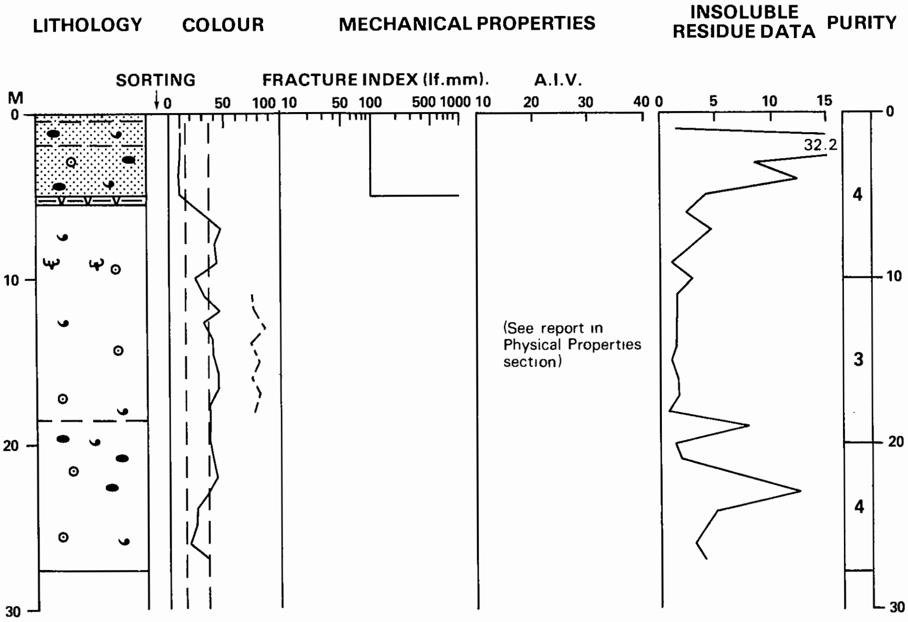
Surface level + 125.8 m (+ 413 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrosparite, dark grey to 4.50 m, buff-grey below, common crinoids at 2.00 m, coral bed at 2.50 m, scattered chert nodules, some silicification	8.75	8.75

Section completed at 8.75 m

Gap of 3.90 m between base of section and top of borehole 26 NW 14

A
NW 5S



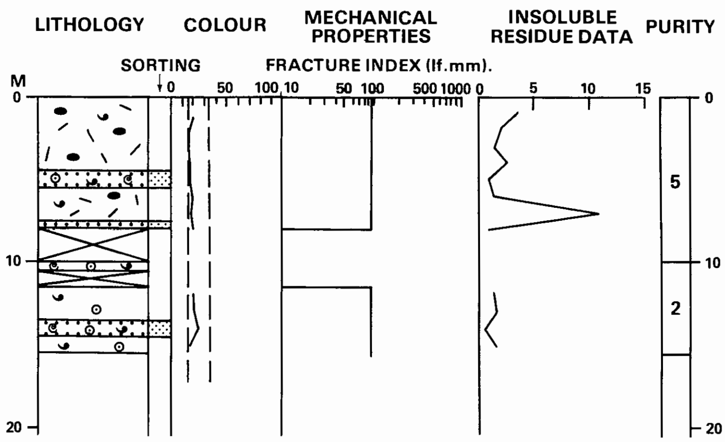
SK 26 NW 5s 2283 6505 Shining Bank Quarry Block A

Surface level +131.4 m (+431 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, scattered chert nodules, some silicification	5.00	5.00
Clay, grey, laminated, iron-stained	0.40	5.40
Monsal Dale Limestones		
Biomicrosparite; brachiopod and crinoid debris, *Lithostrotion vorticale* (Parkinson) at 9.00 m, some chert below 18.00 m, argillaceous at base	22.10	27.50

Section completed at 27.50 m (uppermost 16 m of exposed strata inaccessible)

A
NW 6S

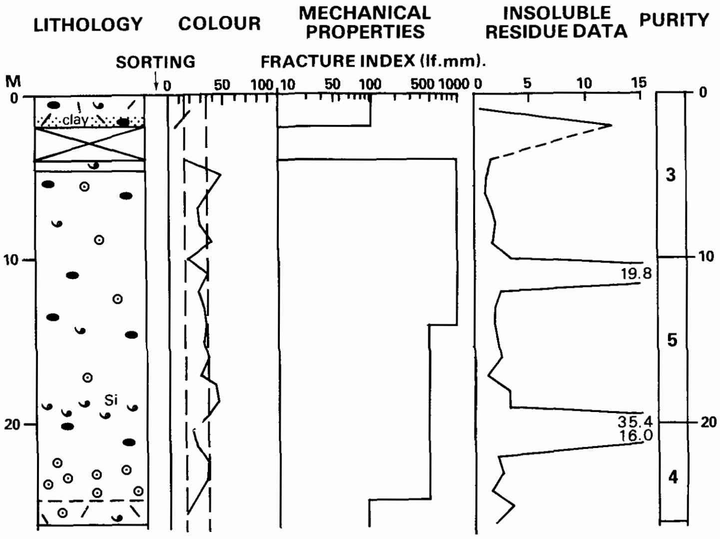


SK 26 NW6s 2034 6608 Lathkill Lodge Block A

Surface level +190.3 m (+624 ft)

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrite, patchy silicification of bioclastic debris. Sporadic chert nodules	4.00	4.00
Biopelsparite, well-sorted	1.00	5.00
Biomicrosparite, mostly finely comminuted bioclastic debris	2.00	7.00
Pelsparite, well-sorted	1.00	8.00
Gap	2.00	10.00
Biosparite, medium calcarenite	0.50	10.50
Gap	1.00	11.50
Biosparite, with abundant pelletal grains between 13.00 and 14.00 m	4.00	15.50

Section completed at 15.50 m

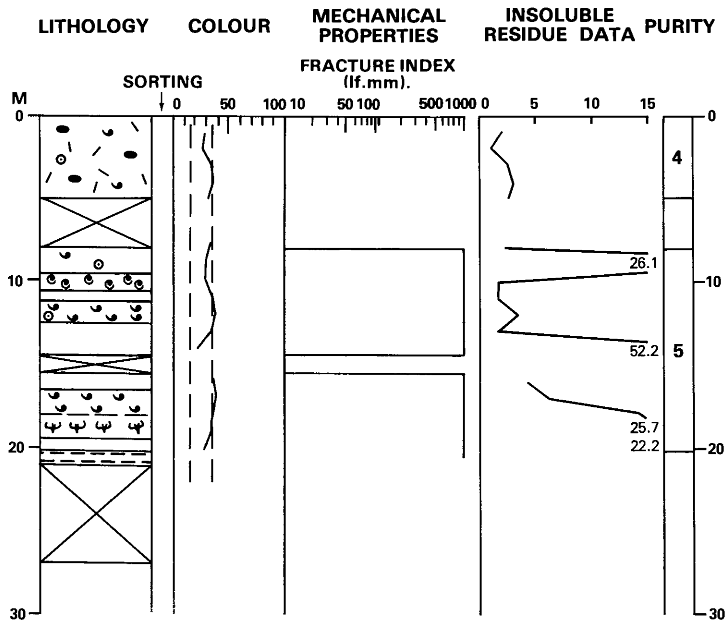


A
NW 7S

SK 26 NW 7s 2134 6556 Conksbury Bridge **Block A**

Surface level +182.9 m (+600 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, common chert nodules, clayey matrix at base	2.00	2.00
Gap	2.00	4.00
Monsal Dale Limestones		
Biomicrosparite, bioclastic debris common	4.00	8.00
Biomicrite, pale to mid-grey, clayey matrix in part	5.00	13.00
Biomicrosparite, mottled, mostly crinoid and brachiopod debris	5.00	18.00
Brachiopod biomicrosparrudite, shells patchily silicified	1.00	19.00
Biomicrosparite, some clay and chert	2.00	21.00
Crinoidal biosparite; subordinate brachiopod debris	3.00	24.00
Biomicrosparite; thin clay at 24.50 m	2.00	26.00
Section completed at 26.00 m		



A

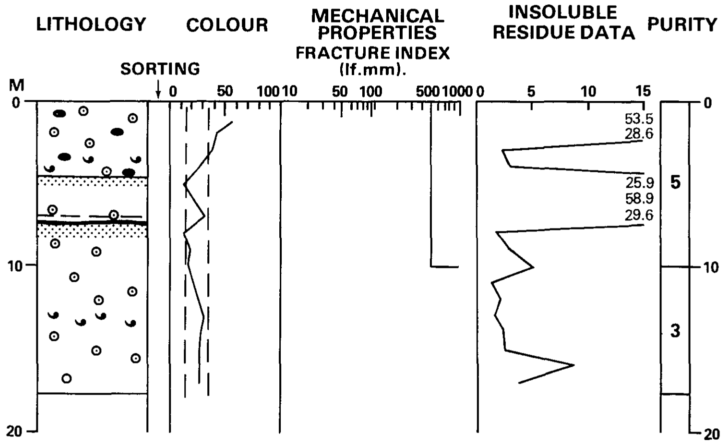
NW 8S

SK 26 NW 8s 2093 6498 Conksbury Lane Block A

Surface level +175.4 m (+576 ft)

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrosparite, fine to medium arenite grade brachiopod and crinoid debris, some chert	2.00	2.00
Biosparite, pale grey, abundant bioclastic debris	3.00	5.00
Gap	3.00	8.00
Biosparite, abundant foraminifera, matrix largely silicified	2.00	10.00
Biomicrosparite, pale grey, brachiopods common	2.00	12.00
Silica rock—altered wall-rock of Long Rake	2.00	14.00
Gap	1.00	15.00
Biosparite	1.00	16.00
Brachiopod biomicrosparrudite, shells variably silicified	2.00	18.00
Clay, grey	0.20	18.20
Biomicrosparite; large colony of *Lithostrotion pauciradiale*, disseminated clay in matrix	0.80	19.00
Silica rock—altered wall-rock	1.20	20.20
Clay, blue-grey and brown	1.00	21.20

Section seen to 27.00 m but rocks highly altered below 21.20 m

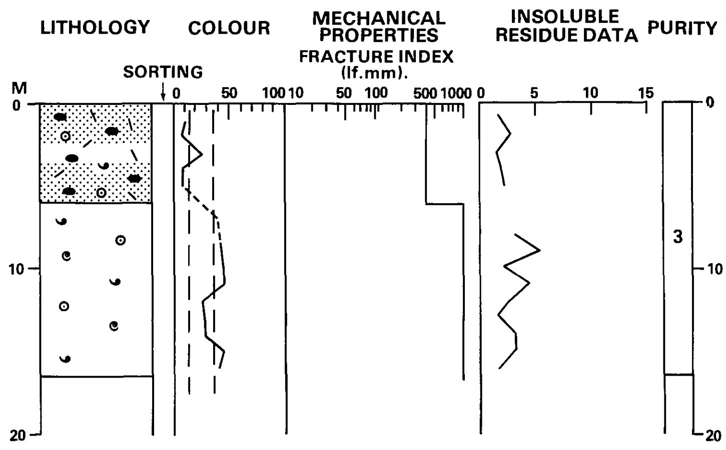


A
SW 1S

SK 26 SW 1s 2321 6397 Stanton Mill Quarry Block A
Surface level +145.4 m (+477 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Crinoidal biosparrudite, pale to dark grey, fining towards base; abundant current-sorted crinoid ossicles and brachiopods. Many small chert nodules. Thin mudstone at 8.25 m	10.80	10.80
Crinoidal biosparite, massive-bedded; shell horizon at 13.00 m, traces of bryozoa, micritic matrix locally, laminated and bioturbated at 15.00 m. Some silicification of bioclasts	6.80	17.60

Section completed at 17.60 m

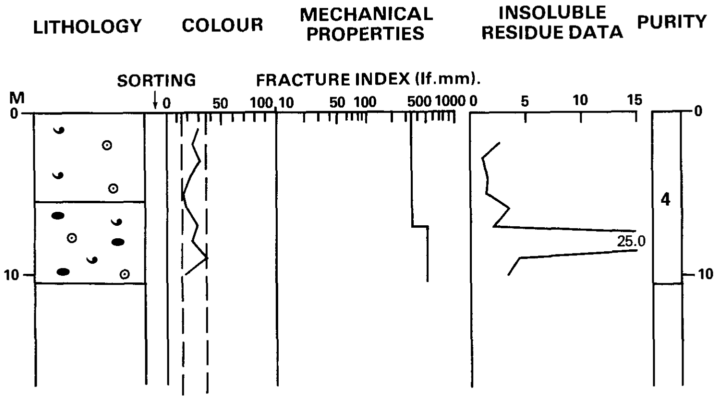


A
SW 2S

SK 26 SW 2s 2287 6460 Alport Flour Mill Block A
Surface level +155.4 m (+510 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, thinly-bedded; nodular and tabular cherts common	6.00	6.00
Monsal Dale Limestones		
Biomicrosparite, mottled, crinoids and brachiopods common locally	10.50	16.50

Section completed at 16.50 m



A

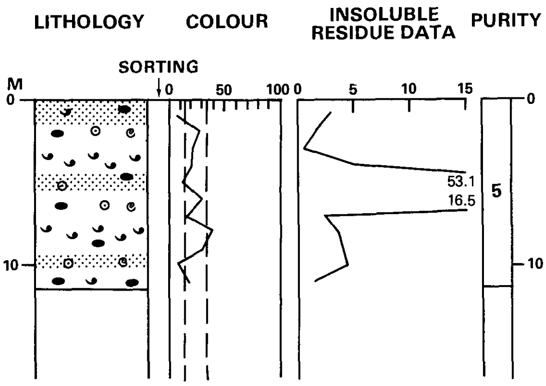
SW 3S

SK 26 SW 3s 2164 6416 Bradford Dale Block A

Surface level +158.7 m (+521 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, thinly-bedded, flaggy in part, bioclastic debris mainly composed of brachiopods and crinoids with some foraminifera	5.00	5.00
Biosparite, locally argillaceous with scattered chert nodules	4.00	9.00
Biomicrite; abundant nodular and tabular chert	1.40	10.40

Section completed at 10.40 m



A

SW 4S

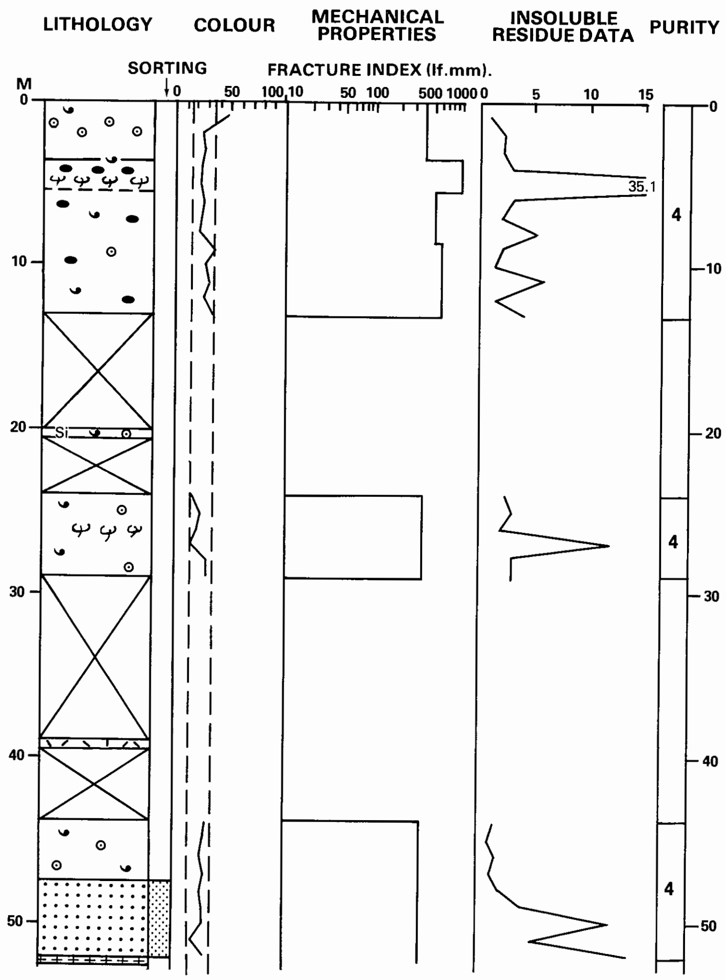
SK 26 SW 4s 2318 6473 Harthill Lodge Block A

Surface level +134.4 m (+441 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey; clayey matrix. Shells and matrix partly silicified	1.00	1.00
Biosparite; abundant bioclasts, influx of brachiopods between 3.00 and 4.00 m. some nodular and tabular chert	4.00	5.00
Biomicrite, dark grey becoming paler towards base, cherty	2.00	7.00
Brachiopod biomicrosparrudite; subordinate crinoid and foraminiferal debris	1.00	8.00
Biomicrosparite, mid to dark grey, cherty	3.25	11.25

Section completed at 11.25 m

A
SW 5S

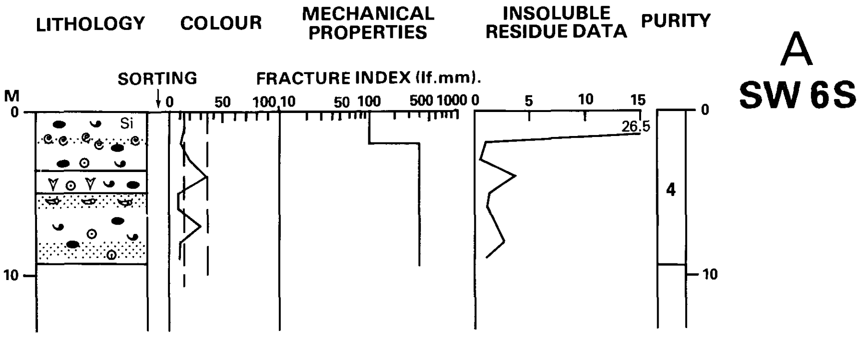


SK 26 SW 5s 2015 6381 Bradford Dale **Block A**

Surface level +210.4 m (+690 ft)

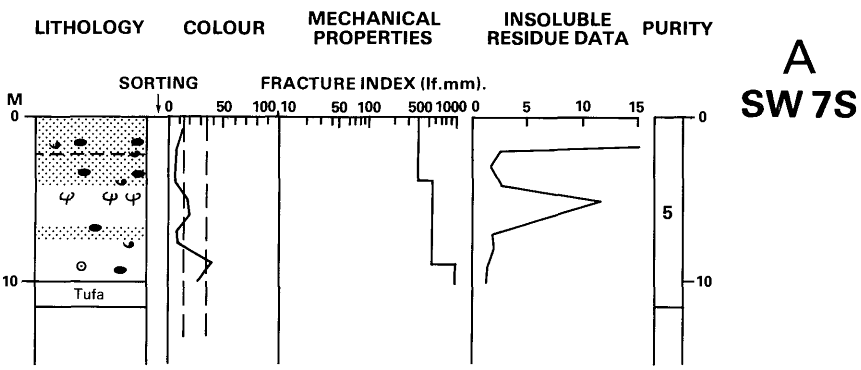
	Thickness m	*Depth* m
Monsal Dale Limestones		
Biosparite, rubbly-bedded; moderately sorted crinoid and brachiopod debris. Fewer allochems and more massively bedded below 1.60 m	3.60	3.60
Biomicrite, corals including *Lithostrotion sp.* between 4.00 and 5.50 m, scattered chert nodules. Patchy silicification of shells	9.40	13.00
Gap	7.00	20.00
Biomicrite, argillaceous; patchy silicification	0.50	20.50
Gap	3.50	24.00
Biomicrite, silicified corals at 27.00 m. Hematite staining at 28.00 m	5.00	29.00
Gap	10.00	39.00
Biomicrosparite, argillaceous	0.50	39.50
Gap	4.00	43.50
Biomicrosparite, mottled at 46.00 m	3.50	47.00
Biopelsparite, scattered crinoid and brachiopod debris, abundant euhedral quartz crystals	5.00	52.00
Lathkill Lodge Lava		
Basalt	0.50	52.50

Section completed at 52.50 m



SW 26 SW 6s 2169 6494 Lathkill Dale **Block A**

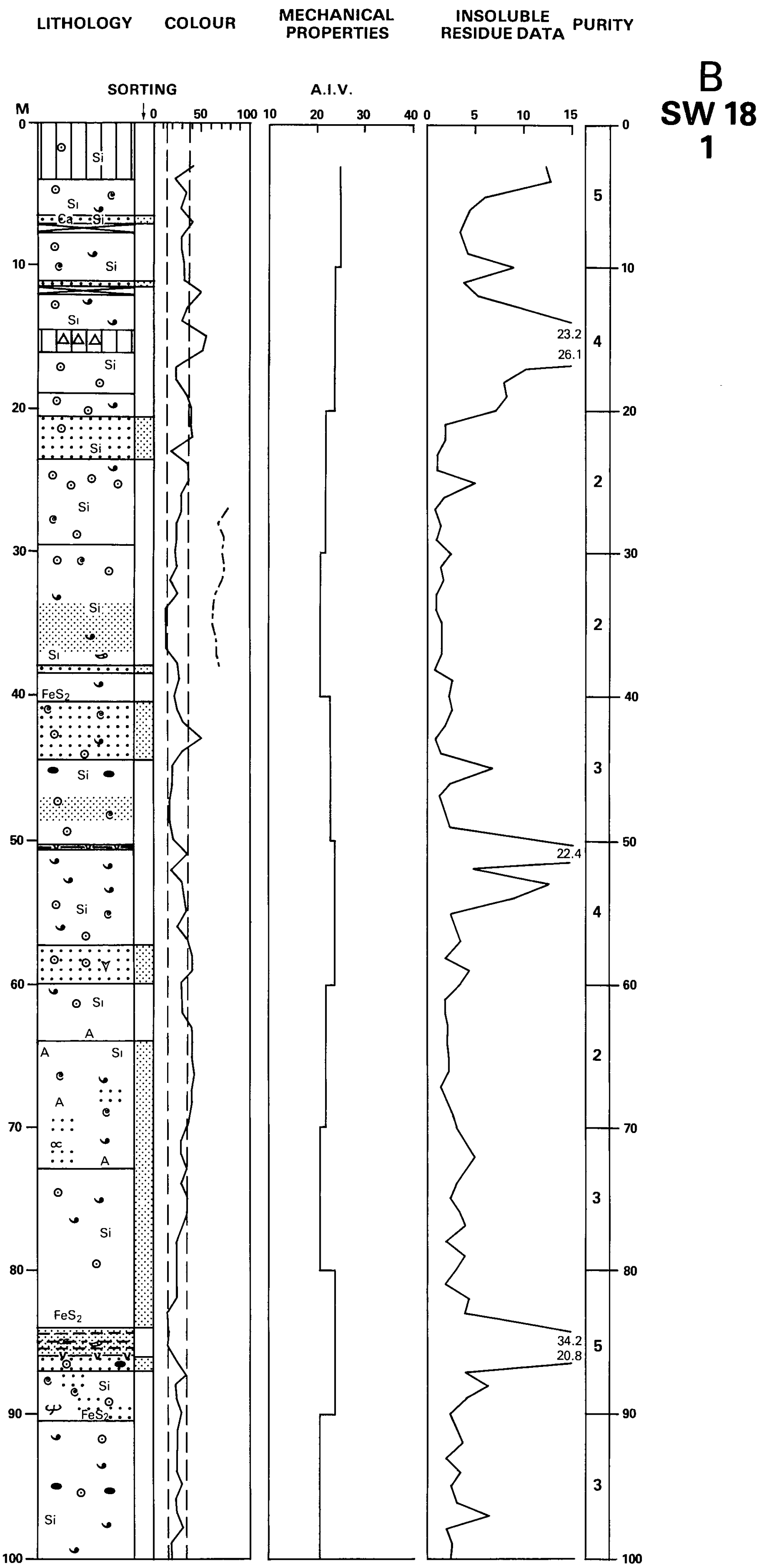
	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, mid-grey to 5.00 m, then alternating dark and mid-grey to base, clusters of foraminifera at 2.00 m and bryozoa fragments common between 4.00 and 5.00 m. Coral band at 6.50 m. Patchy silicification and scattered chert nodules	9.20	9.20
Section completed at 9.20 m		



SK 26 SW 7s 2197 6479 Lathkill Dale **Block A**

Surface level + 152.4 m (+ 500 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, very clayey matrix, common chert, some quartz crystals in matrix. Thin mudstone partings	4.00	4.00
Biomicrite; large silicified colony of *Lithostrotion sp.*	2.00	6.00
Biomicrite; clayey matrix, some chert nodules, leached relict rock below 8.00 m	4.00	10.00
Base of section concealed by tufa		
Section completed at 11.50 m		


LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
SORTING
A.I.V.
M
B
SW 18
1
23.2
26.1
22.4
34.2
20.8

(*Contd*)

SK 26 SW 18 2035 6034 Gratton Moor **Block B**
Surface level +289.5 m (+950 ft)
1973

	Thickness m	*Depth* m
Monsal Dale Limestones		
Dolomite, some crinoid ghosts, many quartz crystals	3.67	3.67
Biosparite, pale grey, medium calcarenite, pelletal towards base, local algal-encrusted brachiopod fragments. Many quartz crystals	3.27	6.94
Gap	0.59	7.53
Brachiopod biomicrudite; scattered quartz crystals and partially silicified shells. *Passes into*	3.54	11.07
Pelletal biosparite	0.19	11.26
Gap	0.30	11.56
Dolomite, vuggy	0.64	12.20
Biomicrite, with patchy dolomitisation along stylolites. Many quartz crystals	2.20	14.40
Dolomite, brecciated, some tuffaceous (?) debris	1.93	16.33
Biomicrite, dark grey calcarenite, highly silicified, patchy dolomitisation along stylolites	2.62	18.95
Biosparite, pale grey, moderately sorted mixed fauna; locally pelletal, quartz crystals throughout	1.72	20.67
Pelletal biosparite, pale grey, well-sorted fine arenite grade clasts, scattered quartz crystals	2.59	23.26
Crinoidal biosparite, pale to mid-grey, scattered brachiopods, traces of silicification and dolomitisation	2.24	25.60
Biomicrite, mid-grey, becoming darker grey below 27.00 m; fine arenite grade brachiopod, crinoid and foraminifera debris, quartz crystals throughout	4.44	29.04
Biosparite, mid-grey to 33.70 m, passing into biomicrite, dark grey; local brachiopod bands. Patchy silicification	9.36	38.40
Brachiopod pelsparite, well-sorted	0.49	38.89
Biomicrite, silicification along veins, some disseminated pyrite	1.66	40.55
Biopelsparite, abundant foraminifera at top, well-sorted, scattered quartz crystals	3.95	44.50
Biomicrite, mid- to dark grey; chert nodules at 45.05 m, argillaceous matrix. *Passes into*	5.90	50.40
Mudstone, red and grey	0.32	50.72
Brachiopod biomicrite with mudstone wisps, locally iron-stained, very argillaceous	3.22	53.94
Biosparite grading to biomicrite at 55.38 m, moderate to well-sorted, influx of quartz crystals at 56.63 m	3.41	57.35
Bee Low Limestones		
Crinoidal pelsparite, pale grey; micritised bioclasts, scattered quartz crystals	2.47	59.82
Biosparite, with arenite grade crinoids at top, passing into biomicrite at 60.80 m, *Coelosporella* common at 62.80 m	4.01	63.83
Pelletal biosparite, pale grey, well-sorted, abundant *Coelosporella*, laminated towards base	8.98	72.81
Biomicrite, pale to mid-grey, well-sorted comminuted brachiopod and crinoid debris, becoming darker-coloured and pyritic below 82.11 m. Hematitic staining at base	11.46	84.27
Shaly limestone, laminated, brecciated, with much hematitic staining	1.31	85.58
Mudstone, calcareous, sheared, volcanic (?)	0.18	85.76
Crinoidal biopelsparite; small chert nodules, abundant quartz crystals	1.14	86.90
Biosparite, *Lithostrotion maccoyanum* (Milne Edwards and Haime) at 89.14 m, chert nodule at 87.72 m	3.45	90.35
Biomicrite, crinoidal at top, abundant quartz crystals, traces of pyrite. Small chert nodules at 96.68 m. *Passes into*	13.36	103.71

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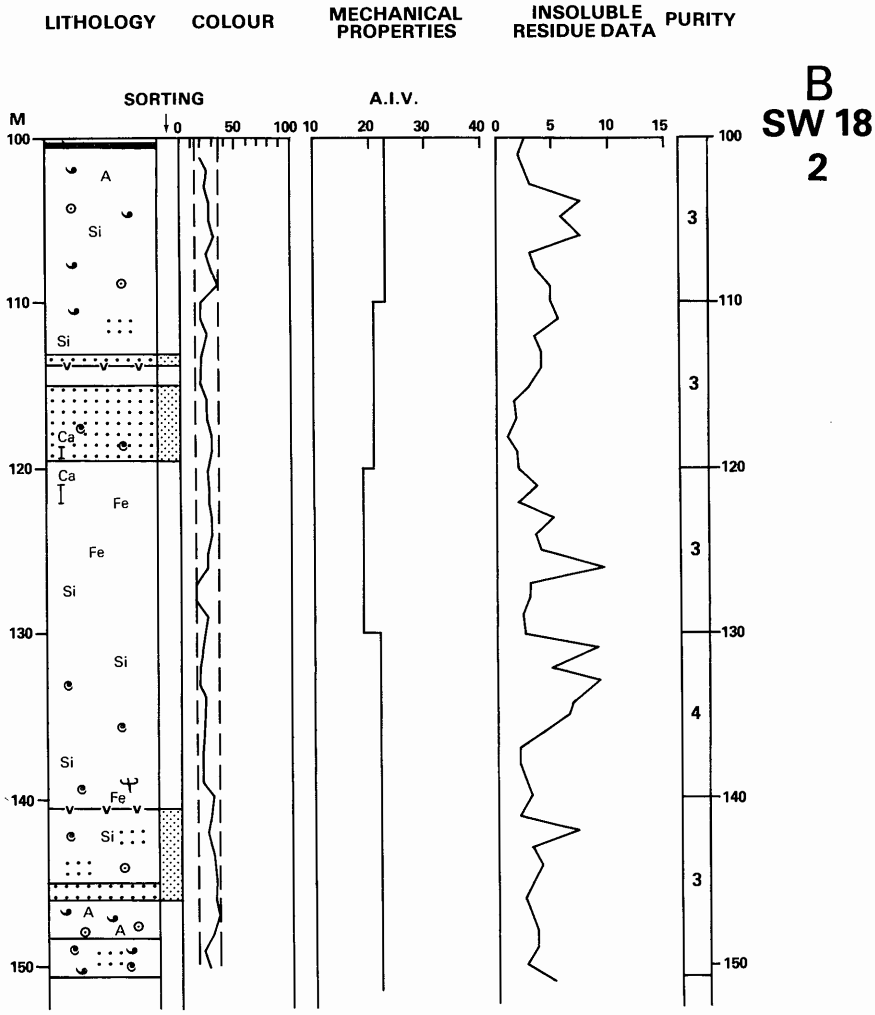
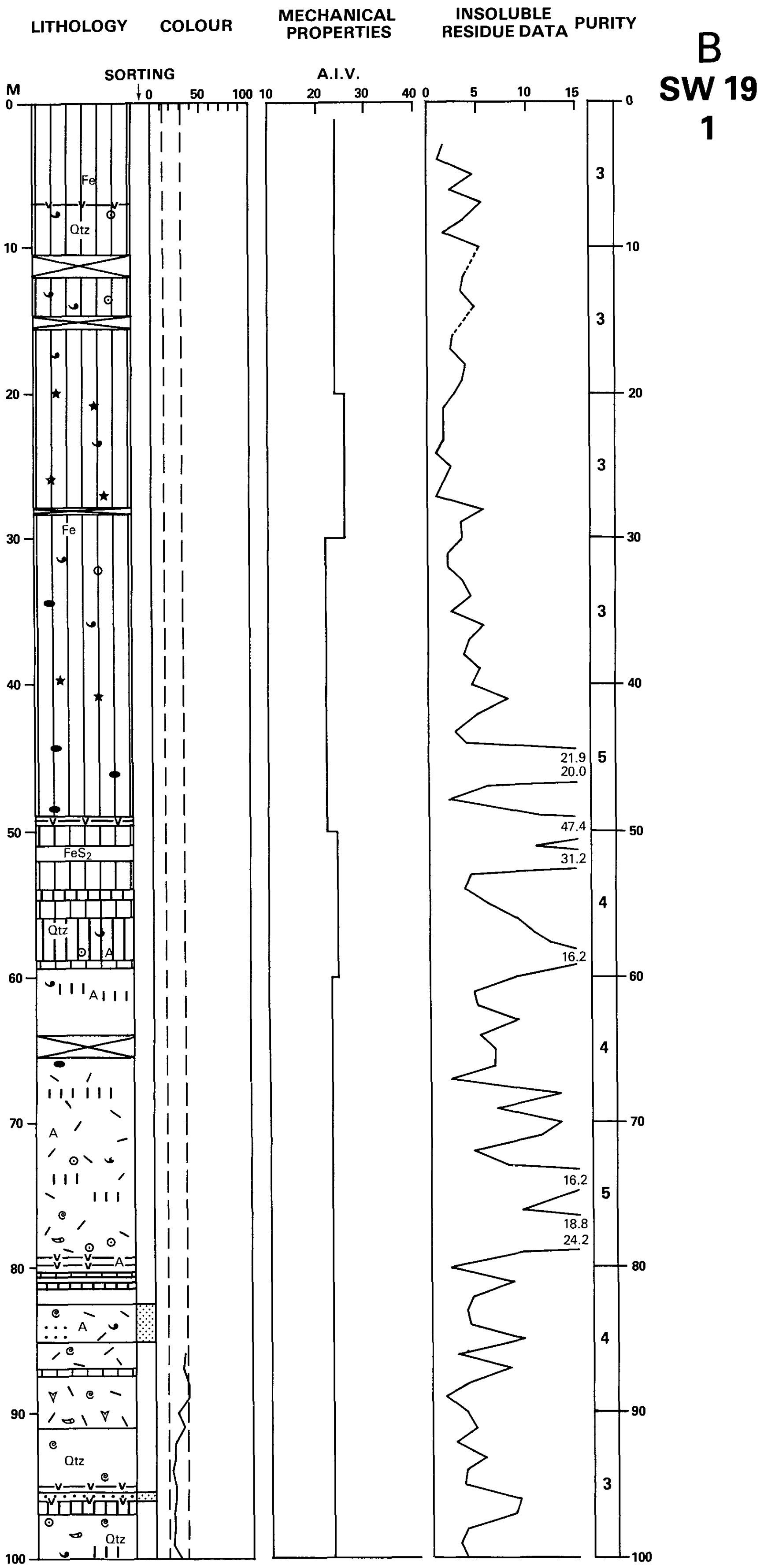


SK 26 SW 18   2035 6034   Gratton Moor   Block B

Tuffaceous limestone, green clay in a calcareous matrix	0.17	103.88
Biomicrite, mottled below 104.40 m, moderate sorting with crinoid, brachiopod and *Coelosporella* debris, becoming pelletal at base. Patchy silicification	8.23	112.01
Pelsparite	1.18	113.19
Tuffaceous mudstone, green	0.09	113.28
Crinoidal biomicrite, mottled grey to dark grey	1.68	114.96
Biopelsparite	4.43	119.39
Biomicrite, passing into biosparite at 135.64 m, much comminuted debris, silicified colonial coral at 138.85 m, common hematite veins, patchy silicification. Disseminated dolomite rhombs at 138.85 m	20.93	140.32
Calcareous mudstone, green and red	0.15	140.48
Pelletal biosparite, fine calcarenite, many quartz crystals. *Passes into*	4.77	145.25
Pelsparite. *Passes into*	0.73	145.98
Biosparite, medium calcarenite with crinoid, brachiopod and dasycladacean algal fragments	2.22	148.20
Foraminiferal biosparite, mid-grey, becoming dark at 148.93 m, some pelletal grains	2.52	150.72

Borehole completed at 150.72 m



LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
B
SW 19
1
SORTING
A.I.V.
M
0
10
20
30
40
50
60
70
80
90
100
Fe
Qtz
FeS2
A
21.9
20.0
47.4
31.2
16.2
16.2
18.8
24.2
3
3
3
3
5
4
4
5
4
3

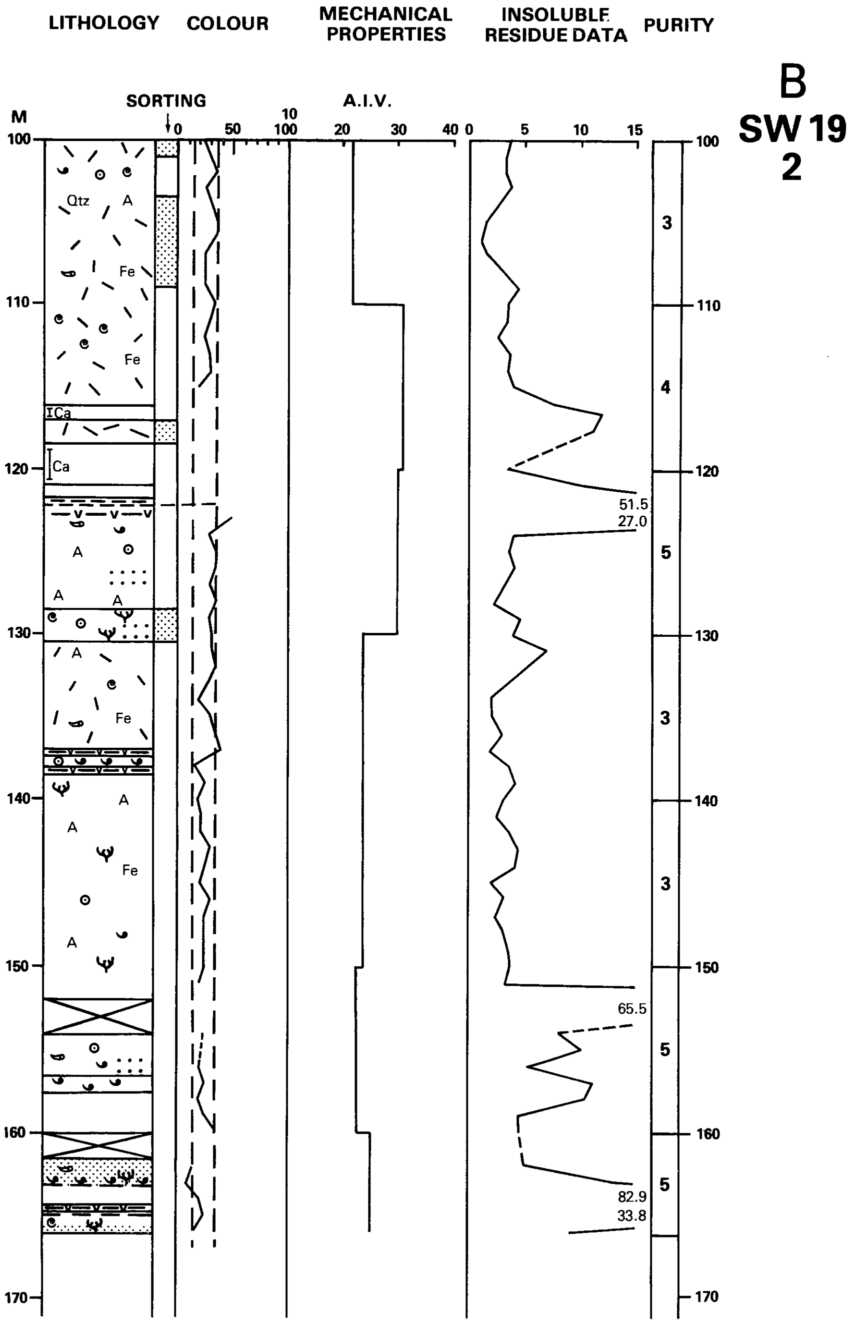
(*Contd*)

SK 26 SW 19 2027 6025 Gratton Moor **Block B**
Surface level +287.7 m (+944 ft)
1973

	Thickness m	*Depth* m
Monsal Dale Limestones		
Dolomite, massive, vuggy, granular, patchy iron-staining, pale green clay at 7.05 m	10.54	10.54
Gap	1.34	11.88
Dolomite, fine-grained, massive	2.81	14.69
Gap	0.71	15.40
Dolomite	0.71	16.11
Gap	0.37	16.48
Bee Low Limestones		
Dolomite, some brachiopod and crinoid moulds, barytes vein at 18.00 m, calcite-filled vugs below 19.70 m	9.12	27.36
Gap	0.59	27.95
Dolomite, brecciated to 30.32 m, partially dolomitised brachiopod and crinoid debris, sporadic chert nodules, some calcite-veining, rare small vugs	21.44	49.39
Mudstone, red and grey, calcareous	0.35	49.74
Dolomite, granular. *Passes into*	1.11	50.85
Biomicrite, mid-grey, rare fine arenite bioclastic debris, scattered dolomite rhombs to 51.00 m, mottled below 51.20 m, clayey matrix, pyrite at base	1.18	52.03
Mudstone, grey	0.14	52.17
Dolomite, massive, granular, sometimes vuggy, with thin limestone bands	1.95	54.12
Biosparite, some patchy dolomitisation	0.63	54.75
Dolomitic biosparite; widely scattered dolomite rhombs	0.95	55.70
Biosparite, pale grey, rare *Koninckopora* at 57.82 and 58.33 m, many euhedral quartz crystals, patchy dolomitisation	3.03	58.73
Dolomite	0.51	59.24
Biosparite, some *Koninckopora* below 60.18 m, patchy dolomitisation	4.84	64.08
Gap	1.53	65.81
Biomicrite, cherty at top, dolomitic between 67.50 and 67.73 m	5.22	70.83
Biosparite; thin-shelled brachiopods at 71.65 m, mottled below 73.50 m, patchily dolomitised at 73.66 m	2.92	73.75
Biomicrite, dolomite rhombs to 74.68 m, bitumen in matrix at 76.20 m	2.75	76.50
Biosparite, locally mottled. Green clays at 79.40 and 79.65 m	4.04	80.54
Dolomitic biosparite	0.31	80.85
Biosparite, mottled below 86.40 m, well-sorted bioclasts; traces of *Koninckopora* at 84.09 m, patchy dolomitisation from 82.47 to 82.67 m and around 84.45 m	6.16	87.01
Dolomite	0.28	87.29
Biosparite, mottled below 89.55 m, *Dibunophyllum sp.* at 91.08 m, euhedral quartz crystals in matrix	3.91	91.20
Biomicrosparite, mottled. Clay at 95.16 m. Silicified towards base	4.50	95.70
Biopelsparite	0.25	95.95
Clay, red and orange	0.22	96.17
Dolomitic biomicrosparite, some silicification	0.58	96.75

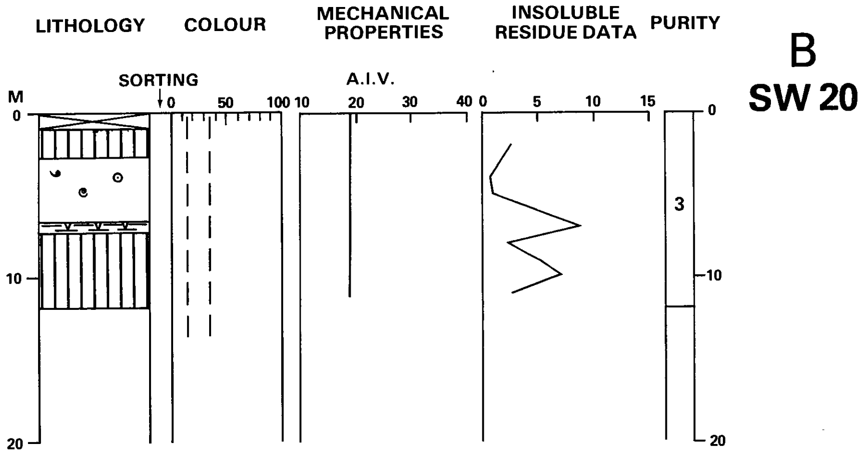
(*Contd*)

SK 26 SW 19   2027 6025   Gratton Moor   Block B



Biosparite grading to biomicrosparite, locally mottled, patchy dolomitisation, quartz crystals and silicification common	19.20	115.95
Calcite vein	1.07	117.02
Biomicrite; fine bioclastic debris	1.42	118.44
Calcite vein	2.72	121.16
Limestone, altered	0.59	121.75
Marl, pale buff, conchoidal fracture	0.48	122.23
Biomicrosparite, argillaceous at top, with fragments of *Koninckopora*. Clay parting at 123.17 m. Sporadic corals including *Syringopora* at 128.41 and 129.80 m, and *Lithostrotion martini* (Milne Edwards and Haime) at 130.28 m	14.79	137.22
Clay, greenish-grey and white	0.40	137.62
Biomicrosparite, with abundant thin-shelled brachiopods and crinoid ossicles	0.32	137.94
Clay, yellowish-brown	0.51	138.45
Biosparite; sporadic corals including *Chaetetes* at 139.32 and 144.26 m, and *Syringopora* at 150.00 m, *Koninckopora* occurs throughout	13.35	151.80
Gap	2.17	153.97
Biosparite; *Axophyllum vaughani* (Salée) at 155.50 m. Passing into brachiopod biosparite at 156.34 m	3.32	157.29
Biomicrite, with *Lithostrotion sp.* at 159.89. m	2.66	159.95
Gap	1.30	161.25
Biomicrite, dark grey, argillaceous, corals including *Diphyphyllum sp.* at 161.31 m and *Lithostrotion junceum* at 162.14 m, abundant brachiopods at base	2.05	163.30
Mudstone, dark grey, calcareous	0.03	163.33
Biomicrite	0.92	164.25
Mudstone, grey and orange	0.38	164.63
Biomicrite, pale but becoming darker towards base. Thin clay at 164.81 m. Flattened *Lithostrotion junceum* at 165.58 m	1.42	166.05

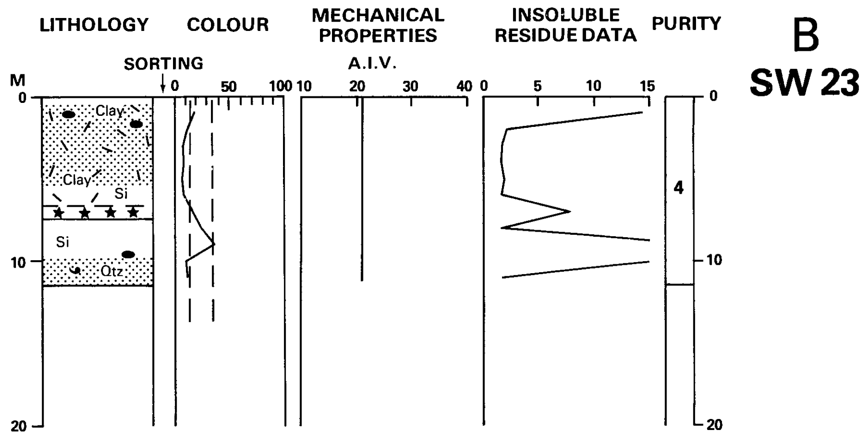
Borehole completed at 166.05 m



SK 26 SW 20 2045 6048 Gratton Moor Farm **Block B**
Surface level +270.0 m (+886 ft)
1973

	Thickness m	*Depth* m
Gap	1.10	1.10
Monsal Dale Limestones		
Dolomite, buff-grey, vuggy, granular, with brachiopod and crinoid moulds	1.67	2.77
Biomicrosparite, with scattered fine to medium arenite grade brachiopod and crinoid debris	3.87	6.64
Clay, brown, calcareous	0.55	7.19
Dolomite, buff-grey, granular, with some small vugs	4.71	11.90

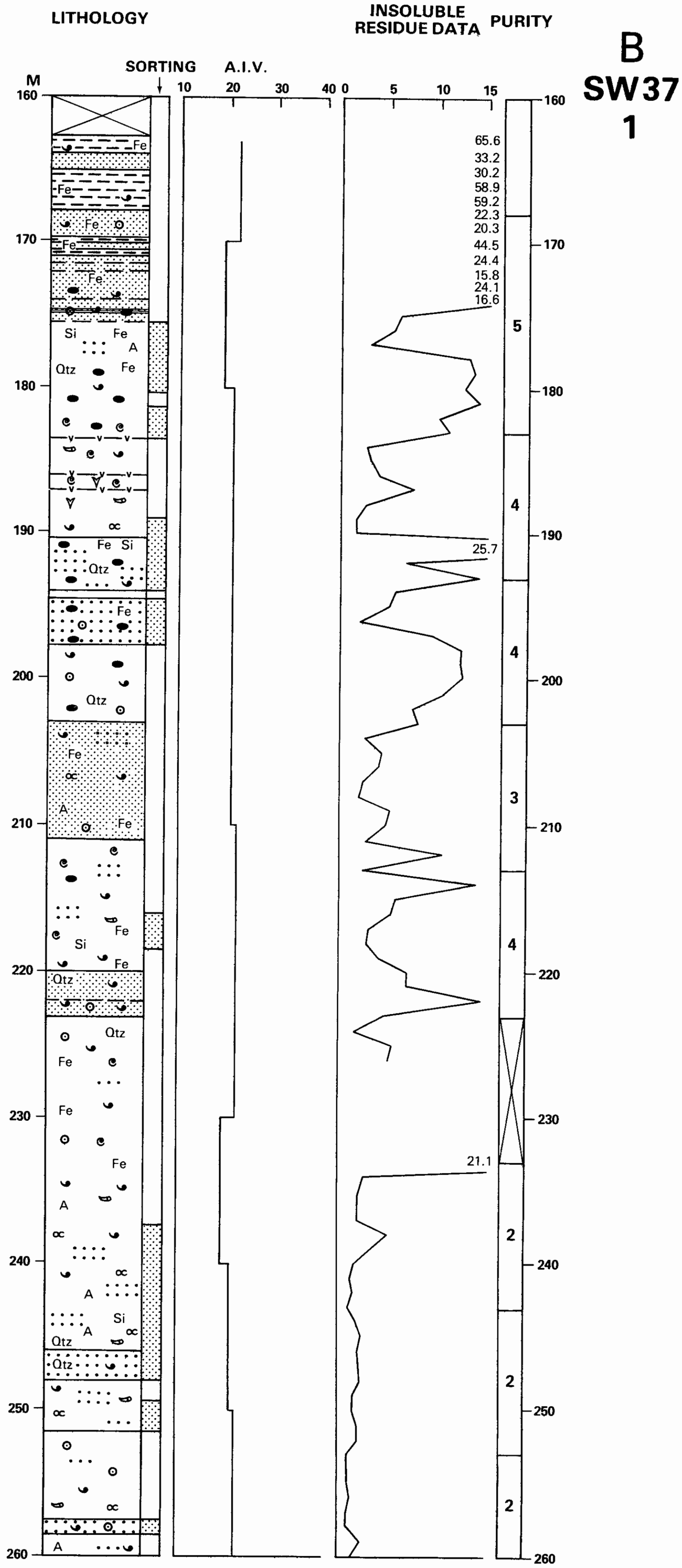
No chemical data available



SK 26 SW 23 2003 6155 Smerrill Grange **Block B**
Surface level +258.2 m (+847 ft)
1973

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrite, dark grey with an argillaceous matrix, chert nodules to 2.00 m, some silicification of shells, scattered euhedral quartz crystals	6.61	6.61
Clay, medium to dark grey, silty	0.11	6.72
Biomicrite, abundant calcispheres, common spar-filled cavities showing geopetal structures	0.65	7.37
Biomicrosparite, pale grey, bioclasts partly silicified, chert nodules at base	2.54	9.91
Biomicrite, dark grey, argillaceous, euhedral quartz crystals throughout	1.56	11.47

No chemical data available


LITHOLOGY
SORTING
A.I.V.
INSOLUBLE RESIDUE DATA
PURITY
B
SW37
1
M
65.6
33.2
30.2
58.9
59.2
22.3
20.3
44.5
24.4
15.8
24.1
16.6
25.7
21.1
5
4
4
3
4
2
2
2

(*Contd*)

SK 26 SW 37 2444 6154 Upper Town, Birchover Block B
Surface level +262.7 m (+862 ft)
1974

	Thickness m	*Depth* m
Namurian sandstones and shales	162.76	162.76
Longstone Mudstones		
Mudstone, black, calcareous, pyritised	1.25	164.01
Eyam Limestones		
Biomicrite, black, argillaceous, with disseminated pyrite	0.93	164.94
Mudstone, black calcareous. Thin limestone developed at 165.23 m	2.81	167.75
Biomicrite, black, argillaceous. Thin mudstone intercalations. Disseminated and nodular pyrite common	1.91	169.66
Mudstone, black, calcareous, pyritised	0.40	170.06
Micrite, black, argillaceous	0.30	170.36
Mudstone	0.38	170.74
Biomicrite, black, argillaceous, with thin mudstone intercalations, pyritous, sporadic chert nodules at 173.76 m	3.38	174.12
Biomicrosparite, dark grey-brown, common bioclasts—mainly broken shell and crinoid debris. Thin mudstone at base	0.28	174.40
Micrite, dark buff-grey, irregularly laminated (0.24 mm to 3.2 mm). Common euhedral quartz crystals	0.56	174.96
Biomicrite, dark grey, fine indeterminate comminuted debris, small chert nodules near top	0.70	175.66
Monsal Dale Limestones		
Biosparite, mid-grey, fine arenite grade pelletal grains present below 175.76 m. Passes into biopelsparite below 179.20 m. Locally cherty. Traces of silicification and flecks of iron ore common throughout. *Passes into*	4.58	180.24
Biomicrite, buff-grey, laminated in part, with abundant chert nodules and scattered quartz crystals. Patchy dolomitisation at 180.96 m. *Passes into*	0.98	181.22
Biosparite, grey-brown, fine arenite grade pellets and comminuted bioclastic debris, common foraminifera, influx of brachiopods between 184.20 and 184.91 m, abundant corals below 187 m. Thin ochreous clays at 183.31 m, 185.90 m and 186.90 m. Sporadic cherts at 182.00 m	8.98	190.20
Biopelsparite, buff-grey, very fine calcarenite, with large chert nodules, local stylolite swarms. *Passes into*	3.56	193.76
Biomicrite	0.64	194.40
Pelsparite, pale but becoming darker at 196.64 m, grey and black cherts, scattered quartz crystals	3.30	197.70
Biomicrite, grey-brown, locally argillaceous, cherty	5.18	202.88
Biosparite, mid to dark grey, argillaceous, traces of encrusting algae at 206.50 m, local pyrite veining	8.32	211.20
Biosparite, mid-grey, finely comminuted and tightly packed bioclastic debris and pelletal grains, abundant small colonial corals between 216.48 and 216.88 m, black chert nodules from 212.36 to 212.80 m	8.42	219.62
Biomicrite, buff-grey, with slender shells orientated parallel to bedding	0.36	219.98
Biosparite, dark grey-black, argillaceous, with abundant brachiopods at 222.59 m. Thin calcareous mudstone at 222.22 m	2.74	222.72
Biosparite, grey-brown, locally micritic, scattered thick-shelled brachiopods with algal encrustations, rare *Coelosporella* from 236.48 to 238.80 m, increasing pelletal grains below 237.20 m. *Passes into*	18.72	241.41
Biopelsparite, buff-grey, with algal-encrusted brachiopods and dasycladacean algal fragments, patchy silicification and scattered quartz crystals. *Passes into*	12.96	254.40
Biosparite, grey-brown, mottled, some encrusting algae, abundant colonial corals from 255.00 to 255.06 m	3.33	257.73
Biopelsparite	0.68	258.41

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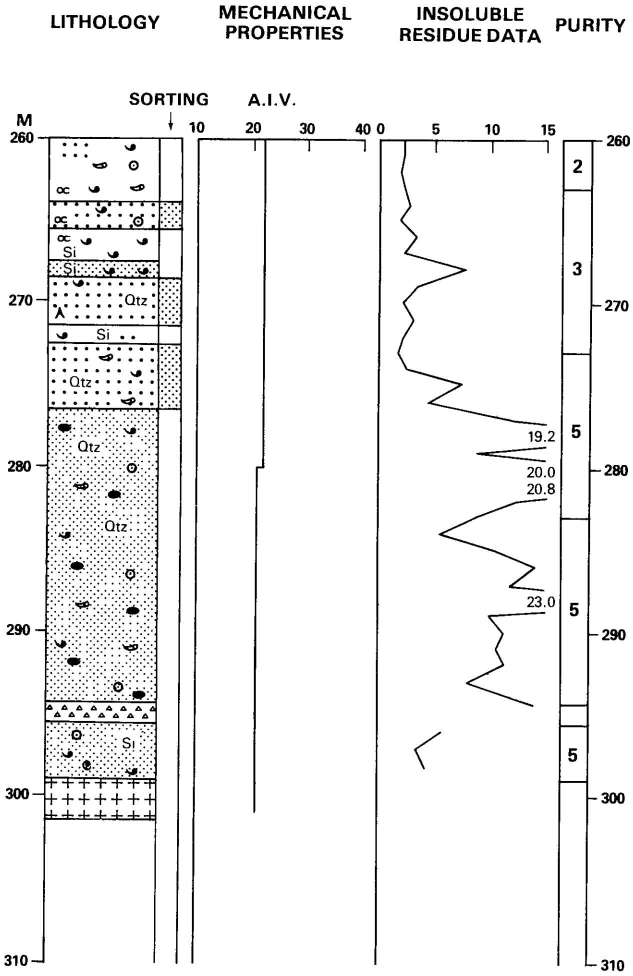
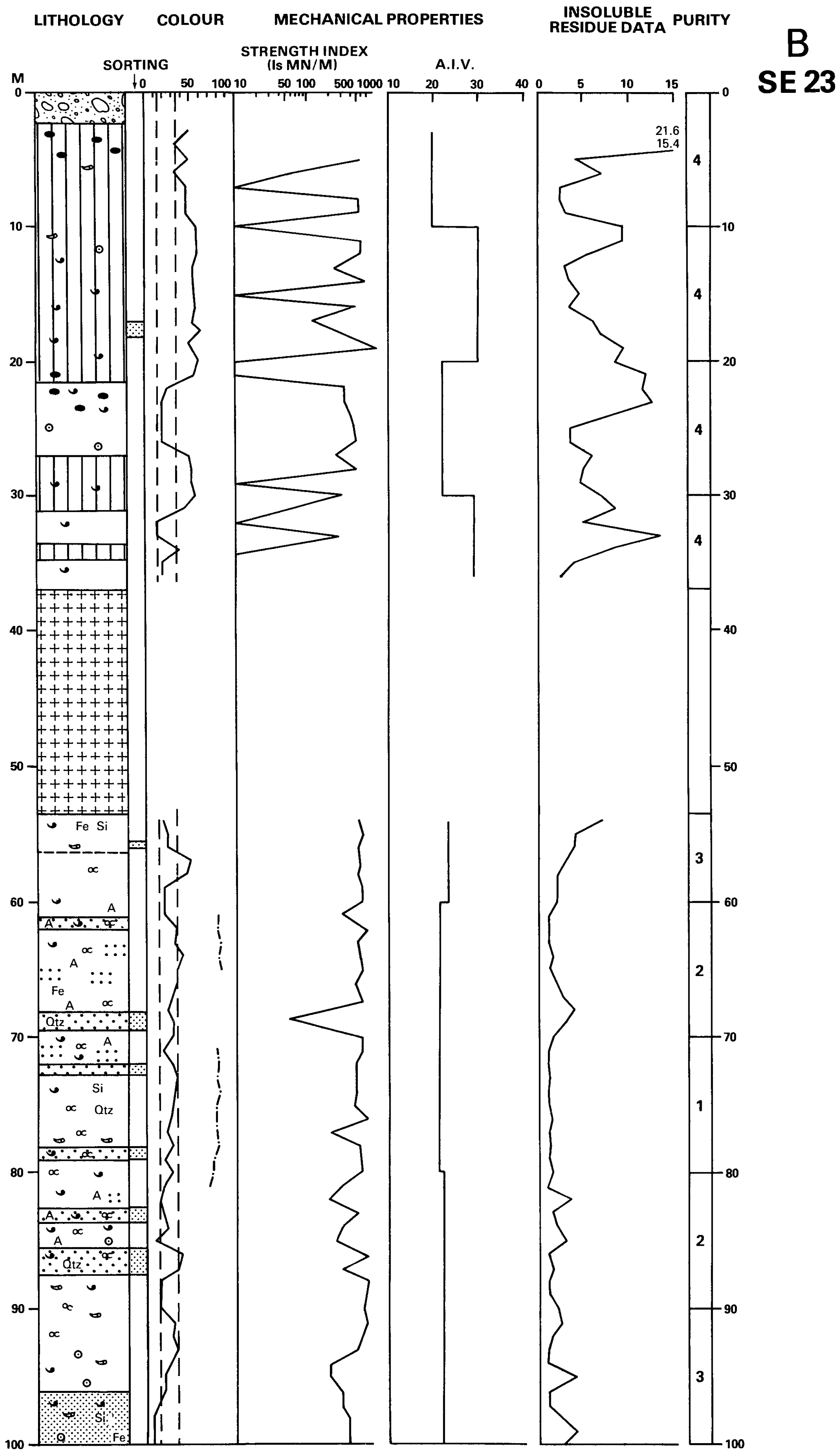


B
SW 37
2

SK 26 SW 37 2444 6154 Upper Town, Birchover Block B

Biosparite, buff-grey, commonly mottled, with coarse arenite shell debris and pelletal grains. Encrusting algae and *Coelosporella* occur throughout. Colonial and solitary corals present	5.72	264.13
Pelsparite. *Passes into*	1.39	265.52
Brachiopod biosparrudite; shells algal-encrusted and patchily silicified	1.82	267.34
Brachiopod biosparrudite, dark grey-brown, intercalated calcareous mudstones	1.07	268.41
Pelsparite, pale buff-grey, current-sorted, locally graded	2.90	271.30
Brachiopod biopelsparrudite, shells abraded and rounded, rare intraclasts, patchy silicification	1.34	272.64
Pelsparite, buff-grey	3.97	276.61
Biosparite, dark grey-black, with abundant finely comminuted bioclastic and pelletal debris. Black chert nodules common	17.58	294.19
Tuff, laminated with pyrite nodules	1.49	295.60
Biosparite, dark grey-black, argillaceous, rudite brachiopod debris common locally	3.54	298.98
Mudstone, black	0.10	299.08
Lower Matlock Lava		
Basalt, greyish green, amygdaloidal	2.46	301.54

Borehole completed at 301.54 m

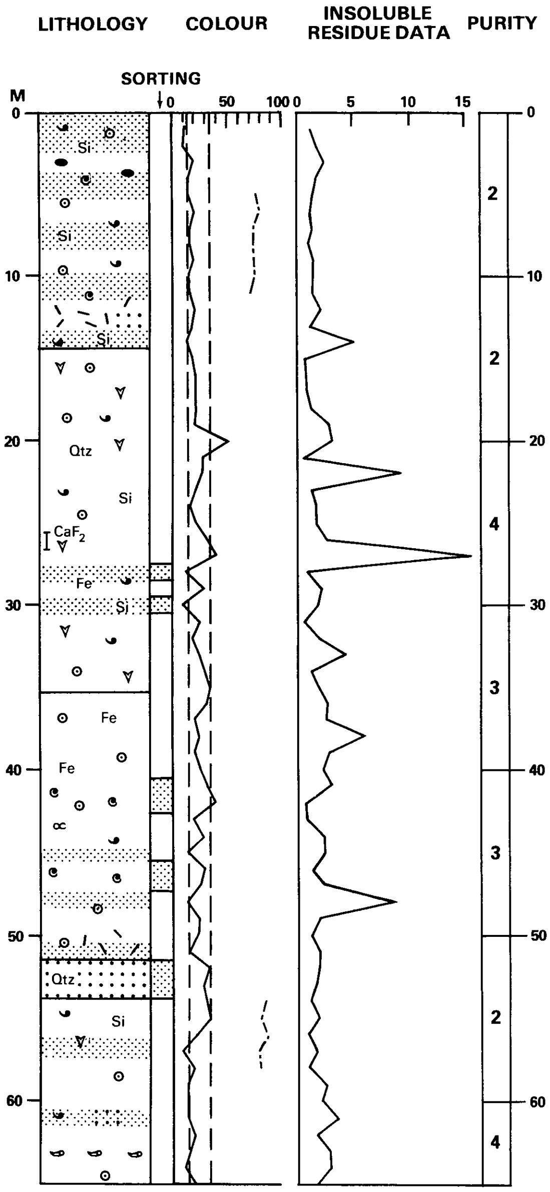

B
SE 23
LITHOLOGY
COLOUR
MECHANICAL PROPERTIES
INSOLUBLE RESIDUE DATA
PURITY
SORTING
STRENGTH INDEX (Is MN/M)
A.I.V.
M
21.6
15.4
Fe Si
Qtz
Si
Fe

SK 26 SE 23 2571 6095 Gurdall, Wensley **Block B**

Surface level +216.3 m (+710 ft)
Dando 250 (waterflush) 56 mm diameter
October 1975

	Thickness m	*Depth* m
Topsoil	2.20	2.20
Eyam and Monsal Dale Limestones		
Dolomite, buff, fine-grained, locally granular and vuggy, with abundant brachiopod debris between 18.53 and 21.45 m, black chert nodules present between 2.43 and 4.50 m and at 21.10 m	19.25	21.45
Biosparite; tightly-packed comminuted bioclastic and pelletal debris, chert nodules present to 23.85 m, patchy silicification, flecks of pyrite occur below 23.40 m	5.59	27.04
Dolomite, buff-yellow	4.08	31.12
Biosparite; fine-grained bioclastic debris set in an argillaceous matrix	2.25	33.37
Dolomite. Fluorite vein at 33.90 m	1.01	34.38
Biosparite; finely comminuted bioclastic debris showing traces of silicification, abundant pyrite in lower 0.1 m	2.50	36.88
Upper Matlock Lava		
Basalt, weathered, with included mudstone fragments, grey-green, pyritous	3.07	39.95
Basalt, amygdaloidal, pyritous	13.63	53.58
Monsal Dale Limestones		
Brachiopod biosparite, mainly comminuted indeterminate bioclastic debris, scattered brachiopod shells, coral (*Syringopora*) at 54.63 m. Patchy silicification, pyritous at top. Clay (0.20 m) at 56.06 m	7.66	61.24
Algal brachiopod biopelsparite, algal-encrusted shells and *Coelosporella* fragments common	0.76	62.00
Brachiopod biosparite, prominent bioturbational mottling below 62.60 m. *Passes into*	0.70	62.70
Algal brachiopod biopelsparite, mottled between 64.64 and 66.20 m, common encrusting and dasycladacean algae, colonial coral (*Lithostrotion martini*) at 64.55 m. Traces of barytes mineralisation at 68.09 m	5.39	68.09
Pelsparite, coral (*Dibunophyllum bipartitum*) at 69.32 m, well-sorted pelletal debris. Continuing from 69.62 m as biopelsparite with current-sorted, algal-encrusted brachiopods. Abundant quartz crystals	3.91	72.00
Pelsparite	0.67	72.67
Biosparite, medium arenite, grade debris, coral (*Chaetetes depressus* (Fleming), at 75.94 m, scattered partly silicified brachiopods. *Passes into*	3.56	76.23
Brachiopod biosparite, buff-grey, mottled, coral (*Palaeosmilia regia*) at 78.40 m	1.90	78.13
Biopelsparite	0.67	78.80
Brachiopod biosparite; broken brachiopod and other indeterminate shell debris, some patchy silicification. Clay-coated stylolites, some closely-spaced.	3.60	82.40
Algal brachiopod biopelsparite; alternating bands of current-sorted brachiopod debris and fine pelletal bands	1.03	83.43
Brachiopod biosparrudite, mid-grey, becoming dark grey below 84.78 m, locally abundant *Coelosporella*. Patchy silicification of brachiopod debris, scattered quartz crystals	2.01	85.44
Pelsparite	2.08	87.52
Biosparite, brachiopod debris predominant, subordinate fine arenite pelletal grains, sporadic corals. Patchy dolomitisation from 91.29 to 91.68 m	9.59	97.11
Biosparite, dark grey; brachiopods common especially near top, abundant tightly-packed, finely comminuted bioclastic debris. Scattered euhedral quartz crystals below 98.87 m	3.09	100.20

Borehole completed at 100.20 m



B

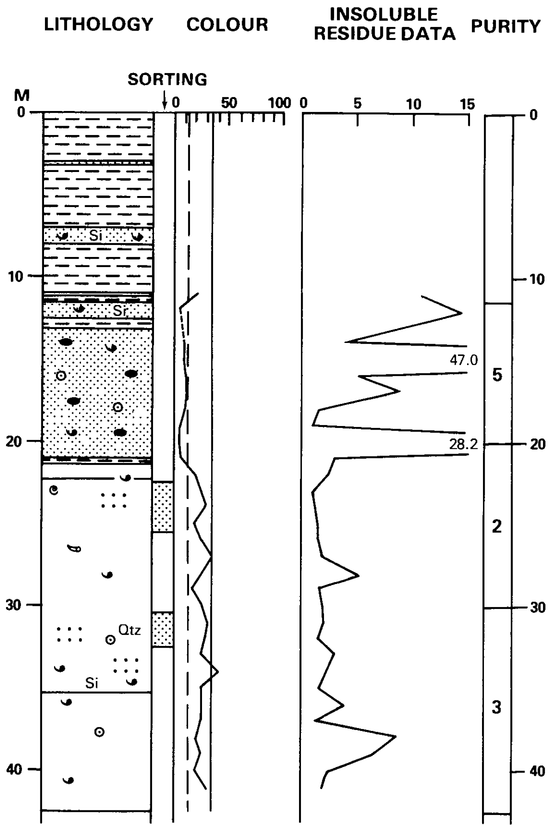
SE 1S

SK 26 SE 1s 2889 5986 Hall Dale Quarry **Block B**

Surface level +205.9 m (+675 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biosparite, mid to dark grey, thinly-bedded, finely comminuted slender and thick-shelled brachiopods, subordinate crinoid ossicles and foraminifera, abundant brachiopods at base. Disseminated clay, patchy silicification, some chert nodules. Many thin mudstone partings	14.30	14.30
Eyam Limestones (reef facies)		
Bryozoan biosparite, predominantly pale or mid-grey; fine arenite to rudite grade comminuted debris, patchy irregular developments of coarse spar, vuggy in part	20.90	35.20
Monsal Dale Limestones		
Crinoidal biosparite, locally argillaceous; bryozoan fragments at top, traces of pyrite	5.30	40.50
Biosparite, mid-grey with some darker beds, bioclastic debris shows algal corrosion envelopes between 42.50 and 43.50 m, matrix is locally micritic. Patchy silicification and some disseminated clay present	11.00	51.50
Pelsparite, abundant quartz crystals	2.00	53.50
Biomicrudite, brachiopod shells and pellets common. Patchy silicification	3.00	56.50
Bryozoan biomicrosparite, dark grey	1.00	57.50
Biosparite, mid to dark grey, solitary and colonial corals at 63.00 m. Patchy silicification	7.50	65.00

Section completed at 65.00 m



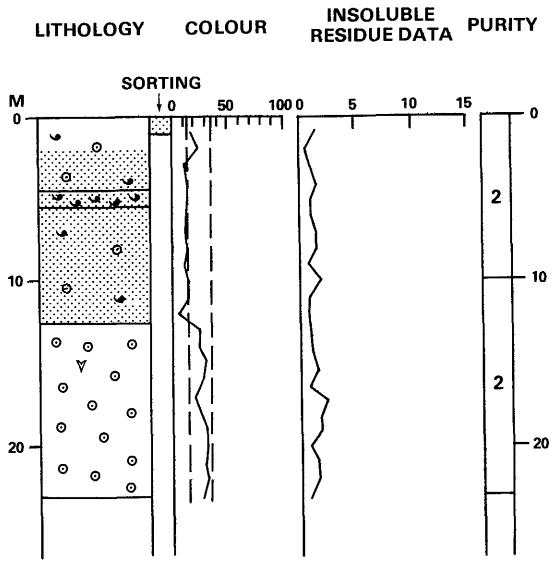
B
SE 2S

SK 26 SE 2s 2865 6064 Cawdor Quarry **Block B**

Surface level +101.5 m (+333 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Shale, black, thin-bedded; many brachiopods	3.00	3.00
Biomicrite, dark brown-black, very argillaceous, flecks of pyrite	0.10	3.10
Shale	4.10	7.20
Biomicrite, dark brown-black; comminuted brachiopod and crinoid debris. Patchy silicification. Flecks of pyrite	0.80	8.00
Shale, black, rare pyritised brachiopods	2.90	10.90
Biomicrite, black, argillaceous with flecks of pyrite and patchy silicification	0.20	11.10
Shale	0.70	11.40
Biomicrite, black, pyritous, silicified	1.10	12.50
Shale	0.70	13.20
Biomicrite, dark grey, argillaceous, spar cement developed locally. Abundant chert and patchy silicification	7.80	21.00
Clay, grey	0.20	21.20
Monsal Dale Limestones		
Biosparite, lightly mottled; abundant spines	1.30	22.50
Biosparite, pellets common throughout, broken corals present at 27.00 m, clusters of brachiopods at 27.00, 30.00 and 33.00 m. Patchy silicification and locally abundant quartz crystals	13.00	35.50
Biosparlutite; disseminated pyrite	1.00	36.50
Biosparite; some disseminated clay. Calcite vein containing galena at 38.00 m	6.00	42.50

Section completed at 42.50 m

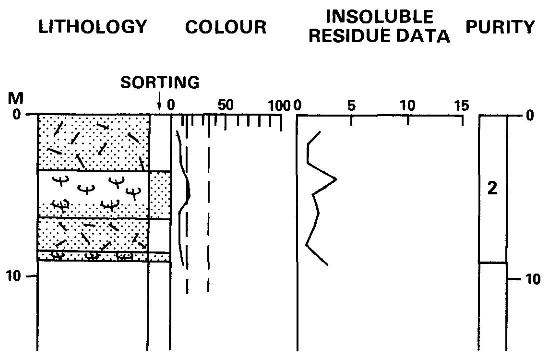


B
SE 3S

SK 26 SE 3s 2677 6033 Northern Dale **Block B**
Surface level +213.4 m (+700 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, mid-grey to 2.00 m, continuing dark grey to base; rolled brachiopods and scattered crinoid debris	4.00	4.00
Brachiopod biomicrosparrudite, dark grey; clay wisps in matrix	1.00	5.00
Biomicrosparite passing down into biomicrite, dark grey; finely comminuted bioclastic debris	7.00	12.00
Eyam Limestones (reef facies)		
Crinoidal biomicrosparite, with abundant coarse arenite to rudite size crinoid debris and rare bryozoa	11.00	23.00

Section completed at 23.00 m



B
SE 4S

SK 26 SE 4s 2701 6060 Northern Dale **Block B**
Surface level +144.8 m (+475 ft)

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, rarely fossilferous, disseminated clay in matrix	3.00	3.00
Biomicrosparite; massive *Lithostrotion junceum* colony, rare brachiopods	3.00	6.00
Biomicrite, dark grey, rare brachiopods	2.00	8.00
Biomicrite, dark grey, *Lithostrotion junceum* colony at 8.50 m, argillaceous matrix	1.00	9.00

Section completed at 9.00 m

APPENDIX D

ANALYTICAL RESULTS

Rapid instrumental and chemical methods of analysis were used. The table below shows estimated confidence limits at the 95% probability level for results on the very high, high and medium purity (≥93.5% $CaCO_3$) limestone, 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
	± per cent	per cent	per cent
CaO	0.80	50.00	–
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
P_2O_5	0.02	0.05	0.02
Loss at 1050°C	0.15	–	–
	± ppm	ppm	ppm
Cu	10	3	1
Pb	10	3	1
Zn	20	5	2
Acid-soluble MnO	20	10	3
Acid-soluble Fe_2O_3	20	10	3
As	2	2	1

Depth* (m)	*percentages*										*parts per million*					
	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	P_2O_5	Loss at 1050°C	Cu	Pb	Zn	MnO	As	Fe_2O_3
NW 9†	**2074 6826**	**Stonedge Lane**		**Block A**												
5.00	40.40	0.03	0.05	0.01	33.00	0.28	0.04	0.02	0.06	30.20	0	0	10	110	–	180
NW 12	**2077 6897**	**Field House**		**Block A**												
10.00	42.30	0.58	0.07	0.11	21.00‡	0.85	2.96	0.51	0.16	35.02	30	0	120	2500	–	11600
15.00	53.00	0.17	0.04	0.17	1.00	0.64	0.24	0.06	0.16	43.08	10	0	70	900	4	1200
27.00	42.90	0.27	0.04	0.08	28.00‡	0.55	0.51	0.12	0.08	32.08	10	0	60	300	–	1600
38.00	53.50	0.52	0.04	0.05	2.01	0.66	0.46	0.12	0.08	42.81	5	0	70	340	–	2200
44.00	54.60	0.17	0.03	0.04	1.84	0.47	0.09	0.04	0.06	43.02	5	30	60	200	–	750
50.00	46.10	0.19	0.04	0.05	25.00‡	0.47	0.29	0.08	0.05	34.49	5	10	40	120	–	1400
51.00	53.50	0.18	0.04	0.20	1.37	1.22	0.07	0.05	0.02	43.27	5	0	30	420	2	1100
57.00	41.70	0.76	0.04	0.07	29.00‡	0.51	0.88	0.19	0.06	31.60	10	60	240	150	–	4800
63.00	51.00	0.30	0.04	0.03	5.40	0.52	0.46	0.12	0.03	41.58	5	10	80	310	–	2400
NW 13	**2142 6587**	**Conksbury Bridge**		**Block A**												
8.00	43.40	0.10	0.03	0.00	27.00‡	0.61	0.03	0.03	0.05	32.23	5	0	60	230	3	800
14.00	54.50	0.11	0.03	0.00	0.91	0.29	0.37	0.08	0.06	43.38	5	0	40	290	–	1200
18.00	45.50	0.03	0.03	0.00	23.00‡	0.16	0.12	0.04	0.05	33.06	5	0	10	310	–	200
25.00	54.70	0.08	0.03	0.01	1.17	0.30	0.28	0.06	0.07	43.18	5	10	70	200	–	2100
31.00	37.70	0.00	0.03	0.01	42.00‡	0.16	0.01	0.02	0.08	26.49	5	0	10	80	–	180
38.00	54.90	0.10	0.03	0.00	0.79	0.29	0.04	0.03	0.03	43.68	5	20	40	280	–	700
82.00	54.90	0.07	0.03	0.00	0.71	0.24	0.07	0.04	0.04	43.55	5	0	0	370	4	350
NW 14	**2369 6585**	**Nutseats Quarry**		**Block A**												
3.00	47.80	0.24	0.04	0.05	16.00‡	0.45	0.12	0.03	0.04	35.53	5	480	50	270	–	1500
10.00	55.40	0.08	0.03	0.00	0.20	0.17	0.04	0.03	0.03	43.94	5	10	30	200	4	140
20.00	54.20	0.13	0.03	0.01	0.57	0.27	0.25	0.06	0.06	43.36	5	0	20	190	–	1100
30.00	54.90	0.07	0.03	0.01	0.24	0.23	0.06	0.03	0.04	43.69	5	0	0	110	–	110
34.00	43.90	0.05	0.03	0.01	25.00‡	0.23	0.14	0.04	0.06	31.38	5	0	0	110	–	110
40.00	55.40	0.17	0.03	0.01	1.06	0.34	0.09	0.04	0.05	43.16	5	0	30	240	2	160
SW 36	**2325 6458**	**Bowers Hall**		**Block A**												
18.00	37.90	0.03	0.04	0.07	39.00‡	0.21	0.03	0.02	0.12	27.50	5	130	80	160	–	780
25.00	52.60	0.29	0.04	0.02	2.77	0.62	0.29	0.07	0.08	42.61	5	20	170	130	–	1500
32.00	47.70	0.11	0.04	0.01	14.50	0.41	0.16	0.04	0.04	36.89	5	10	80	270	–	300
39.00	47.60	0.18	0.03	0.03	14.80	0.25	0.01	0.02	0.03	36.42	0	20	90	120	–	1300
48.00	53.10	0.16	0.04	0.03	1.81	0.34	0.49	0.12	0.11	42.68	5	40	190	170	–	2400
65.00	54.10	0.04	0.04	0.00	0.44	0.29	0.06	0.04	0.03	43.71	0	0	40	100	1	250
77.00	44.40	0.31	0.04	0.04	20.00‡	0.40	0.72	0.14	0.17	33.37	0	10	150	140	–	2700
85.00	53.00	0.38	0.04	0.02	1.82	0.49	0.14	0.05	0.03	43.31	10	30	110	90	2	1300
88.00	42.70	0.20	0.04	0.06	28.00‡	0.28	0.11	0.04	0.04	31.84	0	0	40	70	–	1400
93.00	47.80	1.01	0.05	0.08	10.60	0.51	0.97	0.19	0.05	35.32	0	10	120	90	–	5700
125.00	54.40	0.10	0.03	0.02	0.66	0.25	0.00	0.03	0.03	43.64	0	0	10	160	–	270
NW 1 S	**2133 6945**	**Holmebank Chert Quarry**			**Block A**											
8.00	54.20	0.45	0.05	0.08	1.88	0.54	0.58	0.15	0.14	42.74	5	0	100	310	1	5300
NW 2 S	**2136 6894**	**Endcliff Wood**		**Block A**												
8.00	55.60	0.27	0.04	0.02	0.50	0.39	0.03	0.03	0.01	43.86	0	10	20	135	–	1500
12.00	53.40	0.30	0.04	0.03	4.54	0.33	0.10	0.04	0.00	41.22	5	0	20	170	–	1100
NW 3 S	**2111 6819**	**Bank Top House**		**Block A**												
7.00	32.10	0.18	0.03	0.07	46.00‡	0.22	0.01	0.01	0.04	21.91	0	0	10	125	–	500
12.00	54.80	0.30	0.03	0.01	1.31	0.33	0.00	0.02	0.04	43.55	0	0	20	215	0	100
NW 4 S	**2382 6577**	**Nutseats Quarry**		**Block A**												
4.00	53.70	0.55	0.04	0.14	2.64	0.58	0.28	0.08	0.38	41.73	5	0	60	950	–	2500
NW 5 S	**2283 6505**	**Shining Bank Quarry**			**Block A**											
4.00	51.10	0.49	0.04	0.03	8.53	0.50	0.03	0.02	0.05	39.35	5	20	150	145	–	220
15.00	55.80	0.46	0.03	0.03	0.58	0.26	0.03	0.03	0.01	43.60	5	90	80	120	1	1700
23.00	51.00	0.33	0.04	0.02	10.04	0.29	0.22	0.04	0.04	38.68	5	80	100	140	–	2200
NW 6 S	**2034 6608**	**Lathkill Lodge**		**Block A**												
4.00	54.90	0.18	0.03	0.02	1.42	0.48	0.16	0.06	0.02	43.24	0	0	10	220	–	600
13.00	55.60	0.16	0.03	0.01	0.64	0.35	0.00	0.03	0.01	43.68	0	0	10	360	–	600
NW 7 S	**2134 6556**	**Conksbury Bridge**		**Block A**												
11.00	48.50	0.12	0.03	0.00	15.00‡	0.29	0.22	0.05	0.02	35.62	0	0	50	160	–	500
20.00	40.00	0.18	0.03	0.01	31.00‡	0.21	0.19	0.04	0.06	28.70	5	10	70	200	–	900
NW 8 S	**2093 6498**	**Conksbury Lane**		**Block A**												
12.00	54.60	0.14	0.03	0.00	2.40	0.21	0.00	0.02	0.00	42.82	5	100	40	250	0	500
18.00	50.40	0.16	0.03	0.02	11.30	0.22	0.24	0.03	0.02	37.92	0	50	30	155	0	350
SW 1 S	**2321 6397**	**Stanton Mill Quarry**		**Block A**												
6.00	25.70	0.07	0.04	0.01	55.00‡	0.21	0.37	0.06	0.13	18.36	5	70	190	150	–	3800
15.00	55.10	0.16	0.03	0.02	1.91	0.32	0.00	0.03	0.26	43.10	0	0	40	490	–	470
SW 2 S	**2287 6460**	**Alport Flour Mill**		**Block A**												
3.00	55.10	0.11	0.03	0.01	0.74	0.34	0.01	0.03	0.04	43.60	0	0	40	125	–	220
13.00	55.80	0.11	0.03	0.01	0.69	0.31	0.03	0.03	0.01	43.41	5	10	50	140	0	700

Depth* (m)	*percentages* CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	P_2O_5	Loss at 1050°C	*parts per million* Cu	Pb	Zn	MnO	As	Fe_2O_3
SW 3S	**2164 6416**	**Bradford Dale**		**Block A**												
6.00	54.60	0.14	0.04	0.02	2.03	0.31	0.06	0.03	0.01	42.69	0	10	60	240	–	470
SW 4S	**2318 6473**	**Harthill Lodge**		**Block A**												
5.00	54.20	0.18	0.04	0.06	3.14	0.31	0.03	0.03	0.03	42.24	10	20	90	185	–	1100
10.00	55.40	0.15	0.03	0.01	0.62	0.37	0.07	0.03	0.02	43.68	10	50	60	190	1	1400
SW 5S	**2015 6381**	**Bradford Dale**		**Block A**												
5.00	42.30	0.07	0.03	0.06	27.00‡	0.24	0.17	0.04	0.04	29.28	0	240	180	125	–	150
11.00	54.20	0.09	0.03	0.02	3.95	0.22	0.11	0.05	0.03	41.68	5	170	140	470	4	1300
27.00	51.30	0.19	0.03	0.01	9.44	0.37	0.36	0.04	0.00	39.20	0	0	20	125	–	220
50.00	51.40	0.56	0.04	0.06	5.27	0.42	1.54	0.28	0.03	40.05	10	30	150	1100	–	8700
SW 6S	**2169 6494**	**Lathkill Dale**		**Block A**												
4.00	54.70	0.18	0.03	0.03	2.18	0.24	0.37	0.09	0.04	42.73	5	420	80	450	0	2600
SW 7S	**2197 6479**	**Lathkill Dale**		**Block A**												
5.00	51.40	0.16	0.03	0.02	8.60	0.48	0.12	0.04	0.02	39.29	5	0	40	300	–	600
SW 18	**2035 6034**	**Gratton Moor**		**Block B**												
16.00	31.70	0.00	0.05	–	26.00‡	10.50	0.29	0.06	0.01	34.00	–	–	–	900	–	3700
25.00	51.90	0.01	0.03	–	4.23	0.84	0.00	0.02	0.02	42.00	–	–	–	420	–	2100
40.00	53.60	0.04	0.03	–	2.03	0.58	0.03	0.03	0.00	43.04	–	–	–	190	0	1700
51.00	42.90	1.37	0.07	–	13.50	0.88	5.50	1.00	0.04	34.65	–	–	–	160	–	16300
62.00	55.70	0.03	0.04	–	1.15	0.43	0.11	0.05	0.00	43.35	–	–	–	70	–	360
75.00	53.90	0.05	0.04	–	0.94	0.48	0.22	0.07	0.02	43.44	–	–	–	130	–	1500
85.00	36.80	2.00	0.09	–	22.00‡	0.91	8.20	1.49	0.10	29.44	–	–	–	170	–	26500
95.00	53.70	0.07	0.03	–	2.03	0.43	0.25	0.08	0.01	43.12	–	–	–	130	–	1400
106.00	51.80	0.03	0.03	–	6.12	0.30	0.06	0.04	0.01	40.66	–	–	–	140	–	400
120.00	54.10	0.02	0.03	–	1.17	0.37	0.30	0.08	0.01	43.77	–	–	–	100	1	480
133.00	51.00	0.03	0.03	–	6.54	0.69	0.24	0.09	0.02	40.46	–	–	–	250	–	1400
142.00	52.30	0.67	0.04	–	4.27	0.28	0.22	0.07	0.02	40.69	–	–	–	150	–	4400
SW 19	**2027 6025**	**Gratton Moor**		**Block B**												
10.00	30.90	0.11	0.06	–	3.84	19.90	0.01	0.03	0.05	44.93	–	–	–	830	–	2100
24.00	33.20	0.03	0.05	–	0.19	19.80	0.00	0.02	0.03	47.39	–	–	–	770	–	2300
40.00	34.10	0.04	0.06	–	1.49	18.60	0.00	0.03	0.03	46.52	–	–	–	760	–	2400
54.00	50.20	0.13	0.04	–	1.80	3.65	0.16	0.06	0.01	43.47	–	–	–	940	–	4000
59.00	45.50	0.12	0.04	–	1.55	7.80	0.08	0.04	0.02	43.86	–	–	–	1300	–	5600
65.00	52.80	0.08	0.03	–	4.05	0.51	0.02	0.03	0.01	41.79	–	–	–	530	6	1100
73.00	44.80	0.21	0.04	–	13.10	3.00	0.46	0.12	0.11	36.52	–	–	–	870	–	4200
85.00	51.80	0.09	0.03	–	5.95	0.66	0.04	0.03	0.02	40.97	–	–	–	260	–	430
95.00	52.60	0.11	0.03	–	1.45	1.80	0.13	0.05	0.02	43.53	–	–	–	500	–	1600
105.00	54.70	0.13	0.03	–	0.83	0.27	0.06	0.04	0.01	43.53	–	–	–	310	–	540
115.00	53.40	0.12	0.03	–	2.31	0.30	0.10	0.05	0.03	42.64	–	–	–	670	7	1400
130.00	53.70	0.10	0.03	–	2.83	0.28	0.06	0.04	0.01	42.39	–	–	–	190	–	420
140.00	55.60	0.08	0.03	–	1.97	0.32	0.09	0.05	0.01	42.87	–	–	–	180	4	320
150.00	53.80	0.10	0.03	–	2.29	0.31	0.04	0.04	0.02	42.66	–	–	–	130	–	200
160.00	52.80	0.14	0.03	–	2.67	0.41	0.10	0.05	0.01	42.53	–	–	–	420	3	1300
SE 23	**2571 6095**	**Gurdall, Wensley**		**Block B**												
10.00	31.90	0.02	0.05	0.01	0.86	19.90	0.00	0.03	0.04	46.79	15	0	160	1100	–	4100
23.00	49.60	0.15	0.04	0.02	8.50	0.63	0.32	0.08	0.07	38.60	5	0	20	110	–	1400
33.00	47.30	2.26	0.05	1.68	2.69	2.80	0.37	0.10	0.04	37.68	120	0	530	1400	–	7300
60.00	53.90	0.15	0.04	0.03	0.68	0.42	0.10	0.04	0.06	43.48	5	0	40	250	0	1200
68.00	53.00	0.15	0.03	0.06	1.86	0.40	0.52	0.09	0.02	42.63	5	60	110	250	–	2400
80.00	54.00	0.04	0.03	0.01	0.76	0.51	0.06	0.04	0.02	43.66	5	0	40	140	–	1400
90.00	54.50	0.10	0.05	0.01	0.58	0.43	0.21	0.06	0.02	43.63	5	0	70	130	–	1600
97.00	54.20	0.20	0.04	0.02	0.28	0.50	0.07	0.04	0.04	43.84	0	50	350	130	1	250
SE 1S	**2889 5986**	**Hall Dale Quarry**		**Block B**												
14.00	53.30	0.13	0.05	0.02	3.90	0.45	0.14	0.04	0.03	42.02	5	0	0	150	–	140
22.00	51.50	0.07	0.04	0.03	7.41	0.31	0.05	0.04	0.06	40.03	5	0	10	430	–	300
27.00	53.60	1.77	0.04	3.93	0.54	0.15	0.07	0.04	0.04	36.52	5	270	20	550	–	2300
38.00	52.40	0.14	0.04	0.06	3.91	0.31	0.42	0.12	0.12	41.34	5	0	60	350	–	1400
48.00	52.00	0.10	0.03	0.06	6.11	0.33	0.09	0.04	0.02	40.19	5	40	30	170	–	600
SE 2S	**2865 6064**	**Cawdor Quarry**		**Block B**												
15.00	29.30	0.38	0.06	0.03	56.00‡	1.00	0.59	0.12	0.16	23.77	10	50	460	390	–	4100
20.00	41.60	0.37	0.05	0.03	26.00‡	0.91	0.28	0.07	0.10	33.29	10	30	230	200	–	1700
28.00	52.50	0.08	0.04	0.03	3.97	0.31	0.08	0.04	0.02	42.09	0	0	40	120	0	1500
38.00	51.90	0.20	0.04	0.59	5.01	0.32	0.33	0.10	0.15	40.63	15	2000	130	520	–	2700
SE 3S	**2677 6033**	**Northern Dale**		**Block B**												
5.00	55.20	0.13	0.03	0.00	0.49	0.33	0.02	0.03	0.02	43.63	0	0	10	240	–	220
17.00	54.70	0.14	0.03	0.02	1.15	0.31	0.23	0.07	0.06	43.10	5	0	30	310	–	700
SE 4S	**2701 6060**	**Northern Dale**		**Block B**												
4.00	54.70	0.12	0.03	0.01	2.12	0.34	0.00	0.02	0.01	42.74	5	0	40	145	–	420

* Represents the depth below the surface of the mid-point of the sample.
† The numbers of all the boreholes quoted in this table have the prefix SK 26.
‡ Silica values above 15% have been rounded to the nearest integer.

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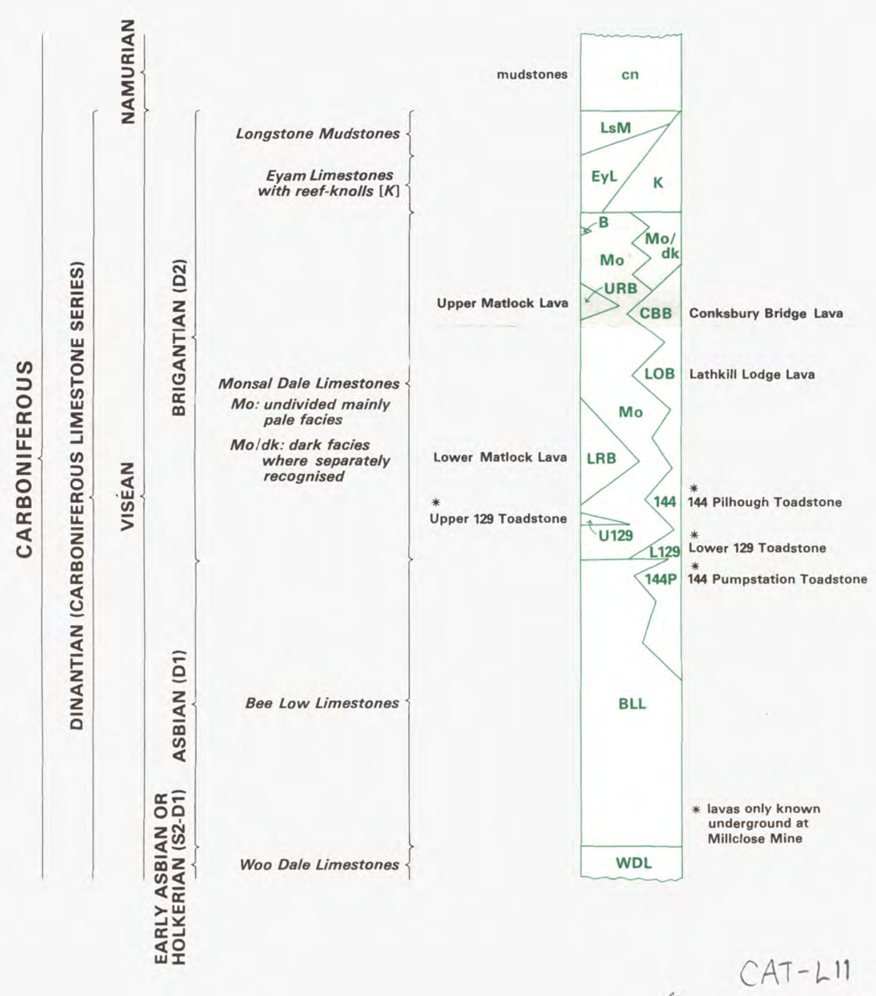

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Contour values are in feet
1 square inch on this map represents 99.639 acres on the ground

Compiled from 6" sheets last fully revised 1914-20. Other partial systematic revision 1945-49 has been incorporated.

THE LIMESTONE AND DOLOMITE RESOURCES OF SHEET SK 26 AND PART SK 27 (BAKEWELL, DERBYSHIRE)

79

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

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Shades of blue are used to indicate limestone purity. Regional variation is shown averaged to a depth of 10m.

LIMESTONE CATEGORIES	COMPOSITION (% $CaCO_3$)	
Very high purity	≥ 98.5	CAT-L1
High purity	≥ 97.0–< 98.5	CAT-L2
Medium purity	≥ 93.5–< 97.0	CAT-L19
Low purity	≥ 85.0–< 93.5	CAT-L20
Impure	< 85.0	CAT-L21
Undivided medium to high purity	≥ 93.5–< 98.5	CAT-L11

LIMESTONES AFFECTED BY DOLOMITISATION

(Background colour indicates % total carbonate) – SEE SEEDS INDICATED ON MAP FACE
BACKGROUND COLOUR
VERY HIGH - CAT-L29
MEDIUM CAT-L30
LOW CAT-L31
IMPURE CAT-L32

NON-CARBONATE SEDIMENTS

Mudstone MUD-3

IGNEOUS ROCKS

Basalt lava IGR-6

Tuff or agglomerate in volcanic vent IGR-7

DRIFT

Alluvium
Calcareous tufa
Head
Boulder clay

MADE GROUND

MG-2

LANDSLIP

L-1

✓ CAPTURE

BOUNDARY LINES

✓ Boundary between categories (for boundaries not coincident with geological boundaries)
✓ Geological boundary, Solid (broken lines on horizontal sections denote uncertainty)
Geological boundary, Drift
✓ Resource block boundary (blocks designated by letters A andB)

STRUCTURAL AND OTHER SYMBOLS

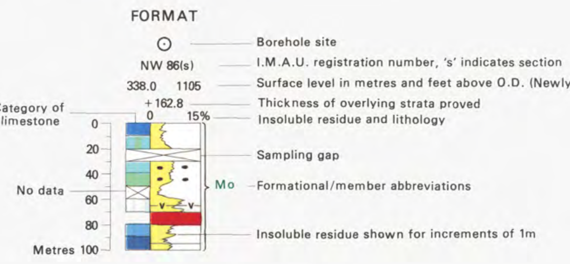
Horizontal strata
12 Inclined strata, dip in degrees
Anticlinal axis
Synclinal axis
✓ Fault at surface, crossmark indicates downthrow side
✓ Mineral vein; where veins are also faults crossmark indicates downthrow side
✓ General area of mineral workings at surface WG-13
Mine shaft, abandoned
Shaft commencing underground (winze)
Approximate position of the Millclose Mine crosscut

BOREHOLE AND SECTION DATA

SITE LOCATIONS

Industrial Mineral Assessment Unit (I.M.A.U.) boreholes
Other boreholes
Collected section (bracket indicates limits)

FORMAT



LITHOLOGICAL SYMBOLS

Chert; symbols on map face show surface distribution
Dolomite
Dolomitised limestone
Varicoloured mudstone/clay/tuffaceous material
Mudstone/shale
CBB Basalt (see vertical section for explanation of stratigraphical symbols)

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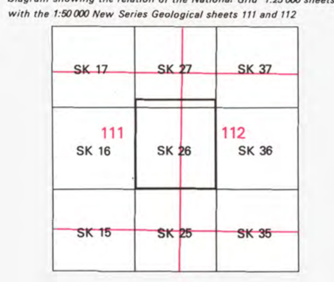
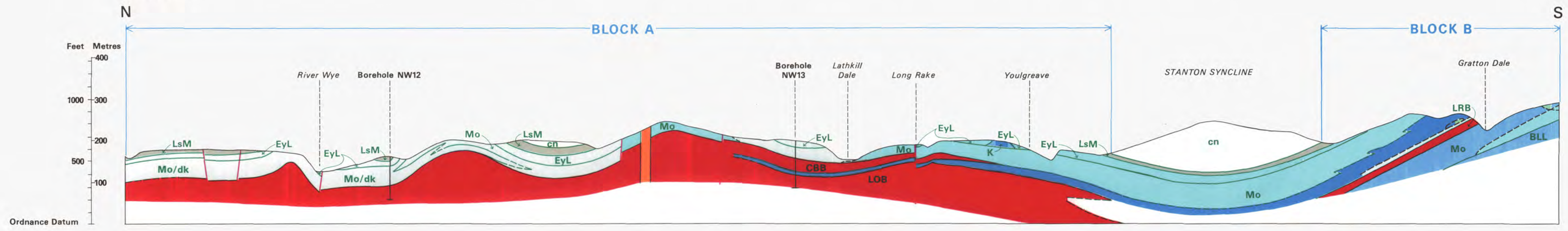
Diagram showing the relation of the National Grid 1:25 000 sheets with the 1:50 000 New Series Geological sheets 111 and 112

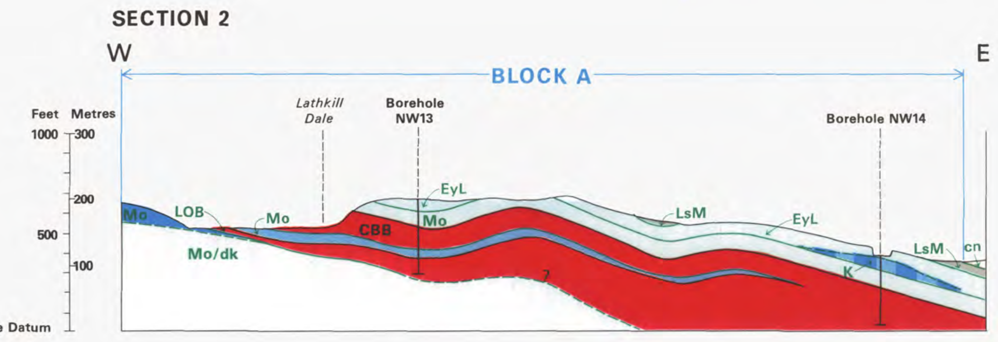


HORIZONTAL SECTIONS SHOWING GENERALIZED LIMESTONE CATEGORIES AT DEPTH

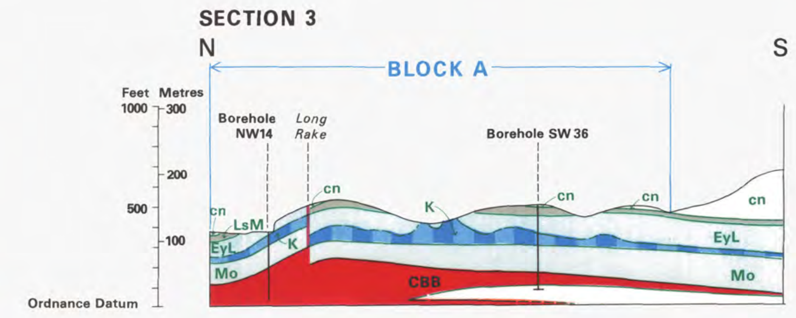
SECTION 1



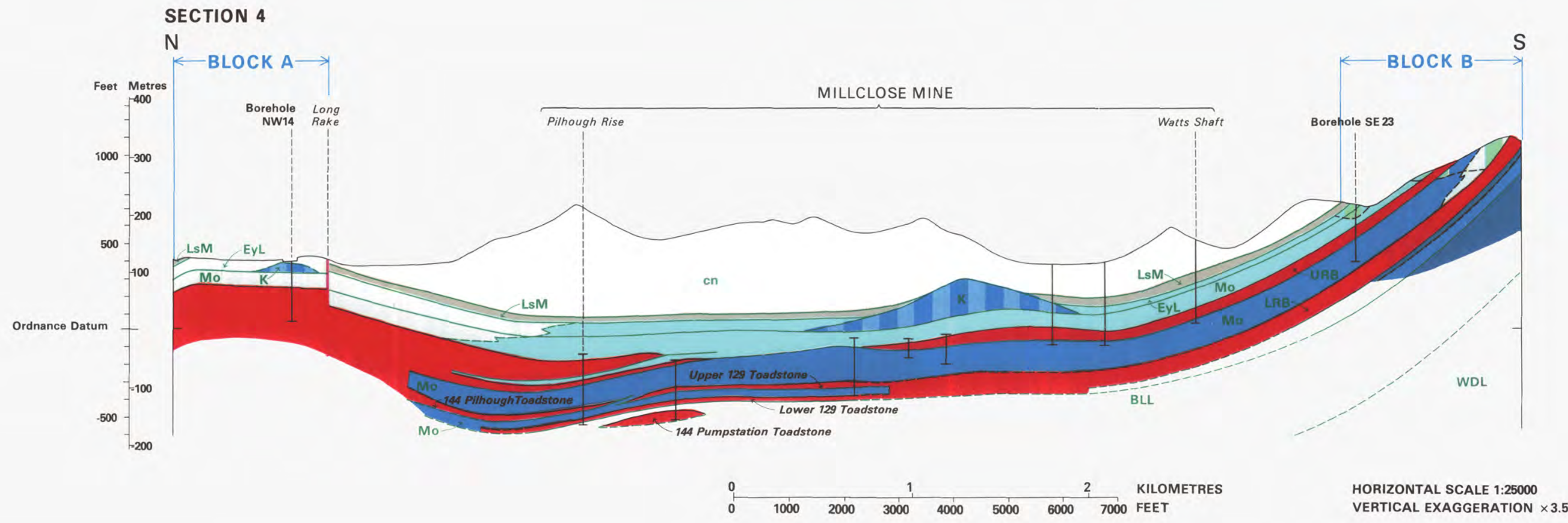
SECTION 2



SECTION 3



SECTION 4



0 1 2 KILOMETRES
0 1000 2000 3000 4000 5000 6000 7000 FEET

HORIZONTAL SCALE 1:25000
VERTICAL EXAGGERATION ×3.5