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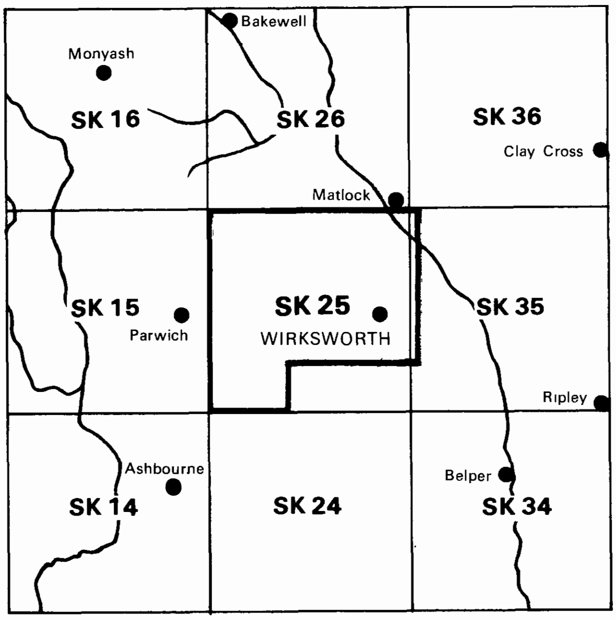

The limestone and dolomite resources of the country around Wirksworth, Derbyshire

Description of parts of 1:25 000 sheets SK 25 and 35

F. C. Cox and D. J. Harrison

Contributors

J. I. Chisholm and N. Aitkenhead

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PREFACE

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

The interdepartmental Mineral Resources Consultative Committee recommended that limestone should be investigated, and following a feasibility study initiated in 1970 by the Institute and funded by the Department of Education and Science, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys in 1972. The work is now 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 67 km^2 of country around Wirksworth, Derbyshire, shown on the accompanying 1:25 000 resource map. The survey was conducted by Dr F. C. Cox and Mr D. J. Harrison with the assistance of Mrs A. J. Stewart and Messrs J. R. Gozzard, J. T. Dove, H. Mathers and T. Waterhouse. Mr R. W. Gatliff contributed Appendix D.

The assessment was based on a geological survey at the 1:10 560 scale by Dr N. Aitkenhead, Mr J. I. Chisholm, Mr R. A. Eden, Dr D. V. Frost, Mr D. Price, Mr G. H. Rhys and Mr I. P. Stevenson. (For the dates of surveys, see the map in the pocket.) Mr Chisholm and Dr Aitkenhead contributed the general account of the geology.

301 chemical analyses were carried out by Mr A. Davis and Mr A. Morigi of the Institute's Analytical and Ceramics Unit.

The G-Exec system of data management was used to provide most of the statistical analyses and new programs were developed during the course of the assessment. Mrs S. Strachan and Mr J. Wheeler worked on this aspect of the assessment with Dr G. Baxter acting as systems analyst to the project.

Mr K. Siddiqui carried out X-ray diffraction analyses of the insoluble residues and Mr M. Beasant prepared the slides for petrographic work.

Mr M. Mitchell, Mr J. Pattison, Dr W. H. C. Ramsbottom and Dr I. C. Burgess provided advice on palaeontology and identified key fossil species.

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

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16 January 1979

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 maybe addressed to Head, Industrial Minerals Assement Unit, Institute of Geological Sciences, Keyworth, Nottingham NG12 5GG.

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

Description of parts of 1:25 000 sheets SK 25 and 35

F. C. Cox and D. J. Harrison

SUMMARY

The study of samples specially collected from 18 cored boreholes, 29 major exposures and 193 scattered localities, together with information from the records and geological maps of the Institute of Geological Sciences, form the basis of the assessment of limestone and dolomite resources in the Wirksworth area, Derbyshire. Fourteen boreholes were drilled under contract for the Industrial Minerals Assessment Unit and in addition, members of the Unit drilled sixteen shallow cored boreholes using a small portable drilling machine. Cores from four boreholes, chemical analyses and many borehole logs were made available by the 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 limestones 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.

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

Bibliographical reference

Cox, F. C. and Harrison, D. J. 1979. The limestone and dolomite resources of the country around Wirksworth, Derbyshire: Description of parts of sheets SK 25 and 35. *Miner. Ass. Rep. Inst. Geol. Sci.,* No. 47.

If it is desired to refer to the part of this report written by the contributors, the citation in the text should be in the form 'Chisholm and Aitkenhead *in* Cox and Harrison, 1979, pp. 5–17; *the bibliographical reference shown above should appear in the list of references.*

Note

All National Grid references in this report fall in 100 km square SK unless otherwise stated.

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INTRODUCTION

The Carboniferous limestones of Derbyshire and Staffordshire give rise to some of the most attractive and spectacular of English scenery, which attracts some 16 million people to the Peak District National Park each year (Peak Park Joint Planning Board, 1975).

In recent years the increase in demand for roadstone and concreting aggregates together with the postwar growth of industry have caused a huge upsurge in the production of limestone. In 1975–76 Derbyshire and Staffordshire produced 17½ million tonnes representing approximately 20 per cent of national production (Institute of Geological Sciences, 1978).

These facts highlight the need for information on the nature of the limestone resources in order that land use and mineral planning may be carried out on a more informed basis. The provision of information covering the variations in the physical and chemical characteristics of the limestones, which affect their possible industrial usage, is the objective of the present survey.

The methods of assessment were developed from a feasibility study and embody the most cost-effective procedures for assessing limestone resources on a regional scale (Cox and others, 1977). The material for study has been obtained from cored boreholes, natural sections and quarry faces. Boreholes have generally been spaced at intervals of approximately 3 km. In addition the survey has greatly benefited by the cooperation of members of the minerals industry who have made available numerous borehole logs and chemical data.

Boreholes were drilled to a depth of at least 100 m and the petrological, mineralogical, chemical and certain of the physical properties of all samples have been determined in the laboratory. Conventional geological nomenclature has been used for technical descriptions, ensuring compatibility between this report and the geological literature; a glossary is appended. The rocks are classified in terms of their calcium carbonate ($CaCO_3$) content so that the relation between limestone category and possible end use can be easily deduced (Table 2).

Whilst detailed results are set out in this report and its appendixes, the accompanying resource map is more generalised. It should be noted that the distribution of limestone categories shown on the map was determined by reference to the average calcium carbonate content over the uppermost 10 m of strata. In the horizontal sections, the vertical distribution of the limestone categories is inferred by extrapolation from accumulated knowledge of the geology augmented by the results from the boreholes which are given for each 10-m interval down to a maximum depth of 100 m. The more detailed assessment of limestones within 10 m of the surface reflects the relative abundance and widespread distribution of data points for this interval, compared with their paucity for the more deeply buried strata.

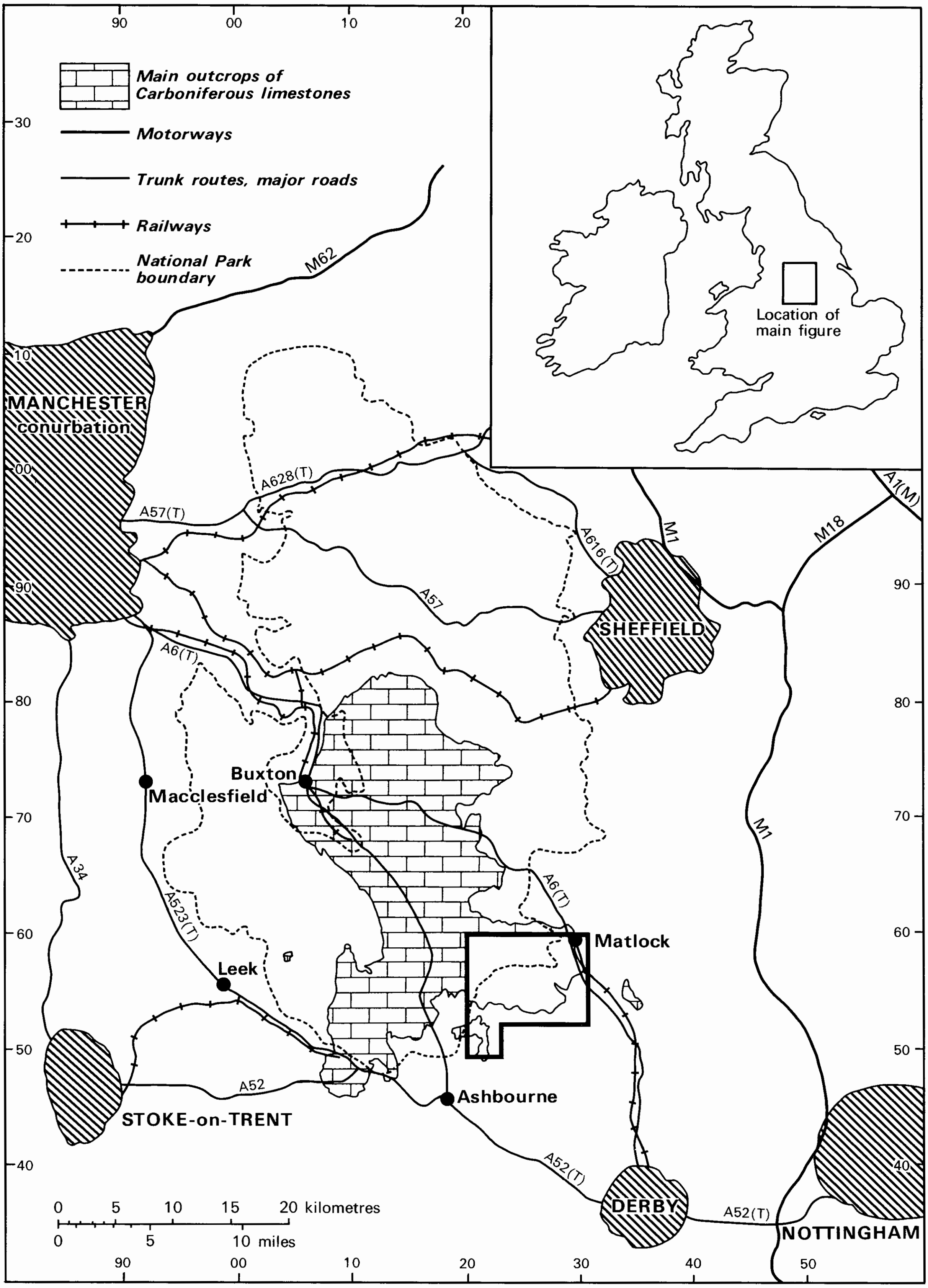


Figure 1 Sketch map showing the location of the area surveyed

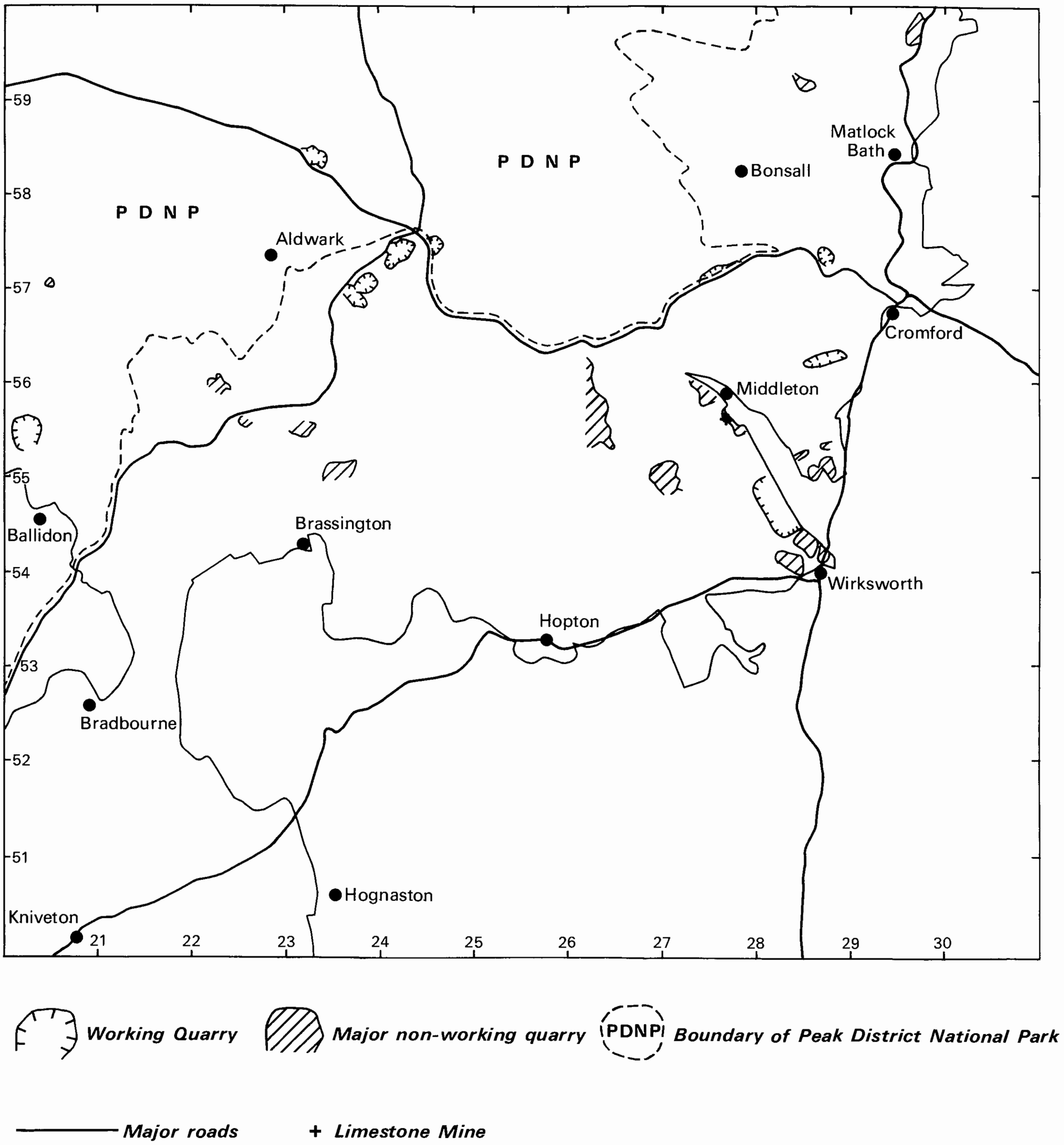


Figure 2 Sketch map showing the distribution of the major quarries at the time of the survey

DESCRIPTION OF THE RESOURCE SHEET

The area lies partly within the Peak District National Park; it is rural and is served by the large settlements of Matlock Bath, Cromford and Wirksworth. It is crossed by the A6 trunk road and the A5012, B5035 and B5056 main roads. A railway spur connects Matlock and Cromford with Derby. The local economy is based on the agricultural, textile, and the mineral extractive and manufacturing industries. The upland limestone plateau supports the rearing of sheep and beef cattle and the lusher pasture of the lower ground the rearing of dairy cattle. In 1772 Sir Richard Arkwright erected a cotton mill at Cromford and in 1783 the Masson Mill at Matlock Bath which is today occupied by the English Sewing Cotton Company. In the past, lead mining was a major industry and many villages flourished as the industry prospered. The mining of vein minerals is now confined to several relatively small opencast operations for fluorite and baryte. Limestone is exploited in a number of large quarries (Figure 2) and in the mine at Middleton. The products are of major importance in the building, road-making, iron and steel, glass, agricultural and chemical industries. In the past, limestone from several quarries has been used as an ornamental stone. In particular Hoptonwood 'Marble' is a well known facing stone from this district. Silica sand and clay is extracted from several small pits and is used in the manufacture of refractories.

TOPOGRAPHY

The undulating upland limestone plateau, rising to 367 m (1204 ft) on Bonsall Moor and 379 m (1244 ft) at Harboro' Rocks, is characterised by treeless pastures, dry

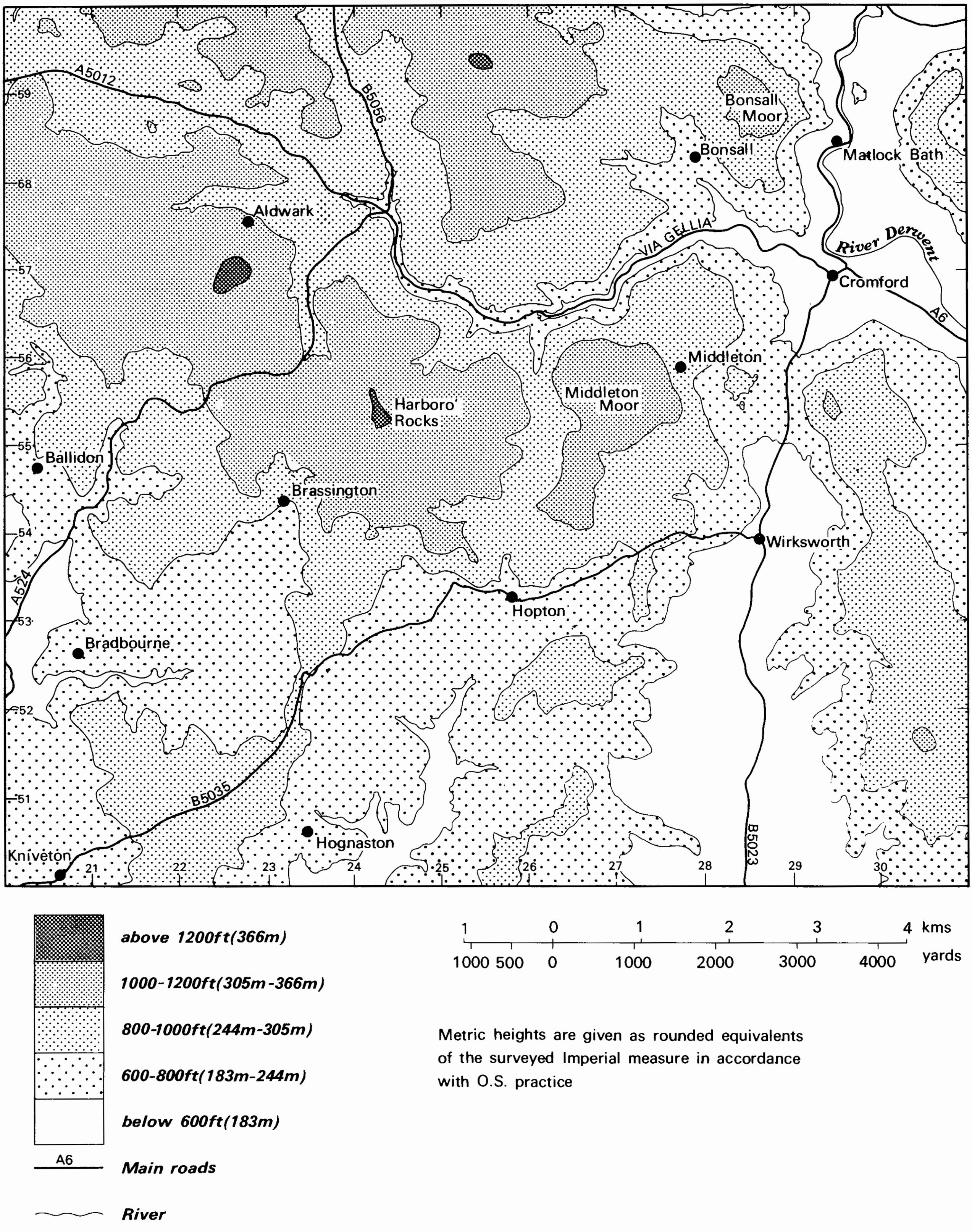


Figure 3 Topography.

valleys and a network of limestone walls. It is dissected by the deep, steep-sided wooded valley of the Via Gellia (Griffe Grange Valley) and the gorge of the River Derwent at Matlock Bath (Figure 3). Between Hopton and Ballidon the area is characterised by prominent dolomite tors in the form of isolated pinnacles and castellated escarpments of 35 m (115 ft) or more in height. In the central and eastern part of the area between Brassington and Matlock spoil heaps from earlier lead mining have further contributed to the scenery. Rows of spoil heaps, derelict shafts and ruined stone buildings are very conspicuous on Middleton Moor, Bonsall Moor and Carsington Pasture. The quarrying of limestone and dolomite and the working of silica sand has also modified the topography. The scarp slope of the plateau margin is a notable feature with relief of the order of 61 m (200 ft). Between Middleton and Wirksworth the margin is faulted and scarp-like. To the south of the plateau margin between Bradbourne and Atlow, an isolated area of limestone forms the rounded features of Haven Hill and Madge Hill. In the south of the area, and to the east of Wirksworth, Namurian shales and sandstones form scarp and dip-slope features. The scarps rise to 322 m (1056 ft) at Barrel Edge, Cromford and 281 m (922 ft) at Callow, and are drained by numerous small brooks which form broad, smoothly contoured valleys. The escarpments are locally wooded and gritstone walls are characteristic.

GENERAL GEOLOGY

J. I. CHISHOLM and N. AITKENHEAD

GEOLOGICAL HISTORY

Most of the area of the resource sheet is underlain by sedimentary rocks of Carboniferous age. During the earlier (Dinantian) part of the Carboniferous period, limestones and mudstones were deposited, with some volcanic intercalations whereas during the later (Namurian) part, mudstones and sandstones were laid down. There were slight earth-movements during deposition, but the main movements that have affected the rocks of the region took place at the end of the Carboniferous period. Folds and faults that were formed then are largely responsible for the present disposition of the strata.

A long erosional interval followed the earth movements. No Permian or Triassic rocks are now preserved though they may have been deposited and then removed during a second erosional episode. Indeed, secondary dolomitisation of the Dinantian limestones has been held to be due to downward seepage of magnesium-rich waters from the Permian sea. Lead and zinc-bearing veins fill fissures in the limestones and the hydrothermal mineralisation they represent mainly postdated the dolomitisation. Isotopic age determinations suggest that mineralisation continued intermittently from the late Carboniferous to the Jurassic, with a maximum in the Permian.

Isolated occurrences of Tertiary sediments are preserved in steep-sided solution-pockets in the limestone. They are mainly sands with some red and grey clays, and are referred to collectively either as Pocket Deposits or as the Brassington Formation. Individual pockets are up to 1 km in length, but are of unknown depth. A renewal of earth-movement is also thought to have taken place during the Tertiary period, with some faulting and folding.

Spreads of surface drift, dating from the Quaternary ice age and later, are the most recent deposits in the area. On the limestone outcrops the main deposits are head, a reddish-brown silt with chert fragments, that attains a few metres thickness locally in hollows, and boulder clay. Alluvial deposits follow the main watercourses.

DINANTIAN ROCKS

The rocks of Dinantian age are almost wholly marine, the area being divisible into a northern 'shelf' province where the sea was generally shallow, and a southern 'off-shelf' province of deeper water. During the earlier part of this epoch the distinction between the provinces was probably not well marked, and limestones may have been deposited everywhere, but in the later part, limestone deposition predominated only on the shelf, and mixed mud and lime deposits were laid down elsewhere. Figure 4 shows the extent of the two provinces and gives generalised lithological sequences from both. At the edge of the shelf province lies a zone of transition within which outward-dipping apron-reef limestones locally developed. Volcanic rocks were formed at times in the shelf province. Figure 4 also shows the extent of the overlying Namurian deposits that conceal the Dinantian rocks at the eastern edge of the shelf province and over most of the off-shelf province.

The Dinantian rocks are subdivided into zones on the basis of either their coral-brachiopod or their goniatite-bivalve fossil assemblages. The standard symbols for these zones and their correlation with the various rock formations and Dinantian stages are shown in Table 1. For convenience, these standard symbols are used in the following text.

Shelf province

Surface outcrops are all in limestones and interbedded volcanic rocks of S_2, D_1 and D_2 age. The older Dinantian strata have not been proved in this area, but are presumed to be present at depth; analogy with adjacent shelf areas suggests that they too are mainly limestones. Consideration of thickness variations within the exposed part of the sequence suggests that the province can be divided into two areas, one in which the sequence is relatively thick (230 to 360 m), and one in which it is relatively thin (70 to 170 m). Generalised sequences for each area are shown in Figure 4, which also shows the approximate geographical position of the boundary between the two. The sequence is thinnest at the shelf margin in the south-east, where several breaks in the succession have been recognised.

Five formations have been distinguished, mainly on the basis of lithology but also on the evidence of contained fossils. The formational names apply throughout the shelf province of the Derbyshire limestones, and are shown in Table 1. In the north-eastern and south-eastern parts of the present area, however, the formations are known by local names (e.g. in published IGS maps and memoirs): these synonyms are also shown in Table 1.

Woo Dale Limestones: The full thickness of the formation is not known, but at least 106 m are present in and beneath the area of outcrop in the Via Gellia, where the limestones are pale grey and chert-free, the topmost 75 m of the sequence containing numerous fine-grained bands. The same lithology has been proved in boreholes near Grangemill [244 577] and near Longcliffe [227 558]. All these occurrences lie in the southern part of the shelf province though the formation is presumably present at depth farther north also.

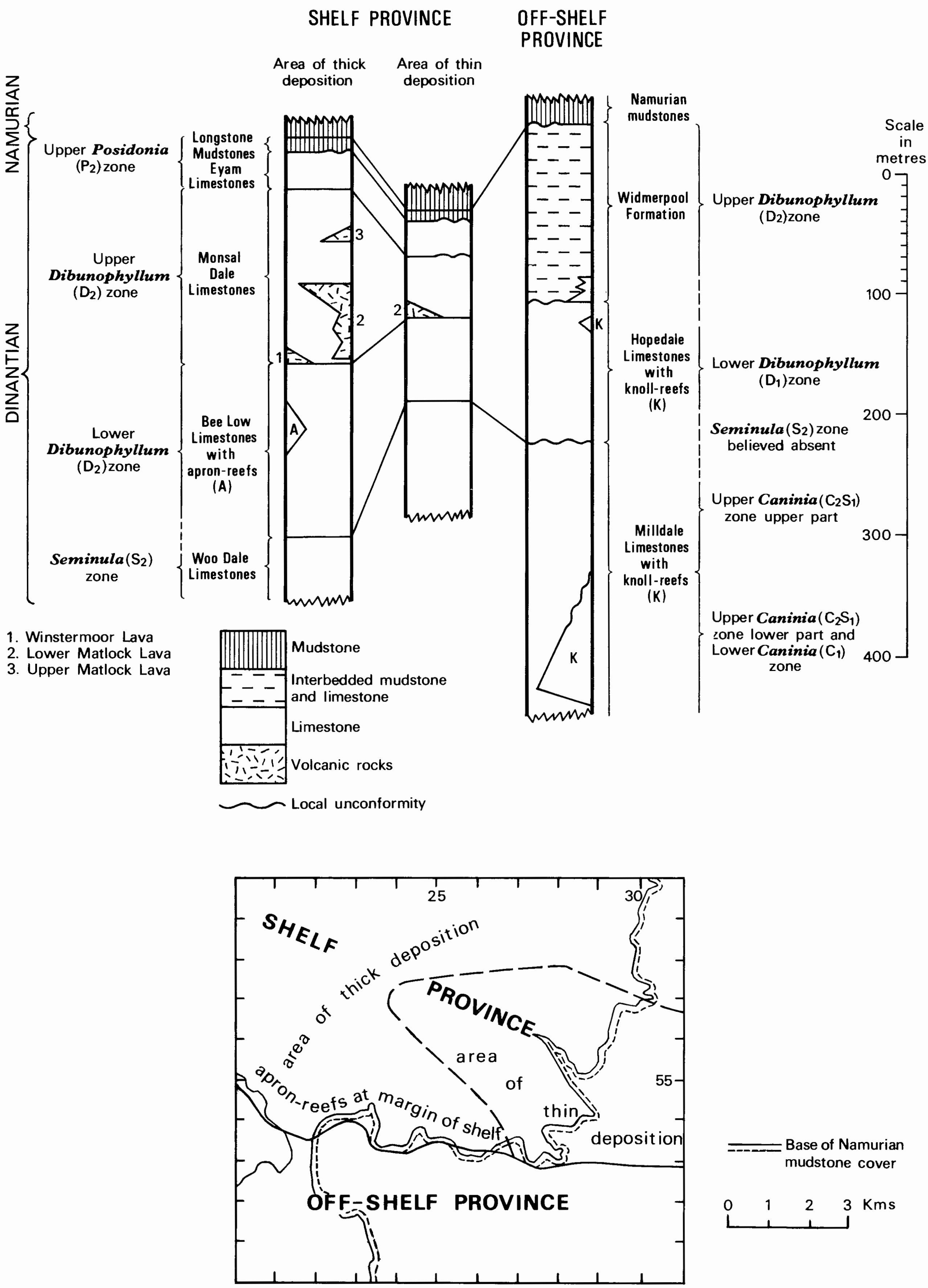


Figure 4 Generalised sections of Dinantian rocks in shelf and off-shelf provinces

Table 1 Dinantian classification

Shelf province: Stage	Formational names used in this report	Local names: Matlock area*	Local names: Wirksworth area†	Coral-brachiopod zones	Goniatite-bivalve zones	Off-shelf province: Formational names used in this report	Off-shelf province: Stage
Brigantian	**Longstone Mudstones**	Cawdor Group	Cawdor Shale	D_2	P_2	**Widmerpool Formation**	Brigantian
	Eyam Limestones		Cawdor Limestone				
	Monsal Dale Limestones	Matlock Group	Matlock Limestone		P_1		
Asbian and ? Holkerian	**Bee Low Limestones**	Hoptonwood Group	Hoptonwood Limestone	D_1	B_2	**Hopedale Limestones**	Asbian
	Woo Dale Limestones	Griffe Grange Bed	Griffe Grange Bed	S_2	base not recognised		
				C_2S_1		**Milldale Limestones**	Arundian
				C_1 (upper part)			Chadian

* Smith, Rhys and Eden, 1967. † Frost and Smart, 1979.

Bee Low Limestones: The formation varies greatly in thickness, reaching a maximum of 165 m in the northern part of the area of thick deposition but averaging only about 70 m in the area of thin deposition. The limestones are mainly calcarenites which are everywhere pale grey, thickly bedded and generally chert-free. Locally at the margin of the shelf province these pass laterally into massive fine-grained shelly apron-reef limestones. There are no lavas or tuffs in the sequence, but sporadic interbedded clays ('wayboards') up to about 0.5 m thick are thought to represent the weathered remnants of falls of volcanic ash. The formation crops out widely in the southern and central parts of the shelf, and elsewhere it appears from beneath a general cover of Monsal Dale Limestones as inliers of limited extent. More than half of the area of outcrop has been affected by dolomitisation, and lead-zinc mineralisation is widespread in the east and south (Figure 6).

Monsal Dale Limestones: The formation varies more markedly in thickness and lithology than the Bee Low Limestones, ranging from 188 m in the north-western part of the area of thick deposition to nil at the south-eastern corner of the area of thin deposition. Average thicknesses for the two areas are about 150 m and 50 m.

The thickness changes sharply at the northern edge of the area of thin deposition (Figure 4), and abruptly again at the shelf margin (Smith, Rhys and Eden, 1967, fig. 3). At Baileycroft Quarry [287 543] the formation wedges out completely.

The limestones are mainly pale grey and medium grey, with some dark grey bands. The darker-coloured limestones tend to be associated with the volcanic rocks, and may be found either overlying them or as their lateral equivalents in areas where they have died out. Darker limestones are, however, also present in the area of thinning at the south margin of the shelf province, where no volcanic association is known (Smith, Rhys and Eden, 1967, p. 22).

Chert is common at some levels in the sequence, especially in the south-eastern and extreme eastern parts of the shelf, but is rare or absent elsewhere. Its distribution shows no systematic connection with volcanic rocks, nor with thickness variation in the sequence as a whole.

Three lenticular bodies of volcanic rock (basaltic lava and tuff) are interbedded with the limestones, but none of them extends over the whole area of the shelf province (Figure 5). The most widespread, the Lower Matlock Lava, reaches a maximum thickness of 115 m at Masson Hill [286 287] where it consists of a complex mass of lava flows and tuff deposits. Traced westwards, the lower parts of the mass interdigitate with limestone and die out. The highest part extends further but it too dies out westwards and southwards, the limit being mapped at a line joining Mouldridge Grange [201 594] and Curzon Lodge [234 561]. Traced southwards into the zone of thin deposition, the whole mass thins rapidly and comes to lie at the base of the sequence (Figure 4). It dies out not far from the shelf margin (Figure 5).

The Winstermoor Lava lies at the base of the formation in the northern part of the zone of thick deposition, and reaches a maximum thickness of about 15 m. It extends over an area of a few square kilometres around Winstermoor [241 594] and has been recognised locally farther south at Longedge Plantation [214 580] and Hoe Grange [215 569].

The Upper Matlock Lava lies near the top of the formation in the north-east corner of the area; its southern and western limits lie close to a line drawn from Cromford [295 569] to Bonsall Moor [256 593]. Its maximum thickness is about 30 m. The source of the volcanic rocks is discussed on p. 8.

The Monsal Dale Limestones crop out over most of the shelf province except the south and centre. Dolomitisation (p. 8) has affected the limestones in several areas.

Eyam Limestones and Longstone Mudstones: The Eyam Limestones consist of an assemblage of grey to dark grey thinly bedded cherty limestones, variably shelly, with knolls and patches of pale reef-limestone and associated crinoidal beds. The reef-limestones, where present, lie at the base of the sequence. Unlike the apron-reefs found at lower stratigraphical levels, they do not indicate proximity to the shelf margin. The formation is generally about 30 m thick and nowhere thicker than 45 m. Variations in thickness are not related to the areas of thin and thick deposition recognised in the underlying Monsal Dale Limestones, and appear to be random except at the south-eastern corner of the area where there is a systematic thinning towards the shelf margin. The thinning, which is associated with disconformities at the top and base of the formation, continues as far as Dale Quarry [284 541], where the whole formation is absent (Smith, Rhys and Eden, 1967, p. 25).

The area of outcrop lies at the eastern side of the shelf province, where the formation dips generally eastwards to pass beneath a thick sequence of dark grey mudstones, the basal 6 m of which are of Dinantian age and are distinguished by the name Longstone Mudstones. Along the south margin of the shelf the Eyam Limestones and Longstone Mudstones are generally absent, and the overlying Namurian mudstones rest directly on older limestones, indicating that localised erosion took place along the margin of the shelf province during, or at the end of, the late Dinantian.

Off-shelf province

In much of this province the exposed Dinantian rocks belong to the Widmerpool Formation, a mudstone-rich correlative of the younger limestones of the shelf province. Older limestones crop out in the south-western part of the resource sheet forming inliers within the Widmerpool Formation outcrop. They belong to two formations, the Milldale Limestones and the Hopedale Limestones: on macrofossil evidence these are thought to be of C_1 to C_2S_1, and D_1 ages respectively (Table 1 and Figure 4). Limestones belonging to the intervening S_2 Zone may be present but have not been proved.

Milldale Limestones are dark, thinly bedded and fine-grained with a little chert and subordinate shaly intercalations. Massive medium to dark grey fine-grained micritic limestones and dolomites form knoll-reefs in the lower part of the formation; these crop out in the central part of the inlier north of Kniveton. The reef-limestone has been proved (p.132) to be about 114 m thick at Standlow Quarry Borehole [2122 5087] and it is estimated that the associated dark thinly-bedded limestones may be as thick as 215 m at outcrop. Their base remains unproved.

Hopedale Limestones: The formation consists mainly of grey thickly bedded bioclastic limestones but also includes fine-grained limestones with a few cherts, small knoll-reefs of grey micritic limestones with associated breccia and some intraformational dolomite. This variability contrasts with the relatively uniform lithology of the limestones of D_1 age in the shelf province. A borehole near Bradbourne (p. 130) proved 100 m of Hopedale Limestones but the full thickness is probably around 120 m.

Widmerpool Formation: Dark shaly mudstones and limestones are thinly interbedded throughout most of this formation which has a maximum thickness of about 200 m. The ratio of mudstone to limestone in the top 60 m, the only part well exposed, is about 3:1. Individual beds of limestone are up to 0.5 m thick and mainly grey and bioclastic. Locally, limestones appear to predominate over mudstones particularly in the lower part of the sequence, producing mappable limestone outcrops.

VOLCANIC ROCKS

The continuity of limestone deposition in the shelf province was broken at intervals by volcanic eruptions that resulted in outflows of basalt lava on to the sea bed. Explosive eruptions also occurred, and gave rise to beds of tuff and agglomerate made up of basalt fragments with occasional blocks of limestone. Several volcanic necks are present in the area; these are vertical or near-vertical pipe-like bodies of agglomerate and tuff that mark the sites of conduits through which the volcanic materials reached the surface. Other feeders, not now exposed, may have supplied part of the erupted material. In addition the weathered remnants of thin volcanic deposits are interbedded with the limestone as clay 'wayboards'. These are generally distributed throughout the shelf province. At a later date there were local intrusions of basaltic magma into the limestone sequence and these solidified as dolerite sills.

Figure 5 shows the present extent of the three beds of lava and tuff interbedded with the limestones, together with the locations of the known volcanic necks and the outcrops of the dolerite sills. The original extent of the lavas may have been reduced by contemporaneous erosion. It is evident that more lavas were erupted in the northern part of the shelf province than in the south and that this greater abundance corresponds with a concentration of volcanic necks and sills. The lavas and tuffs are therefore thought to have come mainly from these necks, although it is not possible to identify which conduit supplied which lava, and it is quite likely, for example, that the complex body known as the Lower Matlock Lava was supplied both from the Grangemill and Bonsall necks. Stratigraphically the lavas all lie within the Monsal Dale Limestones (Figure 4).

DOLOMITISATION

The limestones at outcrop have been altered to dolomite (Parsons, 1922) in two main areas: in the southern and northern parts of the shelf province (Figure 6). There may also be patches of dolomitisation which are not shown on the Resource Map, either because they are not exposed or because they are too small to have been recorded. The extent of the alteration varies from place to place, partially dolomitised limestone having been generally included for mapping purposes with more completely altered rocks. In detail the margins of the altered zones are irregular, and may be either sharp or gradational. They commonly cut across the bedding planes in the limestones, showing that the dolomitisation took place after the limestone was laid down. Unaltered limestone has been proved to lie beneath the dolomite in several places, the maximum known depth of the contact being 128 m below the surface (Ford and King, 1965, p. 1688). Magnesium-rich solutions are assumed to have penetrated downwards, perhaps during Permian or Triassic times, to produce the alteration (Dunham, 1952, p. 415; Frost and Smart, 1979).

In the Bradbourne-Kniveton area incipient dolomitisation is common at outcrop. In particular, the knoll-reefs in the Milldale Limestones are extensively dolomitised near the surface, though probably not at depth except in association with mineral veins or joints. The Hopedale Limestones are partly dolomitised at depth.

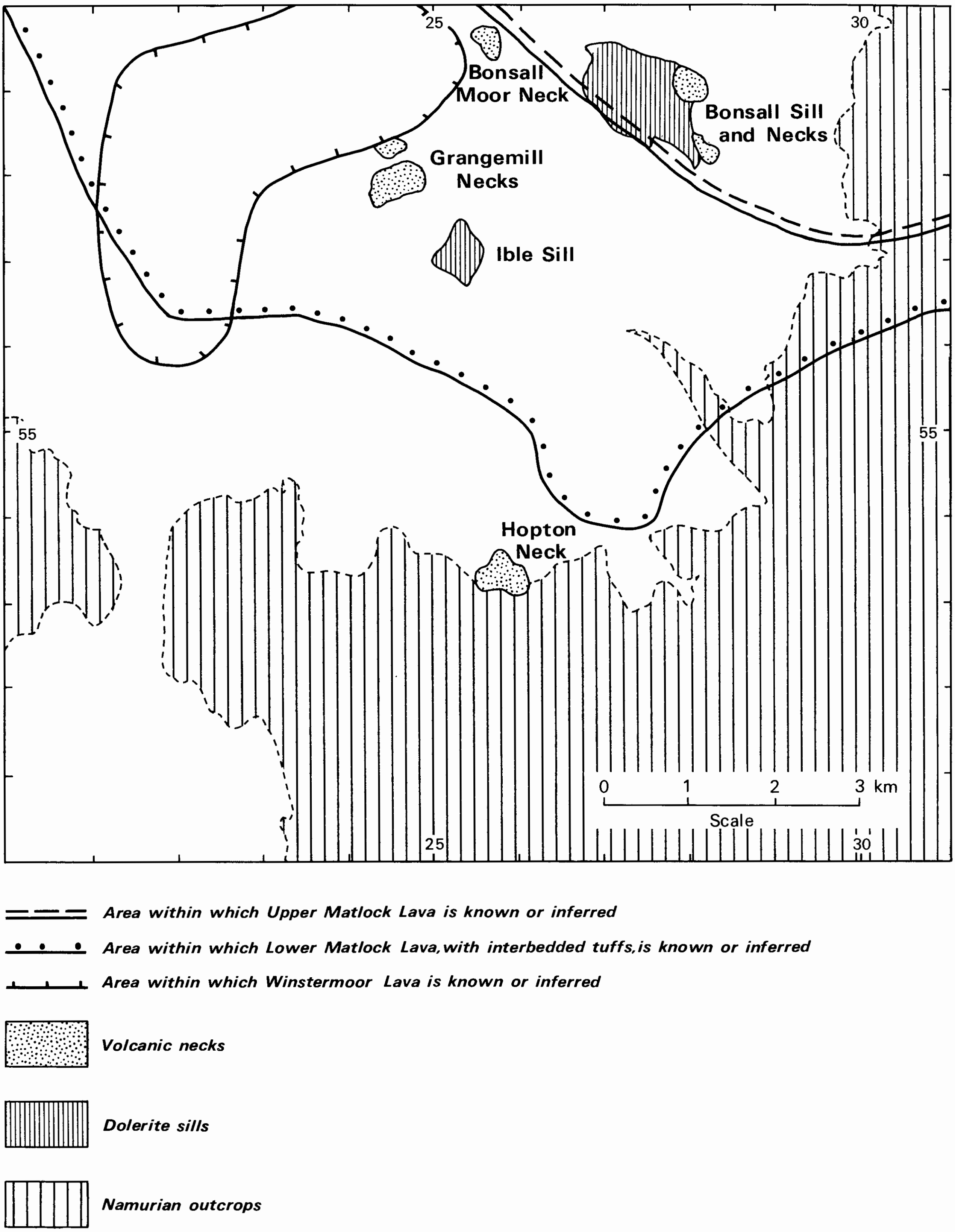


Figure 5 Distribution of the volcanic rocks

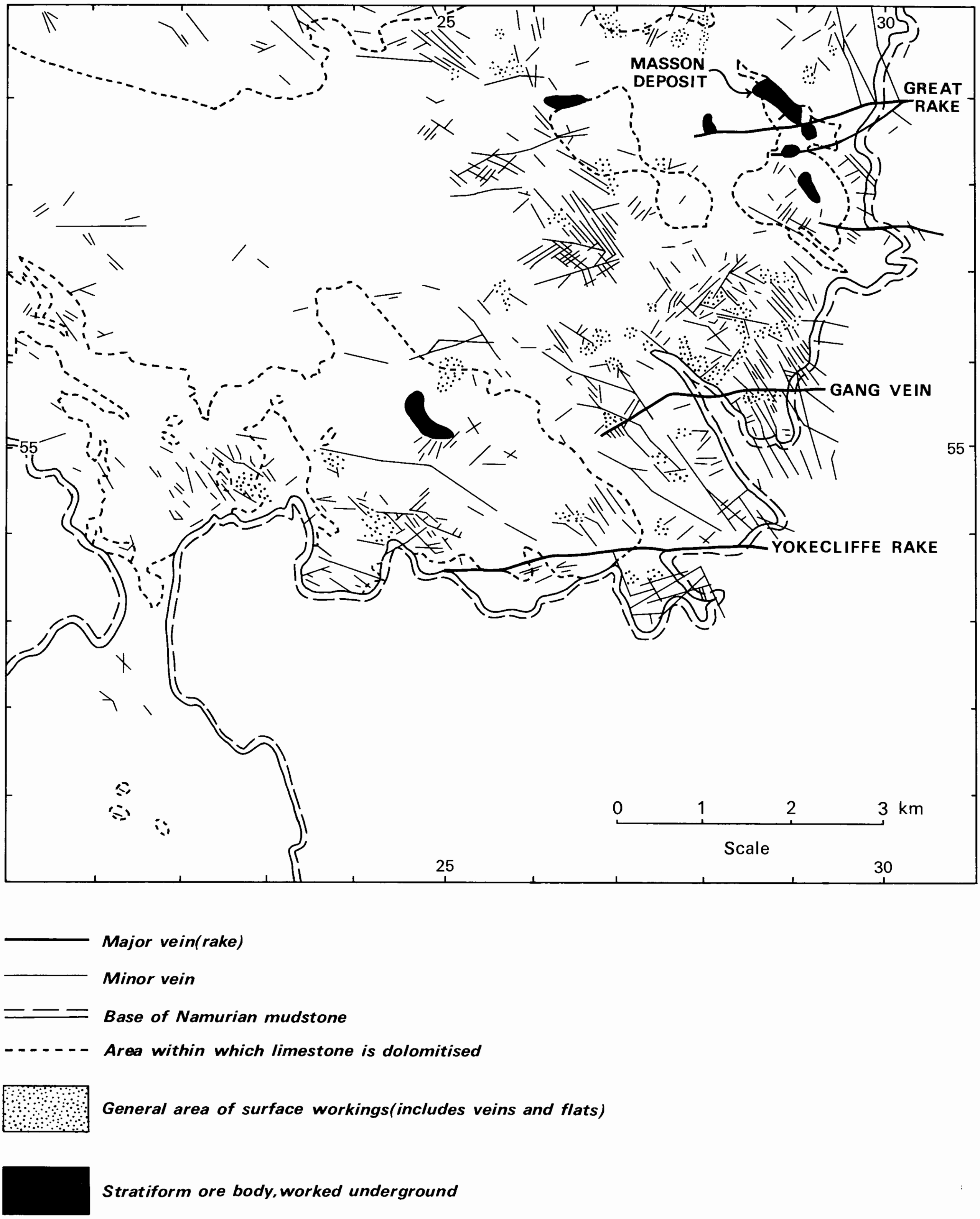


Figure 6 Distribution of dolomitisation and lead-zinc mineralisation in the Dinantian rocks.

Plate 2 Tors of dolomitised Bee Low Limestones: Rainster Rocks, Brassington

Plate 3 The off-shelf province: Hopedale Limestones, Haven Hill and Havenhill Dale

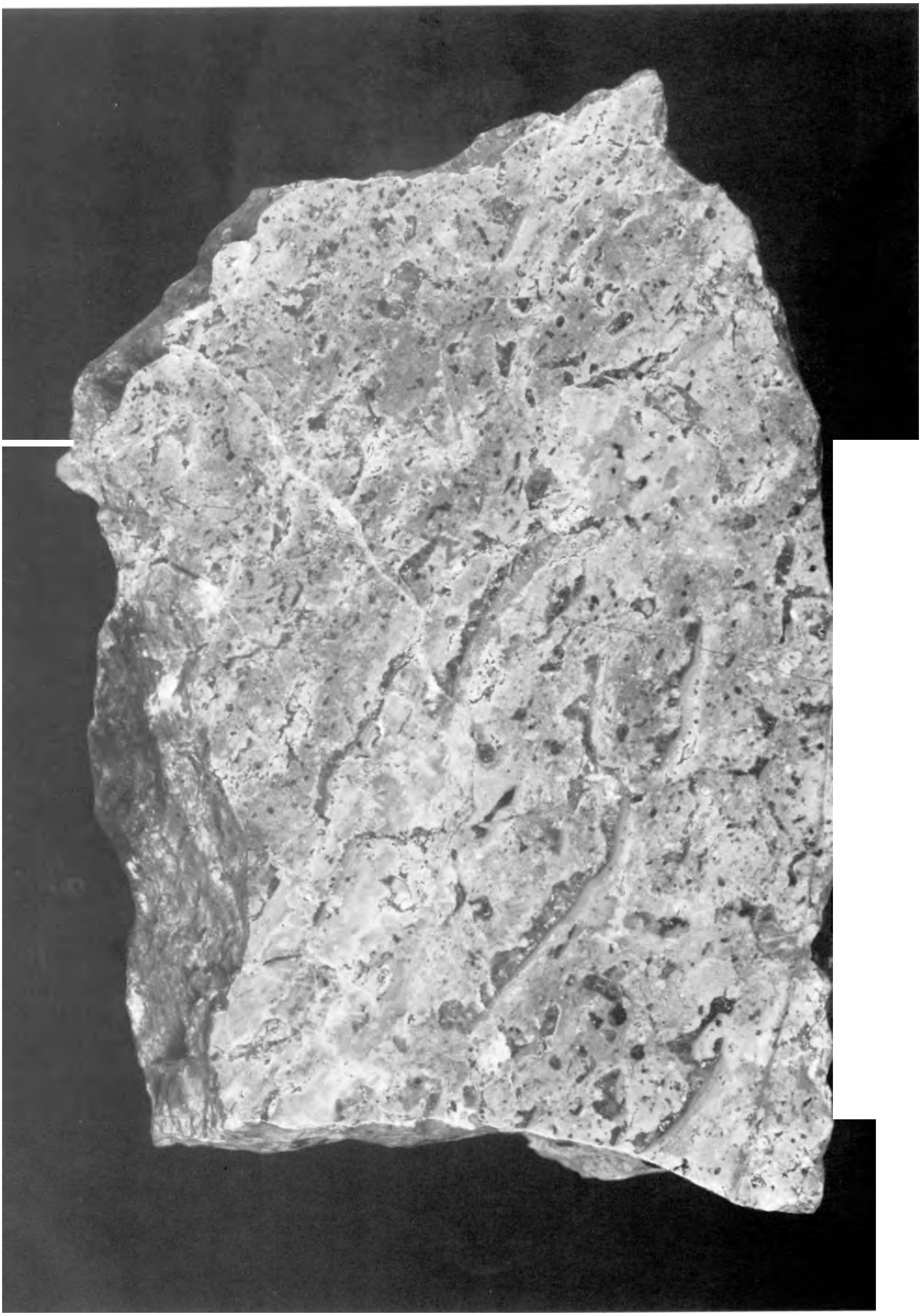
Plate 4 Quarry in massive grey and dark grey limestones with bands of chert: Monsal Dale Limestones, Middlepeak Quarry, Wirksworth

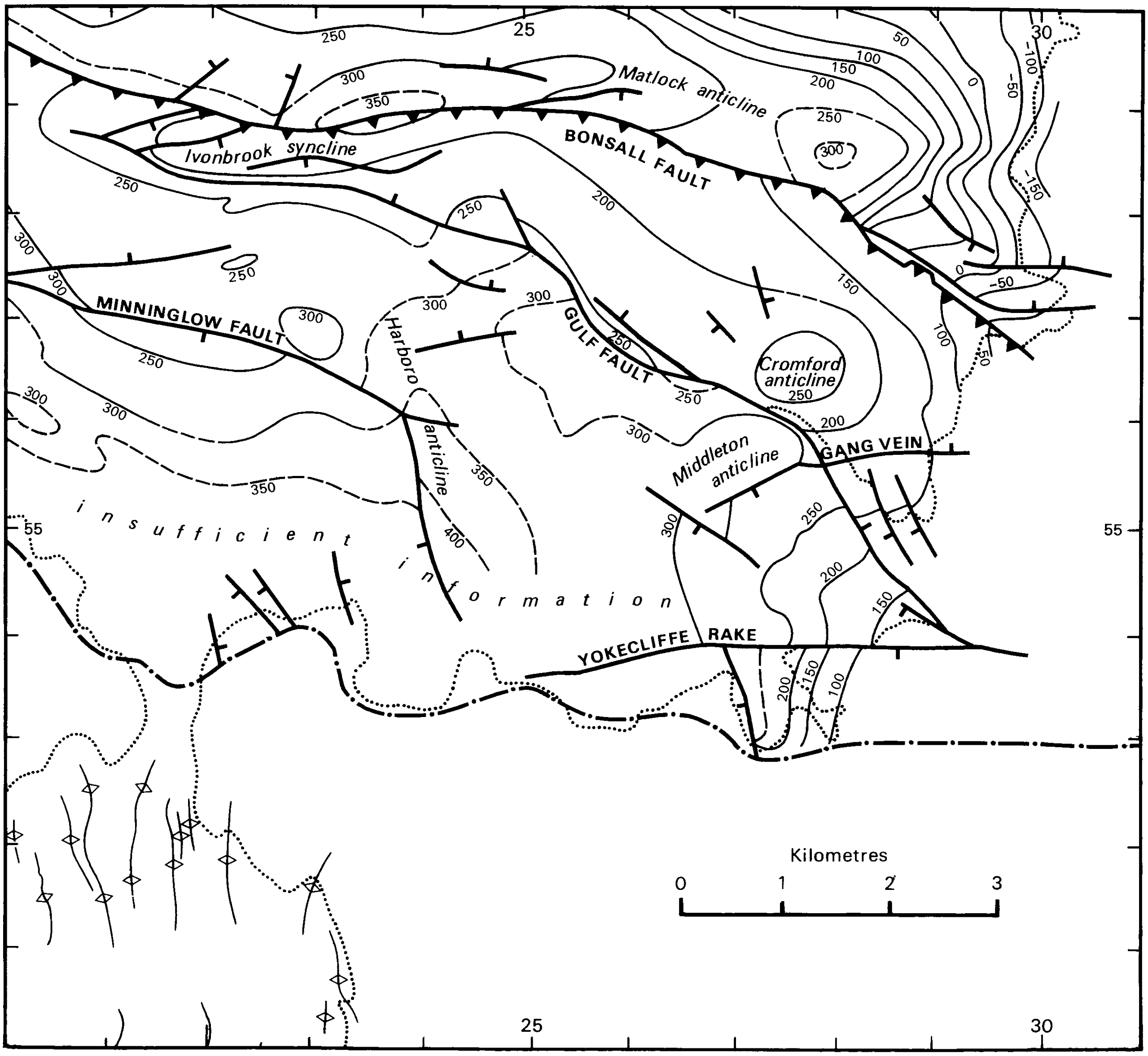
Plate 5 Escarpment of the Monsal Dale Limestones above the Lower Matlock Lava: Longedge, Aldwark

Plate 6 Eyam Limestones at Shaw Quarry, Wirksworth: thinly bedded, dark grey, crinoidal Eyam Limestones overlie a reef-knoll of massive pale grey, bryozoan, crinoidal Eyam Limestones

Plate 7 Irregular erosional base of Eyam Limestones resting unconformably on the Bee Low Limestones, Baileycroft Quarry, Wirksworth

Plate 8 Bryozoan biomicrite from a knoll-reef in the Milldale Limestones





Normal fault, tick on downthrow side.

Reversed fault, ornament on downthrow side.

Margin of shelf province.

Structure contour on top of Bee Low Limestones, height in metres above O.D.; lines broken where projected outside outcrop of Bee Low Limestones.

Anticlinal axes in off-shelf province.

Boundary between Namurian and Dinantian rocks.

Figure 7 Structure of the Dinantian rocks.

STRUCTURE

Shelf province: Earth movements, partly at the end of the Carboniferous period and partly in more recent times, have produced folds and faults in the limestones of the shelf province (Figure 7). The most important structure is the Bonsall Fault, a reversed fault or thrust, with downthrow to the south. The dip of the fault plane can be seen at Ball Eye Quarry [288 573] where it is inclined towards the north-east at between 25° and 40°. An upfold, the Matlock Anticline, is present along the north side of the fault, and there is a corresponding downfold, the Ivonbrook Syncline, along the south side. Dips in these structures range from 5° to 30° on the northern limb of the Matlock Anticline, and up to 30° in the Ivonbrook Syncline. The structure contours (Figure 7) reveal only the broad outlines of these folds; small subsidiary folds within them are common but have not been shown.

Farther south shelf limestones are affected by gentle folds, many of which are too small to appear on Figure 7. Most are either periclines or basins with no definite axial trend. Dips rarely exceed 14° except along the eastern side of the area where a marked monoclinal flexure causes the strata to plunge eastwards beneath the Namurian cover-rocks at angles up to 25°. Faults in this area are normal faults, the most important being the Gulf Fault, the Minninglow Fault and Yokecliffe Rake. All trend between west and north-west. The Gulf Fault has a large throw near Wirksworth, where it gives rise to a marked topographic hollow known as The Gulf, but it loses throw north-westwards and eventually dies out among a plexus of small faults adjacent to the Bonsall Fault.

Except along the eastern monocline the folds and faults are superimposed on a gentle southward rise of the strata towards the shelf margin (Figure 7), along which there are few exposures, but it is clear that the strata are folded or faulted sharply downwards into the off-shelf province.

Off-shelf province: In the Bradbourne–Kniveton area the limestones are much more intensely folded than in the shelf province and a series of anticlines has been traced with a general north–south axial trend and an average wave-length of about 325 m (Figure 7).

LEAD-ZINC MINERALISATION

During a period mainly after dolomitisation, mineralising fluids from a deep source to the east (Ford *in* Sylvester-Bradley and Ford, 1968, pp. 117–123) deposited a suite of minerals in open joints and caverns in the limestone and dolomite. Some metasomatic replacement of these rocks also took place. The orebodies are most abundant in the eastern and southern parts of the shelf province (Figure 6), their distribution in detail being related to the occurrence of impervious layers such as volcanic rocks, clay wayboards, and the Namurian mudstone cover.

Most of the orebodies are well defined near-vertical veins, but there are also various less well defined forms, including flats, pipes and irregular replacements, which lie roughly horizontal or are parallel to bedding. These are more common in the dolomitised areas than elsewhere. The best known of them is the Masson deposit (Figure 6), formed by replacement of limestone at the base of the dolomitised zone and between two of the lavas. The largest examples are shown in Figure 6, but there are also many small replacements alongside the veins throughout the mineralised area.

The major veins – Great Rake, Gang Vein and Yokecliffe Rake (Figure 6) – are up to 10 m wide. They trend roughly east–west and coincide with small faults. The smaller veins occupy joint fissures in two main sets (Figure 6), one parallel to the major veins and one trending in a roughly north-westerly direction. Few of the large faults (Figure 7) are mineralised.

The veins are composed of calcite, baryte and fluorite with minor amounts of lead-zinc ores, mainly galena and sphalerite. The ill-defined bodies contain the same minerals but grade into country rock, which in some instances is silicified.

ASSESSMENT PROCEDURES

Following a desk study, a field survey was commenced and the rocks representatively sampled for processing in the laboratory.

FIELD SURVEY

With the aid of up-to-date 1:10 560 geological maps the number of boreholes required and the natural exposures and quarry sections to be sampled were determined. Core from six boreholes drilled in 1971 at the feasibility stage of the project was available and a further eight boreholes were drilled to complete the survey. The initial six boreholes were drilled to depths ranging from 31 to 70 m and continuous cores of at least 74-mm diameter were obtained. These boreholes were drilled by contractors using track or trailer-mounted Reich or Boyles rigs. Drilling was by airflush. The remaining eight boreholes were drilled to an average depth of 100 m using water, and continuous cores of 56-mm or 47-mm diameter were obtained. The contractor operated truck-mounted Dando rigs equipped with wireline drilling gear. In general the recovery of limestone cores exceeded 90 per cent, but some difficulties were encountered with cherty limestone, dolomite and clay bands. Additional information was provided by core from four commercial boreholes and also from core obtained with a portable 'Minuteman' drill operated by Institute staff. This drill recovered 22-mm diameter core from 16 boreholes drilled to a maximum depth of 10 m. Samples were collected at metre intervals from quarries and natural exposures and these were supplemented by an extensive collection of spot samples. All samples were subjected to preliminary lithological and mechanical logging, the latter including fracture spacing and point load strength testing.

LABORATORY PROGRAMME

Lithological, petrological and mineralogical determinations were made using a combination of microscopical and staining techniques applied to sawn and etched rock surfaces and thin sections. Additional data were obtained by semiquantitative X-ray methods and reflectivity measurements. Chemical analyses for major and trace elements were performed by the Analytical and Ceramics Unit of the Institute on samples from both borehole cores and exposures. A primary classification of the rocks, based on carbonate content, was achieved by measuring the magnitude and nature of the acid-insoluble residue. Aggregate impact tests were carried out in the laboratory.

CLASSIFICATION

There are various classifications of limestones but the two chosen for use in this report are based on petrology and on calcium carbonate ($CaCO_3$) content. The former is used to describe the rocks in lithological terms and the latter is preferred for the assessment of resources by grade and to demonstrate them on the resource map. The relationship between the five categories adopted, their $CaCO_3$ contents and possible end uses is shown in Table 2.

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

RESULTS

STRATIGRAPHICAL PETROLOGY

The Dinantian limestones range from C_1 (Lower *Caninia* Zone) to D_2 (Upper *Dibunophyllum* Zone) (Table 1). As we have seen, they can be divided between shelf and off-shelf provinces, but for assessment purposes they are here described together from the bottom upwards using the regional stratigraphical nomenclature.

The Milldale Limestones

These rocks of the off-shelf province crop out between Haven Hill [211 519] and Kniveton [207 501]. They are represented by a sequence of dark thinly-bedded limestones and knoll-reefs.

The knoll-reef limestones which occur in the lower part of the proven sequence are exposed in several small quarry sections, and a borehole (SW 19) at Standlow Quarry proved nearly 100 m of poorly-bedded knoll-reef limestone passing into a sequence of dark, cherty limestone and mudstone at the base (p. 132). The characteristic reef facies is a uniform lithology of medium to dark grey bryozoa biomicrite. Allochems are predominantly bryozoa, with lesser amounts of brachiopod, crinoid and coral debris of arenite grain size. The exposed knoll-reef limestone and the upper 21 m of borehole SW 19 are dolomitised. The degree of dolomitisation varies from generally slight to intense, particularly in the vicinity of joint planes and mineralised fissures. The chief non-carbonate minerals are silica, which occurs as replacement of shell debris, and hematite. Hematite and limonite are disseminated throughout this deposit, but pyrite is only locally present in trace amounts. Black mudstone partings constitute a further source of impurity. Fluorite, galena and calcite were recorded in association indicating local mineralisation. The knoll-reef limestones are predominantly of medium purity (93.5–97.0% $CaCO_3$) although silicification may reduce this to low purity (85.0–93.5% $CaCO_3$).

The greater part of the Milldale Limestones outcrop is represented by dark, thinly-bedded limestone. A borehole, SW 5, at [2131 5150] proved over 60 m of limestones without reaching the base of the sequence. The limestones consist of uniform, dark grey, well sorted, fine arenite biosparites and biopelsparites with interbedded mudstone bands and partings. Poorly fossiliferous micritic bands occur less commonly. Many bioclasts are very finely comminuted and of indeterminate type, but of those which can be determined, shell, crinoid, foraminifera and pelletal debris are the most commonly occurring. Hematite-stained fissures and impersistent calcite veins form a network through these rocks and dolomitisation locally alters the limestones; in many cases there is associated silicification of bioclastic debris. Euhedral quartz crystals are ubiquitous in the poorly fossiliferous micritic bands and locally silica has replaced rhombohedral dolomite crystals. Chert and clay occur in variable quantities throughout the area. Baryte, bitumen and pyrolusite have also been recorded. The preponderance of non-carbonate minerals in this part of the sequence downgrades the deposit to the impure category (<85.0% $CaCO_3$).

The Woo Dale Limestones

Approximately 30 m of Woo Dale Limestones are exposed in the Via Gellia, and an assessment borehole at Ryder Point (p. 56) [2619 5645] proved a further 99.95 m, giving a total of 128.95 m. The area of exposure is approximately 0.2 km^2.

These limestones may be subdivided into two major lithofacies. The upper facies are dominantly shallow-water deposits comprising pale coloured, massively bedded calcarenites and calcilutites of which the dominant lithologies are algal pelsparites, algal pelletal, biosparites and biomicrites. Clasts are chiefly of fine arenite or lutite size and are well sorted 'high energy' lithologies. The predominant allochems are finely comminuted foraminifera, pelletal, brachiopod and crinoid debris. Calcispheres are locally abundant, whereas dasycladacean algae, corals, gastropods and ostracods occur less commonly. Many bioclasts are encrusted by algae. Spar-filled vugs of 'bird's eye' type (Plate 9) are also abundant at certain horizons and are associated with vadose textures. Algal laminations were also recorded.

Quartz was recorded as an accessory mineral in half of the samples examined together with minor amounts of pyrite and rare hematite. The quartz is in the form of euhedral doubly terminating crystals. Pyrite is chiefly finely disseminated and hematite, which may be replacing original pyrite, occurs along stylolites and joints.

Clay-coated stylolites and grey clay partings are locally common. Bioclasts are rarely silicified, but clay-grade silica has been recorded. Dolomite and baryte occur locally along fissures.

The lower facies of the Woo Dale Limestones as seen in the Ryder Point Borehole is dominantly a crinoid, brachiopod biosparite with varying amounts of peloidal debris. Encrusting algae, corals and bryozoa were all recorded as subordinate allochems. Silica is present in the form of finely crystalline material, euhedral crystals and in the silicification of some larger allochems. Pyrite

Table 2 Classification of limestone by purity with some possible industrial end uses

Category	Percentage $CaCO_3$	Equivalent	Possible industrial use
1 Very high purity	>98.5	55.18	steel, glass, rubber, plastics, paint, whiting
2 High purity	97.0–98.5	54.34–55.18	iron, ceramics, Portland cement, sugar
3 Medium purity	93.5–97.0	52.38–54.34	paper, animal feeding stuffs, agriculture
4 Low purity	85.0–93.5	47.62–52.38	asphalt
5 Impure	<85.0	47.62	natural cement, mineral wool

occurs as scattered flecks and aggregates. Hematite was recorded locally in patches. Mudstone-filled partings and fissures are common towards the lower part of the sequence examined.

The upper facies are dominantly high and very high purity limestones whereas increases in clay and silica in the lower facies result in a reduction in carbonate to high and medium purity limestones.

The Bee Low Limestones

This formation is found at the surface covering an area of 20.02 km² which is over 29 % of the limestone outcrop on this sheet. It includes rocks which are actively worked for their high calcium content as well as a considerable source of aggregate. The lithologies are dominantly biosparites (Figure 9) but biomicrites form approximately a quarter of the sequence. The succession consists of pale-coloured massively bedded calcarenites with associated calcirudites and rare calcilutites. The rocks are dominantly well or moderately sorted with a high proportion of pelsparites. The most commonly occurring allochems are brachiopod, crinoid and pelletal debris with lesser amounts of foraminifera, *Koninckopora* and coral. Bioclasts are commonly encrusted by algae and rarely by coral. Distinctive algal pelsparite beds occur throughout. Bluish-grey and ochreous clay wayboards, which range in thickness from a few millimetres to over 0.5 m, occur throughout the succession. Such beds could not be traced for any significant distance laterally and are therefore of little use in regional correlation, although they may prove useful for local correlation in a survey of reserves. Although there is a wide uniformity of rock types in this formation, an important exception was found on Masson Hill where an assessment borehole (NE 43, p.118) encountered biomicrites, biosparites and mudstones which passed downwards into tuffaceous mudstone interbedded with algal biomicrite. It is clear that a local volcanic event in this region overshadows the pattern seen elsewhere.

On the southern margin of the limestone crop from square [20 54] to [27 53] a marginal belt of apron-reef limestones is developed within the Bee Low Limestones. These limestones are poorly bedded, grey, predominantly bryozoa biomicrosparites with occasional pelsparites. Bioclasts are variable in grain size and distribution, bryozoa are particularly common and geopetal cavities are a distinctive feature.

The Bee Low Limestones between Ballidon and Hopton, and Gratton and Winster moors are extensively dolomitised. The degree of dolomitisation is variable and in some instances the original textures have been destroyed and replaced by an interlocking mosaic of dolomite crystals. In such dolomites, bedding planes are commonly the only sedimentary features which have withstood dolomitisation. Where dolomitisation has been incomplete, relict structures such as moulds of rudite crinoid, brachiopod, or coral debris, are preserved. Figure 10 indicates the range of accessory minerals recorded by petrographic logging and the number of occurrences.

Quartz is the commonest accessory in the Bee Low Limestones although even this mineral was absent from the majority of samples examined. Chert was not recorded but does occur in minor amounts in the Hopedale Limestones of the off-shelf province which are of similar age. (Figure 8 includes data on silica content for both formations.) All other accessories in these rocks are very minor in amounts although pyrite is abundant in the Masson Hill area where there is local volcanism (see above).

The Hopedale Limestones

These limestones are separated from the Bee Low Limestones on the grounds of their lithologies which result from deposition in a different sedimentary environment. They have been formed beyond the reef front in the so-called off-shelf province (Figure 4). They crop out in the vicinity of Haven Hill [210 519] and cover an area of approximately 2 km². They are less massive than the Bee Low Limestones and more variable but as in the other rocks of this age encountered in this district they are predominantly brachiopod crinoidal biosparites, with some pelsparites. In contrast to the Bee Low Limestones, the biosparites may be ill-sorted and coarsely bioclastic. Bioclastic limestones of finer grain size are frequently medium to dark grey, thinly bedded and contain some nodular chert. Allochems are predominantly brachiopod and crinoid debris with lesser amounts of peloidal material, foraminifera, *Koninckopora* and encrusting algal debris. An impersistent horizon near the top of the sequence contains silicified and hematite-stained *Michelinia*. Patch reefs are developed locally and crop out at Wigber Low [205 513] and as a small knoll on the northern slopes of Havenhill Dale [208 524]. The reef lithology is predominantly poorly fossiliferous biomicrite which is brecciated and mixed with crinoid brachiopod biosparrudite at Wigber Low. The sequence is locally dolomitised at outcrop in the Bradbourne–Haven Hill area, and a borehole (SW 18) at Bradbourne [2125 5252] proved 83 m of partially dolomitised limestone. The 100 metres of strata encountered in this hole comprise coarse bioclastic limestones which are mainly pale or medium grey and thickly bedded, and locally contain conglomeratic beds.

The chief non-carbonate mineral is silica in the form of chert, euhedral quartz and as replacement of bioclastic debris. Black mudstone and shaly partings are common in the fine-grained limestone sequence. Further impurities which have been recorded in minor amounts are hematite and pyrite. The greater proportion of the sequence is medium purity limestone (93.5–97.0 % $CaCO_3$) in contrast to the Bee Low Limestones, which are dominantly of high and very high purity (97.0–98.5 and 98.5–100 %) although low purity limestones do occur locally. The thinly bedded, fine-grained limestones which contain chert and shaly partings are of low purity (85.0–93.5 % $CaCO_3$), whereas the patch reef limestones are high purity (97.0–98.5 % $CaCO_3$) or very high purity (>98.5 % $CaCO_3$) limestones.

The Monsal Dale Limestones

These limestones have the most extensive outcrop on the sheet, covering an area of just over 32 km² which is 46 % of the area of limestones assessed. Perhaps the most distinctive feature of this formation is the presence of various volcanic horizons which provide natural markers useful for correlation. This investigation has, by use of detailed lithological studies and the collection of much additional data, necessitated a revision of the published 1:25 000 geological map and a reinterpretation of the number and stratigraphic relationships of the various lavas and tuffs. Figure 4 shows the development of the lavas in the Monsal Dale Limestones and the variation from the 'thick' to 'thin' sequence which has been outlined above (p. 7). In detail this variation is highly localised. For example in the Ember Farm region [20 52]

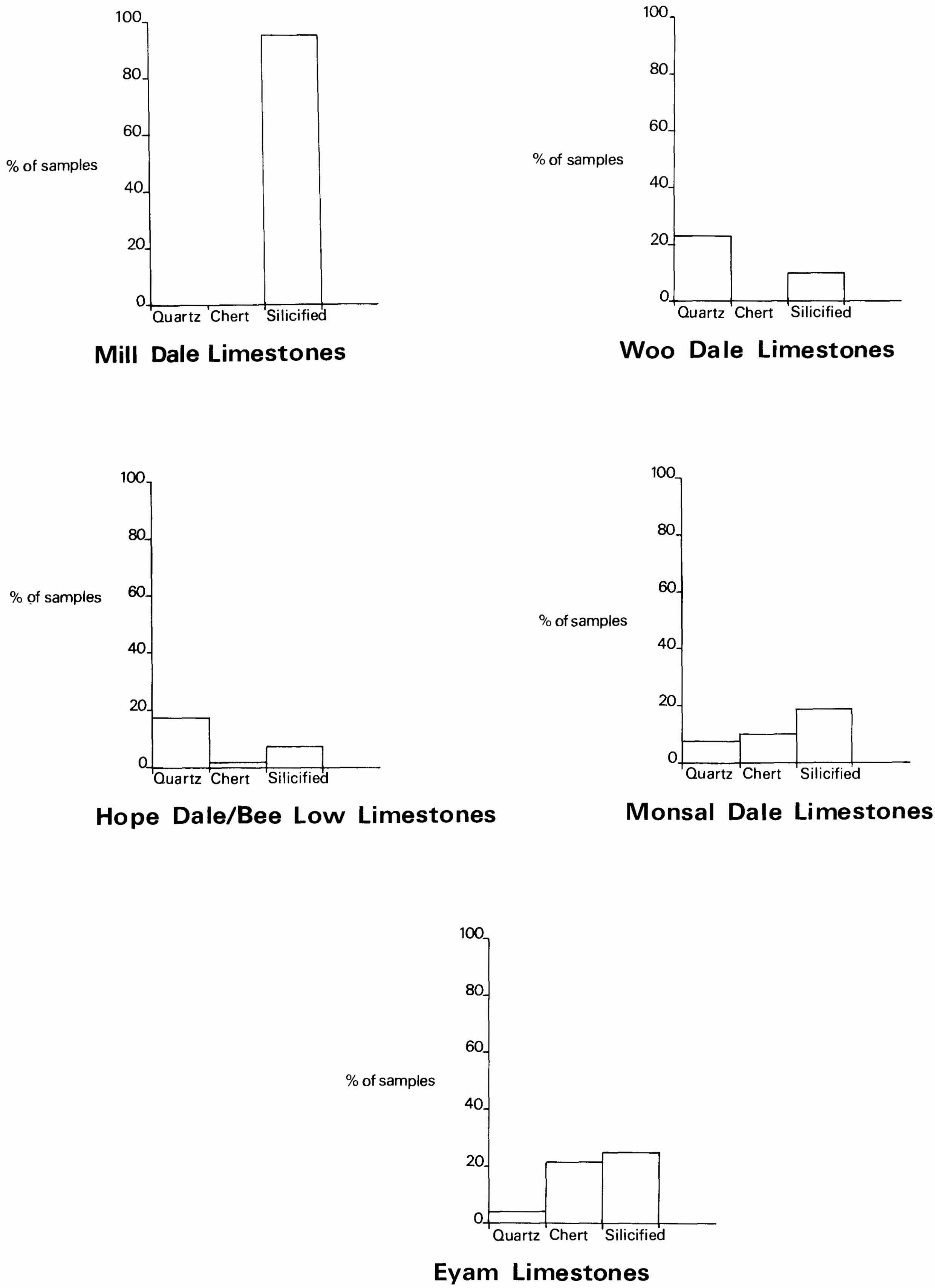


Figure 8 Silica content (determined by petrographic study)

the Monsal Dale Limestones are approximately 180 m thick but south of the Bonsall Fault they thin to 35 to 40m and in the vicinity of Wirksworth [28 54] the Eyam Limestones rest directly on Bee Low Limestones. On the western half of the sheet this change is difficult to define precisely. In the north-west [square 22 59] the approximate thickness is 165 m. South of the Bonsall Fault at Aldwark [square 22 56] a maximum of 133 m is exposed, but although the top of the sequence is not seen there is no evidence of any change in the thicknesses of the horizons exposed when compared to those in the north. It is therefore assumed that the total thickness is similar at these two localities. Within the 'thick area', the Monsal Dale Limestones vary around 180 m, although in the north-east of the sheet over 100 m of the sequence is taken up by lava and associated pyroclastic rocks.

The limestones are highly variable throughout the sheet and consist of pale grey and grey, massively bedded calcarenites with calcirudites. The predominant lithologies are poorly or moderately sorted biomicrites and biosparites with some well sorted biopelsparites and pelsparites. Allochems are predominantly brachiopod and crinoid debris with lesser amounts of peloidal material, coral debris, foraminifera, dasycladacean algae and gastropods. Algal-encrusted bioclasts commonly occur. Diagnostic marker bands are rare but thin pelsparite limestones and clay wayboards have been of minor value in regional correlation.

The Monsal Dale Limestones are extensively dolomitised, but the degree of dolomitisation is variable, producing a range of carbonate rocks similar to those within the dolomitised Bee Low Limestones.

Silica is the chief impurity in these rocks, occurring as chert, euhedral quartz and replacement of shell debris. The occurrence of chert is stratigraphically controlled and geographically restricted (Figure 11). The limestones and dolomites above the Upper Matlock Lava in the Masson area contain chert, as do the limestones approximately 30 m above the Lower Matlock Lava in the Aldwark–Middleton–Wirksworth area. Euhedral quartz is less common than in the underlying Bee Low Limestones whereas over 19 % of all samples examined showed evidence of allochem replacement. Other important non-carbonate minerals are hematite, pyrite, fluorite and clay minerals. Pyrolusite, bitumen, baryte and galena are recorded in trace amounts. A zone of pyrite enrichment, up to 1 m thick, is usually present at the contacts between the basalts and the Monsal Dale Limestones.

Where chert is abundant the limestones are of low or medium purity (85.0–97.0 %). Over the remainder of the crop high quality limestones predominate but beds of lower purity are also common.

The Eyam Limestones

These beds crop out in the eastern area between Matlock and Wirksworth. In much of the ground the succession can be divided into two distinct facies: an impersistent basal layer of knoll-reefs followed by mainly dark-coloured limestones. These are in turn overlain by dark shales with thin limestones of P_2 age (Longstone Mudstones) which are conformable with the Namurian mudstones. There is evidence for a marked stratigraphic break at the base of the Longstone Mudstones, which in some localities rest unconformably on the limestones below [28 54].

The lower division of poorly bedded knoll-reefs is well developed between Middleton and Cromford and along Matlock Dale (30.5 m at High Tor).

Because of the morphology of the knolls (Plate 5) this part of the succession shows a considerable local variation in thickness. However continuous reef facies of a uniform thickness is seen between Middleton [279 556] and Scarthin Nick [570 289]. It is the reef limestones within these rocks that have the highest carbonate content.

Poorly sorted bryozoan crinoid biosparrudite with lesser amounts of biosparites and biomicrites of arenite grain size are the dominant lithologies. Crinoid, brachiopod and bryozoan debris are common allochems with minor amounts of foraminifera, *Koninckopora*, pelletal debris and coral.

These predominantly high purity limestones contain some trace amounts of impurities, chiefly replacement silica with some euhedral quartz crystals present as a secondary form of silica. Traces of clay, hematite, chalcopyrite, galena and baryte were also noted.

The overlying division of thinly bedded and more massively bedded grey and dark grey limestones is approximately 8.5 m thick at [2799 5498] Middlepeak Quarries, 15 m thick in Bonsall Dale [28 57] with a maximum of 26 m developed at [2960 5970] in Harveydale Quarry. They consist of biosparites and biomicrosparites with lesser amounts of pelsparite and biomicrite. The skeletal constituents are variable in grain size and are poorly sorted, although thin, well sorted pelsparite bands are widespread. Beds containing rudite productoids are common. The predominant allochems are brachiopod and crinoid debris, with subordinate foraminifera, pelletal and spine debris. Minor amounts of coral, bryozoa and encrusting *Girvanella* are locally important.

Nodular and bedded chert is present in variable amounts as also is finely disseminated black clay. These impurities and commonly occurring silicified allochems mean that this group of limestones rarely reaches more than medium purity. Other non-carbonate minerals such as pyrite, hematite and carbonaceous debris have been recorded.

The Widmerpool Formation

This sequence of dark mudstones and thin limestones rests unconformably on the Hopedale Limestones but represents continuous deposition from D_1 times passing up into the Namurian mudstones (Figure 4). Over most of the outcrop beds of limestone rarely exceed 0.5 m in thickness.

The Widmerpool Formation may therefore be classified as impure ($<$85 % $CaCO_3$) but the limestones within the formation vary in purity depending on the proportions of chert, silicified bioclasts, hematite, and clay. The limestones are predominantly of medium purity (93.5–97.0 % $CaCO_3$), but impure ($<$85.0 % $CaCO_3$), low purity (85.0–93.5 % $CaCO_3$) and high purity (97.0–98.5 % $CaCO_3$) limestones have been recorded.

Figure 9 is a statistical summary of the variation in the lithology of each formation described above.

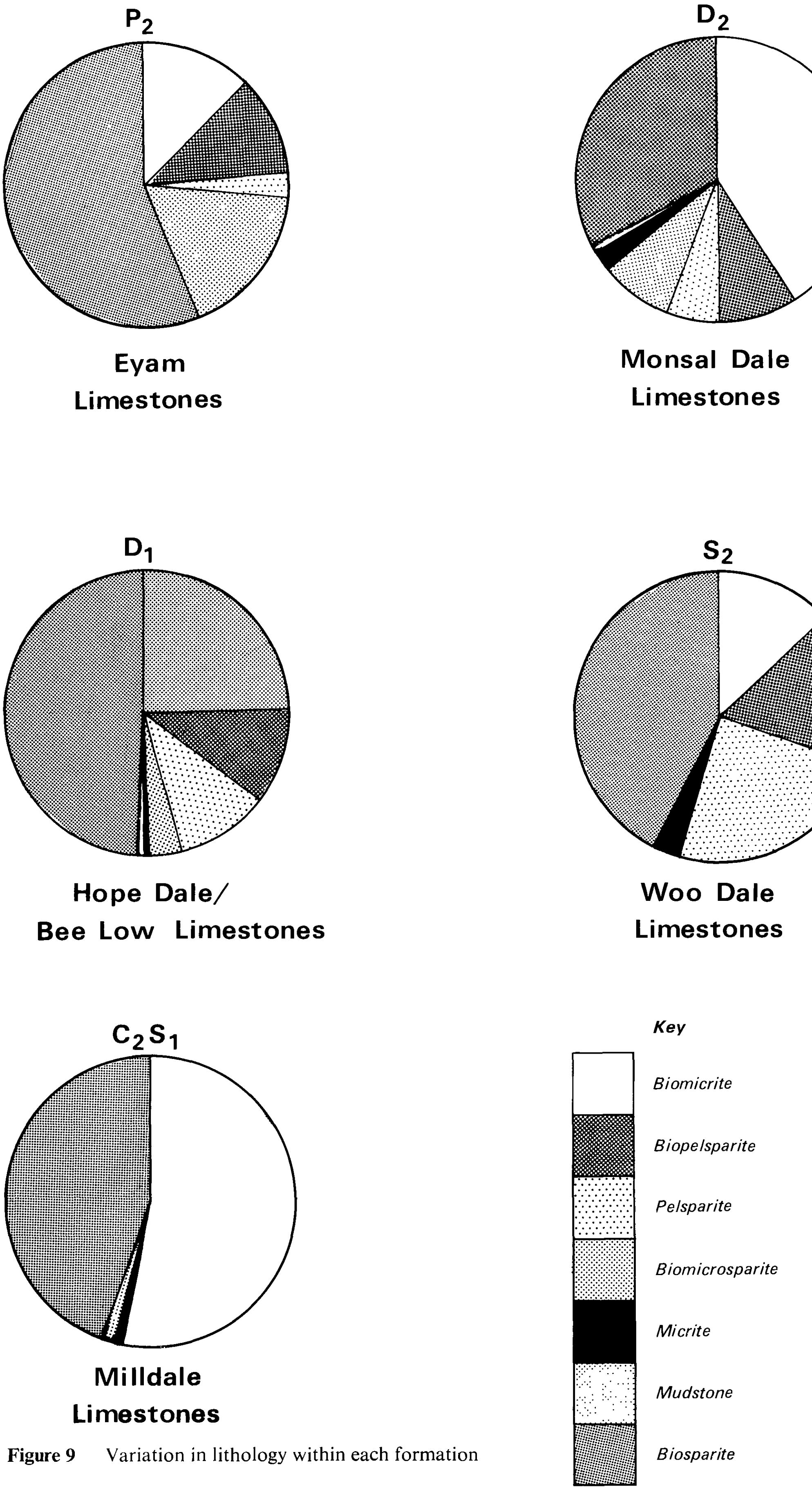


Figure 9 Variation in lithology within each formation

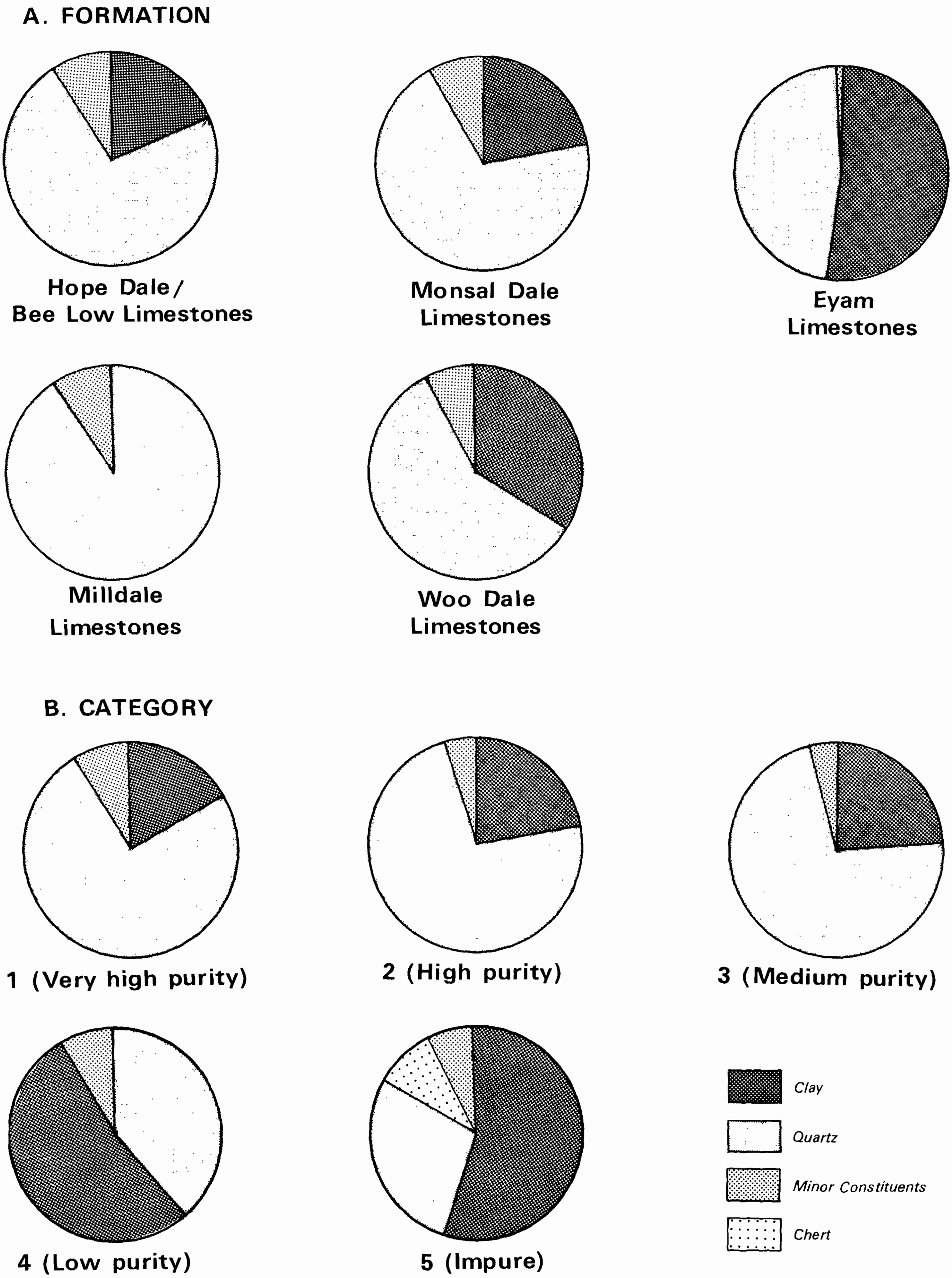


Figure 10 Variation of the non-carbonate fraction for formations and limestone categories

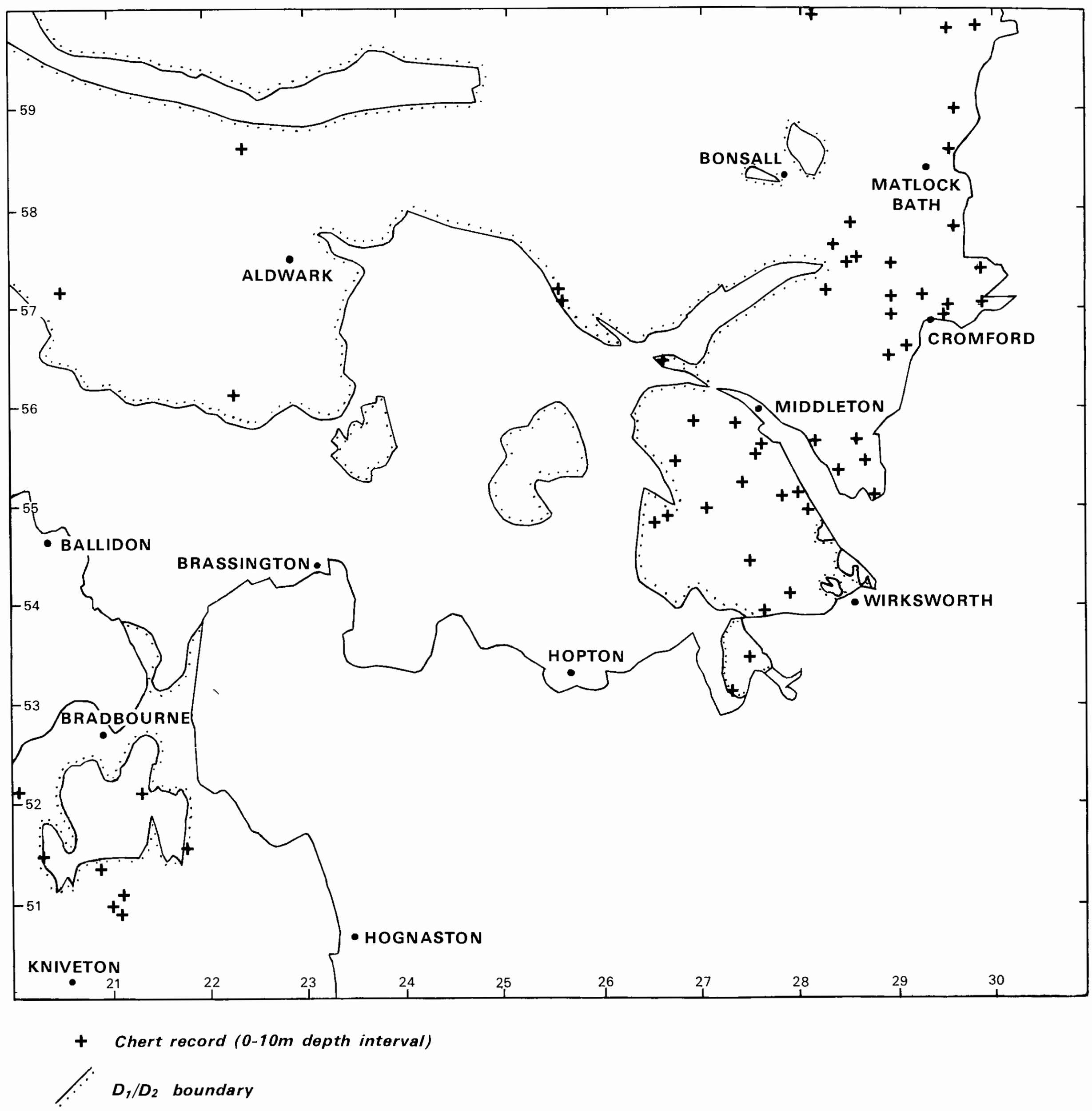


Figure 11 Distribution of chert in the 0–10 m depth interval

NON-CARBONATE FRACTION

The non-carbonate fraction of the limestones and dolomites is collected during the filtration process (Cox and others, 1977, p. 70). The insoluble residues are examined microscopically in reflected light and representative samples are selected for X-ray diffraction analysis.

Microscopical examination in which the three dominant minerals of each residue are recorded showed that silica and clay minerals form over 90 per cent of all residues; pyrite, hematite, limonite, baryte, fluorite, unidentified ore minerals and hydrocarbon were also recorded.

Silica occurs in the form of euhedral quartz crystals, as a chalcedonic replacement of shell structures and as chert. The first are found scattered to a variable degree throughout the rock, but concentrations at several horizons may locally increase insoluble residue by between 2 and 3 per cent; exceptionally, at horizons immediately below a clay or lava, the concentration is increased by more than 5 per cent (see Figure 12). Fossil debris may be partially or completely replaced by silica giving rise to high insoluble residue values; brachiopods are the most susceptible, but silicification of representatives of all the main fossil groups has been recorded. The distribution of chert, recorded from field and borehole observation is shown in Figure 11. Chert is restricted to the Monsal Dale Limestones and Eyam Limestones of the shelf area, and within these rocks the occurrence of chert is limited to the eastern part of the crop. Chert was also recorded in the Hopedale and Milldale limestones, and in the Widmerpool Formation of the off-shelf area.

Clay occurs within the deposits as partings, wayboards, disseminations and clay-coated stylolitic surfaces. Clay wayboards, frequently greater than 0.5 m in thickness, are ochreous and bluish grey, and the limestone immediately below the clay is commonly enriched in quartz euhedra and pyrite. Muddy limestones containing mudstone and shale partings and abundant disseminated clay are typical of the off-shelf province facies. In the shelf area such lithologies are local in occurrence.

Minor amounts of finely divided pyrite are found scattered throughout the limestone but it is most common in the darker limestones and in limestones associated with igneous rocks and clay wayboards. Hematite, limonite and goethite occur as alteration and weathering pro-

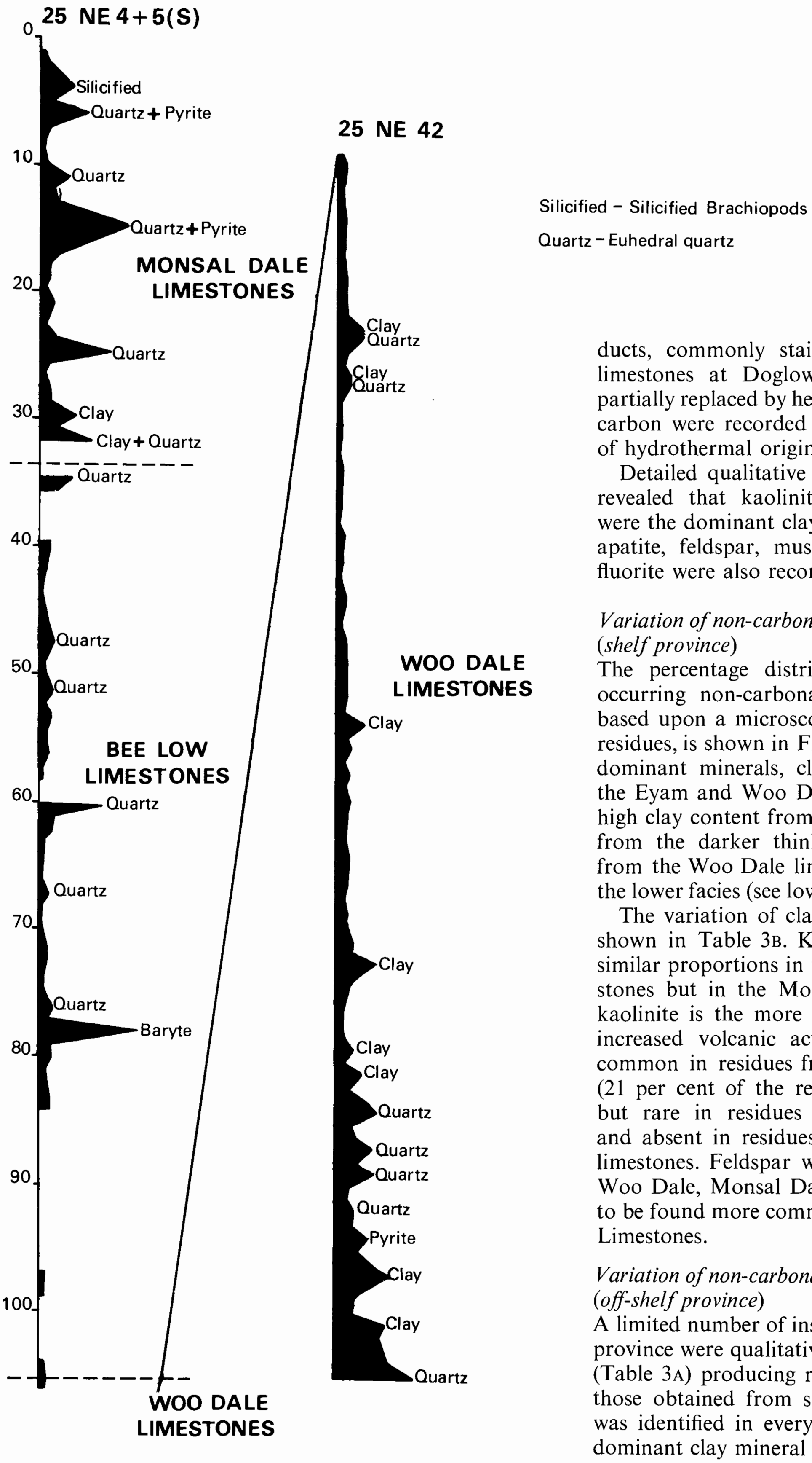


Figure 12 Composite section showing insoluble residue and non-carbonate mineralogy

ducts, commonly staining fissures and fractures, but limestones at Doglow Wood, Hopton [254 536], are partially replaced by hematite. Baryte, fluorite and hydrocarbon were recorded in the residues adjacent to veins of hydrothermal origin.

Detailed qualitative analysis, using X-ray diffraction, revealed that kaolinite, illite and mixed-lattice clays were the dominant clay minerals. Quartz, iron minerals, apatite, feldspar, muscovite, chlorite, amphibole, and fluorite were also recorded (Table 3A, B).

Variation of non-carbonate mineralogy with formation (shelf province)

The percentage distribution of the most commonly occurring non-carbonate minerals in each formation, based upon a microscopic examination of the insoluble residues, is shown in Figure 10A. Quartz and clay are the dominant minerals, clay occurring most frequently in the Eyam and Woo Dale limestones. The residues with high clay content from the Eyam limestones are derived from the darker thinly-bedded limestones, and those from the Woo Dale limestones are largely derived from the lower facies (see lower part of S_2 in Figure 12).

The variation of clay mineral type with formation is shown in Table 3B. Kaolinite and illite are present in similar proportions in the Woo Dale and Bee Low limestones but in the Monsal Dale and Eyam limestones, kaolinite is the more common, possibly as a result of increased volcanic activity. Apatite was found to be common in residues from the Monsal Dale Limestones (21 per cent of the residues analysed contain apatite), but rare in residues from the Bee Low Limestones and absent in residues from the Woo Dale and Eyam limestones. Feldspar was sporadic in residues from the Woo Dale, Monsal Dale and Eyam limestones but was to be found more common in residues from the Bee Low Limestones.

Variation of non-carbonate mineralogy with formation (off-shelf province)

A limited number of insoluble residues from the off-shelf province were qualitatively analysed by X-ray diffraction (Table 3A) producing results significantly different from those obtained from shelf-province limestones. Quartz was identified in every sample. However kaolinite, the dominant clay mineral in the Hopedale Limestones, was sporadic in the Milldale Limestones and was not recorded in the associated knoll-reef limestones of both formations. Smectite is commonly found in Milldale Limestone residues. Muscovite was identified in samples from all formations whereas feldspar is common in the Hopedale Limestones and, to a lesser extent, in the Milldale Limestones. Pyrite is recorded in some residues from all formations and fluorite is occasionally found in residues from the Milldale knoll-reef and Hopedale limestones.

Table 3A X-ray diffraction analyses of off-shelf province limestones

Formation and subdivisions	Minerals identified*								Number of samples analysed
	Quartz	Kaolinite	Illite	Smectite	Muscovite	Feldspar	Pyrite	Fluorite	
Hopedale Limestones D_1	11	10	2	–	9	6	4	2	11
Milldale Limestones C_2S_1	9	1	–	3	6	4	3	–	9
Milldale Knoll-reef C_2S_1	9	–	1	–	4	1	3	2	9

Table 3B X-ray diffraction analyses of clay minerals in shelf province limestones

	Kaolinite	Illite	Mixed layer clay
Eyam Limestones	64%	36%	not recorded
Monsal Dale Limestones	70%	20%	10%
Bee Low Limestones	47%	42%	11%
Woo Dale Limestones	53%	47%	not recorded

* Expressed as number of samples containing a particular mineral

Variation of non-carbonate mineralogy with limestone category

The percentage distribution of the most commonly occurring non-carbonate minerals in each category is shown in Figure 10B. The quartz to clay mineral ratio is high in the pure limestones (low percentage residue), but the ratio is lower in low purity and impure limestones (high percentage residue). Consequently quartz predominates in residues from very high to low categories, but in impure limestones clay is the most common non-carbonate material and quartz and chert are subordinate.

Table 4 Chemistry and correlation statistics of the Milldale Limestones

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
A CHEMISTRY																	
No. of samples	131	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Maximum value	64.40	53.80	13.50	15.70	2.72	0.04	0.55	0.66	0.16	0.15	45.77	2410	0.15	5	20	120	28500
Minimum value	1.70	39.20	0.41	0.81	0.06	0.0	0.0	0.03	0.0	0.0	35.58	210	0.0	0	0	0	500
Mean	11.47	48.18	2.08	8.22	0.78	0.02	0.06	0.20	0.08	0.06	39.75	685	0.05	4	4	17	9793
Standard deviation	9.94	4.30	3.25	5.60	0.77	0.01	0.14	0.18	0.05	0.05	3.36	566	0.05	2	6	30	9122
confidence limits at 95% level, ±																	
%	14.84	4.91	85.93	37.47	54.29	27.50	128.32	49.50	34.37	45.83	4.65	45.44	55.00	27.50	82.49	97.05	51.23
actual	1.70	2.36	1.79	3.08	0.42	0.005	0.08	0.10	0.03	0.03	1.85	311.28	0.03	1.1	3.30	16.50	5016.77
B CHEMISTRY CORRELATION STATISTICS																	
Res.*	1.0	–0.4	–0.3	0.8	0.7	0.4	–0.2	0.7	0.8	0.4	–0.8	0.1	0.5	–0.1	–0.2	–0.3	0.4
CaO		1.0	–0.5	–0.5	–0.5	–0.7	0.3	–0.5	–0.4	–0.5	0.4	–0.7	–0.6	0.1	0.4	–0.5	–0.7
MgO			1.0	–0.4	–0.3	0.3	–0.1	–0.3	–0.5	–0.2	0.6	0.8	–0.2	0.3	–0.2	1.0	0.1
SiO_2				1.0	0.7	0.5	–0.1	0.7	0.9	0.7	–1.0	–0.1	0.8	–0.3	–0.1	0.5	0.6
Al_2O_3					1.0	0.6	–0.1	1.0	0.7	0.7	–0.7	0.1	0.8	–0.3	–0.4	–0.3	0.7
NA_2O						1.0	–0.1	0.6	0.3	0.7	–0.4	0.3	0.7	0.2	–0.2	0.2	0.7
SO_3							1.0	–0.1	–0.2	0.2	0.1	–0.3	–0.2	0.3	0.2	–0.1	–0.3
K_2O								1.0	0.7	0.7	–0.7	0.1	0.7	–0.3	–0.4	–0.3	0.7
SrO									1.0	0.6	–0.9	0.1	0.7	–0.6	–0.3	–0.5	0.6
P_2O_5										1.0	–0.7	0.1	0.9	–0.2	–0.4	–0.3	0.8
Loss†											1.0	0.2	–0.8	0.4	0.1	0.6	–0.6
MnO												1.0	0.1	–0.3	–0.5	0.8	0.4
F													1.0	–0.3	–0.4	–0.3	0.9
Cu														1.0	0.4	0.3	–0.4
Pb															1.0	–0.1	–0.6
Zn																1.0	–0.1
Fe_2O_3																	1.0

Values for MnO, Cu, Pb, Zn and Fe_2O_3 are in ppm; the rest are percentage

*Insoluble residue † Loss at 1050°C

CHEMISTRY

Chemistry variation by formation

By the application of stratigraphic methods a great deal regarding the three dimensional form and disposition of the strata has been determined. Named beds can be projected below the surface and a study of their petrological and faunal characteristics, where they can be sampled, gives a useful guide as to the lithology most likely to occur at any level. The stratigraphical classification of the limestones has been found in many cases to coincide with the industrial classification used in this assessment. It is therefore possible to extrapolate from the stratigraphy to the chemistry, although such conclusions should only be used as a general guide. Tables 4A to 8A quantify the variations in chemistry found in the various formations on the resource sheet.

The *Milldale Limestones* are very predictable in terms of limestone category. The mean insoluble residue for these rocks is the highest of all the formations analysed (the Widmerpool Formation was not analysed because it contains only a minority of true limestones). The Milldale Limestones (Table 4A) are consistently low in calcium but they are similarly low in sodium, sulphur, strontium, phosphorus, fluorine, copper, lead and zinc. The residues are dominated by silica and magnesium, iron and clay silicates. The low sulphur content indicates that pyrite is not an important constituent. These conclusions are confirmed by the correlation matrix (Table 4B), which shows strong positive correlations between insoluble residue, silica, aluminium, strontium, and potassium and the lack of a strong correlation between sulphur and insoluble residue. This last is unusual in that elsewhere the highest sulphur values occur in impure limestones.

Table 5 Chemistry and correlation statistics of the Woo Dale Limestones

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
A CHEMISTRY																	
No. of samples	169	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	15
Maximum value	13.90	56.50	0.54	0.06	0.34	0.04	0.18	0.10	0.26	0.12	43.89	690	0.02	15	40	70	3200
Minimum value	0.10	54.10	0.08	0.01	0.01	0.0	0.0	0.0	0.0	0.0	43.48	40	0.0	0	0	5	180
Mean	1.57	55.64	0.25	0.34	0.12	0.02	0.06	0.04	0.04	0.02	43.74	192	0.0	6	5	23	1225
Standard deviation	1.86	0.67	0.14	0.17	0.09	0.01	0.06	0.03	0.07	0.03	0.15	211	0.01	5	10	15	1159
confidence limits at 95% level, ±																	
%	17.91	0.64	29.68	26.50	39.75	26.50	53.00	39.75	92.75	79.50	0.18	58.24		44.17	106.00	34.56	52.03
actual	0.28	0.34	0.07	0.09	0.05	0.005	0.03	0.02	0.04	0.02	0.08	111.83		2.65	5.30	7.95	637.41
B CHEMISTRY CORRELATION STATISTICS																	
Res.*	1.0	−0.1	0.3	0.3	0.7	−0.1	0.3	0.7	−0.1	−0.1	−0.3	−0.2	0.4	0.2	0.0	−0.3	0.3
CaO		1.0	−0.4	−0.6	0.2	−0.2	0.3	0.3	−0.5	−0.5	0.2	−0.8	−0.2	−0.4	0.2	−0.5	−0.8
MgO			1.0	0.6	0.1	−0.3	−0.4	0.2	0.4	0.4	0.1	0.3	0.5	0.5	0.5	−0.1	0.6
SiO_2				1.0	0.2	0.1	−0.1	0.1	0.6	0.6	−0.5	0.4	0.7	0.3	0.1	−0.1	0.7
Al_2O_3					1.0	−0.3	0.5	0.9	−0.5	−0.5	−0.5	−0.5	0.3	−0.1	0.2	−0.3	0.1
Na_2O						1.0	0.4	−0.4	0.5	0.5	0.1	0.3	0.1	0.1	−0.6	0.2	−0.1
SO_3							1.0	0.4	−0.3	−0.3	−0.3	−0.3	−0.1	−0.5	−0.2	−0.2	−0.4
K_2O								1.0	−0.5	−0.5	−0.4	−0.7	0.2	−0.1	0.5	−0.4	−0.1
SrO									1.0	1.0	−0.1	0.7	0.7	0.4	−0.3	0.2	0.6
P_2O_5										1.0	−0.1	0.7	0.6	0.4	−0.3	0.2	0.5
Loss†											1.0	0.0	−0.3	0.3	−0.1	0.1	−0.3
MnO												1.0	0.2	0.4	−0.4	0.7	0.6
F													1.0	0.3	−0.1	−0.1	0.6
Cu														1.0	−0.1	0.4	0.5
Pb															1.0	−0.2	0.1
Zn																1.0	0.4
Fe_2O_3																	1.0

Values of MnO, Cu, Pb, Zn and Fe_2O_3 are in ppm; the rest are percentages

* Insoluble residue † Loss at 1050°C

The main chemical variation of the limestones of the resource sheet are compared in Figures 13, 14, 15 and 16. All other elements are present in only minor or trace amounts. The values for CaO (Figure 13) are particularly critical to end use and when the industrial classification (Table 2) has been superimposed on this diagram the variation in the quality of the limestones relative to their stratigraphic position is immediately apparent. This trend is reflected although less obviously in each of the other figures.

Only sixteen analyses were carried out on the *Woo Dale Limestones* because of their limited occurrence at outcrop. They exhibit a marked uniformity of lithological type and chemistry (Table 5). Calcium in these limestones reaches its highest concentration for the district and corresponds with low values for those elements which contribute most to the insoluble residues. Fluorine, copper, lead and zinc are present in trace amounts as are sulphur, potassium, strontium, phosphorus and sodium. Of all the formations examined on the sheet these rocks are the most likely to yield limestones very high in calcium and free from impurities.

Nine samples from the *Hopedale Limestones* in the Bradbourne borehole [2125 5252] (p. 130) were analysed. Many of the samples were dolomitised as shown by the MgO figures for which a maximum of 19.40 per cent was recorded. It was felt that the insoluble residue results from spot samples together with the more detailed analysis of this borehole gave a reasonable assessment of the limestone of these beds which have a rather restricted outcrop in the Wirksworth area.

Table 6 Chemistry and correlation statistics of the Bee Low Limestones

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
A CHEMISTRY																	
No. of samples	812	123	123	123	123	123	123	123	123	123	123	123	123	123	123	123	104
Maximum value	95.90	56.40	16.30	10.90	2.96	0.13	5.80	0.97	0.15	1.91	47.10	2400	3.50	50	350	650	37700
Minimum value	0.0	37.10	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.36	20	0.0	0	0	5	90
Mean	2.56	54.43	0.60	1.11	0.20	0.02	0.14	0.04	0.04	0.06	43.08	273	0.06	7	25	48	2222
Standard deviation	8.21	2.70	1.81	1.85	0.47	0.02	0.60	0.10	0.04	0.24	2.11	369	0.33	7	60	89	5305
confidence limits at 95% level, ±																	
%	22.06	0.89	53.86	29.75	41.95	26.78	76.51	44.63	17.85	71.41	0.87	24.13	74.98	17.85	42.85	32.73	46.59
actual	0.56	0.48	0.32	0.33	0.08	0.01	0.11	0.02	0.01	0.04	0.38	65.88	0.07	1.25	10.71	15.71	1035.19
B CHEMISTRY CORRELATION STATISTICS																	
Res*	1.0	–0.6	–0.1	0.9	0.7	0.4	0.7	0.7	0.4	0.0	–0.9	0.3	0.3	0.5	0.3	0.5	0.8
CaO		1.0	–0.8	–0.5	–0.4	–0.3	–0.5	–0.5	–0.2	–0.1	0.4	–0.6	0.0	–0.4	–0.2	–0.6	–0.6
MgO			1.0	–0.1	–0.1	0.0	–0.1	–0.1	–0.1	–0.0	0.2	0.5	0.0	0.1	0.1	0.4	0.1
SiO_2				1.0	0.6	0.3	0.4	0.6	0.3	0.1	–0.9	0.3	0.3	0.3	0.1	0.4	0.7
Al_2O_3					1.0	0.4	0.4	0.6	0.4	0.2	–0.6	0.3	0.0	0.4	0.3	0.5	0.7
Na_2O						1.0	0.4	0.4	0.3	0.1	–0.4	0.1	0.1	0.2	0.0	0.2	0.4
SO_3							1.0	0.8	0.2	–0.1	–0.8	0.1	–0.1	0.4	0.1	0.1	0.6
K_2O								1.0	0.2	0.2	–0.8	0.1	–0.1	0.2	0.1	0.1	0.7
SrO									1.0	0.1	–0.3	0.2	0.1	0.5	0.1	0.3	0.4
P_2O_5										1.0	–0.1	–0.1	0.1	0.1	0.1	0.1	0.1
Loss†											1.0	–0.1	–0.3	–0.4	–0.1	–0.2	–0.8
MnO												1.0	0.1	0.4	0.3	0.7	0.6
F													1.0	–0.1	–0.1	0.1	–0.1
Cu														1.0	0.4	0.5	0.5
Pb															1.0	0.5	0.3
Zn																1.0	0.6
Fe_2O_3																	1.0

Values of MnO, Cu, Pb, Zn and Fe_2O_3 are in ppm; the rest are percentages

* Insoluble residue † Loss at 1050°C

The statistical summary (Table 6) for the D_1 rocks is confined to a chemical assessment of the *Bee Low Limestones*. The maximum value of 95.90 per cent for insoluble residue is taken from the Ember Farm Borehole, NE 43 (p. 118) which encountered a volcanic horizon within the Bee Low Limestones. Tuffaceous debris progressively replaces the limestone with depth, giving rise to impure rocks which are atypical for this formation. The mean insoluble residue and the calcium oxide values both confirm the generalisation that these rocks tend to be of high purity. Although magnesium oxide values are generally low, and this is typical of this formation, the Bee Low Limestones nevertheless have the largest area of outcrop affected by dolomitisation. Where dolomitisation occurs the associated mineralogical changes tend to downgrade the undolomitised limestones which otherwise commonly attain 'high' or 'very high' purity values. The mean silica value also reflects the tendency towards low impurities and is less than half that for the Monsal Dale Limestones. All other major elements measured give similar values to those of the Monsal Dale Limestones. Particularly striking is the marked fall in the concentration of the non-ferrous elements which reflects the general absence of mineralisation and volcanic activity in the Bee Low Limestones. Iron values are also lower than in the Monsal Dale Limestones but this is less marked.

The correlation statistics are similar to those for Monsal Dale Limestones but a small number of differences may be highlighted. Calcium shows a strong negative correlation with magnesium reflecting the abundant dolomite in the formation. Similarly calcium shows small negative correlations with zinc, manganese and iron. The strong positive correlation between fluorite and insoluble residue seen in the Monsal Dale Limestones (Table 7B) is not repeated in the Bee Low Limestones.

The *Monsal Dale Limestones* on this sheet include a complete range of lithologies, which is reflected by the

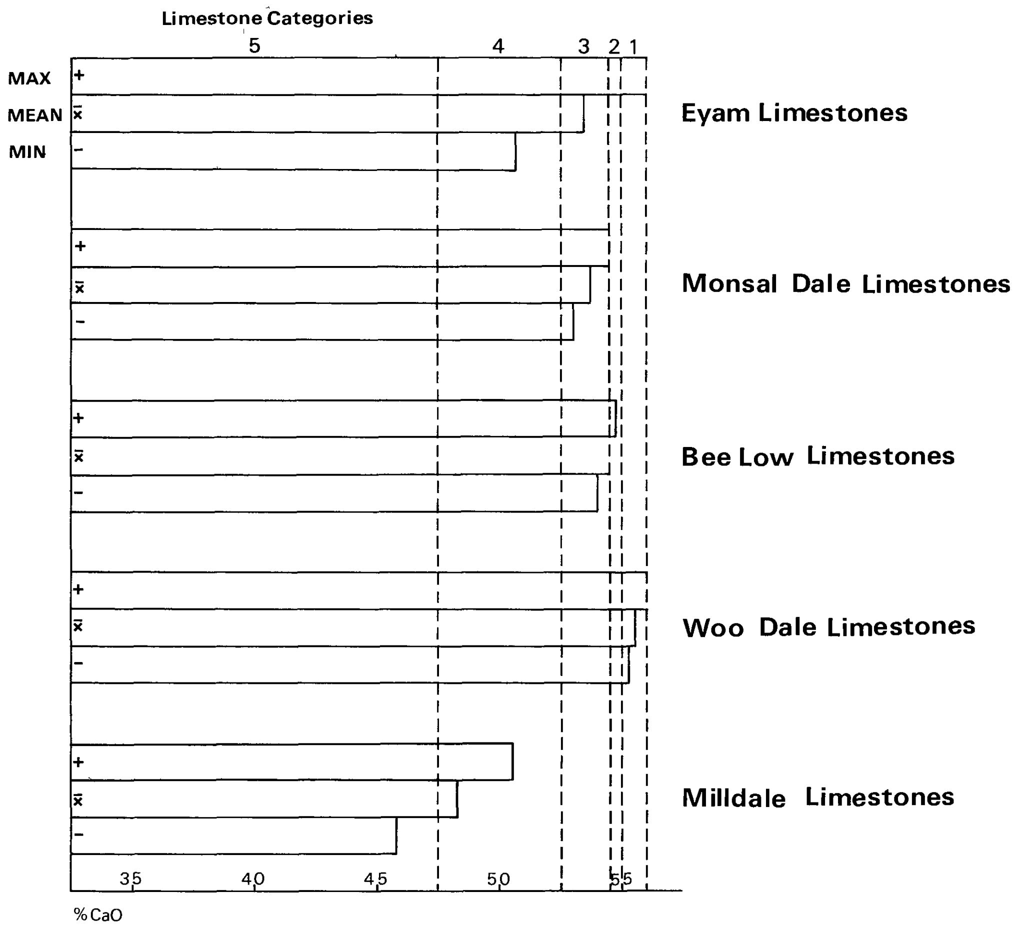


Figure 13 Values of CaO for each formation

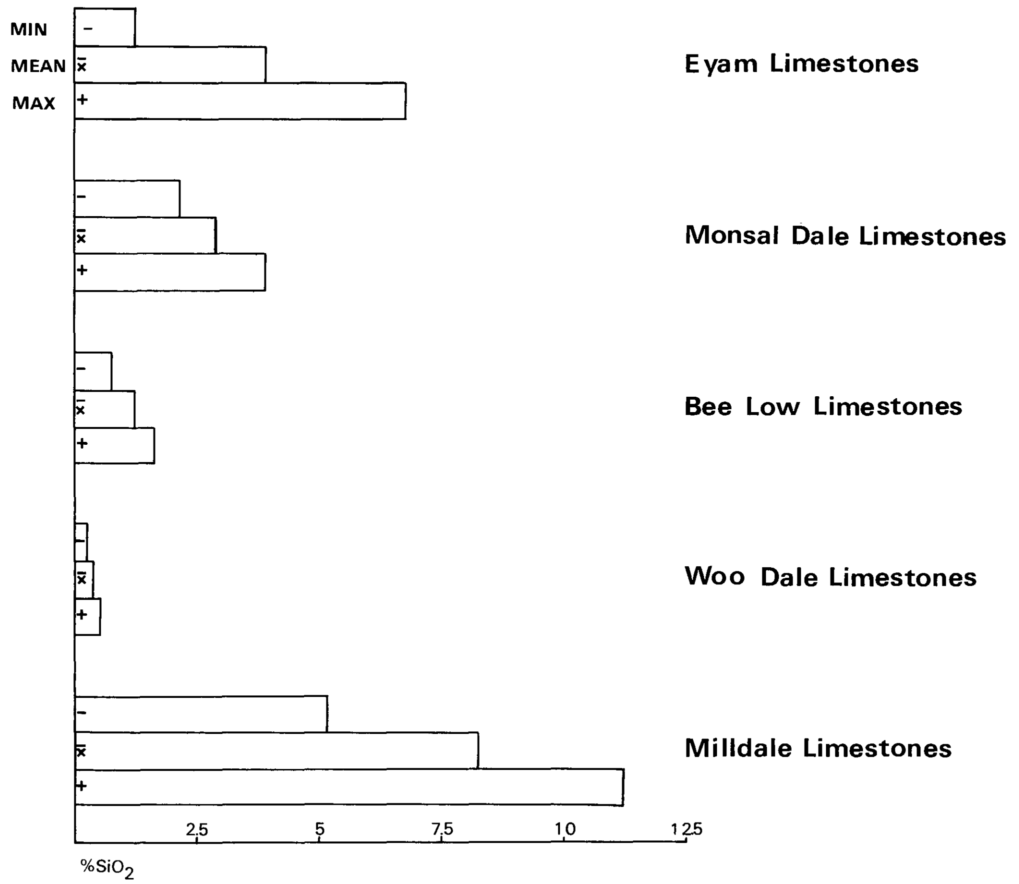


Figure 14 Values of SiO_2 for each formation

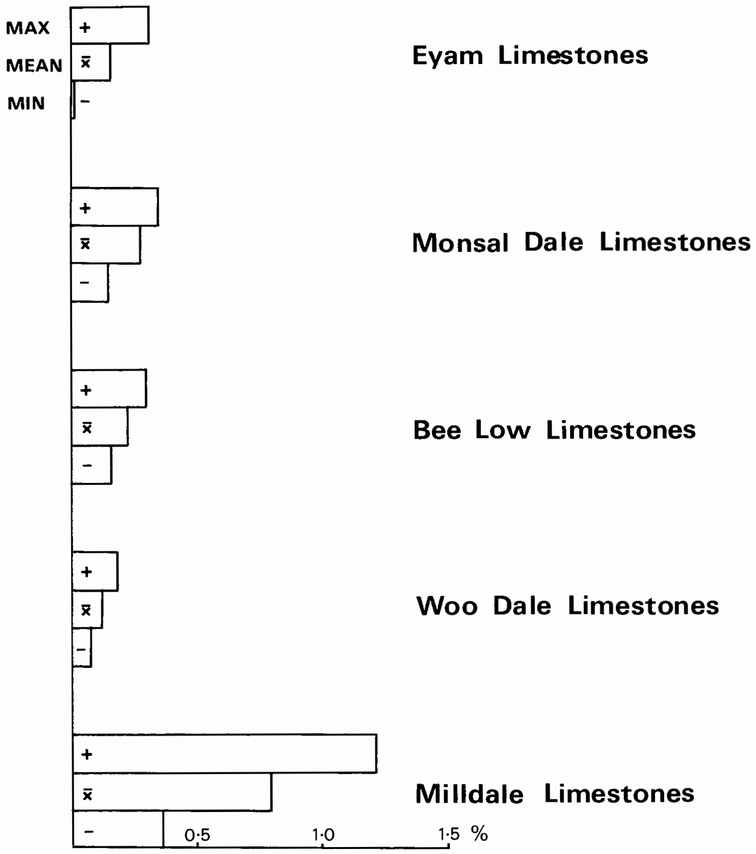


Figure 15 Values of Al_2O_3 for each formation

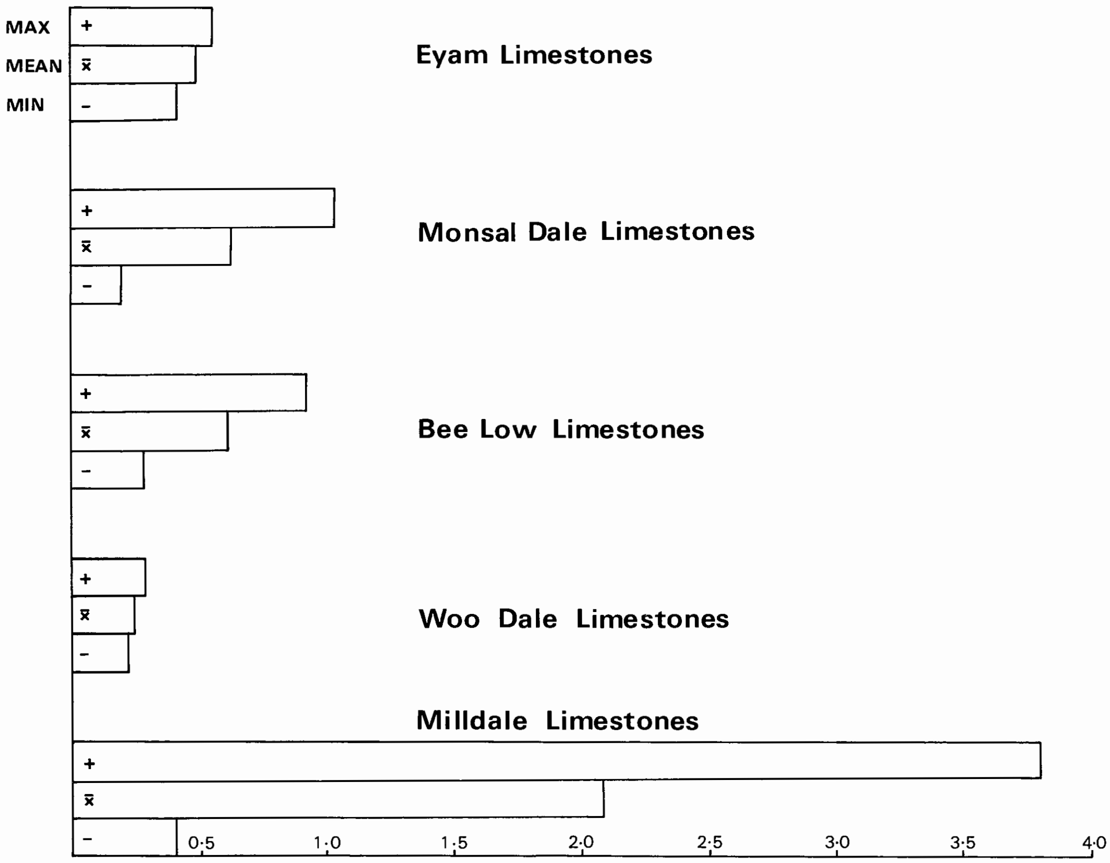


Figure 16 Values of MgO for each formation

Table 7 Chemistry and correlation statistics of the Monsal Dale Limestones

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
A CHEMISTRY																	
No. of samples	631	92	93	93	93	93	92	93	93	93	93	93	93	93	93	93	93
Maximum value	49.70	56.30	19.50	21.80	1.91	0.05	4.39	0.35	0.50	0.26	47.07	1200	14.0	110	4500	1500	33900
Minimum value	0.20	32.60	0.16	0.02	0.0	0.0	0.0	0.0	0.0	0.0	23.0	40	0.0	0	0	0	190
Standard deviation	3.55	53.68	0.64	2.92	0.25	0.02	0.16	0.05	0.04	0.03	41.69	311	0.43	7	115	79	3104
Mean	5.47	3.28	2.06	3.96	0.38	0.01	0.50	0.05	0.06	0.04	3.60	264	1.78	12	489	205	4742
confidence limits at 95% level, ±																	
%	12.02	1.27	66.78	28.14	31.54	10.37	64.83	20.75	31.12	27.51	1.78	17.52	85.88	35.37	87.74	53.55	331.52
actual	0.42	0.68	0.43	0.82	0.08	0.002	0.10	0.01	0.01	0.01	0.74	54.48	0.37	2.48	100.91	40.30	9788.53
B CHEMISTRY CORRELATION STATISTICS																	
Res.*	1.0	–0.5	0.0	0.8	0.4	0.3	0.2	0.5	0.4	–0.1	–1.0	0.3	0.7	0.2	0.3	0.2	0.4
CaO		1.0	–0.7	–0.5	–0.4	–0.3	–0.3	–0.4	–0.3	–0.2	–0.4	–0.2	–0.1	–0.2	–0.2	–0.1	–0.4
MgO			1.0	–0.1	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
SiO_2				1.0	0.5	0.2	–0.1	0.6	0.2	–0.1	–0.8	0.3	0.4	0.1	0.1	0.1	0.3
Al_2O_3					1.0	0.3	–0.1	0.8	0.1	–0.1	–0.3	0.3	–0.1	0.5	–0.1	0.1	0.7
Na_2O						1.0	0.3	0.2	0.2	0.2	–0.2	0.3	0.1	0.2	0.2	0.3	0.3
SO_3							1.0	0.1	0.8	0.2	–0.2	–0.1	0.1	0.1	0.9	0.5	0.1
K_2O								1.0	0.2	–0.1	–0.4	0.2	0.1	0.1	0.1	0.2	0.3
SrO									1.0	0.2	–0.4	0.1	0.2	0.1	0.8	0.3	0.1
P_2O_5										1.0	0.1	0.1	–0.1	0.1	0.3	0.4	–0.1
Loss†											1.0	–0.3	–0.8	–0.2	–0.3	–0.2	–0.3
MnO												1.0	0.2	0.2	–0.1	0.2	0.5
F													1.0	–0.1	0.3	0.1	0.7
Cu														1.0	0.1	0.1	0.7
Fe															1.0	0.4	–0.0
Zn																1.0	0.1
Fe_2O_3																	1.0

Values of MnO, Cu, Pb, Zn and Fe_2O_3 are in ppm; the rest are percentages

* Insoluble residue † Loss at 1050°C

chemical variation of the deposit (Table 7). The calcium values are in general high. The minimum value of 32.60 per cent is taken from a dolomitic limestone in which the total carbonate value was high. The presence of dolomites in this formation gives rise to the very high confidence limits on the magnesium value. The mean however at 0.16 indicates the minor role of dolomites in the formation as a whole. Silica gives a relatively high mean value confirming the presence of widespread silicification. Alumina too at 0.25 ± 0.08 per cent is indicative of the clay wayboards and partings which are common in parts of this formation. Sodium and potassium are virtually absent from these rocks. The highest value recorded for K_2O was from a sample in borehole NE 41 (p. 101), at 46.00 metres. It is rich in kaolinite associated with volcanic activity. Sulphur is present as pyrite but most samples were found to contain less than one per cent. The highest values generally indicate the presence of local mineralisation. Strontium and phosphorus are virtually absent, although a maximum value of 0.50 per cent strontium was recorded from a sample taken from a mineralised section (NE 8s; p. 71). The strontium in this sample substitutes for barium in baryte. Manganese occurs as the oxide pyrolusite and may be seen as dendritic patterns on clean surfaces. However, for this group of sediments it is only present in trace amounts in the massive pale limestones. Lead and zinc are also present in trace amounts except where there is localised mineralisation. Copper values are very low: the only slight rise is seen in association with volcanic activity (e.g. assessment borehole NE 41; p. 101).

As one would expect fluorine values rise rapidly in rocks close to mineralised zones and the high mean value of 0.43 per cent reflects the fact that most of the mineralised limestone is within the Monsal Dale Limestones. This contrasts with all other formations on the sheet for which mean values of 0.10 per cent or less have been found.

Table 8 Chemistry of the Eyam Limestones

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	71	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Maximum value	36.90	56.00	0.69	20.00	0.68	0.03	0.33	0.13	0.07	0.24	43.80	680	1.05	40	130	680	6200
Minimum value	0.20	44.30	0.40	0.09	0.0	0.0	0.0	0.04	0.0	0.0	32.16	90	0.0	0	10	5	150
Mean	2.90	53.43	0.50	3.90	0.19	0.0	0.08	0.06	0.02	0.07	41.36	231	0.16	13	40	117	2155
Standard deviation	5.49	3.69	0.09	6.40	0.25	0.01	0.12	0.03	0.03	0.08	3.66	175	0.34	14	43	214	2440
confidence limits at 95% level, ±																	
%	44.93	5.20	13.56	123.62	99.12		113.00	37.67	113.00	86.10	6.67	57.07	160.08	81.13	80.98	41.19	85.30
actual	1.30	2.78	0.07	4.82	0.19		0.09	0.02	0.02	0.06	2.76	131.83	0.26	10.55	32.39	88.14	1838.13

Table 9 Chemistry and correlation statistics of the dolomites

	Res.†	CaO	MgO	SiO_2	Al_2O_3	NA_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
A CHEMISTRY																	
No. of samples	332	49	49	49	49	49	49	49	49	48	48	48	49	49	49	49	49
Maximum value	87.70	55.20	21.20	82.00	1.41	0.07	1.34	0.29	0.27	0.22	48.21	2280	2.06	30	10100	3800	12300
Minimum value	0.40	7.40	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.64	130	0.0	0	0	15	800
Mean	4.02	35.28	15.34	3.43	0.14	0.03	0.07	0.03	0.02	0.05	44.94	1014	0.16	6	261	228	3957
Standard deviation	7.00	9.05	6.96	11.98	0.25	0.02	0.24	0.05	0.05	0.04	6.13	444	0.41	6	1456	553	2609
confidence limits at 95% level, ±																	
%	18.73	7.37	13.03	100.29	51.28	19.14	98.45	47.86	73.30	23.46	3.96	12.70	73.58	29.01	161.84	70.37	18.93
actual	0.75	2.60	2.00	3.44	0.07	0.01	0.07	0.01	0.01	0.01	1.78	128.81	0.12	1.74	422.41	160.44	749.16
B CHEMISTRY CORRELATION STATISTICS																	
Res.*	1.00	–0.46	–0.22	0.92	0.15	0.31	–0.03	0.08	0.77	–0.15	–0.89	–0.32	–0.08	0.18	–0.04	–0.06	–0.15
CaO		1.00	–0.72	–0.48	–0.01	–0.47	0.20	–0.03	–0.34	–0.31	0.30	0.04	0.08	–0.15	–0.09	–0.02	0.36
MgO			1.00	–0.25	–0.08	0.37	–0.23	–0.0	–0.27	0.44	0.43	0.20	–0.0	0.07	0.10	0.08	–0.25
SiO_2				1.00	0.14	0.19	–0.03	0.07	0.85	–0.15	–0.97	–0.35	–0.08	0.12	–0.05	–0.08	–0.18
Al_2O_3					1.00	0.39	–0.07	0.93	0.19	0.07	–0.16	0.01	–0.08	0.40	–0.07	–0.10	0.36
Na_2O						1.00	–0.16	0.45	0.13	0.22	–0.12	0.09	–0.12	0.17	0.14	–0.15	–0.0
SO_3							1.00	–0.08	0.20	–0.05	–0.09	0.14	0.14	0.18	–0.04	0.58	0.18
K_2O								1.00	0.16	0.11	–0.09	0.08	–0.04	0.29	–0.11	–0.09	0.43
SrO									1.00	–0.14	–0.82	–0.36	–0.16	0.05	–0.09	0.17	–0.21
P_2O_5										1.00	0.23	0.31	–0.22	0.09	–0.05	0.07	–0.15
Loss†											1.00	0.33	0.0	–0.18	0.07	0.04	0.06
MnO												1.00	0.16	0.15	–0.09	0.07	0.58
F													1.00	0.44	–0.05	0.18	0.40
Cu														1.00	–0.16	0.34	0.30
Pb															1.00	–0.05	–0.04
Zn																1.00	0.13
Fe_2O_3																	1.00

Values of MnO, Cu, Pb, Zn and Fe_2O_3 are in ppm; the rest are percentages

* Insoluble residue † Loss at 1050°C

Table 10 Chemistry of the limestones

n*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	F	MnO	Cu	Pb	Zn	Fe_2O_3	Category–
MAXIMUM VALUE																	
94	56.50	20.20	1.30	0.34	0.13	0.32	0.09	0.26	1.91	48.15	0.46	2000	15	270	170	4300	Very high
66	56.30	21.20	2.18	0.57	0.06	0.82	0.10	0.13	0.17	48.21	0.85	1470	40	10100	580	71000	High
66	56.30	20.90	5.31	1.95	0.06	1.34	0.36	0.13	1.81	46.76	1.05	2410	15	790	3800	13100	Medium
33	56.20	18.30	8.39	2.96	0.07	2.98	0.29	0.26	0.27	47.05	3.50	1540	110	850	1500	33900	Low
25	54.30	18.70	82.00	8.60	0.08	5.80	1.22	0.50	0.15	47.17	14.00	2400	30	4500	7500	37700	Impure
MINIMUM VALUE																	
94	30.60	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.85	0	20	0	0	5	110	Very high
66	29.30	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.23	0.0	30	0	0	0	90	High
66	30.70	0.20	0.02	0.0	0.0	0.0	0.01	0.0	0.0	40.07	0.0	40	0	0	0	110	Medium
33	29.40	0.17	0.25	0.0	0.0	0.0	0.0	0.0	0.0	36.66	0.0	40	0	0	0	190	Low
25	7.40	0.17	0.15	0.0	0.0	0.0	0.01	0.0	0.0	6.64	0.0	50	0	0	0	150	Impure
MEAN																	
94	52.51	2.64	0.31	0.06	0.02	0.03	0.02	0.03	0.05	44.22	0.01	340	4	18	34	1222	Very high
66	50.05	4.62	0.78	0.11	0.01	0.07	0.03	0.02	0.03	44.24	0.04	402	6	181	81	2042	High
66	51.01	3.03	2.05	0.28	0.02	0.16	0.05	0.03	0.06	42.84	0.11	565	6	67	137	3473	Medium
33	50.09	2.51	5.15	0.61	0.02	0.25	0.09	0.05	0.05	40.89	0.22	533	14	74	162	6170	Low
25	42.70	2.87	15.53	1.18	0.03	0.49	0.25	0.11	0.05	33.71	1.34	638	9	253	131	10538	Impure
CONFIDENCE LIMITS AT THE 95% LEVEL, ±																	
94	1.54	1.26	0.05	0.01	0.0	0.01	0.0	0.01	0.04	0.27	0.01	86	1	8	6	217	Very high
66	2.31	1.93	0.13	0.03	0.0	0.03	0.0	0.01	0.01	0.40	0.06	99	1	308	32	404	High
66	1.44	1.23	0.26	0.10	0.01	0.07	0.01	0.01	0.06	0.32	0.11	145	1	35	126	812	Medium
33	2.36	1.86	0.79	0.24	0.01	0.02	0.02	0.02	0.02	0.66	0.24	137	7	55	104	2511	Low
25	4.16	2.28	6.12	0.73	0.01	6.58	0.13	0.04	0.02	3.10	1.35	232	3	375	90	4737	Impure
STANDARD DEVIATION																	
94	7.78	0.25	0.25	0.07	0.02	0.05	0.02	0.04	0.20	0.31	0.05	421	4	37	32	1067	Very high
66	9.36	7.82	0.54	0.13	0.02	0.14	0.02	0.03	0.04	1.62	0.13	401	6	1243	129	1647	High
66	5.68	5.96	1.05	0.37	0.02	0.27	0.06	0.03	0.23	1.37	0.25	558	4	134	482	3236	Medium
33	6.77	5.38	2.26	0.69	0.02	0.59	0.07	0.05	0.07	1.84	0.65	390	22	158	303	7234	Low
25	10.07	5.52	14.82	1.76	0.02	1.41	0.31	0.10	0.05	7.50	3.27	563	7	909	217	11476	Impure

Values for MnO, Cu, Pb, Zn and Fe_2O_3 are in ppm;
the rest are percentages
* Number of samples † Loss at 1050°C

Iron was measured by both atomic absorption and beta probe methods and a preferred value taken dependent upon the concentration (p. 54). The variation in iron concentration is a function of its high mobility so that its concentration is not particularly related to formation.

The correlation matrix for this formation (Table 7B) contains few surprises. Insoluble residue has a strong positive correlation with silica content and it follows that calcium values fall with a rise in silica. Alumina and potash have a strong affinity as do sulphur and lead. The positive correlation of fluorine with insoluble residue is to be expected. The strong affinity of strontium and sulphur reflects their association in mineralisation. Similarly copper and iron are both characteristic of the volcanic rocks and the limestones associated with them.

The *Eyam Limestones* embody a wide chemical range in most aspects of the chemistry analysed (Table 8). This is chiefly because of the presence of two lithological extremes within this formation: the patch reefs composed largely of pale crinoid and byrozoan biosparites, which form mounds or 'build ups', within a sequence of thinly-bedded dark biomicrites.

These rocks occur only as a relatively thin cover and at a number of restricted localities. For this reason they were not extensively sampled, and a correlation matrix is not included. The confidence limits indicated on Table 8 are therefore generally high and even the low CaO confidence limits of ±5.20% must be treated with caution when such a small population is being considered. The insoluble residue is a far better indication of the carbonate variation than the calcium value. The insoluble residue indicates that 95% of the samples fall within the categories 'high' and 'very high' purity. Unfortunately, as most of these samples were collected from sections, they do not include a full estimate of the chert content, which is present as beds and nodules in much of the thin-bedded part of this sequence. Similarly thin clays and clay partings also occur and these were only represented in borehole samples.

The Eyam Limestones include a wide chemical variation owing to particular depositional conditions and for this reason local conditions are of vital importance in determining the chemistry.

Chemistry of the dolomites

Table 9 includes chemical data from samples from all the limestones affected by dolomitisation in the district. In Derbyshire, dolomitisation is commonly accompanied by silicification and calcification and the dolomites encountered therefore are rarely chemically uniform. Table 9A demonstrates a range of 13.34 to 17.34 per cent MgO at the 95% confidence level. Pure dolomite has an MgO value of 21.85 per cent and most commercial dolomites fall between 20.75 and 21.70 per cent MgO. Of the 49 samples analysed only eight met these limits. One of these eight samples was taken from the top of borehole SE 13 [2730 5434] where 3.26 m of dolomite overlie the Lower Matlock Lava. The other samples are taken from two localities: Pikehall Road Borehole NW 21 [2248 5965] and Harboro' Rocks NW8s [2427 5533]. Four samples were analysed from Pikehall Road and all gave high values for MgO. Similarly the three samples from Harboro' Rocks show a high magnesia content. The next most important chemical specification for industrial-

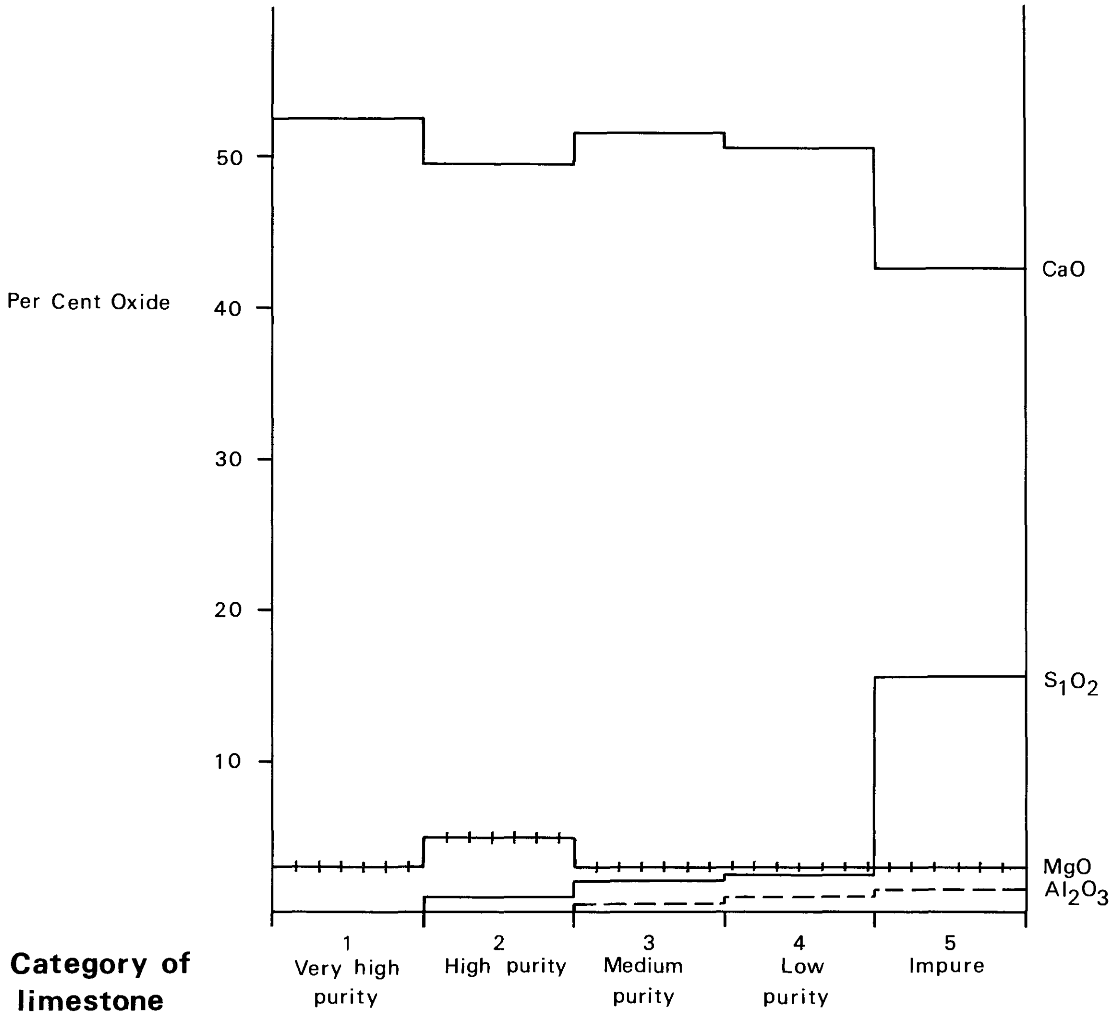


Figure 17 Variation of the major oxides within each category

grade dolomite is that the iron content should be consistent and not rise above 0.8 per cent. For glass manufacture this value should be under 0.25 per cent. When the mineral is intended for use as a filler or extender it should be free of iron, manganese and chromium. The eight samples described above were found to have a mean Fe_2O_3 content of 0.38 per cent and all values were below 0.6 per cent. The mean MnO_2 figure was 726 ppm and all values are below 0.005 per cent.

Table 9A indicates wide variation in the chemistry of this mineral and there are indications that relatively high grade material is locally present. The figures highlight the need for a more detailed investigation of the potential of the dolomites as a resource.

Chemistry variations by category

For the purposes of the resource survey the limestones have been classified by reference to total carbonate values as indicated by approximately 2500 insoluble residue determinations.

The chemical analyses of the limestones enable them to be classified into five categories and a statistical summary gives the essential characteristics of each category (Table 10).

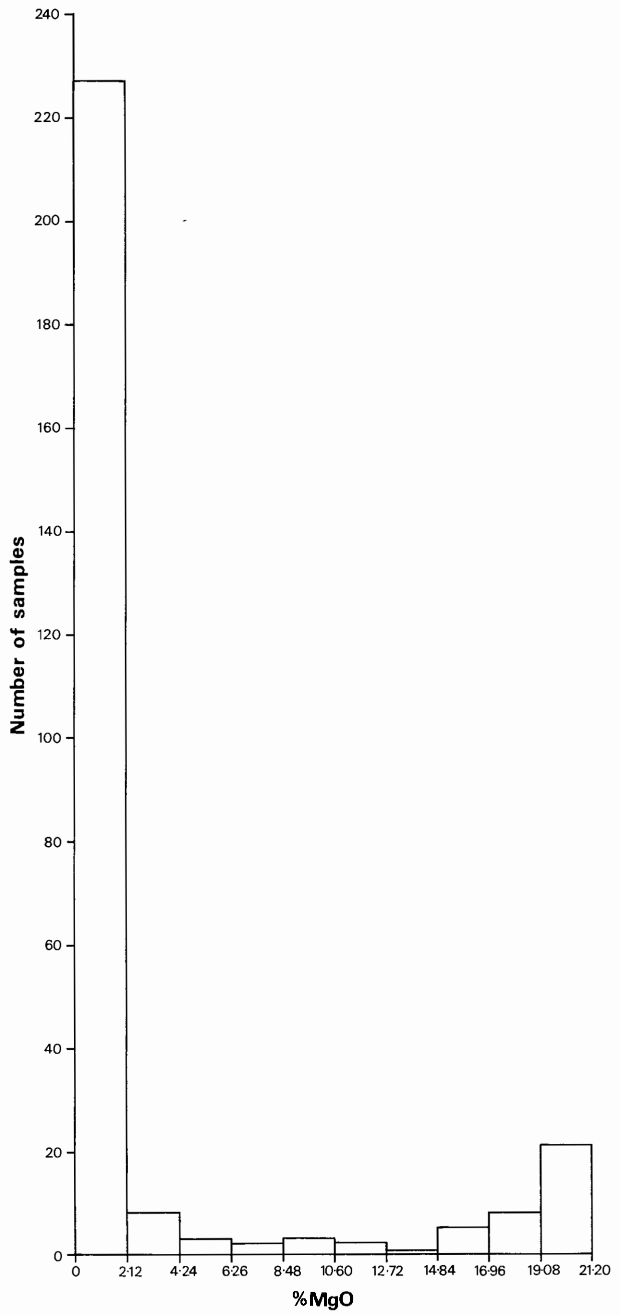
In all the limestones analysed mineral phases of four elements predominate—calcium, silicon, magnesium and aluminium. Of these silicon is present as the oxide, calcium and magnesium occur as carbonates, and all four are represented in clay silicates. A graphic plot of the mean values of these elements expressed conventionally as oxides against the five different categories of limestone is given in Figure 17. Alumina is virtually absent in very high purity rocks, silica is down to 0.31% and magnesia has a mean of 2.69%.

There is a marked drop in the calcium oxide figure for high purity limestones but this is accompanied by a rise in the magnesia value brought about by the presence of dolomites.

This variation is demonstrated in the histograms of CaO and MgO values (Figure 18). There is strong bimodality, clearly separating the magnesium-rich rocks from those high in calcium. The mean silica value for these limestones is similar to that of very high purity limestones.

Although the medium purity limestones contain a similar amount of magnesium to those of very high purity. they show a significant reduction in calcium. Magnesia remains roughly constant in all the categories with the exception of the high purity rocks. The decline in calcium is accentuated between the low purity and impure limestones. This loss of calcium is accompanied by increased silica and alumina values. The increased alumina represents an influx of clay which contributes to the impurity of the two lowest categories.

The soda content appears to be constant for all categories of limestones ranging from 0.03 to 0.04 per cent in the majority of samples analysed. Strontium similarly



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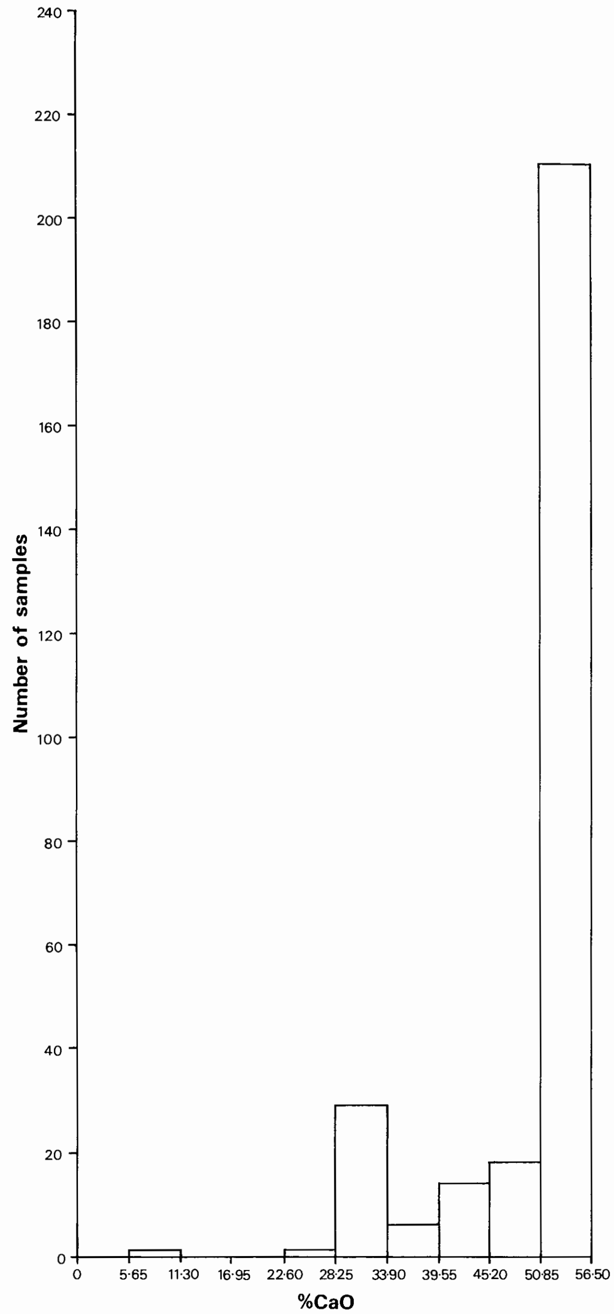


B

Figure 18 Distribution of MgO and CaO values

shows hardly any variation. The maximum value of 0.50 per cent was recorded in impure category limestones.

The mean phosphorus figures (Table 10) range from 0.03 to 0.06 per cent. Confidence limits indicate that there is little variation outside this range. The variation in this element is not however related to limestone category. For example values of 1.91 and 1.81 per cent were recorded for two samples which were collected from a section in Ballidon Quarry (SK 25 NW 65) [2031 5524] to [2026 5535]. These samples were classified as categories one and three respectively. The P_2O_5 value is the only anomalous high value common to both samples. These results may indicate the presence of organic remains in the deposit such as fish scales, which would be very localised.

The most common sulphur-bearing mineral, pyrite, is particularly abundant in limestones adjacent to igneous rocks or where black mudstones or mudstone partings are present. For this reason the highest sulphur values recorded are in impure limestones.

Manganese is present in the dendritic form, pyrolusite. The recorded values are higher in the lower purity rocks but even in impure limestones the value is only 638 ± 232 ppm at the 95 per cent probability level.

Fluorine values are particularly low in very high purity, high purity and medium purity limestones with low standard deviations: mean values range from 0.01 to 0.11 per cent. There is, however, a definite progressive rise in fluorine content from the very high purity to impure limestones. The highest values recorded are usually associated with vein mineralisation and are accompanied by a rise in the lead value. However there is widespread occurrence of trace amounts of fluorine in the form CaF_2 (fluorite) and this 'background' occurrence is unrelated to the vein mineralisation.

Amongst the non-ferrous minerals, copper values are very low and show little variation from category to category. The highest recorded value of 110 ppm at 63 m in SK 25 NE 41 at Bottom Lees Farm, was in a transition facies between the Monsal Dale Limestones and the Shothouse Spring Tuff. It is thought that the abundant volcanic fragments at this level have contributed to the rise in copper content. The lead content is important in many processes where high and very high purity limestones are used. The variation in the samples analysed is greatest in the high purity and impure rocks. Galena and cerrusite are the chief vein minerals. Although mineralisation tends to be concentrated in veins, pipes and flats, 22 per cent of all the samples analysed were found to be above the permitted lead content where low toxicity mineral is required (e.g. cattle food manufacture).

Zinc-bearing minerals are not common in this area although, as with lead, some locally high values were recorded. In the majority of samples analysed zinc values show only minimal variation. The highest values recorded, 3800 ppm and 7500 ppm were in samples of medium purity limestone and impure limestone respectively. The lower value was recorded in mineralised dolomites in borehole SK 25 SW 17 at Ballidon Hill, in which baryte and calcite were particularly abundant. The analysis also shows high manganese values which were foreshadowed in the log by the occurrence of pyrolusite. Fluorite was absent. The higher value recorded was from a mineral exploration borehole [2629 5002] at Tearsall Farm.

The iron content of the limestones of the Tearsall Farm area is highly variable. Several mineral phases have been recorded. In some examples much of the limestone has been replaced by hematite (p. 101). The least variation is however in the very high purity rocks: which are 1222 ± 217 ppm at the 95 per cent confidence level.

COLOUR

Measurements of tri-colour reflectance values were made using an EEL reflectance spectrophotometer. The measurements were taken on sawn, acid-etched rock surfaces and on powder pellet samples. The colour of an etched surface gives an objective value which can be used in correlating boreholes and sections. It is also a general guide to the likely category of limestone; although a small number of spar-rich rocks with high carbonate contents have given low reflectance readings.

The limestones and dolomites exhibit colour variations from white through shades of grey to black. Three colours, pale grey, mid-grey and dark grey are defined by reference to three filters (wavelengths 660, 520 and 470 nm respectively (Table 11).

Table 11 Rock colour defined by limiting reflectance percentages with reference to three filters

Colour	Wavelength		
	660 nm	520 nm	470 nm
Pale grey	>35%	>26%	>24%
Mid-grey	35–15%	26–12%	24–11%
Dark grey	<15%	<12%	<11%

The reflectance values obtained from dolomites classify these rocks as predominantly pale grey. However this result probably contains a degree of error, caused by saw marks on the cut surfaces from which the colour reflectance values were obtained. Although the sawn surfaces were etched, the saw marks could not be eliminated because of the low solubility of dolomite in cold hydrochloric acid.

Table 12 shows the percentage distribution of these shades of grey taken from etched surfaces for the limestone formations of the shelf and off-shelf provinces. Dark limestone in the shelf province is restricted to the 'dark' thinly-bedded lithofacies of the Eyam Limestones and, to a lesser extent, to the Monsal Dale Limestones together with a small percentage of the apron-reef facies of the Bee Low Limestones. Mid-grey limestones are represented in each formation and are particularly common in the knoll-reef facies of the Eyam Limestones, in the Monsal Dale Limestones, in the apron-reef facies of the Bee Low Limestones, and in the lower lithofacies of the Woo Dale Limestones. Pale grey limestones, although represented in each formation, are most common in the Bee Low Limestones and in the upper lithofacies of the Woo Dale Limestones.

The limestones of the off-shelf province contain a greater proportion of dark grey limestone than the equivalent limestones of the shelf province. The Milldale Limestones are predominantly mid-grey, but dark grey limestones are important. The overlying Hopedale Limestones are dominantly mid-grey with a minor amount of dark grey limestone. A field examination of limestones of the Widmerpool Formation shows that they are typically dark grey, but mid-grey and more rarely pale grey beds were also recorded.

The Bee Low Limestones and the upper facies of the Woo Dale Limestones commonly show a high degree of uniformity in colour: they are pale grey to mid-grey. The former are predominantly pale grey (67 per cent pale grey, 33 per cent mid-grey). Exceptionally, the Bee Low Limestones of borehole NE 43 are predominantly mid-grey (16 per cent pale grey, 84 per cent mid-grey). This anomalous value is due to the presence of volcanic material. The Monsal Dale Limestones and Eyam Limestones are more variable in colour; the former contain dark grey and mottled beds which are of particular value in stratigraphical correlation. For example, a dark pyrite-rich limestone occurs consistently over most of the area directly above the level of the Lower Matlock Lava. Volcanic events can give rise to a darkening of the sediment outside the immediate area of activity.

Powder samples were prepared for reflectance measurement (Cox and others, 1977) and the results are summarised in Table 13. Fairly constant values were obtained from the Woo Dale Limestones (upper lithofacies), Bee Low Limestones, Monsal Dale Limestones and from the knoll-reef facies of the Eyam Limestones. However, the very high purity rocks of the 'dark' lithofacies of the Eyam Limestones produced lower reflectance values, as did the dolomites of the Bee Low and Monsal Dale formations. Since these samples were selected on a basis of very high carbonate content such variations are likely to indicate the presence of traces of coloured ions. Where it is intended to use dolomites as fillers and extenders very high reflectance values are required in addition to quite precise chemical specifications. Dolomites which meet the chemical specifications required in such uses have been described (p. 34) but their reflectance values

Table 12 Percentage colour distribution of the limestones within each formation

Formation and subdivisions		Colour (%) Distribution		
		Pale grey	Mid grey	Dark grey
SHELF PROVINCE				
Eyam Limestones	Knoll-reef facies	47	53	0
	Dark lithofacies	12	36	52
Monsal Dale Limestones	Dolomite	84	16	0
	Limestone	34	53	13
Bee Low Limestones	Dolomite	96	4	0
	Apron-reef facies	2	93	5
	Limestone	67	33	0
Woo Dale Limestones	Upper lithofacies	54	46	0
	Lower lithofacies	6	94	0
OFF-SHELF PROVINCE				
Hopedale Limestones		39	54	7
Milldale Limestones	Dolomite	78	22	0
	Limestone	0	78	22

were all found to be below 85 per cent for the 660-nm filter. Reflectance values of around 95 per cent are required for whiting uses. In contrast some of the Eyam Limestone reefs and Woo Dale Limestones yielded samples with values of 95 per cent and above, and parts of the Bee Low Limestones sequence gave consistent values in the low nineties (NW 2s; p. 63).

MECHANICAL PROPERTIES

Details of fracture spacing, point-load strength and aggregate impact value are shown graphically for most boreholes and certain natural sections in Appendix C. Fracture spacing (as defined by Franklin and others, 1971) for almost all the limestones and dolomites commonly falls between 200 and 1000 mm, but values less than 200 mm are associated with the dark facies of the Eyam Limestones and with the Widmerpool Formation. Comparable values were obtained from unweathered lava and dolerite.

Cores from seven boreholes were tested for point-load strength but despite the acknowledged limited sensitivity of the testing machine and the rather poor reproducibility of the results it seems likely that the point-loads strengths of the limestones are reasonably constant in this area of Derbyshire. Statistical values for point-load strength index (Is), corrected to a nominal 76-mm core diameter, are summarised by stratigraphical formation in Table 14. The dolomites may be said to possess high

Table 13 Summary of powder reflectance results for very high purity carbonates (>98.5% carbonate)

Formation and subdivisions		Mean reflectance percentage		
		660 nm	520 nm	470 nm
Eyam Limestones	Knoll-reef	84 (4)*	80 (5)	78 (5)
	Dark lithofacies	65 (9)	56 (10)	53 (10)
Monsal Dale Limestones	Dolomite	73 (5)	62 (6)	57 (6)
	Limestone	81 (4)	74 (7)	73 (6)
Bee Low Limestones	Dolomite	75 (4)	62 (6)	58 (6)
	Apron-reef	81 (2)	77 (3)	75 (3)
	Limestone	85 (4)	79 (5)	77 (6)
Woo Dale Limestones Upper facies		86 (4)	81 (5)	79 (5)

* Figures in brackets show standard deviation

Table 14 Summary of point load strength indices

Formation	Maximum value (Is)	Mean value (Is)	Standard deviation	Number of observations
	MN/m^2	MN/m^2	MN/m^2	
MONSAL DALE LIMESTONES				
Limestone	7.91	4.07	±2.28	88
Dolomite	8.64	2.96	±2.60	15
BEE LOW LIMESTONES				
Limestone	8.48	4.21	±1.87	145
Dolomite	8.52	2.10	±2.89	26
HOPEDALE LIMESTONES				
Limestone	8.64	3.42	±2.72	97
WOO DALE LIMESTONES				
Limestone	8.42	4.72	±1.38	94

strength and the limestones very high strength (Broch and Franklin, 1972, fig. 22). The distribution of point-load strength index values for all tested samples is shown by a histogram in Figure 19. In order to assess the performance of the rocks as aggregates, all samples were subject to the Aggregate Impact Value test (British Standard 812: 1975). The values obtained from limestones and dolomites are shown by a histogram (Figure 20) which depicts a mode between 15 and 20, and a mean of 19.73. The standard deviation is 6.93. The maximum and minimum aggregate impact values are 51.65 and 13.50 respectively. In the Wirksworth area dolerite and unweathered lava were found to possess similar aggregate impact values to limestone. (The reader is referred to Appendix D, where possible sources of error in obtaining the AIVs quoted in this report are discussed.)

THE MAP

The resource assessment map is folded into the pocket at the end of this report. It comprises two elements; a geological map and a limestone and dolomite resource map. Both are printed over the Ordnance Survey 1:25 000 outline edition in grey. This change of format from the first limestone resource map (Cox and Bridge, 1977) was necessary to ensure that the details of the geology and of the assessment of resources are clearly shown.

The geological map follows all the established conventions of the Institute's 1:25 000 series. Cross-sections are drawn along the same lines and at the same scale for both the resource map and the geological map.

The purity of limestone is indicated on the resource map by shades of blue which demonstrate the average purity to a depth of ten metres. Purity values were determined at the sample points by the calculation of the mean, standard deviation and confidence limits for the 95 per cent probability level, assuming the Student's t distribution for each ten metres represented. The mean and positive confidence limit were summed to give a value which when subtracted from one hundred, gave a conservative (worst) estimate of the calcium carbonate content for each thickness increment. This value was used to determine the category of limestone according to the classification in Table 2. This information was then combined with carbonate data from spot samples and any additional field observations (for example, presence or absence of chert); thus indicating the mean composition of the top ten metres of limestone in a regional fashion.

Where beds of limestone of different purities are present within 10 m of the surface, a system of colour banding is used on the map to indicate 'zones of intermixing' (Figure 21). The width of a zone depends on the attitude of the contact between the limestone categories. Where the interface dips gently, the zone will be broad. Where it is vertical the system is, of course, not needed. Zones of intermixing are enclosed by a dotted line and the limestone categories involved are shown by alternating stripes of the appropriate colours. This system is also used where non-carbonate rocks (excluding drift) form part of the uppermost 10 m.

Areas of dolomite and of partial dolomitisation are indicated in green and by green stripes respectively. No attempt has been made to subdivide the dolomite quantitatively on a chemical basis, because it occures intermittently both vertically and laterally and its margin is difficult to map.

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 weighted mean insoluble residue value for each 10-m increment of thickness. Where natural sections are recorded Ordnance Datum is given for the highest stratigraphical horizon collected.

Cross sections

Cross sections have been drawn to show the relationships of the various limestone categories. These sections are based directly upon borehole information, the structure as determined from field evidence and the relationship of the various categories of limestone to the known 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 illustration of the depth of dolomitisation.

Zigzag lines have been used diagramatically to indicate the approximate position of a change in limestone category. The lines do not indicate the precise boundaries between categories.

DESCRIPTION OF RESOURCE BLOCKS

BLOCK A

The block covers an area of 9.83 km^2 and extends across the central part of the limestone plateau between Aldwark and Cromford. Because of its geological similarity to this central region an area of limestones centred on Ballidon to the west is also included within this block. The main topographic feature is the steep-sided valley of the Via Gellia, but tributary dry valleys have further dissected the terrain which ranges in elevation from 122 m (400 ft) in the main valley floor to over 335 m (1100 ft) on the plateau top. The 'water-table', which was found to be 154.7 m (508 ft) above OD in borehole NE 42, is controlled by the level of the River Derwent, but impervious beds such as the Lower Matlock Lava give rise to perched water-tables. In the east of the block, mining has interfered with the natural distribution of underground water; for example, drainage tunnels, such as Cromford Sough, locally control the groundwater level.

The areas covered by each of the main rock types within 10 m of the surface are as follows: limestone 9.48 km^2, limestone intermixed with basalt 0.28 km^2, and basalt 0.07 km^2.

The block boundary encompasses outcrops of the

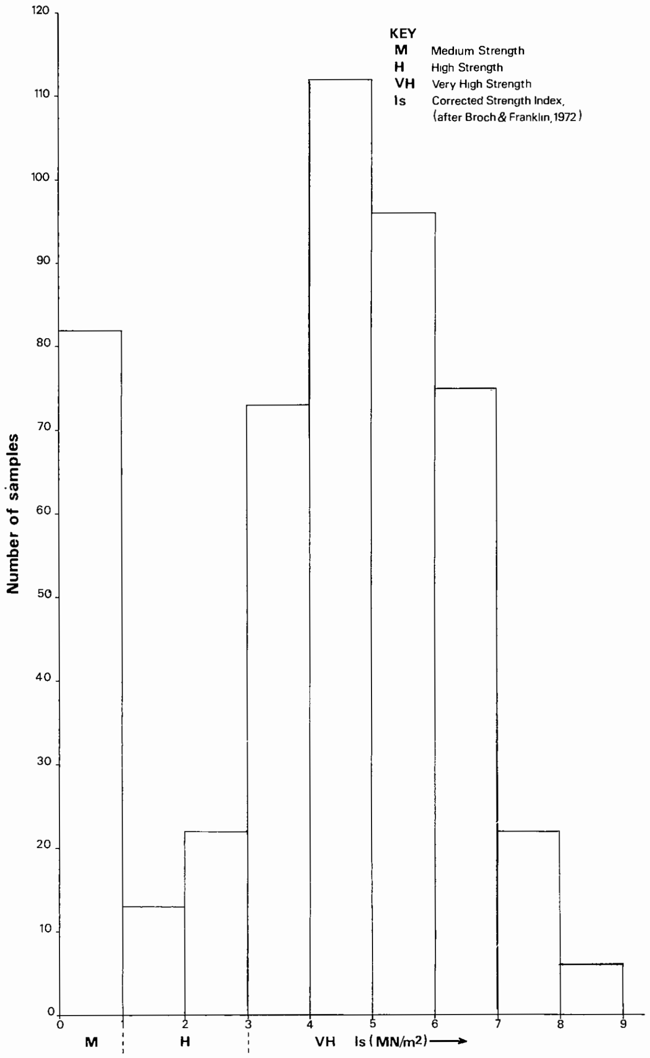


Figure 19 Point-load strength values

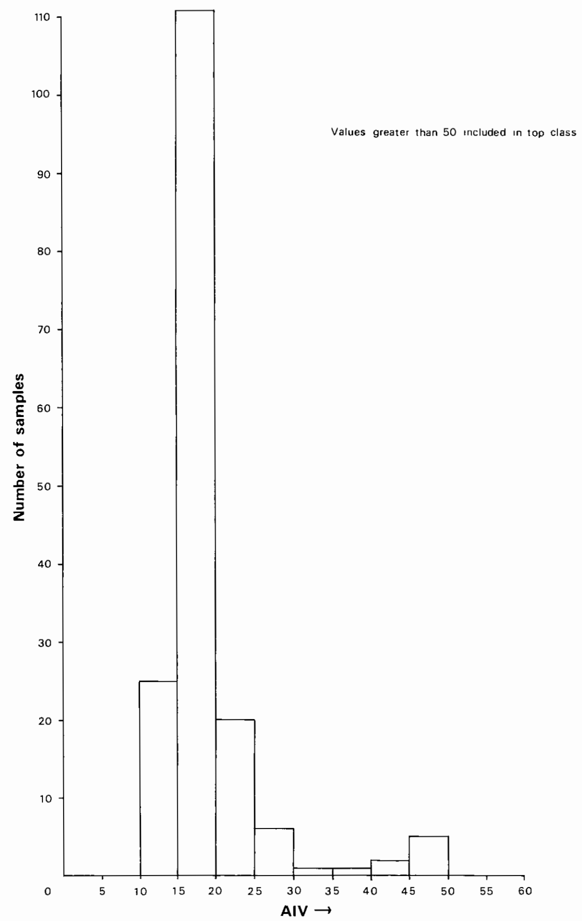


Figure 20 Histogram showing distribution of aggregate impact values for limestones and dolomites. Values greater than 50 are included in the top class

Woo Dale Limestones, Bee Low Limestones, Monsal Dale Limestones and Eyam Limestones: all are very high purity mineral except for a small area of medium and high purity Monsal Dale Limestones at Dean Hollow [287 561].

The Eyam Limestones which crop out in the eastern part of the block are closely related to the knoll-limestone of blocks E and, G but here they occur as a continuous sheet with a thickness of 16 m at Dene Quarry [290 563]. Purity is variable as the Eyam Limestones contain different amounts of silicified bioclasts, clay and ore minerals, but percentage carbonate is predominantly greater than 97.0 per cent and commonly greater than 98.5 per cent.

Below these limestones a complete sequence of Monsal Dale Limestones and Bee Low Limestones through to the Woo Dale Limestones is exposed in the crags and flanking slopes of the Via Gellia. The Monsal Dale Limestones have an average thickness of 40 m and include the Lower Matlock Lava (maximum thickness 13 m) which lies at the base of the formation in the eastern part of the block. Limestone beds immediately above and below the lava locally include abundant quartz euhedra or weathered pyrite, but elsewhere throughout the block the Monsal Dale Limestones are very high purity mineral. Exceptionally, as at Dean Hollow, the beds contain substantial amounts of silicified bioclastic material, so that the limestones are downgraded to medium purity.

The underying Bee Low Limestones are approximately 120 m thick in the western part of the block, but the formation thins eastwards to about 70 m between Middleton and Cromford. The area delineated around Ballidon is entirely within this formation. Typically the limestones are pale coloured and massively bedded, and are remarkably uniform in lithology, purity and mechanical properties. In the Ballidon area they include massive apron-reef limestones which are poorly bedded. They average more than 98.5 per cent $CaCO_3$ although carbonate values below 95.0 per cent were recorded, owing to the presence of concentrations of quartz euhedra. Clay wayboards up to 0.5 m thick are commonly interbedded with the limestones but they are not always sampled by waterflush drilling techniques and are rarely included in section samples. However, as they can be removed by high-pressure water jets during quarrying the estimates of purity given are thought to be realistic in industrial terms.

The Woo Dale Limestones comprise the oldest rocks exposed in this block. Their full thickness is unknown, but about 30 m are exposed in the crags of the Via Gellia and 98.95 m were proved in borehole NE 42. The rocks

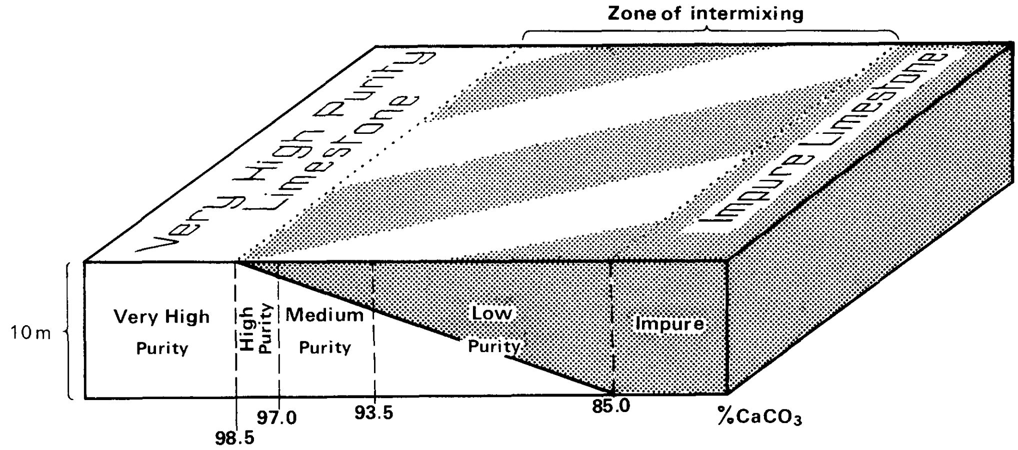


Figure 21 Zones of intermixing produced at the contact of disparate qualities

are lithologically distinct and boreholes demonstrated their high degree of uniformity across the area. Chert has not been seen and the formation does not contain any interbedded igneous rocks. The limestones average more than 98.5 per cent $CaCO_3$ but purity is occasionally reduced by concentrations of up to 7 per cent of euhedral quartz. Clay, occurring as greenish-blue partings and cavity-infillings, and pyrite, occurring as widely scattered particles, are other impurities which locally downgrade the mineral. Purity remains high throughout the uppermost 75 m of the proved sequence, but below this a facies change was seen in borehole NE 42, and the limestones contain substantial amounts of bluish-grey mudstone-filled stylolites and partings, clay-grade silica, quartz euhedra and pyrite. Nodular chert had also been recorded in minor amounts and the limestones are downgraded to medium purity and low purity.

The mechanical properties of the limestones of this block are similar to those of limestones elsewhere on the sheet. The Eyam Limestones give a mean aggregate impact value (AIV) of 18.2 ± 2.46 and have fracture indices which commonly fall between 1000 and 1300 mm. The mean AIV for the Monsal Dale Limestones is 17.2 ± 1.36, and the fracture index ranges from 600 to 100 mm. Fracture indices for the Bee Low Limestones and Woo Dale Limestones fall in the ranges 300–2500 mm and 800–1200 mm respectively. Mean AIVs for these limestones are 22.0 ± 3.91 for the Bee Low Limestones and 19.0 ± 1.50 for the Woo Dale Limestones. The latter produce a mean point-load strength index value of 4.72 ± 1.38 MN/m^2 (Table 14).

The limestones within this block are gently folded and dips rarely exceed 10°. The Gulf Fault trends north-westwards across the block and has a downthrow to the north-east of approximately 65 m where it crosses the Via Gellia. The main faults are not extensively mineralised, but mineral bodies, which in the past have been exploited for lead ore, occur as steeply dipping veins which are most common in the eastern part of the block. Vein deposits normally contain galena, calcite, fluorite and baryte.

Summary statistics for the chemistry and insoluble residues (Table 15) indicate an underlying uniform composition for the samples analysed. These values are taken from analyses made at several levels within the block ranging from 337.48 m OD at Hoptonwood Quarry [262 560] down to 91.88 m OD in the Ryder Point (NE 42) Borehole [2619 5645]. The number of chemical analyses is relatively small but the greater number of insoluble residue determinations confirms the small variation indicated by the chemical analyses. The conclusion is also supported by the petrology. The insoluble residue statistics indicate that most of the samples fall

Table 15 Chemistry of Resource Block A

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	528	65	62	65	65	65	65	65	65	62	62	65	65	65	64	65	58
Maximum value	21.00	56.50	4.41	6.03	0.52	0.05	4.39	0.10	0.50	0.05	44.34	480	2.24	35	4500	230	4600
Minimum value	0.10	49.50	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0	34.42	40	0.0	0	0	10	90
Mean	1.27	55.26	0.30	0.49	0.09	0.01	0.18	0.03	0.02	0.01	43.41	105	0.06	5	144	37	829
Standard deviation	1.66	1.57	0.54	0.89	0.12	0.04	0.66	0.02	0.06	0.02	1.64	90	0.30	6	617	97	1035
confidence limits at 95% level, ±																	
%	11.73	0.72	46.61	46.86	34.64	97.73	94.98	18.82	73.09	35.31	0.99	22	127.30	31	110	66	34.4
actual	0.15	0.40	0.14	0.23	0.31	0.01	0.17	0.01	0.01	0.00	0.43	23	0.08	1	158	25	285

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

well within the highest category of limestone purity. The maximum value of 21% is derived from a mineralised sample collected at Dene Quarry [287 562]. This sample has provided a number of maximum values, e.g. fluorine, sulphur and strontium. The Dene Quarry section passes through Eyam Limestones into Monsal Dale Limestones which have a higher insoluble residue.

Recorded MgO values were extremely low and no trace of dolomitisation was recorded in this block. The maximum Mg figure which occurred in a sample at Prospect Quarry [245 573] was produced by the inclusion of clay wayboard material in the sample analysed.

The highest lead value (4500 ppm) was also from Dene Quarry in association with local mineralisation. Hopton Wood Quarries also yielded many samples with lead values above the permitted limit for a number of end uses.

There is little drift cover over most of the block but thin patches of Head and Alluvium occur in the Via Gellia. Several small areas of landslipped ground occur on the steep sides of the Via Gellia, and a small thin deposit of calcareous tufa has formed around a spring at Marl Cottage [270 568] which is constructed from the tufa.

BLOCK B

This block covers 14.84 km^2: limestone occupies a surface area of 1.77 km^2, dolomite and dolomitised limestone 12.09 km^2, siliceous sands and clay 0.38 km^2, limestone and dolomite intermixed with basalt 0.37 km^2, and agglomerate 0.23 km^2. The ground surface rises steeply from 213 m (700 ft) at the southern plateau margin, to over 366 m (1200 ft) at Harboro' Rocks [243 553] on the plateau top. Numerous dry valleys dissect the marginal plateau slopes but over most of the block the plateau undulates between 305 m (1000 ft) and 366 m (1200 ft), with no major topographic features.

Water was recorded at 163 m (535 ft) above OD in borehole SW 17 and the major direction of groundwater movement is said to be to the east (Downing and others, 1970).

The rocks lying within 10 m of the surface belong chiefly to the Bee Low Limestones, but several small areas of Monsal Dale Limestones are enclosed by the block boundary. Dolomitisation has greatly affected the limestones of this block producing large areas of dolomitised terrain characterised by prominent dolomite tors. The limestones average more than 98.5 per cent $CaCO_3$ but the dolomites and dolomitised limestones are more variable in purity: very high purity, medium purity and impure rocks are recorded. However, insoluble residues of samples taken from the two major natural exposures of dolomite (NW 8s, SW 1s) indicate that the dolomitised Bee Low Limestones are, for the most part, high purity mineral (97.0–98.5 per cent carbonate). Similarly the dolomitised Monsal Dale Limestones are predominantly high purity, but an area of medium purity mineral occurs on the east of the block. A narrow outcrop of predominantly medium purity dolomite with beds of unaltered limestone occurs in the Bee Low Limestones near Longcliffe. The chief non-carbonate minerals in the dolomites are silica, hematite and limonite. Locally the dolomitisation is patchy and variable in intensity. Over 57 m of dolomite is exposed in the crags of Harboro' Rocks and the depth of dolomitisation in borehole SW 17 west of Brassington was proved to be 43 m below the surface. The base of the dolomitisation frequently projects down joints and fissures.

Fracture indices for the dolomites from the Bee Low Limestones commonly fall in the 1000–2500-mm range, but maximum and minimum values of 4500 mm and 40 mm respectively were recorded. The mean AIV for these dolomites and dolomitised limestones is 38.0 ± 13.2, and the mean point-load strength index value is 2.1 $MN/m^2 \pm 2.89$. The dolomitised Monsal Dale Limestones of this block have similar mechanical properties (Table 14).

Several large areas of undolomitised Bee Low Limestones are exposed in the vicinity of Ballidon, Brassington and Hopton; all are very high purity mineral except for a small area of high purity limestone outcropping at the plateau margin north of Bradbourne near Hipley Barn [211 541]. The Bee Low Limestones are similar lithologically, chemically and mechanically to those of Block A, but locally at the plateau margin, they pass laterally into apron-reef limestones which are lithologically distinct and show minor variations in chemical and physical properties. They are approximately 23.4 m in thickness at Hipley Hill [210 542]. The apron-reef limestones average more than 98.5 per cent $CaCO_3$, but up to 7.5 per cent of quartz, clay, bitumen and ore minerals have been recorded. Fracture indices fall in the range 2000–2600 mm and the mean AIV is 15.6 $\pm$ 0.67. The shelf facies Bee Low Limestones of this block have fracture indices which range between 1000 and 2250 mm and produce a mean AIV of 20.6 ± 1.32.

Borehole NW 18 proved a sequence of Bee Low Limestones which passed downwards at 39 m into Woo Dale Limestones. The latter are similar in facies to the Woo Dale Limestones of Block A, and are very high purity mineral. However these limestones are patchily dolomitised adjacent to fissures, which are occasionally clay filled, downgrading the purity.

The effects of the extensive dolomitisation of this block are clearly reflected by the MgO analysis figures (Table 16). The maximum value of 21.10 per cent is from a section sample at Harboro' Rocks [242 553]. Although many samples of dolomite were analysed from this resource block this was the only locality giving values that appear to meet industrial specifications.

The limestones of the block are exemplified by those seen at Ballidon [2031 5524] NW 6s (p. 81). The main variation is in the silica value; the variation is due to the presence of very finely divided clay-grade silica and scattered quartz crystals. All other elements gave very low values although the presence of clay wayboards may cause a rise in the alumina figure. Some limestones encountered were almost 100 per cent calcium carbonate, e.g. at SW 3s [2482 5356], a small section at Carsington in reef limestones (Bee Low Limestones). Such reef limestones (Bee Low Limestones) are not always uniform chemically: a sample at 12 m apparently identical in lithological type to a very pure sample taken from 5 m yielded the highest SO_3 figure recorded in this block and an insoluble residue of seven per cent. Hematite, quartz and clay were all detected in the insoluble residue and it must be assumed that the clay contained a sulphide mineral, probably pyrite.

An unusually high phosphate value (1.91 per cent) was recorded from Ballidon Quarry at 12 m from the surface. This is the highest phosphate record for the sheet and may indicate the presence of organic remains, e.g. fish scales. It is unlikely to be of more than local significance. Lead and zinc values are extremely low within this block: the two highest recordings of 10 100 ppm and

Table 16 Chemistry of Resource Block B.

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	410	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
Maximum value	39.50	56.10	21.10	10.13	1.96	0.13	1.35	0.36	0.26	1.91	48.21	2400	0.85	50	10100	3800	37700
Minimum value	0.10	29.30	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.02	80	0.0	0	0	10	190
Mean	1.81	46.74	7.00	0.59	0.11	0.03	0.10	0.02	0.04	0.11	44.71	659	0.04	8	188	137	2735
Standard deviation	3.58	10.68	8.79	1.36	0.34	0.02	0.27	0.05	0.06	0.32	2.37	539	0.14	7	1242	470	4637
confidence limits at 95% level, ±																	
%	20.13	5.90	32.47	59.18	79.62	19.39	73.56	54.01	31.32	74.54	1.37	21	94.77	25	171	89	44
actual	0.36	2.76	2.27	0.35	0.09	0.01	0.07	0.01	0.02	0.08	0.61	139	0.04	2	321	122	1199

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

3800 ppm respectively are entirely isolated occurrences (NW 5s, p. 80, and SW 17, p. 75). Both samples came from dolomites, and in the second sample (3800 ppm) mineralisation was also indicated by the presence of baryte.

Several large patches of Head partially cover the limestones, dolomitised limestones and dolomites, but they rarely exceed a few metres thick, although borehole NW 18 proved 9 m of silty clay overlying Bee Low Limestones. A large irregular patch of boulder clay several metres thick occurs in the vicinity of Abor Low [258 545]. Numerous pockets of sand and silt occur in the dolomitised areas of the block and some are currently worked for refractory use. These deposits have subsided into sink holes which may have been initiated by groundwater solution at the dolomite–limestone contact. Subsurface solution cavities at Golconda Mine [249 551] are infilled with galena and baryte: mineralising solutions appear to have travelled laterally and dissolved out cavities at the base of the dolomite before filling them with layers of ore mineral. Elsewhere in the block the rocks are locally mineralised with vein and pipe deposits, particularly at Carsington Pastures [246 544] where galena, baryte, cerussite and 'calamine' have been worked.

The strata are gently folded and dips rarely exceed 10° on the plateau but dips are relatively high at the plateau margin, ranging from 12 to 35°. Few faults affect this block.

BLOCK C

This block forms the plateau region between Grangemill [243 576] and Minninglow [209 573] and occupies an area of 9.69 km² containing 7.29 km² of limestone, 1.76 km² of limestone intermixed with lava and tuff, and 0.61 km² of lava and tuff. The plateau undulates between 366 m (1200 ft) and 244 m (800 ft), but the most prominent topographic features are the escarpments of the Monsal Dale Limestones above the Lower Matlock Lava.

Within 10 m of the surface the beds covering the greater part of the block belong to the Monsal Dale Limestones, but Bee Low Limestones are exposed in a small area at the western block boundary.

A maximum thickness of approximately 120 m of Monsal Dale Limestones is exposed in this block. The sequence contains the Lower Matlock Lava which varies in thickness from 0 to 30 m in this area, and also contains the Winstermoor Lava which is locally present at the base of the Monsal Dale Limestones to a thickness of approximately 6 m. The Lower Matlock Lava dies out south-west of a line joining Mouldridge Grange [201 594] and Curzon Lodge [234 561]. Limestone beds immediately above and below the lavas commonly contain an abundance of euhedral quartz crystals and flecks of pyrite, but this alteration seldom exceeds 1 m in thickness in any one sequence.

Purity is variable in the Monsal Dale Limestones of this block: percentage calcium carbonate values range from greater than 99 per cent to less than 85 per cent. Most of the limestones are nevertheless of high purity (98.5–97.0 per cent $CaCO_3$) but with minor proportions of medium purity limestones (97.0–93.5 per cent $CaCO_3$). Major impurities are silica, in the form of quartz euhedra, chalcedony as a replacement of bioclastic debris and chert, and clay which occurs as wayboards, partings and stylolite and cavity infillings. Chert is abundant in the vicinity of Hoe Grange Quarry [223 561] and is recorded in small amounts at Roystone Grange Quarry [205 571] and near Greenlow Farm [224 580].

Dolomitisation has partially altered the limestones in the vicinity of Aldwark, Minninglow and Hoe Grange Quarry but alteration is mainly limited to several beds of dolomite totalling 1.4 m thick and patchy dolomitisation adjacent to fissures and fractures.

Fracture indices for the Monsal Dale Limestones of this block fall in the range 150–1500 mm, and the mean point-load strength index and mean aggregate impact values are 3.6 MN/m² ± 2.61 and 18.0 ± 1.68 respectively. The mean point-load strength index is smaller than the index given by other limestones on the sheet: this is due to the patchy dolomitisation and fractured nature of the tested samples.

The Bee Low Limestones which occupy a small area near Minninglow Grange [201 578] are of very high purity and of a similar nature to the Bee Low Limestones of Block A. However the Bee Low Limestones proved beneath the Winstermoor Lava in borehole NW 22 are partly brecciated, rubbly and mineralised with calcite, and contain clay-filled fractures. Their mean purity is therefore downgraded to high purity. The mechanical properties of these limestones are also affected by the rubbly, brecciated nature of the core: fracture indices fall in the range 100–400 mm, the mean point-load strength index is 3.54 MN/m² ± 2.27 and the mean AIV is 17.6 ± 2.14.

Table 17 Chemistry of Resource Block C.

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	258	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
Maximum value	34.00	56.30	19.50	19.00	8.60	0.05	0.46	1.22	0.12	0.13	47.05	1900	1.39	35	350	620	26200
Minimum value	0.30	30.80	0.16	0.10	0.0	0.0	0.0	0.0	0.0	0.0	30.68	70	0.0	0	0	5	250
Mean	2.72	52.68	1.13	2.69	0.44	0.02	0.06	0.06	0.04	0.04	42.40	518	0.09	7	37	63	3964
Standard deviation	3.63	5.35	3.62	3.68	1.24	0.01	0.09	0.17	0.03	0.03	2.50	420	0.25	7	74	115	4679
confidence limits at 95% level, ±																	
%	17.07	2.95	93.25	39.67	82.34	23.69	42.16	77.93	20.52	24.79	1.71	23	80.18	27	58	53	34
actual	0.46	1.55	1.05	1.07	0.36	0.01	0.02	0.05	0.01	0.01	0.72	122	0.07	2	21	33	1356

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

The minimum CaO percentage of 30.80 (Table 17) is from a sample taken from Hoe Grange Quarry [223 561] where there is a development of chert and clay wayboards. Some very high CaO figures were recorded, for example, in borehole NW 16 [2209 5644] (p. 89), there was 56.30 per cent CaO at 13 m, and in borehole NW 22 [2125 5815] (p. 93) 56.20 per cent at a depth of 76 m. Although the average quality for the limestones of most of this block is in the high purity category there is a considerable variation in the CaO values within individual sections and boreholes. Silica accounts for most of the high residues at this locality and iron values are also relatively high. Thin beds of dolomite give rise to the maximum MgO values recorded within this block.

Immediately below the Winstermoor Lava there is a bed of medium purity limestone. CaO values are around 53 per cent with much of the non-carbonate fraction made up of silica and alumina.

There is little direct evidence of extensive mineralisation in the area of this block. (The maximum fluorine value was derived from a sample (from borehole NW 16) affected by minor faulting.) However, the mean lead concentration over the whole block is high (37 ppm) and is close to the maximum permitted limit of 40 ppm for foodstuffs usage. A detailed examination of the basic data shows that Roystone Grange Quarry (Section NW 10s [2051 5711], p. 97) was the only collected sequence that had yielded samples below the permissible limit.

An isolated occurrence of Pocket Deposits (0.03 km²) fills a solution cavity in the Bee Low Limestones at Minninglow and has been worked in the past for sand and clay. Patchy thin deposits of Head cover small areas of the block and alluvial deposits have been mapped in the valleys at Grangemill.

The Ivonbrook Syncline, in which dips are as high as 32°, skirts the south side of the Bonsall Fault: elsewhere in the block the shelf limestones are gently folded and dips rarely exceed 15°. Several major faults cut the strata, notably the Minninglow Fault which downthrows to the south approximately 65 m. Mineralisation in this block is limited to fault planes and joint fissures.

The groundwater level is thought to be below 226 m (732 ft) OD as borehole NW 22 was proved to be dry. The perched water-table above the Lower Matlock Lava found in nearby areas was not encountered in this block.

BLOCK D

This block covers an area of 5.66 km² and comprises mainly the plateau between Bonsall and Ible. The ground is over 335 m (1100 ft) in the vicinity of Whitelow (253 581), and slopes gently southwards to the topmost crags of the deeply incised valley of the Via Gellia, and east and north-eastwards to the dry valleys of Horse Dale and Bonsall Dale. Westwards the plateau surface is broken by the outcrop of the Shothouse Spring Tuff which locally forms a steep escarpment.

The area covered by each of the main rock types within 10 m of the surface is as follows: limestone 3.93 km², dolomite 0.75 km², basalt and tuff intermixed with limestone 0.24 km², basalt and tuff 0.48 km², dolerite 0.26 km².

The limestones and dolomites of this block belong mainly to the Monsal Dale Limestones and are on average of medium or low purity. However, limestone quality is variable in the block, and over 13 m of very high purity mineral are exposed in Cotterhole Quarry [265 568]. The maximum thickness of the Monsal Dale Limestones proved in this area was 57 m of limestone which passes downwards into tuffaceous limestone and tuff in a borehole (NE 41) at Bottom Leys Farm [259 580]. It is probable that in the western part of the block, a small thickness of Monsal Dale Limestones underlies the tuff, but in the eastern areas the Lower Matlock Lava, which is the lateral equivalent of the Shothouse Spring Tuff, is underlain by very high purity Bee Low Limestones (p.71). The Monsal Dale Limestones are predominantly pale grey and massive with a fracture index of 1000 mm and a mean AIV of 20.25 ± 2.62. However the limestones around borehole NE 41 are pale and dark grey with a mean point-load strength of 4.45 MN/m² ± 1.50, a mean AIV of 16.96 ± 1.37 and fracture indices which commonly fall between 150 and 300 mm. Silica, in the form of euhedral quartz, chalcedonic replacement of shell debris and rare nodular chert, is the chief impurity but clay and ore minerals are also contaminants. However the Monsal Dale Limestones proved in borehole NE 41 contained considerable amounts of pyrite, hematite, disseminated clay, black mudstone and quartz euhedra. Nodular chert and patchy silicification are also common at certain levels in this borehole. Consequently carbonate values fall to 90.5 per cent. This downgrading of the carbonate level is thought to be confined to a small area, being the product of local volcanism.

Table 18 Chemistry of Resource Block D.

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	65	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Maximum value	23.5	56.00	2.84	14.90	1.91	0.04	0.35	0.35	0.05	0.06	43.97	950	0.01	110	100	80	33900
Minimum value	0.5	45.30	0.26	0.12	0.0	0.0	0.0	0.02	0.0	0.0	35.15	120	0.0	0	0	10	200
Mean	4.76	53.13	0.71	2.87	0.50	0.03	0.10	0.07	0.01	0.01	41.94	426	0.01	15	21	44	10439
Standard deviation	5.17	8.69	0.83	4.87	0.79	0.01	0.11	0.11	0.02	0.02	3.01	303	0.01	36	38	26	10975
confidence limits at 95% level, ±																	
%	28.30	5.62	94.53	137.23	127.48	47.67	95.91	129.77	133.38	142.96	5.79	58	121.29	192	144	47	85
actual	1.35	2.99	0.67	3.94	0.64	0.01	0.10	0.09	0.01	0.01	2.43	247	0.01	29	30	21	8873

* The figures for iron are shown in parts per million,
as it may be present as a trace or a major element

Eyam Limestones, predominantly of medium purity, crop out over a small area between the Bonsall Fault at Upper Town [273 583] and the northern slopes of Bonsall Dale [274 581]. The limestones are dark grey and thinly bedded and are locally underlain by a thin development of massive high purity knoll-reef Eyam Limestones.

A large irregular dolerite sill, emplaced in Bee Low Limestones at Ible, has been quarried in the past for aggregate, although the dolerite contains numerous weathered joints and shows a tendency to spheroidal weathering. Basalt from the Lower Matlock Lava has also been quarried from Bonsall Wood Quarry [282 574] in the Via Gellia.

Dolomitisation has affected an area of Monsal Dale Limestones in the vicinity of Bonsall, producing massive dolomites and dolomitised limestones which have an average carbonate content of 97.0 per cent to 93.5 per cent. The dolomites are commonly highly altered with many calcite-filled vugs. The depth of dolomitisation in this block is not known, but it was found to be over 9 m in a borehole (NE M4) at Bonsall [280 578] (Figure 23).

There are few chemical analyses of samples from this block and Table 18 should be used only as a general guide to the chemistry. However, insoluble residues from many spot samples confirm the generally medium purity of the limestones. The presence of mineralisation and dolomitisation necessitates a detailed appraisal of the local ground conditions if any particular area is to be evaluated for reserves. Borehole NE 41 [2587 5795] at Bottom Leys Farm passed through much of the Monsal Dale Limestones above the Shothouse Spring Tuff. The samples show considerable variation in CaO values, owing to the presence of thin clays, cherts and volcanic debris. In contrast the two samples from Cotterhole Quarry NE 9s [265 568] are of very high purity giving normative carbonate values of 99.96 per cent.

A thin deposit of boulder clay covers the limestone over a small area in the vicinity of Blake Mere and Two Meres [253 588]. An area of Monsal Dale Limestones is affected by landslip [281 578] at Bonsall and minor landslips occur on the steeply sloping outcrops of the Lower Matlock Lava and Shothouse Spring Tuff.

Structurally, the block lies in the downthrown area between the Bonsall and Gulf faults; the folding is gentle and dips rarely exceed 15°. The area is extensively mineralised especially in the vicinity of Bonsall Leys [26 57] where veins up to 9 m wide, trending predominantly north-east and north-west, have been worked for galena, calcite, fluorite and baryte. Many veins are intruded along steeply dipping faults but minor veins often follow joint planes. Ore minerals also occur as conformable metasomatic replacement bodies. Working is now restricted to small opencast operations for fluorite in the vicinity of Blake Mere.

The flow of water through the limestones is controlled by joints, bedding planes and by the extensive network of old mine workings. Standing water at 25.43 m below surface was recorded from a well at Leys Farm [259 573]. Springs issue [269 569] above the crop of the Lower Matlock Lava and water also drains from a spring [279 575] in the Monsal Dale Limestones where water is probably trapped above a clay wayboard.

BLOCK E

This forms the south-eastern part of the plateau and covers 4.76 km²: limestone occupies an area of 4.62 km², and limestone intermixed with basalt 0.14 km². The limestone plateau lies mainly between 274 m (900 ft) and 350 m (1150 ft) on Middleton Moor, but falls at the margins to 152 m (500 ft) at Wirksworth and 107 m (350 ft) at Cromford.

The area is drained by two major lead-mining soughs which drain eastwards from the margin of the plateau. Consequently the main direction of groundwater movement is eastward. The watertable is thought to lie below 122 m (400 ft) OD (Downing and others, 1970).

The two major faults, the Gulf Fault and Yokecliffe Rake, subdivide the block into three parts. There are also numerous minor faults, many of which are mineralised. Much of the block bears evidence of past lead mining, but mineral working is now restricted to opencast operations for baryte and fluorspar in the vicinity of Slinter Wood [286 569]. Folding is gentle and dips rarely exceed 15°.

The limestones lying within 10 m of the surface belong mainly to the Eyam Limestones and Monsal Dale Limestones and are of medium purity, but quarries in the Wirksworth area expose Bee Low Limestones and knoll-reefs of the Eyam Limestones (Plate 6) which are of very high purity. In the southern part of the block there is a small area of very high purity knoll-reef limestones in the Eyam Limestones. The Eyam Limestones are lithologically variable but over most of the block the formation comprises two distinct facies: a basal layer of very high purity knoll-reefs is overlain by mainly dark coloured medium purity limestones. These are overlain by the Longstone Mudstones: dark shales with thin beds of

Table 19 Chemistry of Resource Block E

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	304	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
Maximum value	26.00	56.40	0.59	1.80	1.48	0.05	4.39	0.21	0.50	0.26	43.80	500	2.24	40	4500	1100	6200
Minimum value	0.20	43.40	0.17	0.09	0.0	0.0	0.0	0.01	0.0	0.0	31.86	40	0.0	0	0	0	110
Mean	2.29	53.79	0.39	3.05	0.25	0.02	0.27	0.05	0.04	0.04	41.78	184	0.11	7	194	97	1371
Standard deviation	2.92	2.79	0.12	4.40	0.33	0.01	0.71	0.04	0.09	0.05	2.75	140	0.38	7	705	198	1461.9
confidence limits at 95% level, ±																	
%	15.07	1.70	9.89	47.27	44.47	28.87	85.35	24.05	73.91	47.66	2.15	24.92	115.38	31.74	118.99	66.75	34.9
actual	0.34	0.91	0.04	1.44	0.11	0.01	0.23	0.01	0.03	0.02	0.90	46	0.13	2	231	65	47.8

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

limestone. The knoll-reef limestones are pale grey, unbedded and coarsely bioclastic with fracture indices in excess of 3000 mm and with an AIV of 18.43 ± 2.16. These limestones are approximately 23 m thick at Shaw's Quarries [288 551]. The dark Eyam Limestones rest on Monsal Dale Limestones and, where these are cut out at Baileycroft Quarry [287 542], on Bee Low Limestones. The dark limestones, more than 12 m thick at Dene Quarry [289 563] and Shaw's Quarries [288 551], are grey and dark grey, thinly bedded and in part, very cherty. The chert occurs as nodules and beds. Finely disseminated clay is a major impurity in the darker limestones, and silicified skeletal debris and quartz euhedra are common at some levels in the sequence. Fracture indices for the dark Eyam Limestones of this block are commonly 200 mm to 400 mm, and the mean AIV is 16.26 ± 1.45. The Longstone Mudstones form a narrow marginal outcrop in the northern part of the block, and the maximum thickness here is probably of around 11 m, but this was not proven during the resource survey.

The Monsal Dale Limestones are much thinner in this block than elsewhere in the sheet area. There the average is about 50 m, but the thickness decreases rapidly at the shelf margin and the formation wedges out completely at Baileycroft Quarry. The limestones are predominantly pale to mid-grey, massive, bioclastic limestones with occasional shell beds and dark grey beds. Dark grey, thinly bedded limestones with shale partings and beds of breccia are found in the vicinity of Dale Quarry [285 540] and are associated with the thinning at the southern margin of the shelf province.

The Monsal Dale Limestones vary greatly in purity and all categories are present. Nodular and bedded chert is common at some levels and argillaceous matter is locally present in considerable concentrations in the darker limestones. Clay wayboards, up to 1 m thick, are commonly interbedded with the limestones, but they have been excluded from the purity calculations as they can easily be removed during quarrying. Silicification and minor pyritisation are locally associated with clay wayboards and with the Lower Matlock Lava: a further source of impurity is chalcedonic replacement of shell debris. The level of impurity is generally high and the category of the Monsal Dale Limestones of this block is consequently depressed to medium purity.

The Lower Matlock Lava is approximately 14 m thick on Middleton Moor and is at least 10.5 m thick at Hoptonwoodstone Quarry [278 555], but the lava thins rapidly to the south-east and is absent in the quarries west of the Gulf Fault southward of Middletoncross [280 552]. Beneath the lava very high purity limestone of the Bee Low Limestones is present.

Fracture indices for the Monsal Dale Limestones commonly fall in the range 500–1000 mm, but the dark argillaceous limestones of the southern shelf margin at Wirksworth have fracture indices of 100–200 mm. The mean AIV for the Monsal Dale Limestones of this block is 17.30 ± 2.39.

Very high purity Bee Low Limestones are exposed in quarries at Middleton and Wirksworth, and the beds are very pale, massive, uniform bioclastic limestones with fracture indices of 500–1500 mm and a mean AIV of 19.98 ± 2.76. The full thickness of this formation was not proved during this survey but approximately 34 m are exposed below the Lower Matlock Lava at Hoptonwoodstone Quarry. These beds are mined beneath Middleton Moor. In the quarries to the south-east the lava is absent, and Dale Quarry [285 540] exposes approximately 17 m of Bee Low Limestones. At Baileycroft Quarry [287 542] the topmost beds of the formation undergo an abrupt facies change as they approach the shelf margin, and the beds become grey in part, with shaly and brecciated bands. A thin pyritous clay parting is recorded in Middlepeak Quarries [280 550], but clay wayboards are absent, which is not typical of the Bee Low Limestones elsewhere on the sheet. Silica in the form of euhedral quartz crystals is the major impurity, and is locally abundant in a 1.5-m bed immediately below the Lower Matlock Lava. Purity is generally very high but limestones of high and medium purity occur where quartz euhedra are concentrated.

The wide variation in mineralogy and lithology is clearly reflected in the summary statistics for the chemistry of the block (Table 19). The range of CaO values indicates that all limestone categories are present although, as already described, it is clear that much of the variation is between rather than within particular stratigraphic formations. An unusually high maximum figure for SO_3 was found at NE 8s where a minor mineral vein was present. This also gave rise to high lead and zinc figures. Lead values are highly variable and section NE 10s [2741 5579] (p. 108) gave evidence of localised high lead levels and this in the absence of any obvious sulphide mineralisation. Iron values are generally low.

The major impurity and variation is accounted for by silica, since other contaminants, such as alumina, are are present in only small amounts.

Drift cover is mainly restricted to thin patches of valley-fill head, but the limestones of the central region are patchily covered with boulder clay which has been proved, in a borehole (SE 13, Block B) close to the Block E boundary, to be approximately 16 m thick. A small, thin outlier of Namurian mudstone covers the limestones near Intake Quarry (274 549). Landslips occur above the Lower Matlock Lava in the vicinity of Hoptonwoodstone Quarry, where beds of the Monsal Dale Limestones are creeping down-dip over the lava.

BLOCK F

The block covers an area of 3.80 km² and is located on the limestone plateau which rises to over 365 m (1200 ft) at Blakelow Hill on Bonsall Moor. Although the limestones are concealed beneath only a thin cover of soil and patchy head, there are no major exposures in the area.

The water-table is estimated to lie between 198 m (650 ft) and 137 m (450 ft) above Ordnance Datum (Downing and others, 1970), and the chief direction of groundwater movement is to the north, in the direction of Elton.

The block forms part of the Matlock Anticline, in which the dips range between 4 and 35°. The Bonsall Fault, which downthrows to the south, forms the southern boundary of the block westward of Moor Farm [251 591]. The block contains 1.91 km² of limestone, 1.31 km² of dolomite, 0.35 km² of limestone intermixed with basalt, 0.12 km² of dolomite intermixed with basalt, 0.03 km² of basalt, and 0.08 km² of agglomerate. The limestones and dolomites of this block belong to the Monsal Dale Limestones and Bee Low Limestones and are, on average, of high and very high purity.

The Monsal Dale Limestones sequence is relatively thick in this area of the sheet, and approximately 65 m between the Lower Matlock Lava and the Bee Low Limestones are exposed in this block. The beds which lie immediately below the Lower Matlock Lava are, to a depth of approximately 20 m, pale or mottled grey, massive limestone of very high purity. Similarly a thickness of approximately 20 m of very high purity mineral forms the lowest part of the Monsal Dale Limestones. Between these beds of very high purity mineral the limestones are commonly slightly less pure and average 97.0 per cent to 98.5 per cent carbonate. They incorporate occasional dark beds which contain minor amounts of clay, but the chief impurity is silica, which occurs as concentrations of quartz euhedra and as a clay-grade stylolite infill. Pyrite occurs as minor aggregations and the limestones are locally stained by limonite which results from the weathering of pyrite. A pyritous black mudstone 0.6 m thick was recorded in the high purity Monsal Dale Limestones of borehole NE 17, Brightgate [2621 5940], but this was not used in purity calculations as it could be readily removed during quarrying by the use of high pressure water jets. West of Bonsall Moor the Monsal Dale Limestones become predominantly high purity mineral due to an increase in siliceous impurities.

Fracture indices for the Monsal Dale Limestones commonly fall between 400 and 1000 mm and the mean AIV is 19.1 ± 1.16. The mechanical properties of the underlying Bee Low Limestones were not recorded for this block, but the Bee Low Limestones proved in borehole NW 21 [2248 5965] of the adjacent block (Block G) have a mean AIV of 18.2 ± 1.51, a mean point-load strength value of 4.97 MN/m² ± 1.13 and a fracture index which commonly falls between 300 to 700 mm.

The Winstermoor Lava, which reaches a maximum thickness of about 15 m, lies at the base of the Monsal Dale Limestones in part of the block, and extends under a few square kilometres around Winstermoor [241 594]. The underlying Bee Low Limestones are of very high purity in an area between Bonsall Moor and Grange Barn [227 588] and are of high purity in the western part of the block. The major non-carbonate minerals are quartz, clay (infilling stylolites) and rare pyrite; silicification is locally recorded associated with dolomitisation.

Silicification and minor pyritisation is commonly found in the limestones which lie immediately adjacent to the basaltic lava flows and the Bonsall Moor Neck [256 596].

The block forms part of an area of dolomitisation which affects the north-western part of the sheet. Both Monsal Dale Limestones and Bee Low Limestones are dolomitised, and the degree of alteration is commonly intense producing granular dolomite with vugs. The depth of dolomitisation has not been proved, but a borehole at Elton (NW 21) in the adjacent block (Block G) proved 35.32 m of dolomitised Monsal Dale Limestones.

Because the Brightgate Borehole (NE 17) [2621 5940] is the only source of samples in this block and there are no major sections, Table 20 is a summary of the data from Appendix C. As the borehole was sited on the nose of the Matlock Anticline (p. 17) it penetrates most of the Monsal Dale Limestones exposed in this block. In general the CaO analyses indicate high purity limestone with some very high purity limestone. Although pyrite was identified at two levels within the sequence it is only present in very minor quantities. At a depth of 12 m an unusually high fluorine value of 0.96 per cent coincides with a higher than average insoluble residue; however, the petrological study did not reveal the presence of any vein mineralisation. These rocks are free from lead with the exception of a single sample at 20 m which included a thin clay wayboard. Most silica values are below 1 per cent although local silicification was recorded.

Superficial deposits are virtually absent from this block but a small patch of head was mapped near Tearsall Farm [255 598].

BLOCK G

The block covers an area around Matlock Bath and Bonsall in the north and north-east part of the sheet extending almost continuously to Elton Common in the north-west. Most of the plateau at Elton Common ranges between 289 m (950 ft) and 320 m (1050 ft) OD but in the east the plateau slopes steeply on the flanks of Masson Hill from 339 m (1111 ft) OD to less than 152 m (500 ft) OD in the Via Gellia and at the plateau margins. However, the chief topographic feature is the narrow, steep-sided valley of the River Derwent (Matlock Dale), which cuts down through the limestones to less than 91 m (300 ft) OD between Matlock and Cromford.

The block covers 9.91 km² and limestone crops out over 2.79 km², dolomite 2.87 km², limestone and dolomite intermixed with igneous rock 1.26 km², and igneous rock (basalt, dolerite, agglomerate) 2.99 km². Within 10 m of the surface the rocks belong mainly to the Eyam Limestones and Monsal Dale Limestones, but also include small amounts of Bee Low Limestones.

The Eyam Limestones, which crop out mainly along the eastern plateau margin, are lithologically, chemically and physically variable. The formation may be divided into two distinct lithofacies similar to the Eyam Lime-

Table 20 Chemistry of the Brightgate Borehole (SK25 NE 17, Block F)

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	60	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Maximum value	4.6	56.40	0.33	2.86	1.46	0.03	0.46	0.26	0.13	0.01	43.93	170	0.96	10	70	20	4500
Minimum value	0.1	52.80	0.14	0.04	0.0	0.01	0.0	0.0	0.08	0.0	41.37	80	0.0	5	0	10	200
Mean	1.23	54.84	0.21	0.74	0.25	0.02	0.06	0.04	0.10	0.01	43.23	118	0.12	9	.5	11	1031
Standard deviation	1.10	1.00	0.06	0.80	0.45	0.01	0.14	0.07	0.02	0.01	0.85	31	0.29	2	19	3	1417
confidence limits at 95% level, ±																	
%	24.22	1.16	18.76	68.42	113.84	28.40	142.19	109.78	10.18	82.53	1.24	16.50	159.12	12.91	228.90	16.35	87
actual	0.30	0.64	0.04	0.51	0.28	0.01	0.09	0.04	0.01	0.01	0.54	19.55	0.19	1.19	12.31	1.76	900

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

stones of Block E. A basal development of very high purity knoll-reef limestone attains a maximum thickness of 30 m in the riverside crags of Matlock Dale, but its thickness varies from approximately 15 m in Bonsall Dale to 1–3 m in Harveydale Quarry [296 597] and it is absent where the Eyam Limestones are exposed between the Great Rake and the Bonsall Fault. Draped over the crests of these knoll-reefs, or lying directly on Monsal Dale Limestones where the reefs are not developed, are low purity, thinly bedded, grey and dark grey cherty limestones which have a maximum thickness of approximately 30 m. The major impurity in these beds is silica, occurring as nodular and bedded chert and as partially silicified limestone. Commonly the darker grey beds also contain black mudstone partings and finely disseminated clay. Above the Eyam Limestones the Longstone Mudstones, which contain thin limestones near the base but are mainly dark shales, attain a total thickness of 11 m near High Tor [297 589].

The mechanical properties of the Eyam Limestones of this block are broadly similar to those of equivalent age in Block E. The knoll-reef limestones are poorly bedded with fracture indices commonly in excess of 3000 mm and with a mean AIV of 21.5 ± 1.78. The dark cherty limestones give a mean AIV of 17.9 ± 1.31 and have fracture indices which fall between 200 and 750 mm.

The Monsal Dale Limestones of this block contain two bodies of volcanic rock (the Upper and Lower Matlock lavas) interbedded with the limestones. The thickness of the lavas is variable; the Upper Matlock Lava is 24 m in borehole NE 28, 16 m in the crags of Matlock Dale, 13 m thick in a borehole [290 579] above Upperwood, Matlock Bath and thins to 0.2 m of clay at Scarthin Rock [297 570]. The Lower Matlock Lava attains its maximum thickness of 105 m at Masson Hill but thins in a short distance to 97 m in a borehole [288 584] on the eastern flanks of Masson Hill. This trend is seen to continue at Tearsall Farm [261 599] where there is an estimated thickness of 46 m.

The Monsal Dale Limestones above, between, and below the lavas maintain a similar thickness throughout the block. Above the Upper Matlock Lava the limestones have a maximum thickness of 34 m and are predominantly grey and massive with occasional clay partings, but south of High Tor the beds in the lower part of the sequence become dark grey and thinly bedded commonly with black mudstone partings. Chert is common in the middle of the sequence in Matlock Dale, and in the vicinity of Leawood Cottage [276 599] and Town End Farm [286 578] chert is abundant through almost the full thickness of beds. A further impurity is siliceous replacement of shelly material and consequently these limestones have carbonate values which commonly fall in the range 85 per cent to 93.5 per cent. The limestones between the lavas maintain a thickness of some 33 to 37 m throughout much of the area but the Snitterton borehole (NE 28) proved 41.7 m of these beds, which are predominantly of high purity. The beds are massive, pale grey and contain numerous clay wayboards many of which are pyritous. Occasionally the limestones below clay wayboards are red stained where pyrite has weathered to hematite. However, the major impurities are authigenic quartz crystals and the siliceous replacement of bioclastic debris. Below the Lower Matlock Lava the Monsal Dale Limestones crop out on the south-west flanks of Masson Hill near Bonsall and farther west they occupy much of the gently undulating plateau of Elton Common. The limestones vary between 45 and 55 m in thickness and are impure in the eastern outcrops; they are mainly of medium purity at Elton Common where additionally the beds are dolomitised. The high level of impurities in the lowest Monsal Dale Limestones east of Bonsall is due mainly to silicification. A transition from a limestone with scattered well formed quartz crystals, through a partially silicified limestone, to a rock composed almost wholly of quartz crystals is seen in these beds. This local alteration is associated with mineralisation along Great Rake. Other significant impurities recorded in these limestones are pyrite, hematite staining, fluorite and clay wayboards.

The limestones within the formation give a mean AIV of 17.7 ± 2.42 and have fracture indices which commonly fall between 150 and 1500 mm.

Dolomitisation has affected large areas of the Monsal Dale Limestones at Elton Common, Masson Hill, Matlock Bath and in the vicinity of Tearsall Farm and Leawood Cottage on the northern edge of the sheet. The dolomitisation is generally intense but the dolomites of Masson Hill contain thin irregular beds of unaltered limestone. The dolomites above the Upper Matlock Lava are of low purity and locally contain much unaltered chert, but the dolomites between the lavas are of high purity throughout the block except where they are locally altered by silicification adjacent to the Great Rake. The dolomitised area of Monsal Dale Limestones below the Lower Matlock Lava at Elton Common is predominantly of medium purity, but low purity siliceous dolomite and dolomite associated with fluorite locally reduce

Table 21 Chemistry of Resource Block G

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	373	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Maximum value	95.90	56.30	21.20	82.00	2.29	0.08	5.80	0.97	0.27	0.24	47.16	1170	7.40	35	180	1500	35200
Minimum value	0.30	7.40	0.17	0.28	0.0	0.0	0.0	0.01	0.0	0.0	6.64	60	0.0	0	0	0	160
Mean	7.69	46.52	10.08	6.04	0.24	0.03	0.23	0.06	0.04	0.03	40.72	437	0.56	6	21	156	3005
Standard deviation	13.76	12.17	33.12	12.97	0.46	0.02	0.90	0.15	0.05	0.05	7.17	318	1.59	7	38	275	5615
confidence limits at 95% level, ±																	
%	19.08	8.66	108.80	71.10	64.38	20.77	132.94	78.77	38.46	53.33	5.83	24.07	93.95	35.53	60.11	58.38	61.89
actual	11.28	4.03	10.97	4.29	0.15	0.01	0.31	0.05	0.01	0.02	2.37	105.18	0.53	2.13	12.62	91.07	1860

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

the quality. The depth of dolomitisation here was proved in the Elton Borehole (NW 21) to be 36.8 m. Elsewhere dolomitisation was found to penetrate 78.9 m below surface in a borehole [291 576] at Upperwood, Matlock Bath and 17.3 m below surface in borehole NE 29 near the northern sheet margin.

Fracture indices for the dolomites commonly fall in the range 200–1300 mm; the mean point-load strength value is 3.27 $MN/m^2 \pm 2.72$ and the mean AIV is 18.9 ± 1.01.

The Bee Low Limestones of this block which outcrop in two small areas near Bonsall are much less pure than those elsewhere on the sheet. Beds of high and medium purity limestones are recorded in hillside sections and in Ember Farm Borehole (NE 43), but low purity limestones are evident and impure limestones commonly occur. The limestones at the surface are locally completely altered to silica rock analogous to the silicification of the overlying Monsal Dale Limestones, and the most commonly occurring impurity throughout the crop is authigenic quartz. Borehole NE 43 proved a sequence of Bee Low Limestones which contain a substantial amount of mudstone and tuffaceous mudstone interbedded with the limestones. Pyrite is abundant, further reducing the carbonate value to less than 85 per cent. This uncharacteristic high level of impurity in the Bee Low Limestones is due to the presence of tuff of local origin and also to silicification associated with mineralisation along the Great Rake. However, in the western part of the block, the Bee Low Limestones proved (borehole NW 21) beneath the dolomitised Monsal Dale Limestones (below 36.88 m) are also less pure than is typical for them elsewhere on the sheet. In this area, high and medium purity limestones are common, the chief impurity arising from silicification associated with patchy dolomitisation. Fracture indices for these limestones range from 0.25 to 0.40. The point load index recorded was 4.20 $MN/m^2 \pm 1.71$. The AIV result was 18.0 ± 1.43.

In addition to the bedded lavas and tuffs within the limestones, a large dolerite sill, the Bonsall Sill, is emplaced in the Monsal Dale Limestones and Bee Low Limestones. Although the base of the sill was not reached, over 55 m of dolerite was proved in a borehole in the vicinity of Becks Mere [275 591]. Two small volcanic necks are also associated with the igneous rocks at Bonsall. Where the limestones are in contact with the igneous bodies they are locally enriched in quartz euhedra and may contain substantial amounts of disseminated pyrite.

Structurally the block lies to the north of the Bonsall Fault. An important structural feature is the Matlock Anticline. Dips range from 5 to 45° on its northern limb. The Great Rake, a major mineral vein, lies near the crest of the anticline and workings up to 18 m wide are seen in the limestones, many of which are silicified. Lead ore, fluorite, calcite, blende and baryte have been worked from several veins, pipes and flats in the past, but the most notable orebody is the fluorite-bearing flat of Masson Hill. Here the limestone immediately below the level of dolomitisation is replaced by fluorite with some calcite, baryte and galena. The orebody is up to 15 m thick and extends approximately 240 m down dip and 480 m along the strike.

The wide diversity in mineralogy and lithology within this block give a similarly wide chemical variation. The CaO values typify this variation (Table 21). The maximum MgO value of 21.20 per cent is from the Elton Borehole NW 21 [2248 5965] (p. 116). The analyses of dolomites from this locality indicate the presence of dolomite suitable for most industrial uses. Iron values are very low in this borehole (under 0.06 per cent). Lead concentration was unusually high (180 ppm) in only one sample; it was below 50 ppm for all others.

The Ember Farm Borehole, NE 43 [2845 5844] penetrated a major part of the Bee Low Limestones which atypically were consistently high in silica. Although the highest values reflect the presence of local volcanism, the wider occurrence of quartz throughout the sequence and the nearby development of silica rock in the margins of the Great Rake contribute to widespread silicification in this locality.

In most sections and boreholes sampled lead values are well below 40 ppm. A far greater variation is seen in the zinc values, as is indicated by the confidence limits. The source of this variation is not always apparent. In borehole NE 28 at Snitterton, [2788 5989] 1500 ppm of zinc was recorded from a sample just above the Lower Matlock Lava, but in the Elton Borehole (NW 21) relatively high zinc values could not be related either to obvious volcanism or mineralisation.

Superficial deposits are distributed in a few small patches. Several landslips are present locally on steep slopes, and thin deposits of head on the plateau. A narrow deposit of alluvium occupies the floodplain of the River Derwent in Matlock Dale and a substantial deposit of calcareous tufa has formed where warm springs emerge at Matlock Bath.

Table 22 Chemistry of Resource Block H

	Res.*	CaO	MgO	SiO_2	Al_2O_3	Na_2O	SO_3	K_2O	SrO	P_2O_5	Loss†	MnO	F	Cu	Pb	Zn	Fe_2O_3
No. of samples	249	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
Maximum value	64.40	53.80	19.70	15.70	2.72	0.07	0.64	0.66	0.16	0.17	46.95	2410	0.15	30	470	770	28500
Minimum value	1.70	30.40	0.41	0.81	0.06	0.0	0.0	0.02	0.0	0.0	35.58	210	0.0	0	0	0	500
Mean	8.75	45.56	5.50	6.01	0.71	0.03	0.07	0.17	0.05	0.06	41.41	929	0.04	6	31	76	8400
Standard deviation	8.21	6.80	6.66	5.23	0.69	0.02	0.16	0.16	0.05	0.05	3.64	654	0.04	6	95	161	7283
confidence limits at 95% level, ±																	
%	12.23	6.21	50.46	36.22	40.67	24.83	89.52	40.62	43.11	33.11	3.66	29.30	51.37	42.31	128.79	87.91	36.09
actual	1.07	2.83	2.77	2.18	0.29	0.01	0.06	0.07	0.02	0.02	1.52	272	0.02	2.5	40	67	3032

* The figures for iron are shown in parts per million, as it may be present as a trace or a major element

Perched groundwater is present above the Bonsall Sill at Bonsall, but elsewhere in the block the groundwater level is thought to lie between 152 m (500 ft) and 107 m (350 ft) OD (Downing and others, 1970).

BLOCK H

This block lies to the south of the main plateau and covers an area of 8.45 km². Most of the ground ranges between 290 m (950 ft) and 213 m (700 ft) OD but the incised gorge of Havenhill Dale cuts down below the 183 m (600 ft) contour. The level of the water-table has been recorded at 163 m (535 ft) OD in boreholes SW 18 and SW 19.

The carbonate rocks of this block belong to the Milldale Limestones, Hopedale Limestones and Widmerpool Formation of the off-shelf province of deposition, and they are predominantly of low purity.

High-purity limestones occur in the western outcrops of the Hopedale Limestones, between Wigber Low and Havenhill Dale. These beds are commonly grey, massive, coarsely bioclastic limestones with local developments of micritic knoll-reef. Hematite staining is the major impurity, but silicified bioclasts, dark shale, and rare nodular cherts are recorded.

The lower part of the Milldale Limestones is characterised by a series of medium purity, massive, mid-grey, fine-grained, bryozoan micritic limestones and dolomites. These beds occur as knoll-reefs in the vicinity of Standlow Farm [214 508], and have been proved (borehole SW 19) to 99.86 m giving a total known thickness of 114 m. The degree of dolomitisation, although variable, is intense in the vicinity of joints and fissures, but is generally slight and patchy below 37 m. The chief impurities are silica, replacing shell debris, limonite and hematite staining, and rare pyrite. Fluorite, calcite and galena are recorded from old mine workings in the knoll-reefs at Standlow Quarry [212 509].

The greater part of the outcrop of the Milldale Limestones comprises impure, dark, thinly bedded, fine-grained limestones. These beds are estimated to be approximately 215 m thick at outcrop, but the base is not proven. The limestones contain thin black shale and mudstone bands, black nodular and bedded chert and patchy hematite staining adjacent to fissures, joints and fractures.

The exposure of the Hopedale Limestones, between Haven Hill and Bradbourne, are predominantly low purity mineral and the beds of the Widmerpool Formation, which crop out continuously in a belt around the Haven Hill/Kniveton inlier are impure mineral. The low purity sequence of the Hopedale Limestones was proved in the Bradbourne borehole (SW 18) to be over 100 m thick and the total thickness is probably about 120 m. There is some variation in purity within these beds, and medium purity and impure limestones are present. The limestones are thinly and thickly bedded, pale and dark grey, fine and coarsely bioclastic, and locally contain black nodular chert, silicified bioclasts and black mudstone and shale partings. Small outcrops of dolomite and dolomitised limestones occur, borehole SW 18 proving 84.63 m of partially dolomitised limestone. Hematite staining is locally prominent and pyrite is present in minor amounts. The Widmerpool Formation which has a maximum thickness of approximately 200 m contains a sequence of dark shaly mudstones and thin limestones. The ratio of mudstone to limestone is generally about 3:1 but in lower parts of the sequence, limestones locally predominate over mudstones. The individual beds are usually less than 0.5 m in thickness and vary in purity. Silica is the chief impurity in these limestones, occurring as bedded and nodular chert and replacing shell debris. The limestones are commonly hematite-stained and locally argillaceous.

The twenty-seven chemical analyses taken for this block (Table 22) are derived from three boreholes: Bradbourne SW 18 [2125 5252], New House SW 5 [2131 5150] and Standlow Quarry SW 19 [2122 5087]. The limestones proved at Standlow Quarry are extremely uniform in lithology as the borehole is sited on a reef-knoll. The upper part of this knoll is dolomitised and this is reflected in the MgO values (see chemical analyses in the logs Appendix (C)). Below the dolomite, the MgO values remain relatively high because the dolomitising fluids have penetrated joints and cracks down into the reef. Towards the base of the borehole the presence of cherty silty mudstones is heralded by a fall in the CaO figure and a corresponding rise in silica. Relatively high lead and zinc values near the top of the sequence are caused by the presence of mineral veins. Although sulphides were recorded in the petrological log, SO_3 is virtually absent. The other borehole at Kniveton (SW 5) proved similarly uniform limestones. Sulphur and lead are absent. The very high iron values are characteristic of the limestones in this block: hematite is found in all formations.

The Bradbourne Borehole (SW 18) demonstrates extensive dolomitisation although this is thought to be rather localised and similar to the fissure dolomitisation seen in the Standlow Quarry Borehole. The extent of dolomitisation is variable and this is clearly seen in the analyses. The dolomites tend not to meet the normal commercial specifications. Silica values are generally lower than in the limestones, with a consequential rise in calcium.

The mechanical properties of the carbonate rocks of this block are broadly similar to limestones and dolomites elsewhere on the sheet, although fracture indices are generally much lower. The mean AIVs for the knoll-reef facies and the dolomites of the Milldale Limestones are 18.77 ± 2.76 and 22.20 ± 0.99 respectively. The limestones and dolomites of the Hopedale Limestones proved in borehole SW 18 gave a mean AIV of 17.18 ± 1.56 and a mean point-load index value of 3.42 ± 2.72 MN/m^2.

In the northern part of the block the beds are largely free of overburden, although patches of alluvium occur in Havenhill Dale, and thin patches of head occur as valley fill between Wigber Low and Haven Hill. Farther south, an extensive patch of boulder clay covers part of the Milldale Limestones and Widmerpool Formation outcrop, and at least 2.6 m has been recorded at Kniveton.

The main structural elements affecting the beds are shown in Figure 7. The limestones of the off-shelf province are much more intensely folded than the equivalent shelf limestones, and a series of anticlines trending north-south can be traced. Several normal faults cut the Milldale, Hopedale and Widmerpool formations and locally produce faulted boundaries. Surface remains of mineral working are evident in the Bradbourne–Haven Hill–Kniveton area, and galena, baryte, calcite and fluorite have been recorded.

The block contains 8.38 km^2 of limestone and 0.07 km^2 of dolomitised limestone at the surface.

APPENDIX A

CLASSIFICATION, TERMINOLOGY AND GLOSSARY

CLASSIFICATION

The petrographic classification of limestones by Folk (1959; 1962) is widely accepted and is used in this report in a slightly modified form. The classification is summarised in Table 23.

Clastic limestones consist of two basic components, namely allochem grains and matrix. Allochem grains are discrete bodies that 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 microns) termed micrite, a slightly coarser crystalline fabric (4 to 16 microns) termed microspar, and crystalline calcite cement or spar (greater than 16 microns).

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

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

10 to 49.9 per cent   Dolomitic limestone
50 to 89.9 per cent   Calcitic dolomite
90 per cent and above   Dolomite

In the first category, the use of Folk terminology is not precluded, for example, Biosparite Dolomitic.

TERMINOLOGY

The nomenclature of the major rock types is set out in Table 23. If a rock contains more than 25 per cent of allochems which are not mentioned in the main rock name, these are used to qualify the rock name and have an initial capital letter, for example, Crinoidal biosparite. Subordinate diagnostic allochems may also qualify the main rock name; these are differentiated by the use of a small initial letter, for example, algal Brachiopod biosparite. In the records which follow, however, a more formal version of the nomenclature is used, the qualifiers following the grain-size name in descending order of abundance. The example above would thus be cited as Biosparite Crinoid algae.

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 that contain clay or silt grade material.
Authigenic Referring to those constituents that came into existence with or after the formation of the host rock.
Bioclasts Broken fragments of organic skeletal material.
Calcarenite A limestone consisting predominantly (more than 50 per cent) of detrital calcite particles of sand size (0.062 to 1 mm).
Calcilutite A limestone consisting predominantly (more than 50 per cent) of detrital particles of silt and/or clay size (less than 0.062 mm).
Calcirudite A limestone consisting predominantly (more than 50 per cent) of detrital calcite particles larger than sand size (greater than 1 mm).
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, from which its origin and environment of formation may be inferred.
Gangue A mineral in a vein other than an ore mineral.

Geopetal Pertaining to any rock feature that indicates the relation of top to bottom during, or shortly after, sedimentation; particularly horizontally bedded infilling in the bottom of a cavity.
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.
Intraformational A term applied to rocks or structural features which occur between two sets of defined strata. It implies temporary change in the condition of sedimentation.
Metasomatism A metamorphic change involving the introduction of material from an external source.
Monocline A unit of strata that dips or flexes from the horizontal in one direction only and is not part of an anticline or syncline. It is generally a large feature of gentle dip.
Pericline The three-dimensional structure formed by an arch fold.
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.
Reversed fault A fault with a major dip-slip component in which the hanging wall is on the upthrow side.
Sough An adit or tunnel driven specifically to drain a mine.
Strike The direction of trend that a structural surface takes as it intersects the horizontal.
Stylolite An irregular suture-like boundary developed in some limestones.
Syncline A trough fold, the core of which contains stratigraphically younger rocks.
Thrust fault A fault with a dip of 45° or less in which the hanging wall appears to have moved upwards relative to the foot wall.
Unconformable Strata which do not succeed the underlying rocks in immediate order of age.
Vadose Between the ground surface and the water table.
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.

APPENDIX B

EXPLANATION OF FORMAT FOR BOREHOLE LOGS

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 25.

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 16. Thus the full Registration Number is SK 25 NW 16. This is abbreviated to NW 16 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 25 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	Dando 'Pendant' 150 Dando 250 Minute Man—portable drill
Air	Reich JO 82

Table 23 Classification of limestone (based on Folk, 1959)

Volumetric allochem composition	LIMESTONES: >10% allochems, Allochemical rocks — Sparry calcite cement > microcrystalline ooze	LIMESTONES: >10% allochems, Allochemical rocks — Microcrystalline ooze > sparry calcite cement	LIMESTONES: <10% allochems, Microcrystalline rocks — 1–10% allochems	LIMESTONES: <10% allochems, Microcrystalline rocks — <1% allochems
>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 to pellets >3:1	Biosparite	Biomicrite	*Fossils* Fossiliferous micrite	
<25% intraclasts; <25% oolites; Volume ratio of fossils to pellets 3:1 to 1:3	Biopelsparite	Biopelmicrite	*Pellets* Pelletiferous micrite	
<25% intraclasts; <25% oolites; Volume ratio of fossils to pellets <1:3	Pelsparite	Pelmicrite		

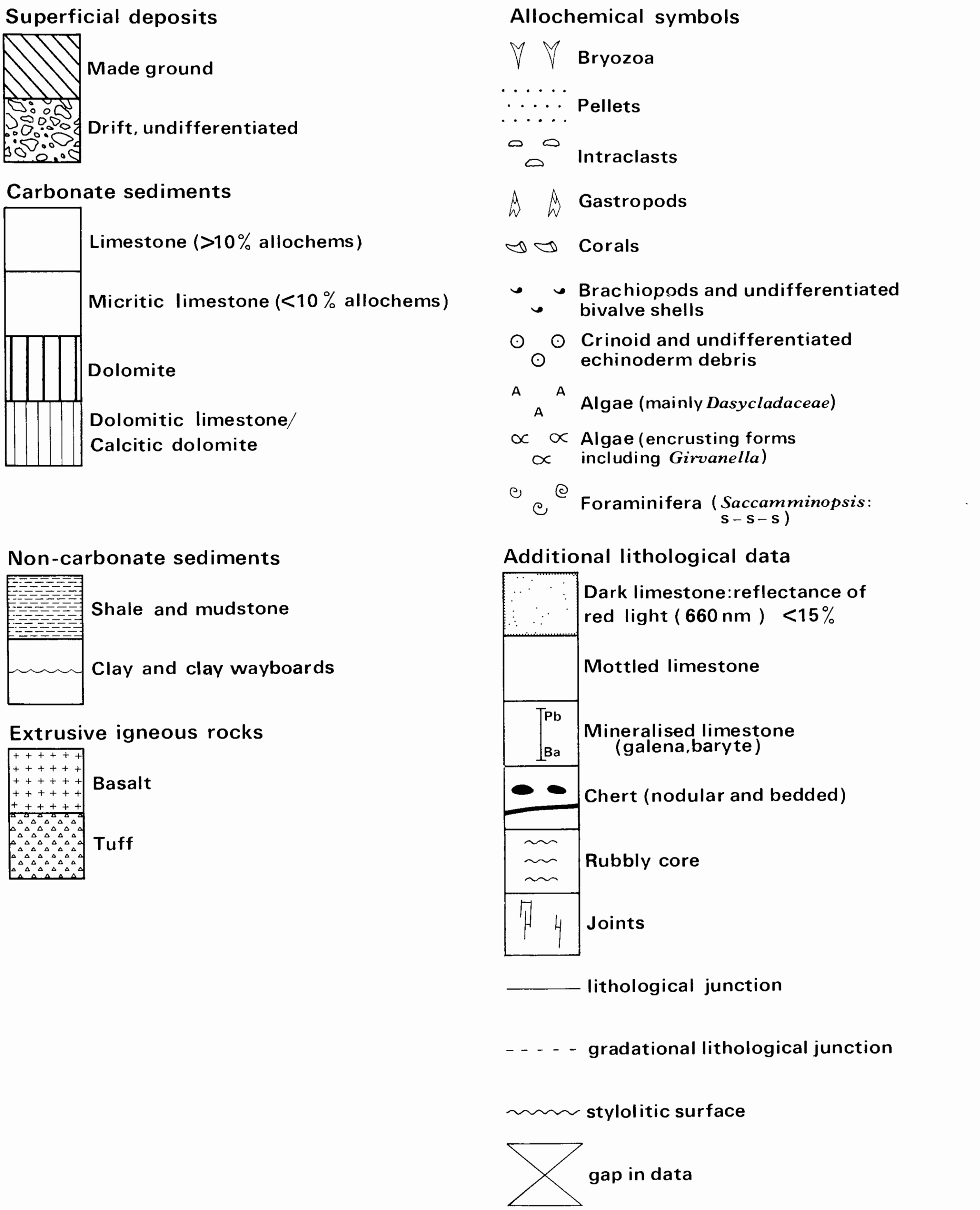


Figure 22 Explanation of symbols used on the graphic logs

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 22.

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 and from powder pellet samples are shown graphically. A white magnesian 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 and sections, 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.

16 Residue mineralogy is summarised.

Classification into categories by carbonate content
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	>98.5
2	High purity	97.0–98.5
3	Medium purity	93.5–97.0
4	Low purity	85.0–93.5
5	Impure	<85.0

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

	Estimated 95% confidence limits	Lower determination limit	Detection limit
CaO	±0.8%	50%	–
SO_3	±0.10%	0.10%	0.01%
Na_2O	±0.02%	0.02%	0.02%
F	±0.10%	0.05%	0.03%
SiO_2	±0.10%	0.10%	0.02%
MgO	±0.14%	0.10%	0.02%
Al_2O_3	±0.10%	0.10%	0.01%
K_2O	±0.02%	0.02%	0.01%
Fe_2O_3	±0.12%	0.10%	0.05%
SrO	±0.04%	0.20%	0.10%
P_2O_5	±0.02%	0.05%	0.02%
Loss*	±0.15%	–	–
Cu	±10 ppm	3 ppm	1 ppm
Pb	±10 ppm	3 ppm	1 ppm
Zn	±20 ppm	5 ppm	2 ppm
MnO†	±20 ppm	10 ppm	3 ppm
Fe_2O_3†	±20 ppm	10 ppm	3 ppm
As	±2 ppm	2 ppm	1 ppm

* At 1050°C † Acid-soluble

APPENDIX C
RECORDS OF BOREHOLES AND SECTIONS

RESOURCE BLOCK A F23

Source of data	*Registration number*	*Grid Reference*
IMAU borehole (drilled by contractor)	NE 42	2619 5645
Other boreholes	NW 19	2392 5701
	NW 20	2342 5729
Major sections used in the assessment	NW 1S	2426 5732
	NW 2S	2380 5690
	NW 9S	2455 5738
	NE 3S	2695 5664
	NE 4S*	2638 5573
	NE 5S	2623 5604
	NE 8S*	2874 5628

Logs of additional shallow IMAU boreholes may be consulted at the Keyworth office of the Institute.

* Part in Block E

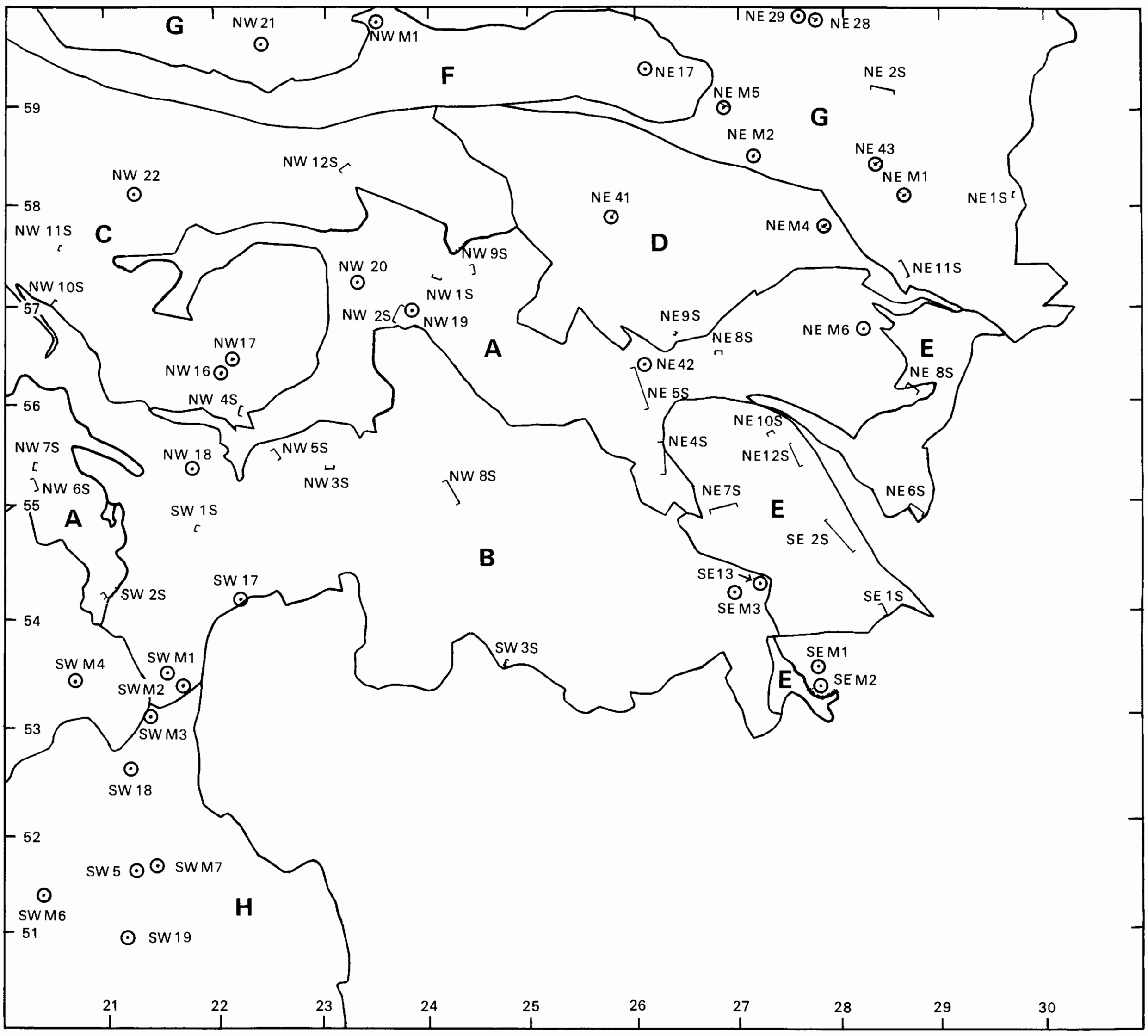


Figure 23 Distribution of resource blocks and data points

RESOURCE BLOCK A

SK 25 NE 42[1] **2619 5645**[2] **Ryder Point**[3]

Surface level +178.88 m[4]
Dando 250, waterflush, 47-mm diameter[5]
December 1975[5]

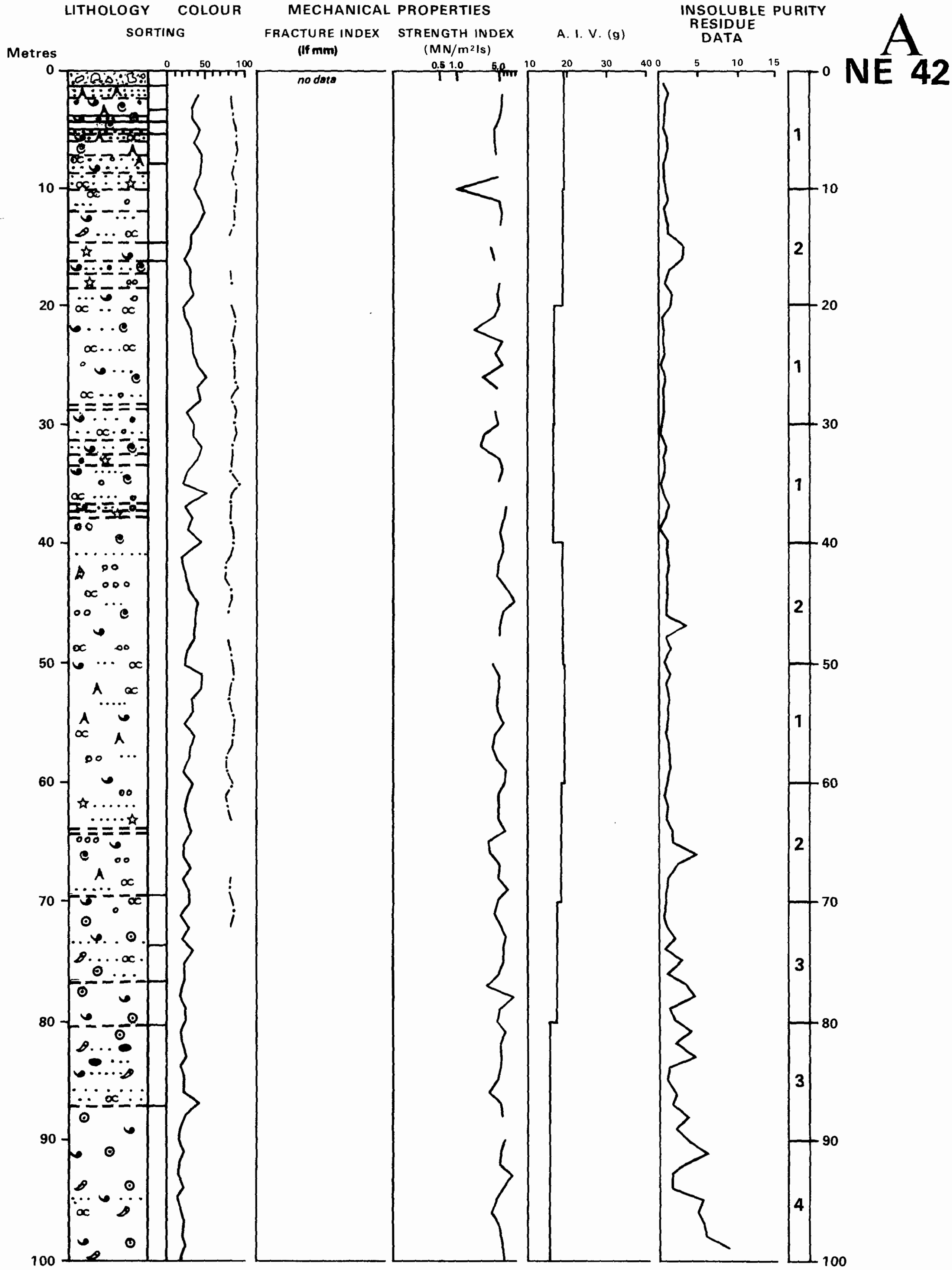
	Thickness m	*Depth* m
Made ground, road aggregate with clay	1.21	1.21[8]
Woo Dale Limestones[6]		
Biopelsparite algae[7], buff-grey, lutite to fine arenite closely packed bioclasts and pelletal debris, some *Koninckopora*, abundant euhedral quartz	1.12	2.33
Biosparite Calcisphere, buff-grey, very fine arenite calcisphere, pellet, foraminifera, shell and crinoid debris, rare *Koninckopora*, some euhedral quartz	1.37	3.70
Biosparite Pellet Foraminifera algae, buff-grey, very fine arenite pellet and bioclastic debris, common coarse arenite algal nodules and foraminifera	0.35	4.05
Biosparite Foraminifera, buff-grey, very fine arenite, some quartz euhedra	0.95	5.00
Pelsparite, buff-grey, very fine arenite, well sorted	0.33	5.33
Biosparite Pellet algae, buff-grey, fine arenite, some quartz euhedra	0.67	6.00
Biomicrite, pale grey, fine arenite foraminifera, shell debris, algae and *Koninckopora*	1.15	7.15
Biopelsparite, buff-grey, fine arenite pellet and comminuted bioclastic debris, some *Girvanella* encrusted rudite brachiopods; calcispheres and *Koninckopora*	1.53	8.68
Pelsparite, medium buff-grey, fine arenite, common birds-eye structures, some quartz euhedra, very well sorted	1.52	10.20
Biomicrite, buff-grey, fine arenite calcispheres and algae	1.45	11.65
Biosparite Pellet, buff-grey, fine arenite	2.85	14.50
Biomicrite, buff-grey, lutite to fine arenite bioclasts, some birds-eye structures, some clay-filled cavities and flecks of pyrite	1.47	15.97
Biosparite Pellet, buff-grey, lutite–fine arenite bioclasts, abundant quartz euhedra, well sorted	1.17	17.14
Biomicrite, buff-grey mottled, fine arenite–lutite bioclasts, common birds-eye structures, some calcispheres, rare flecks of pyrite	1.28	18.42
Biopelsparite algae, buff-grey, fine arenite pellet, algal nodules and *Girvanella* encrusted bioclasts, some birds-eye structures, patchy disseminated siliceous clay, pyrite, and silicified bioclasts	9.93	28.35
Micrite, buff-grey, abundant birds-eye structures	0.29	28.64
Biosparite Pellet algae, buff-grey, fine arenite, some algal nodules	2.48	31.12
Biopelsparite, pale buff-grey, medium arenite, well sorted	1.46	32.58
Micrite, pale buff-grey, very fine arenite calcispheres, common birds-eye structures	0.72	33.30
Biopelsparite calcisphere, buff-grey, abundant fine arenite pellet shell, foraminifera, calcisphere and encrusting *Girvanella*	3.47	36.77
Biosparite calcisphere, buff-grey, medium arenite, well sorted	0.82	37.59
Micrite, pale grey, common birds-eye structures	0.37	37.96
Biosparite calcisphere, buff-grey, common comminuted fine arenite shell, foraminifera, calcisphere, pellet and algal nodule debris, bioclasts commonly *Girvanella* encrusted, locally common ostracods, algal laminated, some birds-eye structures, well sorted, trace pyrite	25.84	63.80
Micrite, pale buff-grey, common birds-eye structures	0.25	64.05
Biomicrite calcisphere, pale buff-grey, fine to medium arenite bioclastic, some flecks and aggregations of pyrite, some blue-grey clay-lined stylolites, scattered euhedral quartz, well sorted	5.23	69.28
Biosparite Crinoid Pellet, buff-grey, fine to coarse arenite crinoid, shell, foraminifera, pellet and encrusting algae debris, variable pellet content, some silicified stylolites, silicified bioclasts, quartz euhedra and flecks of pyrite	7.20	76.48
Biosparite Crinoid Brachiopod, medium buff-grey, coarse arenite crinoid and brachiopod debris, disseminated clay-grade silica, some blue-grey mudstone filled stylolites, some flecks of pyrite	4.02	80.50
Biopelsparite, very fine to coarse arenite *Girvanella* encrusted brachiopod debris, foraminifera, crinoid and algal nodule debris, rare coral, well sorted, some nodular chert, common aggregated pyrite and finely disseminated clay-grade silica	6.60	87.10
Biosparite Crinoid Brachiopod, coarse arenite, some fine arenite pellet debris, rare coral, common quartz euhedra, common blue-grey mudstone-filled fissures 96.42–96.80 m, pyritous, bioclasts patchily silicified, some black clay coated stylolites	13.06	100.16

Borehole complete at 100.16 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
12.00	55.90	0.10	0.01	0.0	0.22	0.12	0.15	0.04	0.02	0.0	210	43.58	0	0	20	260	12.00
32.00	56.50	0.18	0.03	0.0	0.19	0.12	0.20	0.04	0.0	0.0	230	43.75	0	0	30	80	32.00
40.00	56.20	0.06	0.03	0.0	0.08	0.11	0.11	0.05	0.0	0.0	210	43.89	15	0	30	50	40.00
51.00	56.50	0.06	0.02	0.0	0.01	0.09	0.06	0.04	0.0	0.0	180	43.84	0	0	20	40	51.00
72.00	56.00	0.06	0.03	0.0	0.21	0.08	0.11	0.03	0.0	0.0	320	43.74	0	0	20	80	72.00
87.00	55.30	0.17	0.03	0.0	0.51	0.16	0.25	0.08	0.0	0.0	1000	43.49	0	10	10	50	87.00

Resource Block A SK 25 NE 42 2619 5645 Ryder Point



RESOURCE BLOCK A

SK 25 NW 19 2392 5701 Longcliffe Quarry

Surface level +268.7 m.

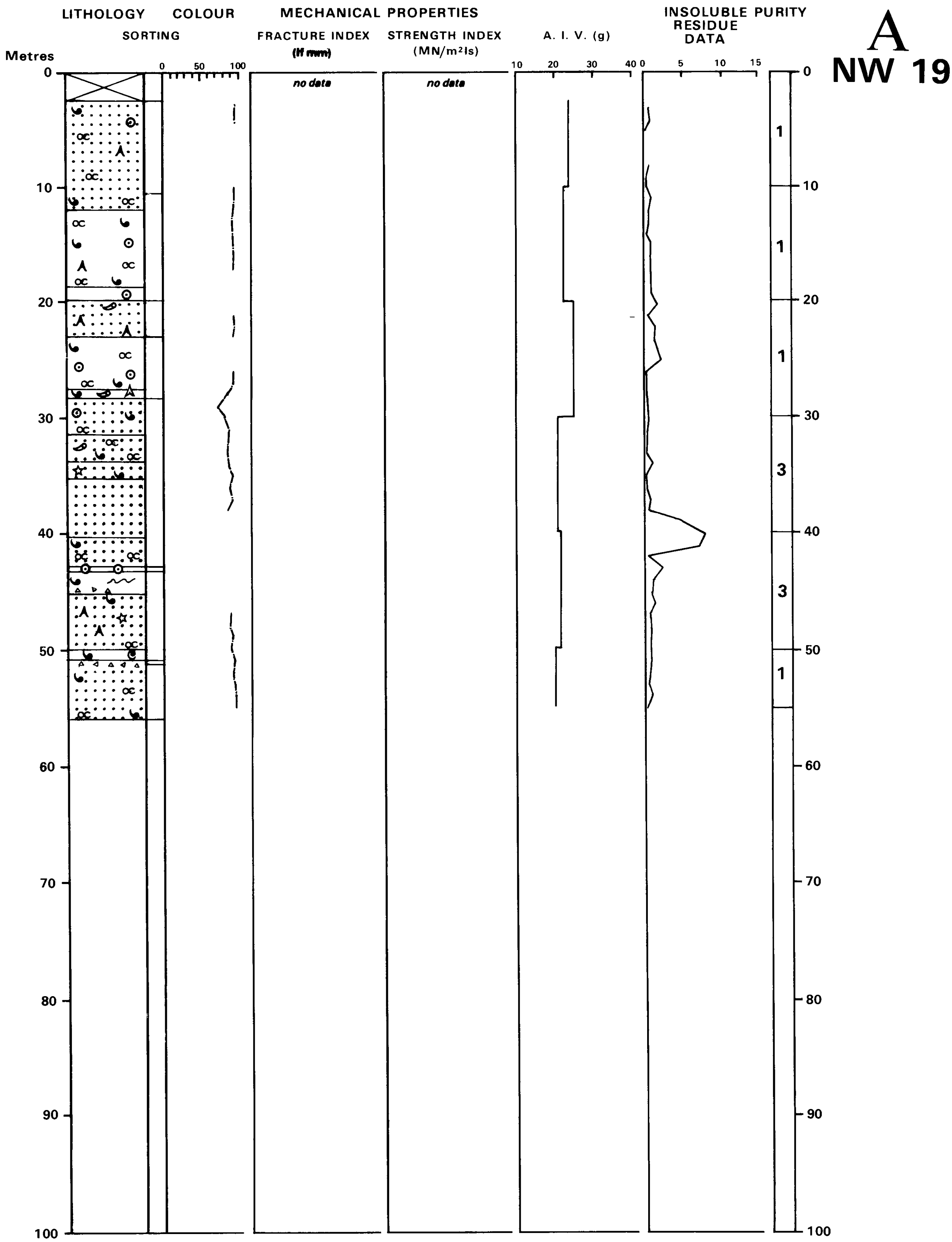
	Thickness m	*Depth* m
Open hole	2.43	2.43
Bee Low Limestones		
Pelsparite, abundant medium arenite pellets, subordinate comminuted brachiopod and crinoid debris, rare *Koninckopora*, well sorted	9.67	12.10
Biosparite algae, abundant arenite *Girvanella* encrusted brachiopod debris, subordinate comminuted crinoids and dasycladacean algae	6.43	18.53
Biosparite, medium to dark grey, some fragmented brachiopod and crinoid, recrystallised	1.07	19.60
Pelsparite algae, pale grey, abundant pelletal debris, common *Koninckopora,* rare coral well sorted	3.30	22.90
Biosparite Pellet, pale grey, abundant arenite *Girvanella* corroded shell debris and comminuted bioclastic debris, common pelletal debris	4.58	27.48
Biosparite Brachiopod gastropod, pale grey, common rudite brachiopod, coral and gastropod debris	0.70	28.18
Pelsparite, medium grey, abundant fine arenite pellets, common comminuted, algal encrusted crinoid and brachiopod debris, well sorted	3.08	31.26
Biosparite Pellet algal, pale grey, abundant finely comminuted algal encrusted shell debris, crinoid fragments and pelletal material, colonial coral 32.11 m. Well sorted	2.17	33.37
Woo Dale Limestones		
Biomicrite Pellet, pale grey, abundant very closely packed lutite and arenite pellet and finely comminuted bioclastic material, some birds-eye structures, well sorted	1.63	35.00
Pelsparite, medium grey, fine arenite, well sorted	4.85	39.85
Pelsparite, pale grey, fine arenite, common algal nodules and comminuted shell debris	2.79	42.64
Biosparite Crinoid Pellet, medium grey, abundant medium arenite crinoid debris, poor sorting	0.25	42.89
Biomicrite Pellet, medium grey, abundant lutite and fine arenite pellet and comminuted bioclastic debris, well sorted, common green clay-coated stylolites, rare flecks of pyrite	1.61	44.50
Biomicrite, algal laminated, brecciated, limonite stained	0.20	44.70
Pelsparite, abundant medium arenite pellet and shell debris, some dasycladacean algae, rarely algal laminated, some birds-eye structures	5.30	50.00
Micrite, pale grey, fine arenite, some foraminifera and shell fragments	0.80	50.80
Biosparite Pellet, pale grey, abundant lutite to fine arenite pellet and algal encrusted shell debris, well sorted. Brecciated in upper 0.10 m	5.08	55.88

Borehole complete at 55.88 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
5.00	56.00	0.06	0.01	0.0	0.25	0.12	0.08	0.03	0.02	0.01	130	43.87	5	15	15	50	5.00
18.00	56.10	0.0	0.0	0.0	0.19	0.11	0.01	0.02	0.0	0.01	180	43.87	0	5	10	20	18.00
25.00	56.10	0.0	0.0	0.0	0.18	0.14	0.0	0.01	0.0	0.0	185	43.92	5	5	20	40	25.00
34.00	56.00	0.0	0.0	0.0	0.29	0.21	0.13	0.03	0.0	0.01	190	34.74	5	5	15	40	34.00
40.00	56.10	0.01	0.0	0.0	0.25	0.19	0.08	0.03	0.03	0.0	230	43.87	5	10	5	50	40.00
46.00	55.60	0.03	0.0	0.01	0.49	0.24	0.25	0.07	0.03	0.0	3200	43.48	5	10	25	100	46.00

Resource Block A SK 25 NW 19 2392 5701 Longcliffe Quarry



RESOURCE BLOCK A

SK 25 NW 20 2342 5729 Aldwark

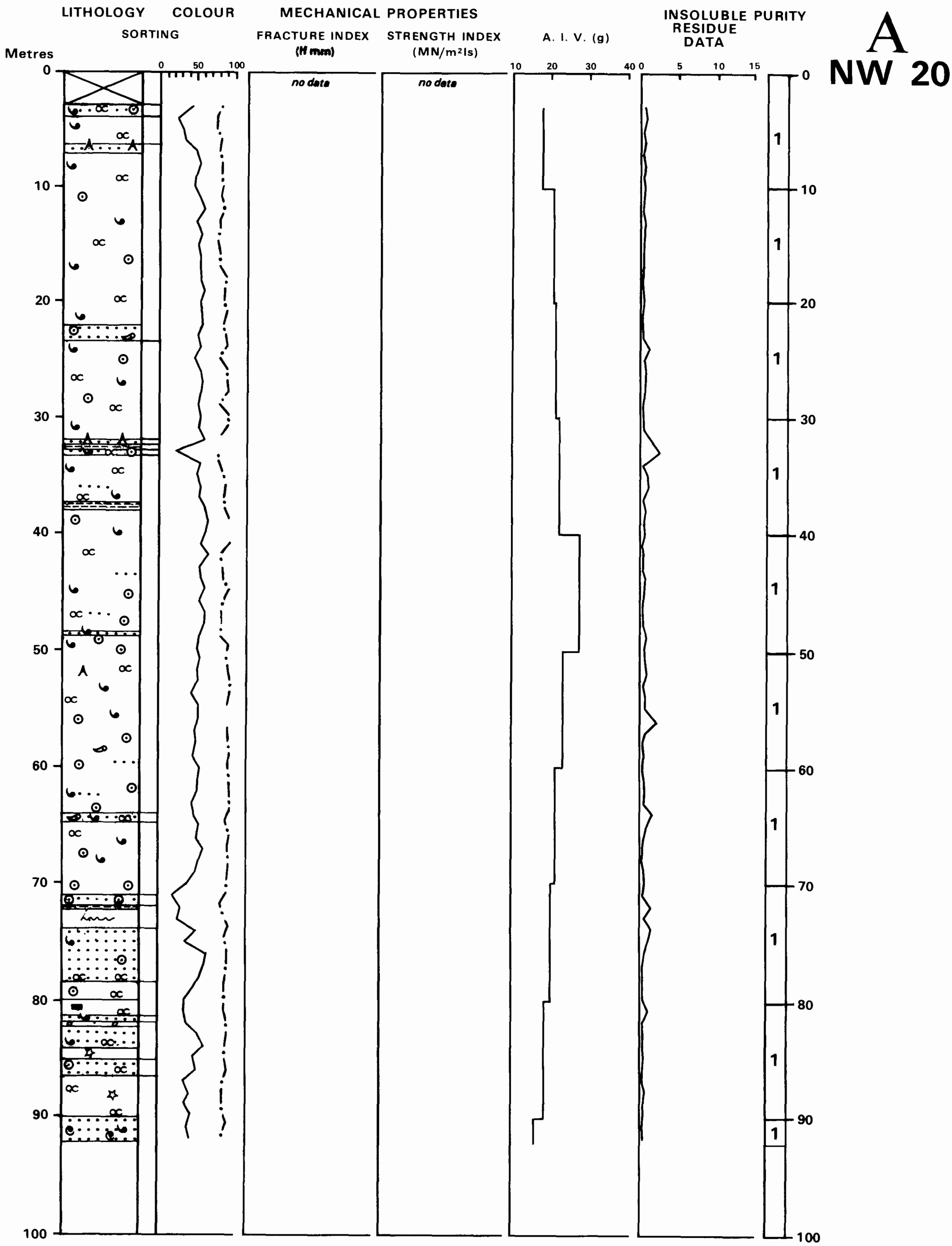
Surface level +294.0 m.

	Thickness m	*Depth* m
Open hole	2.59	2.59
Monsal Dale Limestones		
Biosparite, pale grey, abundant medium arenite comminuted shell, crinoid and pelletal debris, well sorted	1.27	3.86
Biomicrite, medium grey mottled to dark grey, fine arenite	2.50	6.36
Bee Low Limestones		
Pelsparite Algal, pale grey, fine arenite, common *Koninckopora*, well sorted	0.064	7.00
Biosparite algal, pale grey, abundant medium arenite algal encrusted shell and crinoid debris, locally algal laminated, well sorted	15.00	22.00
Pelsparite, pale grey, fine to medium arenite, some coarse arenite crinoid and coral debris, well sorted	1.20	23.20
Biomicrite, pale grey, abundant fine arenite comminuted bioclasts, frequently algal corroded, some fine rudite brachiopods	8.80	32.00
Biomicrosparite Pellet, pale grey, frequent pellet and dasycladacean algal material, well sorted	0.20	32.20
Clay, green and yellow	0.30	32.50
Pelsparite, medium grey mottled to dark grey, some *Girvanella* encrusted rudite brachiopods, some foraminifera and *Koninckopora*. Common iron-staining	0.50	33.00
Biomicrite, pale grey, abundant arenite comminuted bioclasts, some *Girvanella* encrusted rudite brachiopod debris	4.06	37.16
Mudstone, ochreous	0.30	37.46
Biosparite, pale grey, abundant arenite comminuted, crinoid and shell debris, some pellets	10.65	48.11
Biomicrite Pellet, buff-grey, fine arenite pellet and shell debris	0.30	48.41
Biosparite, pale grey, fine to medium arenite comminuted crinoid, shell, foraminifera and encrusting algae, some pellets, matrix predominantly spar with some admixed micrite	15.48	63.89
Pelsparite, medium grey, locally mottled, some *Girvanella* encrusted brachiopod debris, rare coral	0.71	64.60
Biosparite, pale grey, abundant medium arenite crinoid and shell debris	6.25	70.85
Biosparite Pellet, medium to dark grey, abundant medium arenite crinoid and pelletal material, well sorted	1.00	71.85
Mudstone	0.24	72.09
Micrite, pale grey, some lutite bioclasts, abundant stylolites	1.76	73.85
Pelsparite, pale grey, fine arenite, rare rudite crinoid and brachiopod debris, algal laminated 77.34–78.06 m, well sorted	4.21	78.06
Biosparite algae, pale grey, medium arenite *Girvanella* encrusted bioclasts and lithoclasts, rare coral	0.12	78.18
Biosparite, pale grey, common algal encrusted bioclasts and crinoid debris	1.80	79.98
Micrite, dark grey mottled, trace algal lamination	1.60	81.58
Biosparite Pellet, pale grey, fine arenite bioclastic, algal laminated, well sorted	0.60	82.18
Biosparite, medium grey, common lutite calcispheres	0.60	82.78
Biosparite Pellet algae, pale grey, medium to coarse arenite pellet and *Girvanella* encrusted shell debris, some algal nodules	1.37	84.15
Woo Dale Limestones		
Biomicrite, pale grey, laminated, common birds-eye structures	0.85	85.00
Pelsparite, pale grey, fine to medium arenite, some crinoid debris	1.76	86.76
Micrite, some birds-eye structures, algal laminations and micrite intraclasts	3.41	90.17
Biosparite Pellet, pale grey, fine arenite, common foraminifera and shell debris	2.26	92.43

Borehole complete at 92.43 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
5.00	56.10	0.06	0.01	0.01	0.21	0.15	0.02	0.02	0.02	0.01	130	43.83	5	5	5	40	5.00
13.00	56.10	0.0	0.0	0.0	0.22	0.17	0.05	0.02	0.02	0.0	220	43.79	0	10	10	70	13.00
24.00	56.10	0.0	0.0	0.0	0.27	0.15	0.10	0.02	0.03	0.0	210	43.80	5	5	5	80	24.00
33.00	56.10	0.0	0.0	0.0	0.46	0.18	0.20	0.04	0.02	0.0	260	43.73	0	0	5	80	33.00
56.00	56.10	0.0	0.0	0.0	0.17	0.16	0.01	0.02	0.02	0.0	170	43.83	5	5	10	30	56.00
64.00	56.10	0.01	0.0	0.0	0.28	0.19	0.06	0.02	0.03	0.0	140	43.61	5	0	15	60	64.00
74.00	56.10	0.03	0.01	0.03	0.21	0.18	0.02	0.03	0.04	0.02	160	43.68	5	0	25	50	74.00
81.00	56.10	0.02	0.01	0.04	0.48	0.26	0.24	0.09	0.05	0.03	390	43.55	5	5	5	100	81.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX
STRENGTH INDEX
(MN/m²Is)
no data
no data
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
A
NW 20

RESOURCE BLOCK A

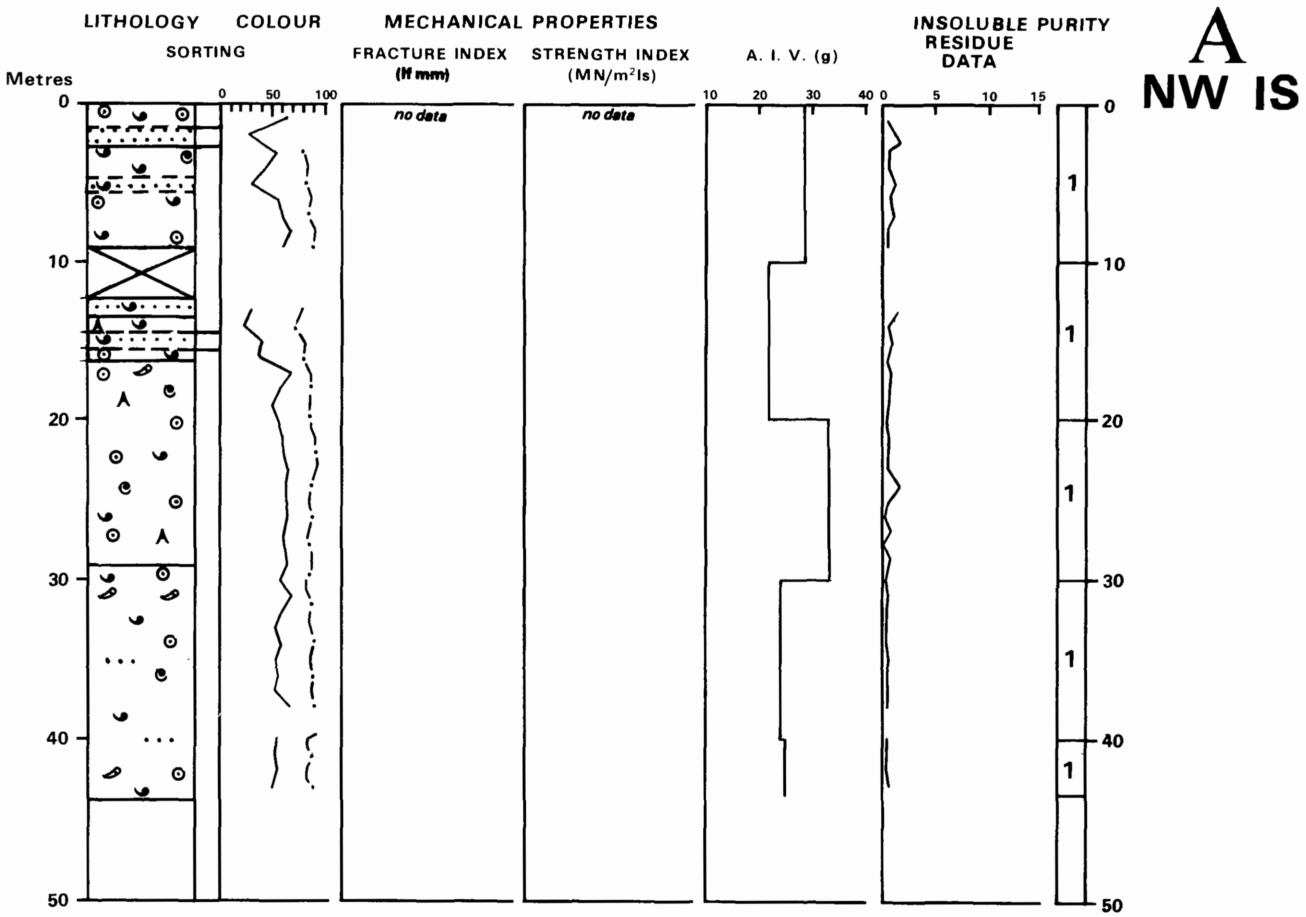
SK 25 NW 1s 2426 5733 Grangemill Quarry

Surface level +260.22 m

	Thickness	*Depth*
Bee Low Limestones	m	m
Biosparite, pale grey, common arenite crinoid and brachiopod debris	1.50	1.50
Pelsparite, medium grey, medium arenite, well sorted	1.00	2.50
Clay, ochreous	0.20	2.70
Biosparite Brachiopod, buff-grey, fine to coarse arenite, subordinate foraminifera and crinoid debris	1.80	4.50
Biopelsparite Brachiopod, medium grey, fine arenite to fine rudite	1.00	5.50
Biosparite, pale grey, fine to medium arenite brachiopod, crinoid and foraminiferal debris. Matrix predominantly spar with some patchy micrite	3.80	9.30
Gap	3.40	12.70
Biopelsparite Brachiopod, medium grey, fine to coarse arenite	1.10	13.80
Clay, greenish-grey	0.20	14.00
Biomicrite Algal, medium grey, fine to medium arenite *Koninckopora* and brachiopod debris	0.50	14.50
Biopelsparite, grey, arenite-sized brachiopod and pelletal debris, well sorted	1.00	15.50
Biomicrosparite, grey, fine to medium arenite brachiopod and crinoid debris	0.90	16.40
Clay, greenish-grey	0.10	16.50
Biosparite, pale grey, fine to medium arenite crinoid and brachiopod debris, subordinate foraminifera, *Koninckopora,* and coral	12.40	28.90

	Thickness	*Depth*
	m	m
Clay, ochreous	0.10	29.00
Biosparite, pale grey, frequent fine to medium arenite brachiopod, crinoid and foraminiferal debris, some arenite pellet, *Koninckopora* and coral debris, moderate sorting	14.80	43.80

Base of section at 43.80 m



Chemical analyses of major elements (percentages)

Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
2.00	54.60	0.01	0.01	0.0	0.91	0.39	0.30	0.05	0.0	0.0	350	43.70	0	0	10	150	2.00
5.00	55.30	0.01	0.01	0.0	0.16	0.16	0.02	0.01	0.0	0.01	120	43.90	0	0	10	40	5.00
17.00	55.60	0.0	0.01	0.0	0.09	0.13	0.0	0.01	0.0	0.01	120	43.86	0	0	10	50	17.00
24.00	55.40	0.0	0.01	0.0	0.0	0.11	0.0	0.01	0.0	0.01	90	43.94	0	0	10	50	24.00
38.00	55.30	0.0	0.01	0.0	0.0	0.14	0.0	0.01	0.0	0.01	110	43.91	0	0	20	40	38.00

RESOURCE BLOCK A

SK 25 NW 2s 2380 5690 Longcliffe Quarry

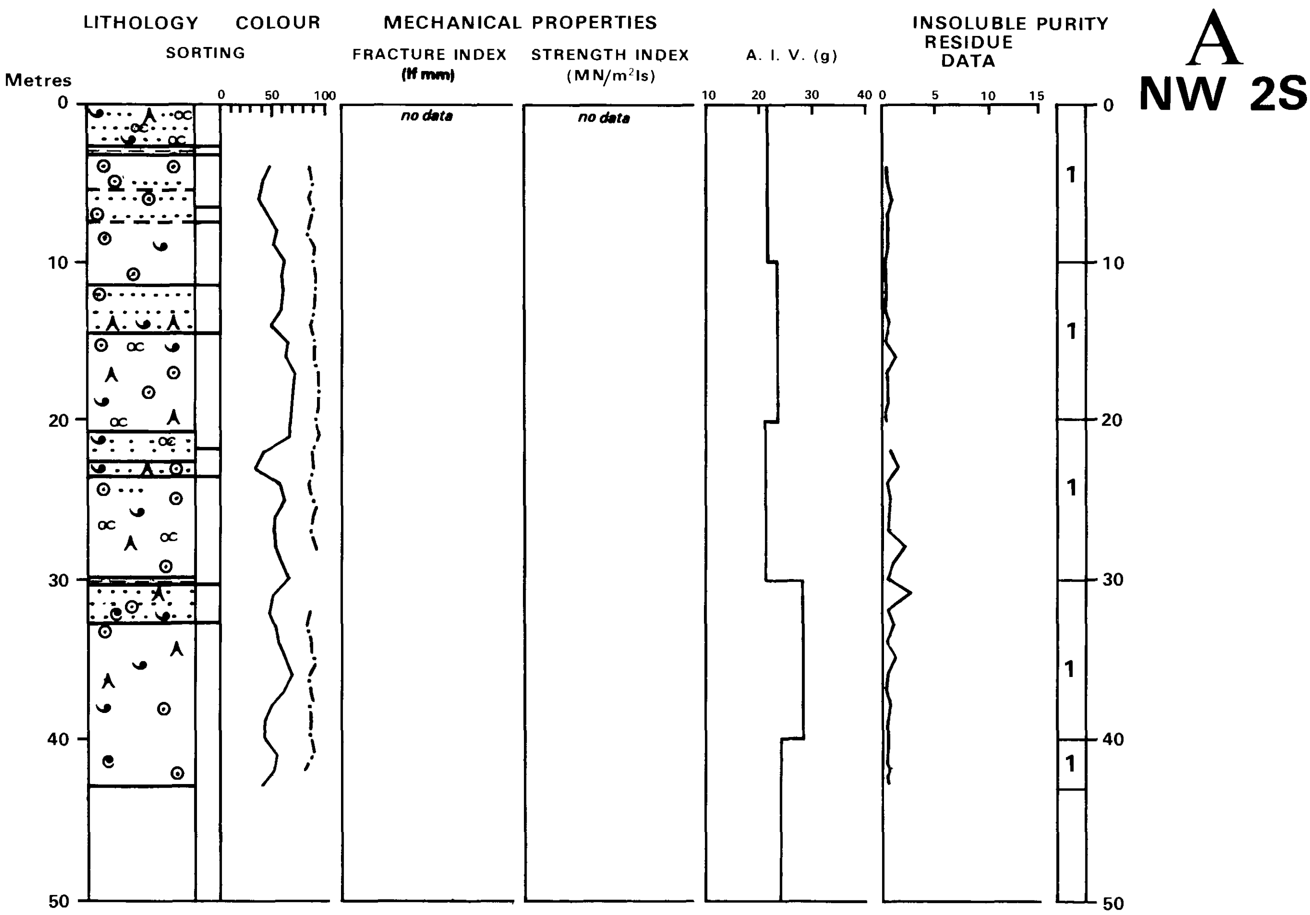
Surface level +294.76 m

	Thickness m	*Depth* m
Bee Low Limestones		
Pelsparite, pale grey, abundant fine arenite pelletal debris, some algal encrusted brachiopod fragments, well sorted	2.80	2.80
Clay, ochreous and grey	0.40	3.20
Biosparite Crinoid, grey, common coarse arenite crinoid debris, subordinate fine to medium arenite, comminuted brachiopods pellets and *Koninckopora*	2.40	5.60
Biopelsparite, buff-grey, common arenite crinoid and shell debris	1.90	7.50
Biosparite Crinoid, pale grey, abundant fine arenite bioclastic debris, some rudite crinoid and brachiopod debris	4.00	11.50
Biopelsparite, pale grey, common coarse arenite bioclastic debris, some *Koninckopora*, well sorted	3.00	14.50
Biosparite Crinoid algae, pale grey, fine arenite to fine rudite crinoid and shell debris, some *Koninckopora*. Shell debris commonly encrusted with *Girvanella*	6.00	20.50
Biopelsparite algae, buff-grey, common arenite pelletal debris, occasional algal encrusted rudite brachiopod debris	1.80	22.30
Clay, greenish grey	0.04	22.34
Biopelsparite, medium arenite, some *Koninckopora*	0.96	23.30
Clay, greenish grey	0.10	23.40
Biosparite, buff-grey, fine arenite comminuted bioclastic debris, some algal nodules,	6.30	29.70
Clay, ochreous	0.40	30.10
Biopelsparite, buff-grey, common medium arenite crinoid, foraminifera and shell debris, rare *Koninckopora*, well sorted	2.40	32.50
Biosparite Crinoid, grey, abundant coarse arenite crinoid debris, subordinate finely comminuted shell, dasycladacean algae and foraminiferal debris, matrix predominantly spar, some patchily developed micrite	10.10	42.60

Base of section 42.60 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
1.00	55.60	0.0	0.0	0.0	0.0	0.14	0.0	0.0	0.01	0.01	200	43.84	5	0	10	80	1.00
4.00	55.80	0.0	0.0	0.0	0.20	0.11	0.02	0.0	0.01	0.01	2800	43.84	5	0	60	380	4.00
5.00	55.40	0.0	0.0	0.0	0.20	0.15	0.09	0.01	0.02	0.01	2100	43.79	0	30	50	280	5.00
10.00	55.40	0.0	0.0	0.0	0.04	0.07	0.0	0.0	0.02	0.01	150	43.91	0	0	10	110	10.00
15.00	55.50	0.0	0.0	0.0	0.0	0.10	0.0	0.0	0.02	0.01	200	43.93	5	0	10	110	15.00
18.00	55.70	0.0	0.0	0.0	0.04	0.08	0.01	0.01	0.02	0.01	210	43.93	0	20	10	100	18.00
20.00	55.50	0.0	0.0	0.0	0.04	0.14	0.0	0.0	0.02	0.01	130	44.34	0	20	10	60	20.00
22.00	55.30	0.0	0.0	0.0	0.53	0.12	0.44	0.02	0.03	0.01	320	43.71	5	0	20	50	22.00
25.00	54.90	0.0	0.0	0.0	0.09	0.08	0.01	0.0	0.0	0.01	240	43.93	0	0	10	80	25.00
29.00	55.50	0.0	0.01	0.0	0.0	0.07	0.01	0.0	0.0	0.01	1000	43.85	0	0	10	60	29.00
31.00	55.00	0.0	0.0	0.0	0.0	0.09	0.0	0.0	0.0	0.00	210	44.03	5	20	10	80	31.00
35.00	54.90	0.0	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.01	130	43.97	5	0	10	40	35.00
40.00	55.10	0.0	0.0	0.0	0.02	0.10	0.01	0.0	0.0	0.01	110	43.75	0	0	10	40	40.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX (ff mm)
STRENGTH INDEX (MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
no data
no data
A
NW 2S

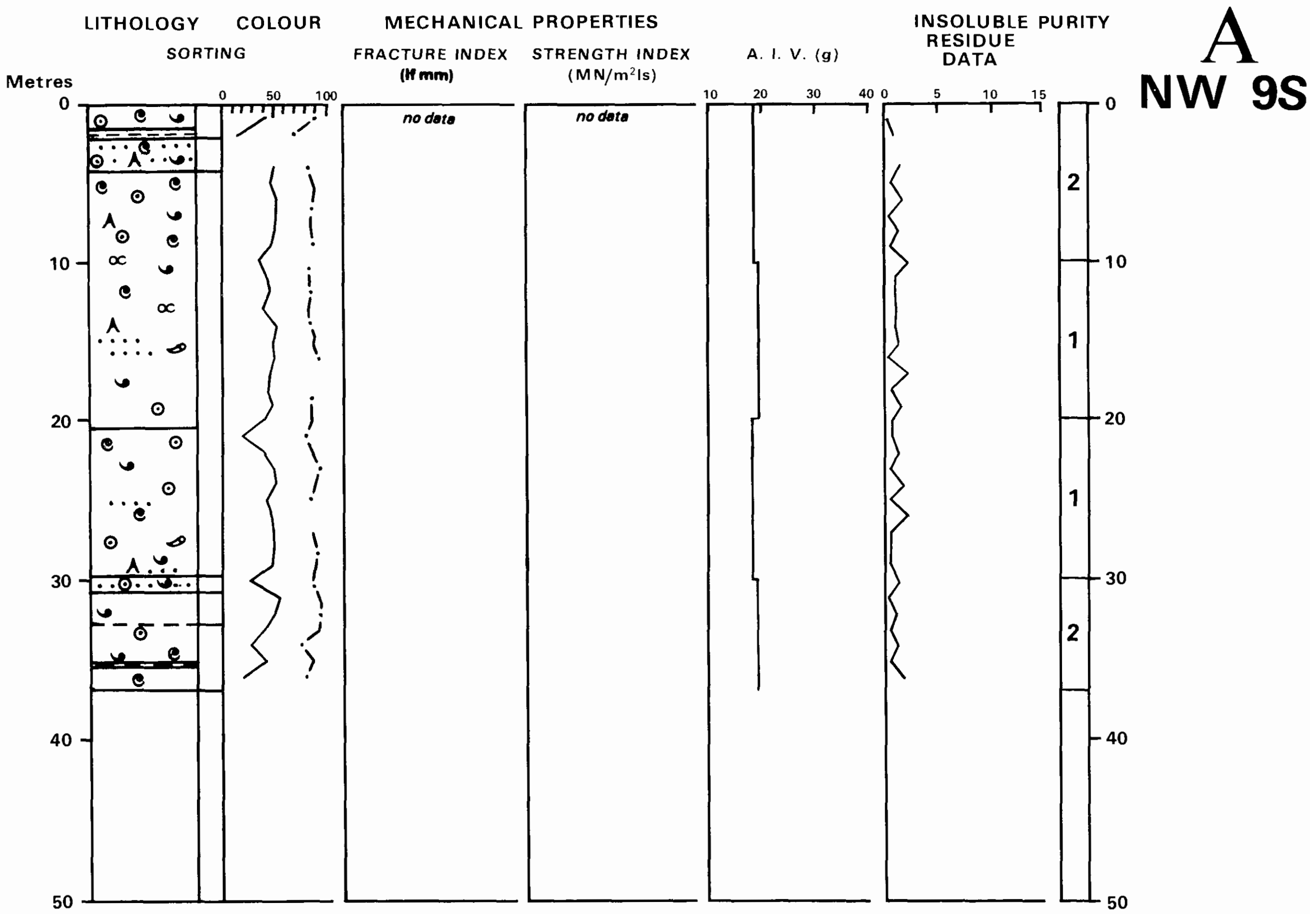
RESOURCE BLOCK A

SK 25 NW 9s 2455 5738 Prospect Quarry

Surface level +269.76 m

	Thickness m	*Depth* m
Bee Low Limestones		
Biosparite, buff-grey, common fine arenite foraminifera and comminuted shell debris	1.50	1.50
Clay, ochreous	0.50	2.00
Biopelsparite, dark grey, fine to medium arenite crinoids, foraminifera, and comminuted shell debris, rare *Koninckopora*	2.00	4.00
Biosparite, pale grey, abundant fine to medium arenite comminuted bioclastic debris, matrix predominantly spar with some admixed micrite	15.50	20.50
Biosparite, pale grey (dark grey, 20.50–21.50 m), abundant fine to coarse arenite crinoid, brachiopod, and foraminiferal debris, occasional pelletal and coral debris, rare *Koninckopora,* matrix predominantly spar but is locally a mixture of spar, microspar and micrite	9.00	29.50
Biopelsparite, medium grey, fine to medium arenite comminuted bioclastic debris, including *Koninckopora* and *Palaeosmilia murchisoni,* well sorted	1.00	30.50
Biosparite, buff-grey, fine to medium arenite bioclastic	2.00	32.50
Biomicrite, pale grey-dark grey mottled, some coarse lutite to fine arenite comminuted foraminifera, shell and crinoid debris, well sorted	4.00	36.50

Base of section 36.50 m



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
1.00	55.30	0.02	0.01	0.0	0.02	0.26	0.03	0.03	0.02	0.02	1300
4.00	56.20	0.01	0.0	0.01	0.14	0.18	0.04	0.03	0.02	0.02	1500
10.00	55.00	0.0	0.0	0.01	0.34	0.22	0.03	0.03	0.02	0.02	1100
17.00	56.30	0.01	0.0	0.01	0.20	0.19	0.03	0.03	0.02	0.02	1400
26.00	55.40	0.03	0.0	0.0	0.29	0.20	0.07	0.04	0.02	0.02	1200
30.00	55.50	0.02	0.0	0.0	0.12	0.25	0.09	0.04	0.02	0.03	1300
36.00	49.50	0.27	0.01	0.02	0.56	4.41	0.30	0.10	0.03	0.03	3700

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
44.02	10	15	10	40	1.00
43.95	5	20	20	75	4.00
43.87	5	10	10	140	10.00
43.90	5	10	10	45	17.00
43.80	5	20	10	55	26.00
43.93	5	0	10	45	30.00
44.19	5	0	10	330	36.00

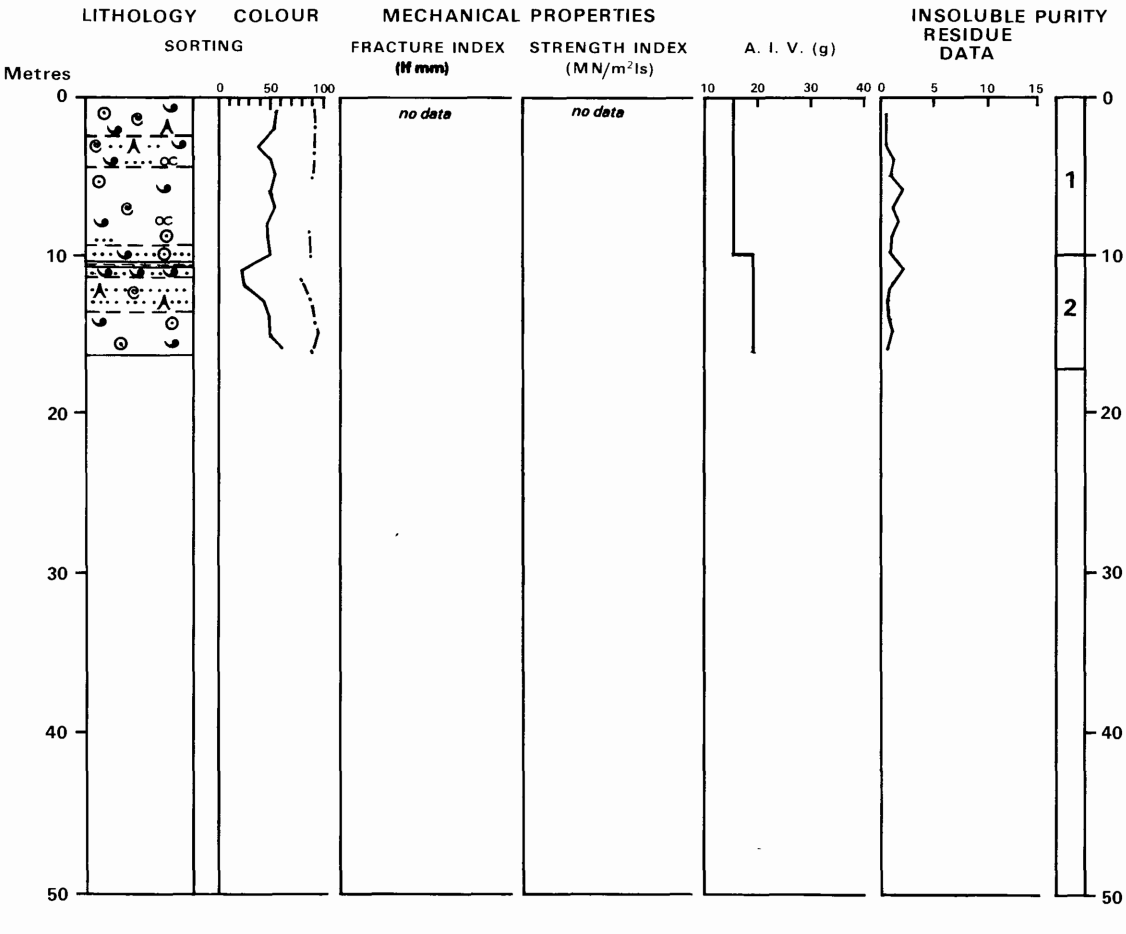
RESOURCE BLOCK A

SK 25 NE 3s 2695 5664 Via Gellia Quarry

Surface level +172.64 m

	Thickness m	*Depth* m
Bee Low Limestones		
Biosparite, pale grey, fine to medium arenite comminuted bioclastic debris, some *Koninckopora* and *Girvanella* encrusted brachiopods	2.50	2.50
Biopelsparite algal, buff-grey, medium arenite comminuted bioclasts, some *Girvanella* and *Koninckopora*	1.00	3.50
Pelsparite Brachiopod algal, buff-grey, medium arenite to fine rudite, common Brachiopods, some encrusted with *Girvanella*	1.00	4.50
Biosparite, buff-grey, fine to medium arenite comminuted bioclastic debris, some foraminifera, some quartz euhedra 5.50–6.50 m	5.00	9.50
Pelsparite, buff-grey, medium arenite	1.00	10.50
Clay, on potholed surface	0.30	10.80
Biosparrudite Brachiopod, grey, abundant coarse rudite brachiopod debris, rare *Girvanella* encrusted, subordinate arenite comminuted bioclastic and pelletal debris	0.70	11.50
Pelsparite, buff-grey, fine to medium arenite, some foraminifera and *Koninckopora*	2.00	13.50
Biosparite, buff-grey, fine to medium arenite comminuted shell and crinoid debris	2.75	16.25

Base of section 16.25 m



A
NE 3S

Chemical analyses of major elements (percentages)

Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
3.00	55.90	0.0	0.0	0.06	0.25	0.38	0.0	0.03	0.0	0.01	240	43.80	5	30	30	60	3.00
11.00	55.50	0.10	0.0	0.0	0.50	0.42	0.45	0.05	0.0	0.0	3200	43.38	5	10	25	40	11.00

RESOURCE BLOCK A/E

SK 25 NE 4s 2638 5573 Hoptonwood Quarry

Surface level +341.48 m

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrudite Brachiopod, buff-grey, abundant fine rudite bioclastic debris, subordinate medium arenite comminuted bioclastic debris, rare coarse rudite thick-shelled brachiopods, patchy silicification of shell debris	2.50	2.50
Biomicrite Brachiopod, grey-brown, fine to coarse arenite, some rudite brachiopods, patchy silicification of rudite brachiopod debris, thin baryte vein 3.50–4.50 m	2.40	4.90
Clay	0.40	5.30
Biosparrudite Brachiopod, buff-grey, abundant coarse rudite thick-shelled brachiopods, delicate meshwork of silicification and pyritisation	1.20	6.50
Biomicrite, buff-grey, medium to coarse arenite, trace silicification of bioclasts	2.00	8.50
Biomicrite Crinoid, buff-grey, medium arenite to fine rudite, some corals and thin-shelled brachiopod debris, rare algal encrusted bioclasts	2.00	10.50
Biomicrudite, buff-grey to grey mottled, medium arenite to coarse rudite, common finely comminuted bioclastic material, brachiopod debris, some encrusted with algae and coral, trace silicification of bioclasts, locally common flecks of pyrite	3.65	14.15
Clay	0.45	14.60
Biomicrudite Brachiopod, buff-grey, abundant coarse rudite brachiopods, delicate meshwork of silicification and pyritisation	0.90	15.50
Clay	1.00	16.50
Biopelsparite, buff-grey, abundant fine arenite pelletal material, subordinate arenite to medium rudite bioclasts, locally well sorted, some quartz euhedra and silicified bioclasts	2.00	18.50
Biomicrudite, buff-grey, mottled, fine arenite to fine rudite crinoid and brachiopod debris, rare *Coelosporella*	7.50	26.00
Biosparite, dark grey, medium arenite to fine rudite crinoid and brachiopod debris, latter may be encrusted with *Girvanella,* common finely disseminated brown clay	4.00	30.00
Mudstone, black, carbonaceous	0.25	30.25
Pelsparite, grey, fine arenite, very well sorted, some quartz euhedra and flecks of pyrite	2.05	32.30
Lower Matlock Lava		
Clay, white, iron-stained–weathered basalt	2.00	34.30
Bee Low Limestones		
Biomicrudite Crinoid, buff-grey, medium arenite to medium rudite crinoid and slender shell clasts, rare *Koninckopora,* locally abundant euhedral quartz	3.20	37.50
Gap	2.50	40.00
Biomicrudite Crinoid, buff-grey mottled, coarse arenite to fine rudite crinoid debris	0.50	40.50
Biosparrudite Crinoid, coarse arenite to fine and slender shell debris, fine spar matrix with patchy micrite	6.00	46.50
Gap	1.00	47.50
Biosparite, buff-grey, fine arenite, well sorted, common quartz euhedra	1.00	48.50
Biosparite Crinoid, coarse arenite crinoid and shell debris in a mixed spar-micrite matrix, common *Girvanella* encrusted bioclasts, locally common *Koninckopora*	9.00	57.50
Pelsparite, buff-grey, fine arenite, common algal nodules, very well sorted, abundant quartz euhedra 58.50–59.00 m	1.50	59.00
Clay, variable thickness	0.40	59.40
Biopelsparite Crinoid, medium arenite, some coarse arenite to fine rudite crinoid debris	1.10	60.50
Biosparite, abundant very fine arenite comminuted bioclasts, rare fine rudite thin-shelled brachiopod debris, some quartz euhedra	1.00	61.50
Clay	0.50	62.00
Gap	2.00	64.00
Pelsparite, fine to medium arenite, rare algal nodules, well sorted	1.20	65.20
Biosparite, medium to coarse arenite crinoid debris with subordinate shell, pellet and algal (*Koninckopora* and *Girvanella*) debris, predominantly well sorted	5.80	71.00
Biopelsparite, fine to medium arenite, common *Koninckopora* and algal nodules, well sorted	4.20	75.20

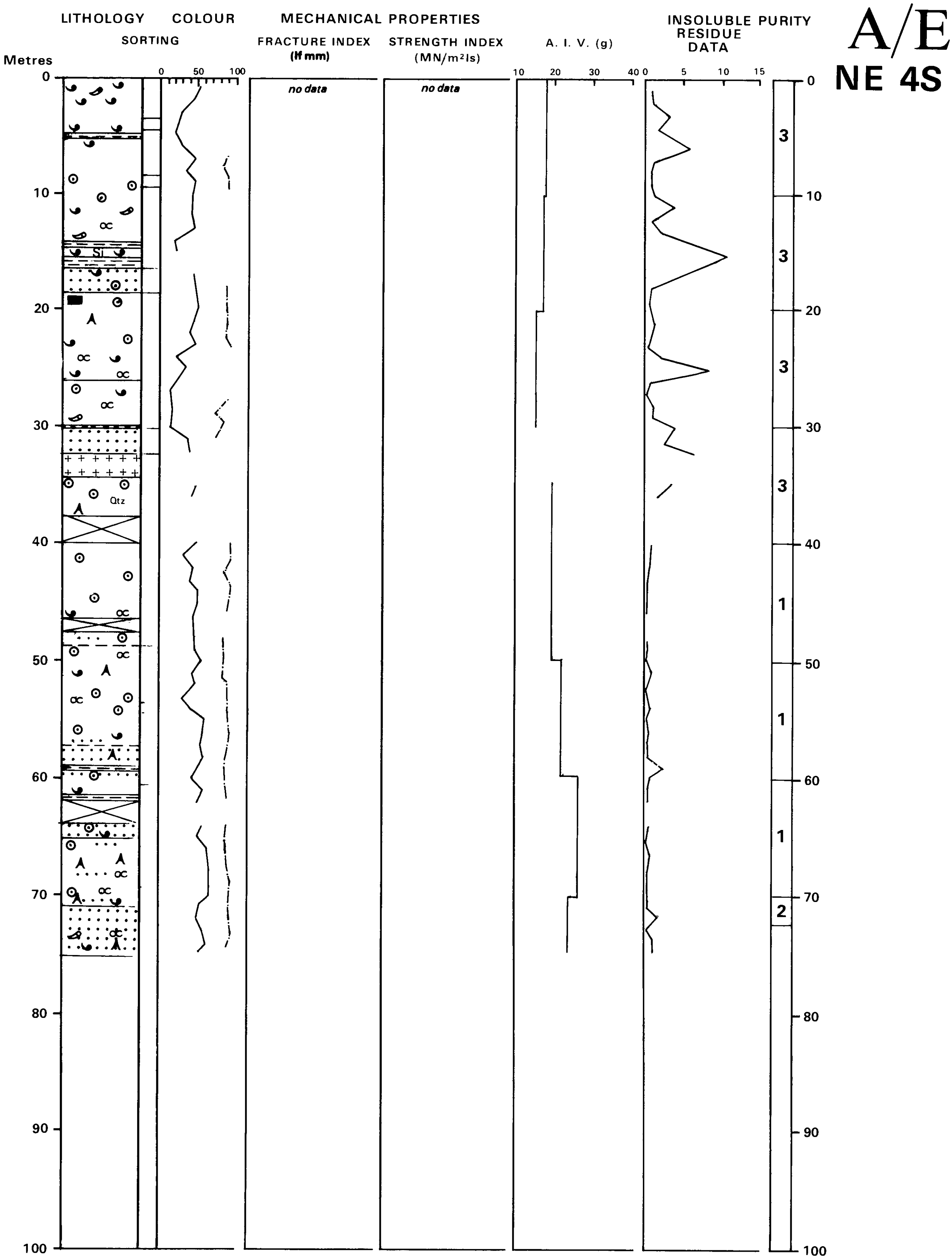
Base of section 75.20 m

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
BLOCK E											
4.00	54.40	0.70	0.0	0.0	1.29	0.43	0.02	0.03	0.05	0.01	1300
11.00	54.90	0.0	0.0	0.0	2.11	0.42	0.06	0.03	0.03	0.01	380
25.00	55.20	1.16	0.03	0.07	3.78	0.46	0.25	0.05	0.26	0.05	3500
28.00	55.60	0.0	0.0	0.0	0.43	0.59	0.14	0.04	0.02	0.01	1100
BLOCK A											
51.00	55.70	0.0	0.0	0.0	0.31	0.38	0.0	0.03	0.0	0.0	440
72.00	56.00	0.0	0.0	0.0	0.67	0.38	0.0	0.03	0.0	0.01	1200

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
BLOCK E					
42.03	5	320	60	210	4.00
42.69	5	5	15	100	11.00
39.96	15	850	230	480	25.00
43.77	10	15	40	140	28.00
BLOCK A					
43.61	0	60	25	130	51.00
43.55	5	250	35	70	72.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX (If mm)
STRENGTH INDEX (MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE
PURITY DATA
Metres
no data
no data
A/E
NE 4S
Si
Qtz
3
3
3
3
1
1
1
2

RESOURCE BLOCK A

SK 25 NE 5s 2623 5604 Hoptonwood Quarry

Surface level +331.50 m

	Thickness m	*Depth* m
Bee Low Limestones		
Biosparite Crinoid, buff-grey, coarse arenite to fine rudite, subordinate finely comminuted bioclasts, shell debris commonly encrusted with *Girvanella,* rare *Koninckopora*, matrix predominantly spar with some admixed micrite	13.50	13.50
Pelsparite, buff-grey, fine arenite, rare *Girvanella* encrusted shell debris and algal nodules, well sorted	1.70	15.20
Clay	0.40	15.60
Biopelsparite Crinoid, grey-brown, medium-coarse arenite, patchy silicification	2.50	18.10
Clay	0.40	18.50
Biosparite, grey-brown, fine to coarse arenite comminuted bioclastic debris	6.00	24.50
Biopelsparite, grey-brown, fine to coarse arenite comminuted bioclastic and pelletal debris, some *Koninckopora*, well sorted	2.80	27.30
Clay	0.20	27.50
Biopelsparite algae, grey, fine to coarse arenite, abundant *Koninckopora*, rare colonial coral, well sorted	2.00	29.50
Biosparite, buff-grey, medium to coarse arenite crinoid and brachiopod debris, common *Girvanella* encrusted shell debris, rare *Koninckopora*, mottled 31.50–32.50 m	4.00	33.50
Pelsparite, buff-grey, fine arenite, some coarse arenite–fine rudite crinoid, brachiopod and coral debris, clasts commonly encrusted with *Girvanella*, well-sorted	2.00	35.50
Biosparite Crinoid algae, pale grey, coarse arenite, common *Koninckopora*	0.60	36.10
Clay	0.15	36.25
Biopelsparite algae, buff-grey, fine arenite to fine rudite comminuted bioclastic debris, common *Koninckopora*, some *Girvanella* encrusted shell debris, well sorted	1.25	37.50
Biosparite, buff-grey, medium arenite, common finely comminuted crinoid, shell and pelletal debris, some *Koninckopora*, some *Girvanella* encrusted shell debris, common quartz euhedra	3.80	41.30
Gap	12.70	54.00
Biopelsparite, buff-grey, fine arenite to fine rudite, abundant comminuted bioclastic and pelloidal debris, common *Koninckopora*, some *Girvanella* encrusted bioclasts, rare intraclasts, well sorted	2.50	56.50
Gap	2.25	58.75
Biosparite, buff-grey, medium arenite, well sorted, some quartz euhedra	1.55	60.30
Pelsparite algal, buff-grey, fine to coarse arenite, common *Koninckopora*, rare intraclasts, very well sorted	2.10	62.40
Woo Dale Limestones		
Calcilutite, grey, common birds-eye structure	0.90	63.30
Pelsparite, buff-grey, fine arenite, some coarse arenite crinoid debris, some *Koninckopora*, well sorted	2.80	66.10
Biopelsparite, buff-grey, common fine arenite pellet and finely comminuted bioclasts, common coarse arenite bioclastic debris, rare fine rudite coral, some *Koninckopora*, some *Girvanella* encrusted shell debris, locally algal laminated, well sorted	3.40	69.50
Pelsparite, grey-brown, fine to medium arenite, some comminuted crinoid and algae encrusted shell debris, rare *Koninckopora*, common birds-eye structures 75.50–76.50 m, well sorted	7.80	77.30
Calcilutite, grey, rare arenite coral and shell debris, some birds-eye structures, well sorted	2.65	79.95

Base of section 79.95 m

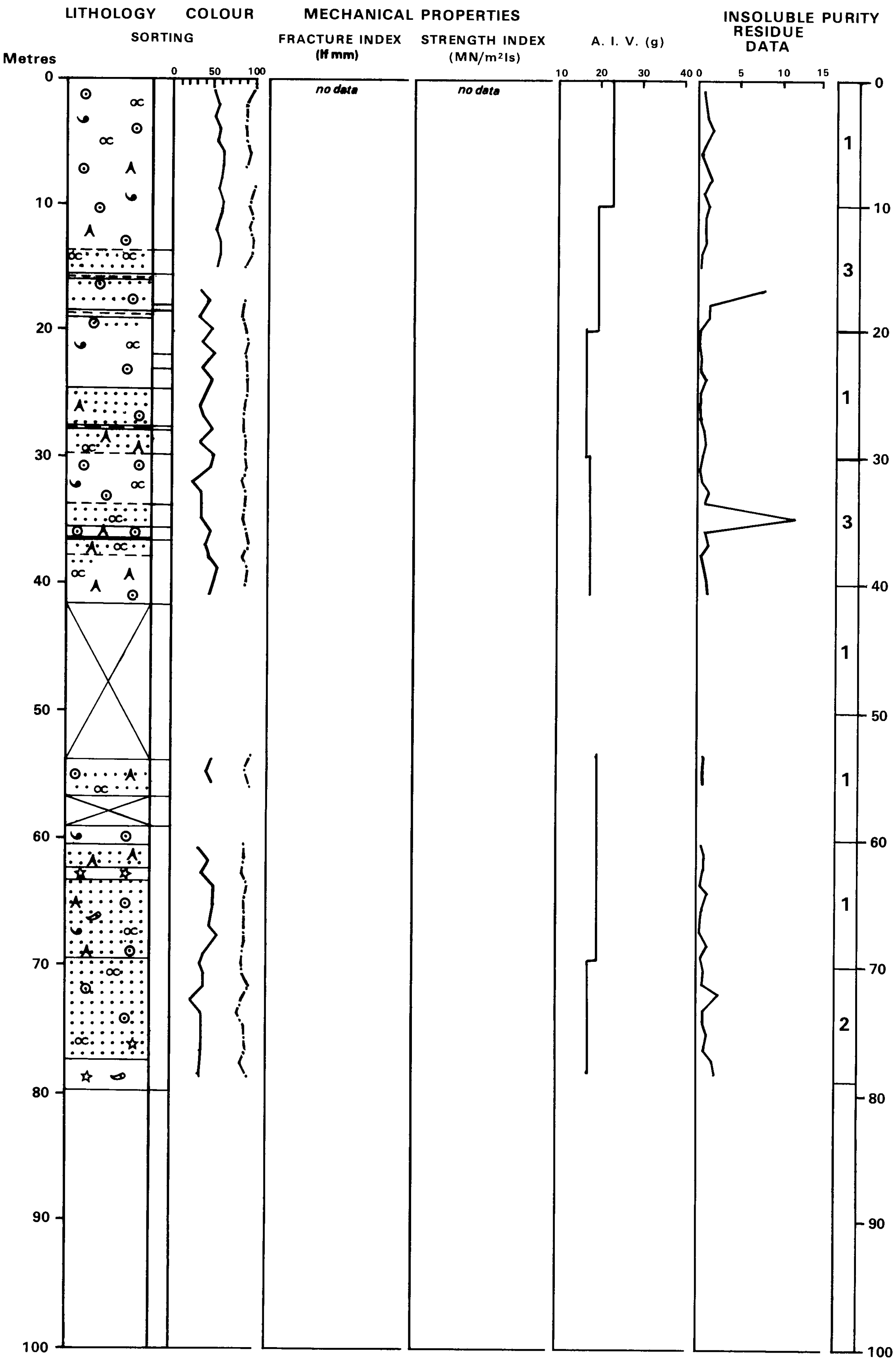
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
4.00	58.80	0.0	0.0	0.0	0.87	0.38	0.0	0.05	0.0	0.0	1200
17.00	53.40	0.05	0.0	0.0	6.03	0.37	0.0	0.05	0.01	0.0	1600
24.00	54.70	0.0	0.0	0.0	0.12	0.42	0.01	0.05	0.0	0.0	250
34.00	56.00	0.21	0.0	0.0	0.16	0.40	0.0	0.05	0.0	0.01	1200
35.00	50.30	2.98	0.02	0.02	0.80	0.43	0.52	0.09	0.08	0.0	4600
63.00	56.00	0.0	0.0	0.0	0.29	0.48	0.10	0.06	0.0	0.0	1400
73.00	55.70	0.09	0.0	0.01	0.50	0.54	0.34	0.10	0.0	0.01	1800

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
43.40	0	150	15	60	4.00
40.84	10	40	20	90	17.00
43.71	5	25	20	90	24.00
43.53	5	270	30	230	34.00
39.04	35	180	140	310	35.00
43.76	5	40	25	70	63.00
43.75	10	10	10	50	73.00

Resource Block A SK 25 NE 5s 2623 5604 Hoptonwood Quarry



A
NE 5S

RESOURCE BLOCK A/E

SK 25 NE 8s 2874 5628 Dene Quarry

Surface level +242.03 m

	Thickness m	*Depth* m
Eyam Limestones		
Biosparite Brachiopod, dark grey, common fine to coarse arenite comminuted brachiopod, crinoid and foraminiferal debris, common coarse rudite brachiopods, patchily silicified, common finely disseminated clay	0.50	0.50
Biosparite, medium grey, medium to coarse arenite comminuted shell, crinoid, spine and foraminiferal debris, patchily silicified bioclasts	3.00	3.50
Biosparite Crinoid, dark grey, abundant finely comminuted bioclastic debris, common foraminifera, some fine rudite crinoid and brachiopod debris, patchily silicified bioclasts, abundant finely disseminated black clay	1.00	4.50
Biosparite, medium grey to grey-brown, medium arenite to medium rudite bioclasts, predominantly crinoid, shell and foraminifera, rudite brachiopod debris commonly patchily silicified	3.00	7.50
Biopelsparite, buff-grey, medium arenite, well sorted	0.75	8.25
Biosparite Brachiopod, grey, medium arenite, some coarse rudite brachiopods, common quartz euhedra, common disseminated clay	0.50	8.75
Biopelsparite Brachiopod, buff-brown, medium to coarse arenite comminuted shell, foraminifera, crinoid and pelletal debris, some rudite brachiopod debris patchily silicified	3.75	12.50
Biosparrudite Crinoid, dark grey, common medium rudite crinoid debris, common disseminated black clay	1.50	14.00
Eyam Limestones, Knoll-Reef Facies		
Biomicrudite Crinoid bryozoa, pale grey, common fine to medium rudite crinoid debris, common arenite comminuted bioclasts, occasional rudite brachiopods with geopetal cavities, occasional fragmentary bryozoa	5.50	19.50
Biosparite Crinoid Brachiopod, grey-brown, common fine to medium rudite crinoid and brachiopod debris, common disseminated grey clay and some clay partings	1.00	20.50
Biomicrite, grey, fine to medium arenite comminuted bioclastic debris, rare flecks of chalcopyrite	2.00	22.50
Monsal Dale Limestones		
Biosparite, buff-grey, fine to coarse arenite comminuted shell, crinoid, foraminifera and pelletal debris, rare dasycladacean algae	2.50	25.00
Biosparite, grey, fine to coarse arenite bioclastic	1.80	26.80
Biopelsparite, pale to dark grey, fine to coarse arenite. Well sorted, locally common quartz euhedra, patchily silicified bioclasts	12.20	39.00
Biosparite, buff-grey to grey-brown, mottled, very fine arenite to fine rudite brachiopod, crinoid, pellet, foraminifera and rare bryozoan debris, patchily silicified bioclasts	8.50	47.50
Biosparrudite Brachiopod, grey-brown, abundant very finely comminuted bioclastic debris, common fine-medium rudite brachiopod debris (patchily silicified), subordinate pelletal debris	1.00	48.50
Biopelsparite Brachiopod bryozoa, buff-grey abundant coarse arenite to fine rudite brachiopod debris, subordinate crinoid debris, common fine to coarse arenite comminuted bioclastic and pelletal debris, patchily silicified bioclasts	1.30	49.80

Base of section 49.80 m

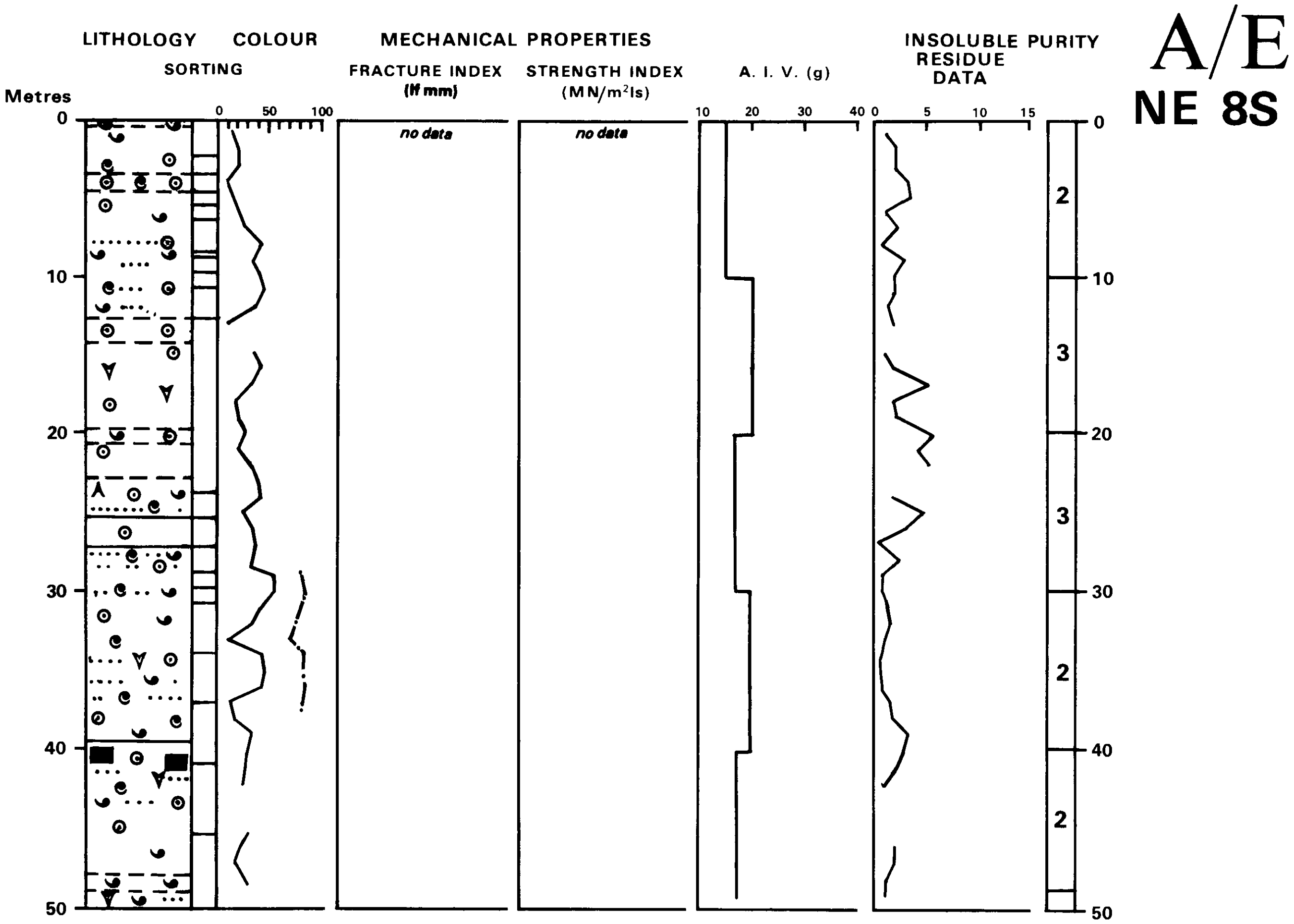
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
BLOCK E											
9.00	54.90	0.0	0.0	0.0	1.33	0.48	0.03	0.05	0.0	0.02	320
17.00	55.20	0.33	0.0	1.05	1.00	0.40	0.03	0.05	0.0	0.02	1800
23.00	46.50	4.39	0.05	2.24	0.87	0.50	0.21	0.08	0.50	0.10	3000
BLOCK A											
32.00	55.70	0.0	0.0	0.01	0.49	0.44	0.05	0.05	0.0	0.02	280
44.00	54.90	0.30	0.0	0.26	0.68	0.43	0.09	0.05	0.08	0.02	2700

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
BLOCK E					
43.14	5	20	30	210	9.00
41.46	15	130	100	160	17.00
34.42	15	4500	750	160	23.00
BLOCK A					
43.61	0	5	35	85	32.00
42.73	5	90	140	170	44.00

Resource Block A/E SK 25 NE 8s 2874 5628 Dene Quarry



RESOURCE BLOCK B

Source of data	*Registration number*	*Grid Reference*
IMAU boreholes (drilled by contractor)	NW 18	2182 5544
	SW 17	2230 5417
	SE 13	2730 5434
Major sections used in the assessment	NW 3s	2322 5547
	NW 5s	2259 5565
	NW 6s	2031 5524
	NW 7s	2030 5545
	NW 8s	2427 5533
	SW 1s	2189 5490
	SW 2s	2100 5420
	SW 3s	2482 5356

RESOURCE BLOCK B

SK 25 NW 18 2182 5544 Longcliffe

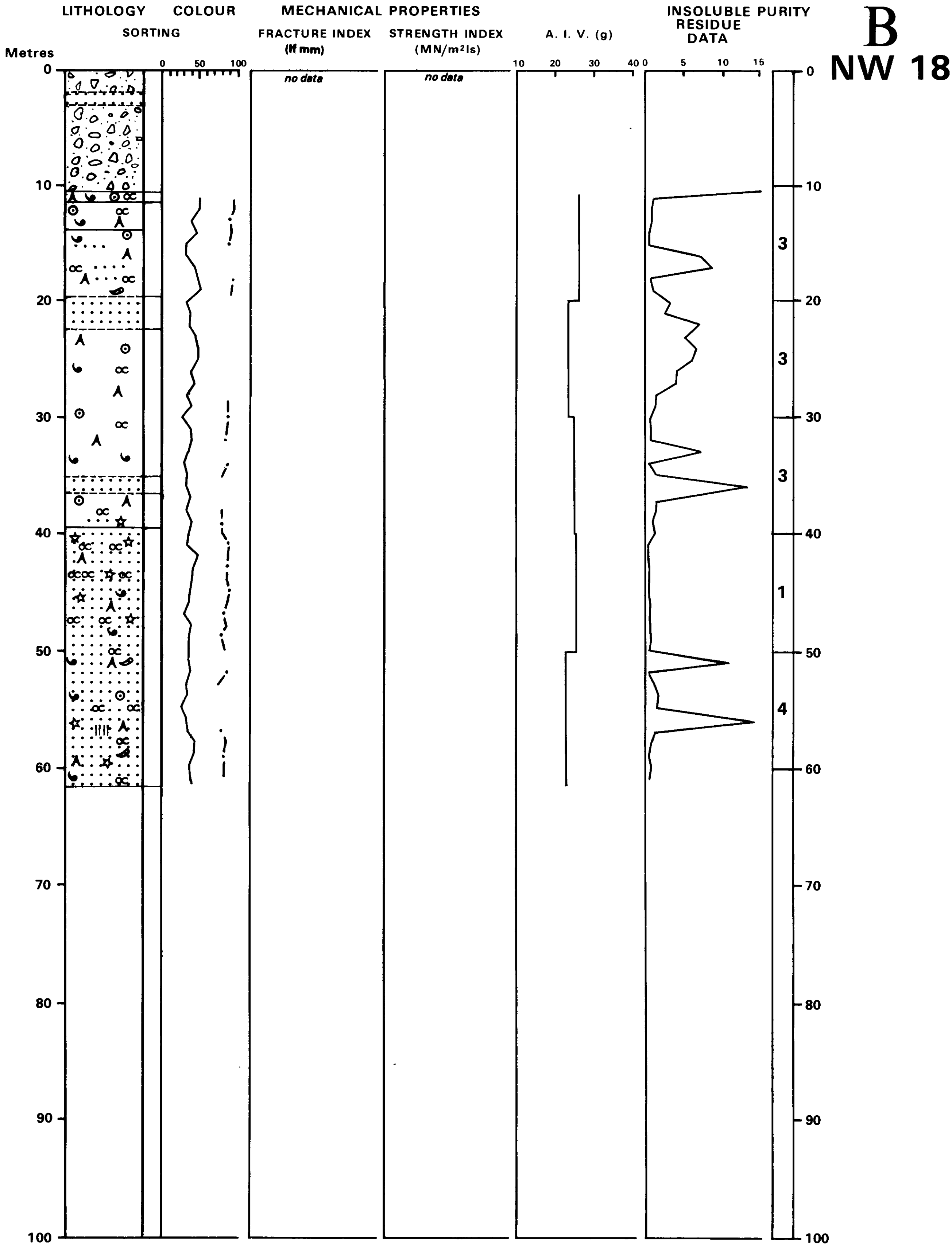
Surface level +273.41 m
February 1971

	Thickness m	*Depth* m
Recent		
Clay silty, yellow brown	2.00	2.00
Sand silty, yellow brown, with lumps and flakes of clay	1.00	3.00
Clay silty, some limestone fragments	2.00	5.00
Silt clayey, well sorted fine gravel in lowest 1 m	2.00	7.00
Silt Sandy calcareous clayey, yellow, very fine sand to gravel fractions	2.00	9.00
Bee Low Limestones		
Limestone, pale grey, rubbly	1.60	10.60
Biosparite, buff-grey, abundant coarse arenite crinoid and shell debris, some *Koninckopora* and *Girvanella* encrusted	0.87	11.47
Biomicrite, pale grey, abundant medium arenite crinoid and shell debris, some *Koninckopora* and *Girvanella* encrusted shell debris, some euhedral quartz, and limonite stained fissures	2.13	13.60
Biosparite algae, pale grey, fine to medium arenite comminuted shell, crinoid and pelletal debris, subordinate *Koninckopora* and *Girvanella* encrusted bioclasts. bioclasts, pelsparite locally developed 19.78–22.38 m, 34.94–36.33 m, some quartz euhedra, some small vugs	25.74	39.34
Woo Dale Limestones		
Pelsparite algae, buff-grey, fine arenite tightly packed pelletal debris, fine spar matrix, some shell debris, commonly *Girvanella* encrusted, rare *Koninckopora* and coral, locally common aggregated pelletal debris, common birds-eye structures, scattered euhedral quartz	5.66	45.00
Biomicrite, pale grey, very fine arenite to lutite bioclasts, well sorted	0.50	45.50
Pelsparite, fine arenite, some medium rudite brachiopods, locally abundant bioclasts, matrix variable between spar and micrite, common birds-eye structures, some algal lamination, common *Girvanella* encrusted bioclasts, some *Koninckopora,* locally common quartz euhedra, patchily dolomitised adjacent to fissures, well sorted	10.30	55.80
Biopelsparite, buff-grey, fine to coarse arenite pellet, shell and crinoid debris, some *Girvanella* encrusted and corroded bioclasts, rare *Koninckopora* and bryozoa	2.23	58.03
Pelsparite, fine arenite, closely packed, well sorted, some euhedral quartz, rare coral	0.52	58.55
Pelsparite algae, fine arenite, algal laminated, common birds-eye structures, some quartz euhedra	0.14	58.69
Pelsparite, fine to medium arenite, some fine rudite crinoid and shell debris, locally abundant *Koninckopora,* some algal lamination. Rare birds-eye structures and dolomitisation, some *Girvanella* encrusted bioclasts and pelletal debris	2.83	61.52

Borehole completed at 61.52 m.

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
10.00	45.80	0.15	0.04	0.03	10.13	0.25	1.96	0.18	0.15	0.09	37700	35.02	30	100	650	2400	10.00
12.00	55.40	0.03	0.03	0.0	0.61	0.22	0.01	0.0	0.12	0.06	1000	43.77	10	0	30	170	12.00
15.00	55.80	0.04	0.03	0.0	0.42	0.25	0.01	0.0	0.15	0.06	800	43.94	10	0	30	320	15.00
21.00	55.50	0.03	0.02	0.0	0.27	0.21	0.04	0.01	0.13	0.06	1000	43.90	10	0	50	320	21.00
30.00	55.10	0.03	0.03	0.0	0.44	0.21	0.02	0.01	0.15	0.06	1500	43.73	10	0	60	420	30.00
35.00	54.80	0.04	0.02	0.0	0.73	0.21	0.11	0.01	0.11	0.06	2400	43.51	10	10	80	690	35.00
40.00	55.20	0.03	0.04	0.02	0.66	0.38	0.06	0.02	0.26	0.12	2700	43.63	10	0	20	460	40.00
45.00	55.30	0.03	0.03	0.0	0.44	0.28	0.03	0.01	0.10	0.06	300	43.88	10	0	20	140	45.00
50.00	54.50	0.03	0.02	0.0	0.43	0.25	0.02	0.0	0.10	0.05	2400	43.77	10	0	70	690	50.00
55.00	54.10	0.0	0.02	0.0	0.35	0.37	0.08	0.02	0.07	0.02	3200	43.77	10	0	40	570	55.00
60.00	55.30	0.04	0.03	0.0	0.45	0.38	0.01	0.0	0.09	0.06	1100	43.84	5	0	10	340	60.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX (If mm)
STRENGTH INDEX (MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
no data
no data
B
NW 18

RESOURCE BLOCK B

SK 25 SW 17 2230 5417 Brassington

Surface level +256.57 m
Dando 250 rig, waterflush, 56 mm diameter
October 1975

	Thickness m	*Depth* m
Recent		
Clay, sandy red	2.80	2.80
Bee Low Limestones: dolomite		
Dolomite, buff-grey, fine grained, some rudite crinoid and brachiopod debris, some thin calcite and baryte veinlets	1.13	3.93
Gap	0.79	4.72
Dolomite, yellow-grey, fine grained granular, vuggy, some fine rudite crinoid debris and coral	6.55	11.27
Gap	1.48	12.75
Dolomite, grey, fine grained, vuggy, some coarse arenite to fine rudite crinoid and brachiopod debris, some baryte veins	29.15	41.90
Biosparite, grey-brown, medium arenite closely packed foraminifera, shell and crinoid debris	0.23	42.13
Dolomite, grey-brown, medium-grained granular, common vugs	1.23	43.36
Bee Low Limestones		
Biosparite, buff-grey, abundant coarse arenite crinoid and shell debris, subordinate pellet, spine, foraminifera, encrusting algae and dasycladacean algae fragments, some quartz euhedra and patchily silicified bioclasts, patchy dolomitisation	2.98	46.34
Biosparite Pellet algae, grey-brown to dark grey, abundant medium arenite, *Girvanella* encrusted brachiopod and crinoid debris, pellet, foraminifera spine and *Koninckopora* debris, patchy dolomitisation, some quartz euhedra, galena calcite vein 47.14–47.40 m	7.09	53.43
Biopelsparite algae, grey-brown, medium arenite *Girvanella* encrusted brachiopod, and crinoid debris, some algal nodules and *Koninckopora*, well sorted common baryte and calcite veins, patchy dolomitisation and ironstaining, some quartz euhedra	16.07	69.50
Biosparite Crinoid, pale grey, coarse arenite, poor sorting	1.12	70.78
Pelsparite, fine arenite, some *Koninckopora*, well sorted	0.67	71.45
Biopelsparite, coarse arenite *Girvanella* encrusted shell, pellet, crinoid and foraminiferal debris, some *Koninckopora*	2.30	73.75
Pelsparite, fine arenite, some *Koninckopora, Girvanella* encrustations and colonial coral, well sorted	1.25	75.00
Biosparite Crinoid Pellet algae, coarse arenite, common *Girvanella*	0.88	75.88
Biopelsparite, medium arenite, some quartz euhedra, well sorted	0.70	76.58
Biosparite Crinoid Pellet algae, pale grey, coarse arenite, some quartz euhedra	2.15	78.73
Biopelsparite, medium arenite, some quartz euhedra, well sorted	0.85	79.58
Biosparite Crinoid Pellet algae, pale to dark grey, coarse arenite *Girvanella* encrusted Crinoid and brachiopod debris, bioturbated, some coral, common iron-stained, patchily dolomitised calcite infilled fissures	20.58	100.16

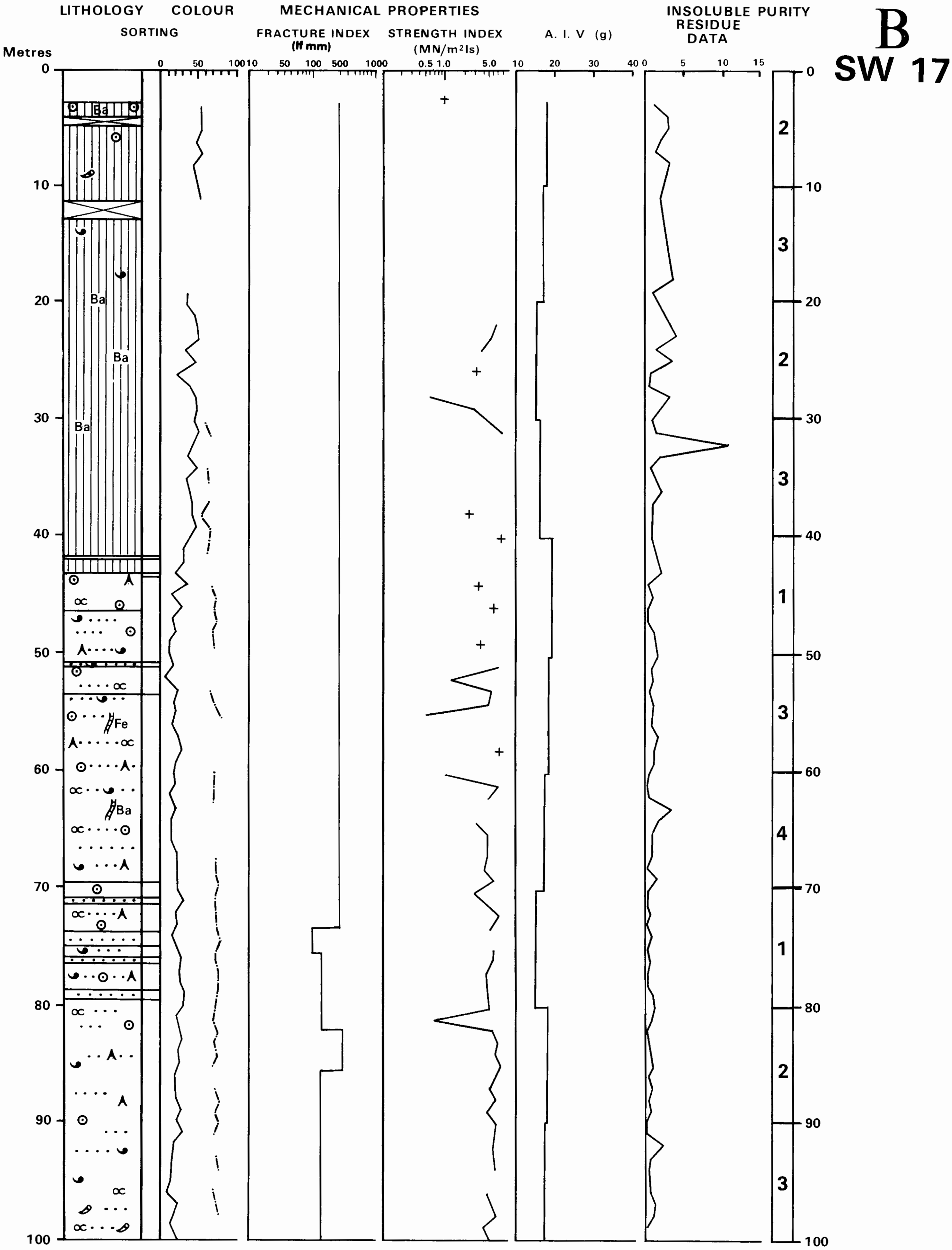
Borehole complete 100.16 m

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	Mgo	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
7.00	33.00	0.04	0.04	0.0	0.44	19.60	0.13	0.03	0.03	0.14	3300
28.00	34.20	1.00	0.02	0.0	0.02	16.90	0.0	0.01	0.10	0.08	4600
36.00	32.00	0.07	0.0	0.0	0.01	20.40	0.0	0.01	0.02	0.04	2200
52.00	47.20	0.03	0.01	0.0	0.04	7.40	0.0	0.01	0.0	0.0	1400
57.00	37.10	0.05	0.01	0.0	0.04	16.30	0.0	0.01	0.03	0.11	4400
66.00	44.80	0.01	0.01	0.0	0.02	9.50	0.0	0.01	0.0	0.0	3800
80.00	56.00	0.08	0.02	0.0	0.02	0.54	0.0	0.01	0.0	0.01	520
92.00	51.10	0.82	0.02	0.0	0.0	3.03	0.0	0.01	0.0	0.01	2700
96.00	56.10	0.11	0.03	0.0	0.03	0.76	0.0	0.01	0.0	0.03	600

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
47.07	15	5	65	1070	7.00
45.74	15	20	3800	1170	28.00
47.94	5	0	230	990	36.00
45.54	5	35	100	890	52.00
47.10	15	130	380	1270	57.00
45.78	5	35	170	1480	66.00
44.03	5	5	60	410	80.00
43.48	5	5	70	1400	92.00
44.52	5	5	35	680	96.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX (ff mm)
STRENGTH INDEX (MN/m²Is)
A. I. V (g)
INSOLUBLE RESIDUE
PURITY DATA
Metres
Ba
Fe
B
SW 17

RESOURCE BLOCK B

SK 25 SE 13 2730 5434 Four Lane Ends, Wirksworth

Surface level +257.56 m Reich Rig, waterflush
February 1971

	Thickness m	*Depth* m
Recent and Pleistocene and/or Tertiary		
Topsoil, dark brown to yellow clayey with chert pebbles	5.00	5.00
Clay, grey with small pebbles of limestone, brown, sandy 14.00–16.00 m	11.00	16.00
Sand, brown, clayey, fine to medium grained	13.00	29.00
Monsal Dale Limestones: dolomite		
Dolomite, grey-brown, vuggy, common rudite brachiopod debris	3.26	32.36
Lower Matlock Lava		
Clay, ochreous and green, patchy iron staining	0.18	32.44
Bee Low Limestones		
Biosparrudite Brachiopod, pale grey, common rudite brachiopods current orientated, abundant quartz euhedra	2.26	34.70
Biomicrite, pale grey, fine to medium arenite crinoid debris, well sorted	0.62	35.32
Biosparite Brachiopod Pellet, pale grey, medium arenite *Girvanella* encrusted brachiopod and pelloidal debris, bioturbated, well sorted	0.94	36.26
Pelsparite, pale grey, fine arenite, mottled, bioturbated, very well sorted, some quartz euhedra	2.27	38.53
Biomicrite Crinoid, pale grey, medium arenite crinoid, algal nodules and brachiopod debris, locally bioturbated	15.92	54.45
Biomicrosparite, pale grey mottled, medium arenite crinoid and dasycladacean algae debris	1.05	55.50
Biomicrite Crinoid, pale grey, medium arenite crinoid debris	1.95	57.45
Biomicrite, pale grey, fine to medium arenite, brachiopod, algal nodule and pellet debris	2.12	59.57
Pelsparite, medium grey, arenite *Girvanella* encrusted brachiopod debris	0.30	59.87
Biomicrite Crinoid, pale grey, medium arenite crinoid and brachiopod debris	5.39	65.26
Clay, green-grey, calcareous	0.15	65.41
Pelsparite, pale grey, medium arenite, some weathered flecks of pyrite	0.30	65.71
Biomicrite Crinoid, pale grey, medium arenite, mottled, some encrusting algae and dasycladacean algae	4.15	69.86

Borehole complete 69.86 m

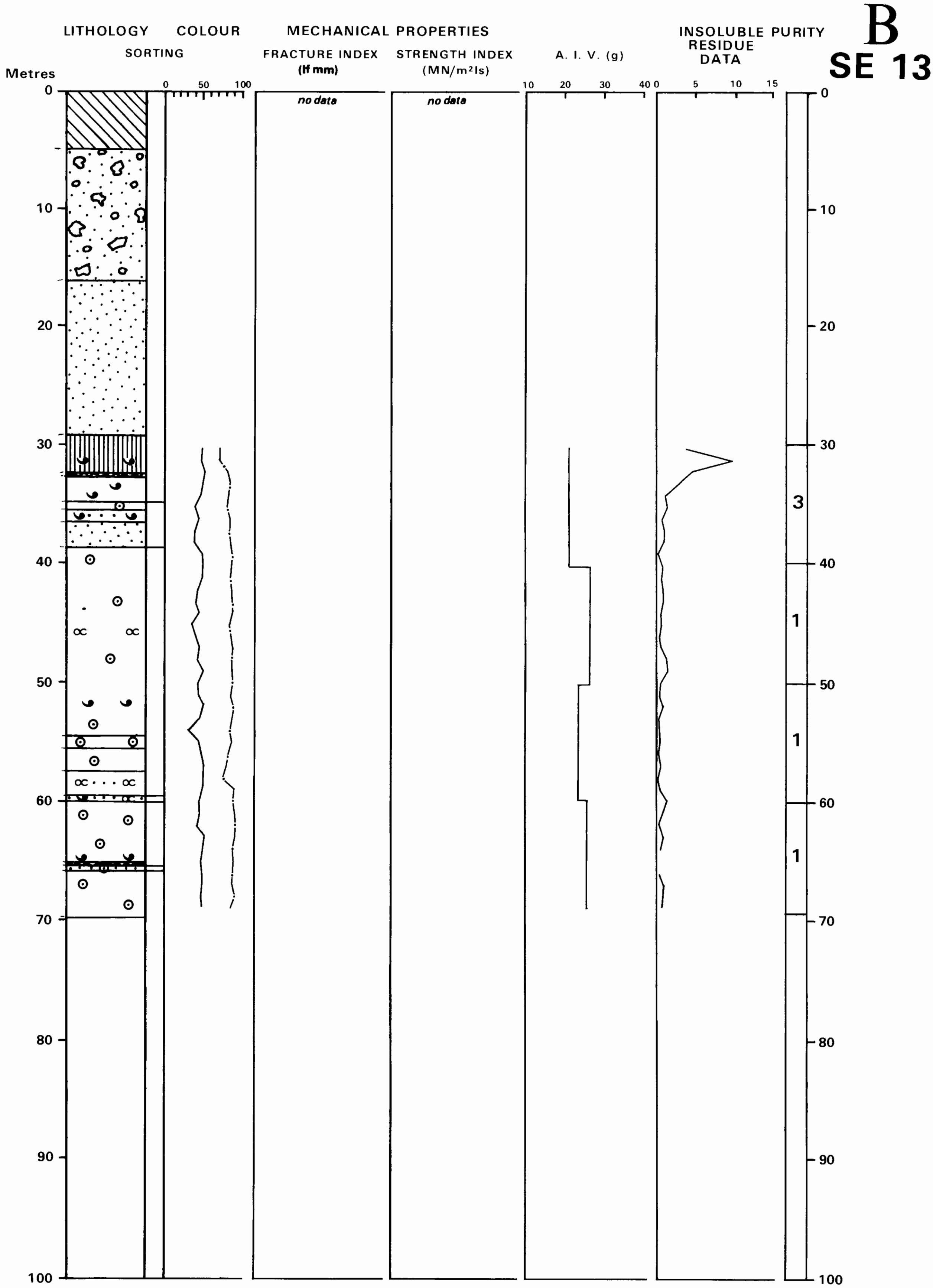
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
30.00	30.90	0.0	0.04	0.01	1.32	20.80	0.14	0.02	0.0	0.0	6000
34.00	54.70	0.02	0.04	0.03	1.09	0.56	0.06	0.02	0.11	0.04	900
38.00	55.30	0.02	0.04	0.02	0.67	0.38	0.12	0.02	0.12	0.02	700
45.00	55.70	0.02	0.04	0.02	0.47	0.28	0.01	0.01	0.10	0.02	2000
50.00	55.80	0.02	0.03	0.02	0.61	0.22	0.01	0.01	0.10	0.02	700
55.00	55.70	0.02	0.03	0.01	0.24	0.22	0.04	0.01	0.09	0.02	800
60.00	55.70	0.02	0.02	0.02	0.46	0.22	0.34	0.04	0.10	0.01	1000
65.00	55.70	0.01	0.03	0.02	0.55	0.25	0.25	0.04	0.10	0.02	1600
68.00	55.80	0.02	0.03	0.02	0.53	0.19	0.19	0.01	0.12	0.04	1000

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
46.82	5	0	50	850	30.00
43.53	10	0	40	190	34.00
43.72	10	0	30	150	38.00
43.76	10	90	100	290	45.00
43.63	10	0	30	80	50.00
43.81	10	0	40	140	55.00
43.71	10	0	40	80	60.00
43.66	10	10	50	120	65.00
43.58	10	20	40	90	68.00

Resource Block B SK 25 SE 13 2730 5434 Fourlane Ends Wirksworth



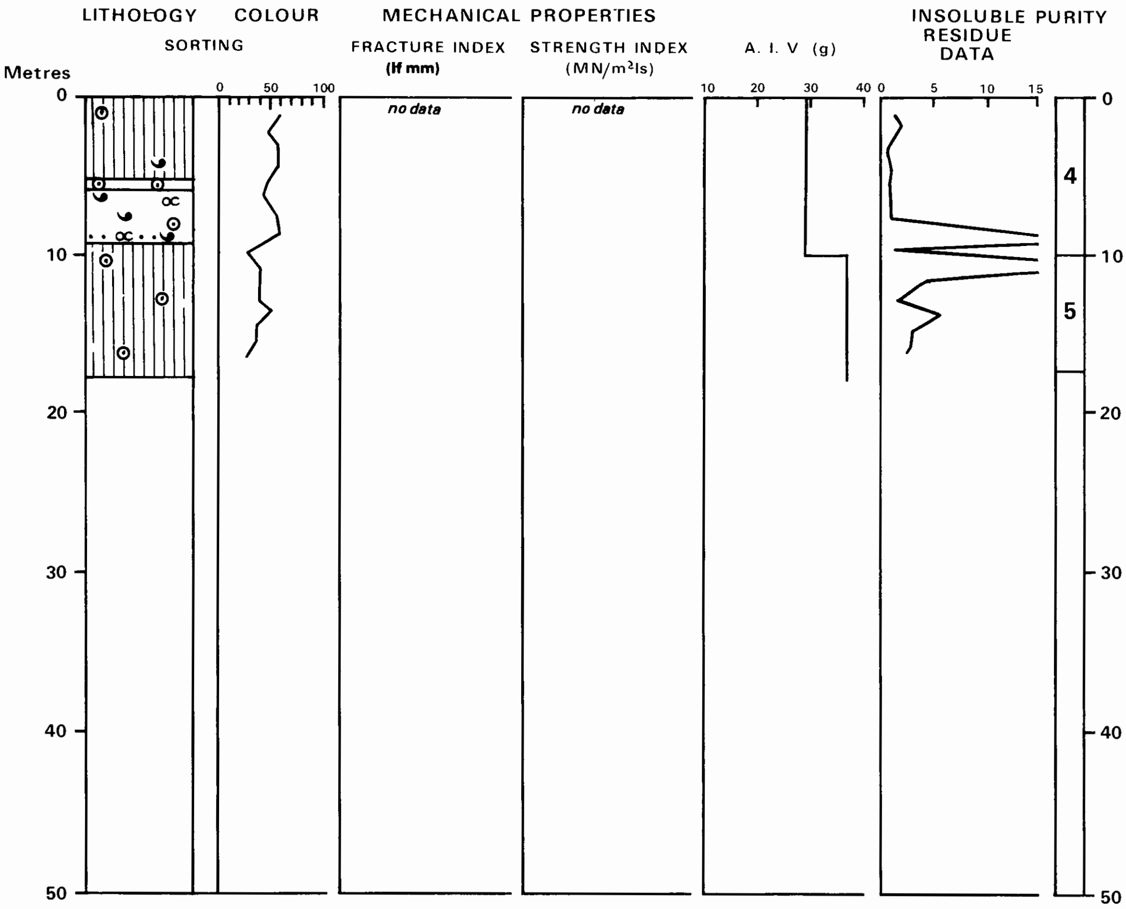
RESOURCE BLOCK B

SK 25 NW 3s 2322 5547 High Peak Quarry

Surface level 354.14 m

	Thickness m	*Depth* m
Bee Low Limestones: dolomite		
Dolomite, buff-yellow, coarsely crystalline, vuggy, some crinoid debris	5.30	5.30
Biosparite Crinoid, common fine rudite crinoid debris	0.60	5.90
Biosparite, buff-grey, medium-coarse arenite brachiopod debris commonly encrusted with *Girvanella,* some pelletal debris	3.40	9.30
Dolomite, yellow-brown, coarsely crystalline, vuggy, rare crinoid debris	3.70	13.00
Limestone, Dolomitised, vuggy, some arenite crinoid debris	1.00	14.00
Dolomite, yellow-brown, coarsely crystalline, vuggy, rare crinoid debris	3.60	17.60

Base of section 17.60 m



B
NW 3S

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
3.00	33.80	0.0	0.04	0.0	0.07	17.40	0.02	0.0	0.0	0.06	2300
7.00	55.20	0.0	0.0	0.0	0.30	0.25	0.04	0.0	0.0	0.01	3900
11.00	31.80	0.0	0.07	0.0	0.15	18.70	0.03	0.01	0.0	0.05	2700
15.00	52.50	1.34	0.02	0.80	0.27	0.54	0.05	0.01	0.02	0.01	7900

Trace elements (ppm)

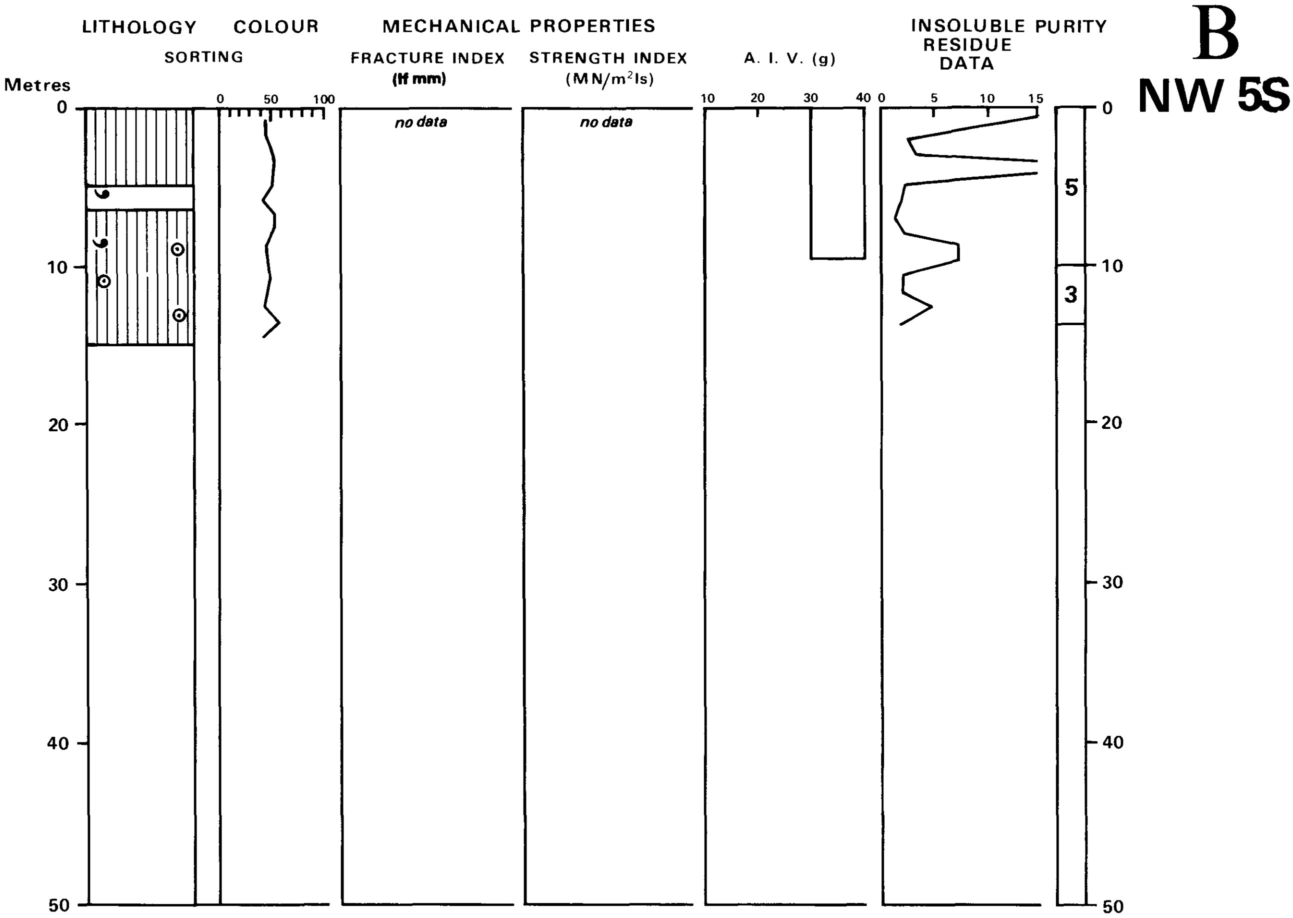
Loss†	Cu	Pb	Zn	MnO	Depth
47.13	5	10	130	620	3.00
43.83	5	70	130	320	7.00
47.17	10	210	210	940	11.00
40.91	10	90	300	1550	15.00

RESOURCE BLOCK B

SK 25 NW 5s 2259 5565 Longcliffe Station Quarry

Surface level +334.95 m

	Thickness	*Depth*
Bee Low Limestones: dolomite	m	m
Dolomite, pale yellow-grey, granular, vuggy, original texture completely destroyed	4.60	4.60
Biomicrolutite, buff, some lutite debris, very well sorted	1.50	6.10
Dolomite, yellow-brown, granular, vuggy, rare poorly preserved fine arenite crinoids and brachiopods	8.60	14.70
Base of section 14.70 m		



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
2.00	42.10	0.0	0.01	0.0	0.40	10.50	0.04	0.0	0.0	0.02	6200
5.00	55.10	0.0	0.0	0.0	1.25	0.16	0.0	0.0	0.01	0.0	1100
9.00	40.40	0.0	0.02	0.85	0.13	12.00	0.08	0.0	0.0	0.01	4100
13.00	29.30	0.01	0.05	0.0	0.37	19.90	0.00	0.0	0.0	0.04	2800

Trace elements (ppm)

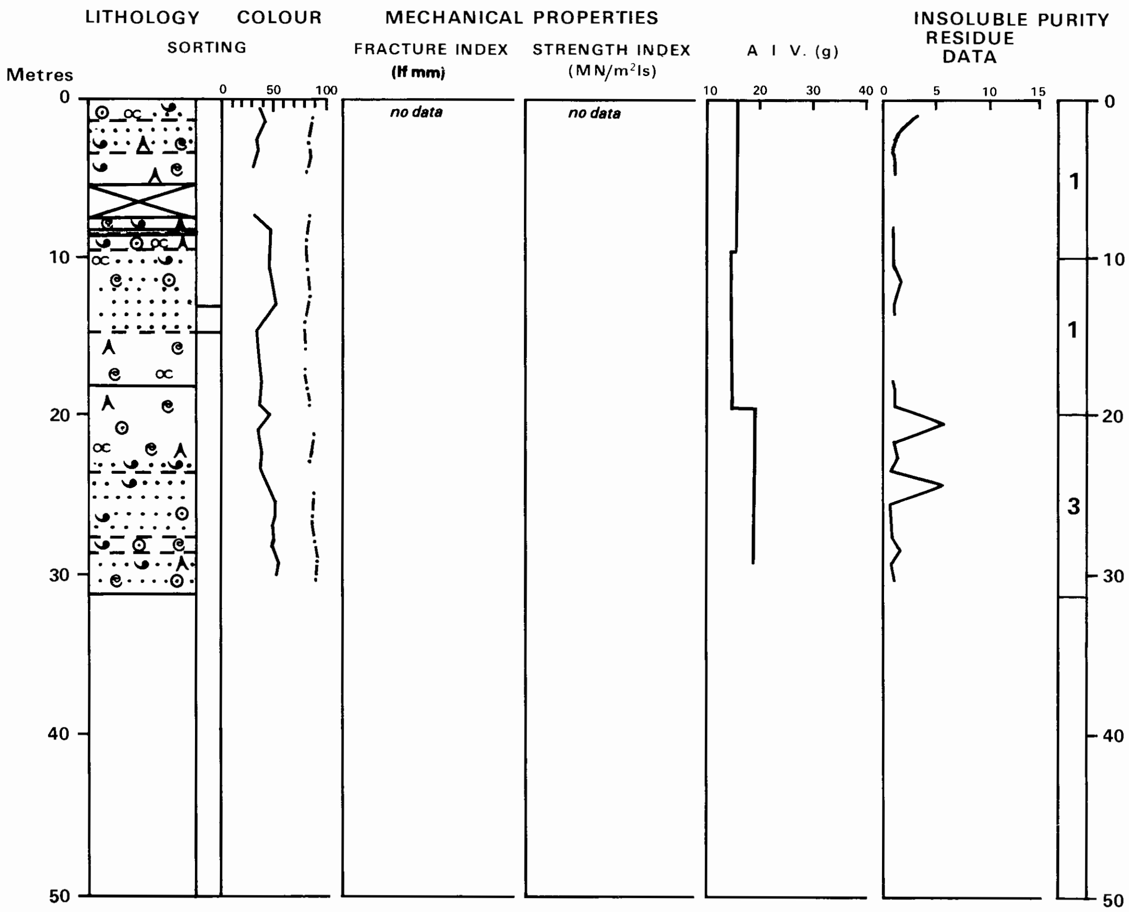
Loss†	Cu	Pb	Zn	MnO	Depth
45.62	5	720	410	640	2.00
43.44	0	20	60	210	5.00
45.12	5	40	230	980	9.00
47.53	0	10100	20	770	13.00

RESOURCE BLOCK B

SK 25 NW 6s 2031 5524 Ballidon Quarry

Surface level +230.40 m

	Thickness m	*Depth* m
Bee Low Limestones		
Biosparite, buff-grey, fine to medium arenite bioclasts, rare *Koninckopora*	1.50	1.50
Biopelsparite, buff-grey, common medium arenite brachiopod and crinoid debris, some *Koninckopora* and foraminifera	2.00	3.50
Biosparite, grey, fine to medium arenite bioclastic debris, predominantly foraminifera and *Koninckopora*	2.00	5.50
Gap	2.00	7.50
Biosparite, grey, fine arenite bioclastic	0.80	8.30
Clay, ochreous	0.30	8.60
Biosparite, pale buff, medium arenite comminuted brachiopod and crinoid debris, subordinate foraminifera, pellets and *Koninckopora,* rare encrusting algae	0.90	9.50
Biopelsparite Brachiopod, buff-grey, fine arenite to medium rudite bioclasts, predominantly *Girvanella* encrusted brachiopod debris, subordinate foraminifera crinoid debris	2.00	11.50
Biomicrite, buff-grey, fine to medium arenite crinoid and foraminiferal debris, rare *Koninckopora*	1.00	12.50
Pelsparite, buff-grey, medium arenite, well sorted	2.00	14.50
Biosparite, grey, fine arenite, rare *Koninckopora* and *Girvanella*	3.65	18.15
Biosparite, grey, fine to medium arenite foraminifera, crinoid and shell debris, rare *Koninckopora*	5.35	23.50
Biopelsparite Brachiopod, grey, fine arenite to fine rudite brachiopod and crinoid debris, subordinate foraminifera and *Koninckopora*	4.00	27.50
Biosparite, buff-grey, fine to medium arenite	1.00	28.50
Biopelsparite, grey, medium to coarse arenite crinoid and brachiopod debris, fine to medium arenite pellets, foraminifera and *Koninckopora*	2.70	31.20
Base of section 31.20 m		



Chemical analyses of major elements (percentages)

Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
1.00	54.50	0.03	0.0	0.01	1.34	0.26	0.07	0.03	0.02	0.01	1800	43.26	20	10	20	190	1.00
5.00	54.70	0.03	0.0	0.0	0.56	0.32	0.21	0.05	0.02	0.01	1600	43.61	10	50	10	100	5.00
12.00	54.60	0.05	0.0	0.15	0.18	0.27	0.08	0.04	0.02	1.91	1800	41.85	10	20	30	190	12.00
21.00	54.50	0.16	0.01	0.03	0.43	0.29	0.21	0.07	0.03	0.25	2200	43.23	10	310	30	380	21.00
25.00	52.00	0.07	0.04	0.24	3.55	0.55	1.95	0.36	0.07	1.81	2700	40.07	0	20	40	150	25.00
29.00	55.40	0.02	0.03	0.02	0.15	0.26	0.06	0.04	0.02	0.15	1200	43.82	0	0	10	130	29.00

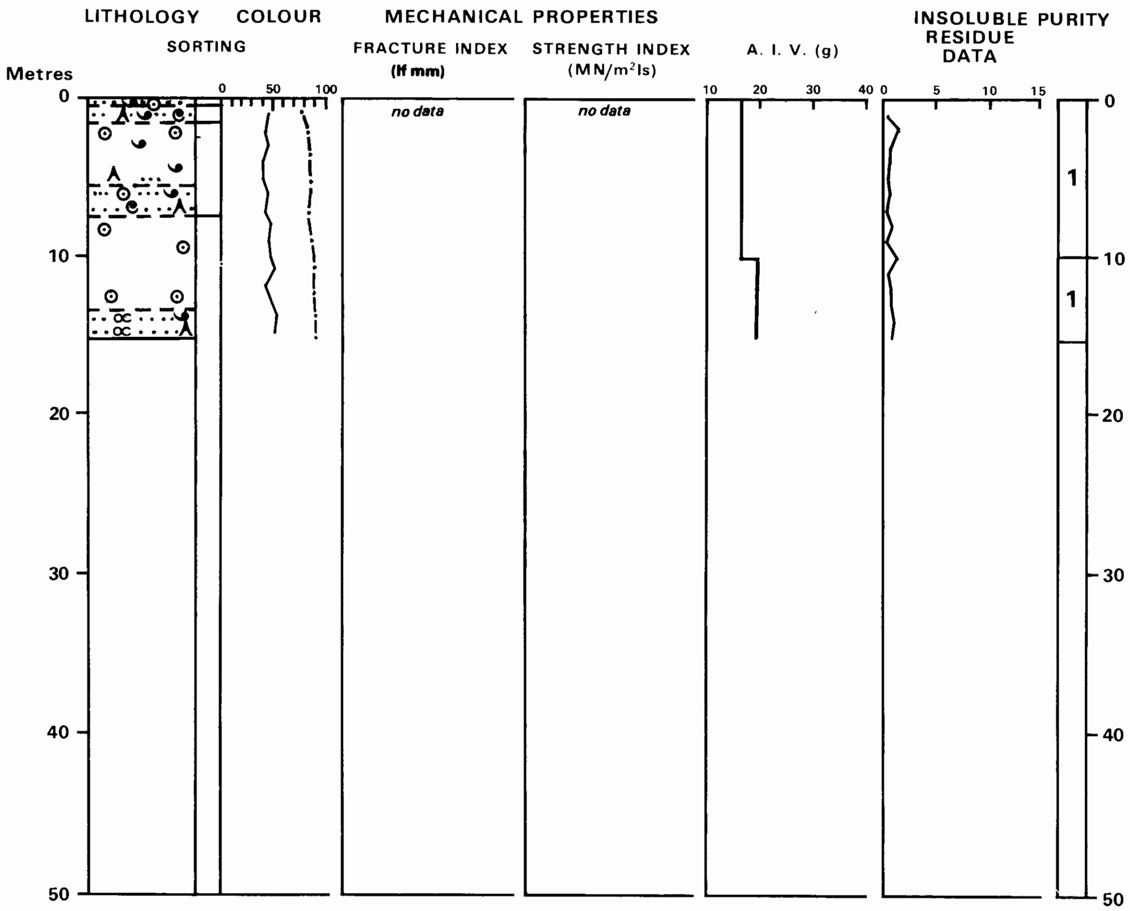
RESOURCE BLOCK B

SK 25 NW 7s 2030 5545 Ballidon Quarry

Surface level +196.89 m

	Thickness m	*Depth* m
Bee Low Limestones		
Biosparite, buff-grey, medium arenite bioclasts	0.50	0.50
Biopelsparite, well sorted	1.00	1.50
Biosparite, buff-grey, abundant fine arenite to fine rudite crinoid debris, subordinate comminuted brachiopods, pellets and *Koninckopora*	4.00	5.50
Biopelsparite, medium arenite, common shell, crinoid, foraminiferal and algal (*Koninckopora*) debris	2.00	7.50
Biosparite Crinoid, buff-grey, coarse arenite	6.00	13.50
Biopelsparite Brachiopod algal, buff-grey, common medium-coarse arenite pelletal and comminuted bioclastic debris, common fine rudite brachiopod and crinoid debris, some *Koninckopora,* brachiopod debris commonly coated with *Girvanella*	1.70	15.20

Base of section 15.20 m



B
NW 7S

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
2.00	55.20	0.0	0.0	0.0	0.45	0.23	0.03	0.0	0.02	0.03	1400
6.00	55.70	0.0	0.0	0.0	0.25	0.16	0.10	0.0	0.02	0.14	210
10.00	55.60	0.05	0.0	0.0	0.30	0.12	0.01	0.0	0.01	0.03	1200
14.00	55.90	0.0	0.0	0.0	0.23	0.14	0.0	0.0	0.01	0.05	190

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
43.58	0	20	40	310	2.00
43.72	0	0	10	160	6.00
43.64	0	20	20	200	10.00
43.89	0	0	10	120	14.00

RESOURCE BLOCK B

SK 25 NW 8s 2427 5533 Harboro' Rocks

Surface level +379.17 m

	Thickness	*Depth*
Bee Low Limestones: dolomite	m	m
Dolomite, buff-yellow, fine-grained, vuggy, some crinoid debris, abundant altered rudite brachiopod debris 6.10–7.15 m	24.50	24.5
Gap	1.00	25.50
Dolomite, buff-yellow, vuggy	1.00	26.50
Gap	1.00	27.50
Dolomite, buff-yellow, vuggy, some altered crinoid and shell debris	21.00	48.50
Gap	2.00	50.50
Dolomite, buff-yellow, vuggy	5.00	55.50
Gap	1.00	56.50
Dolomite, buff-yellow, vuggy	1.10	57.60

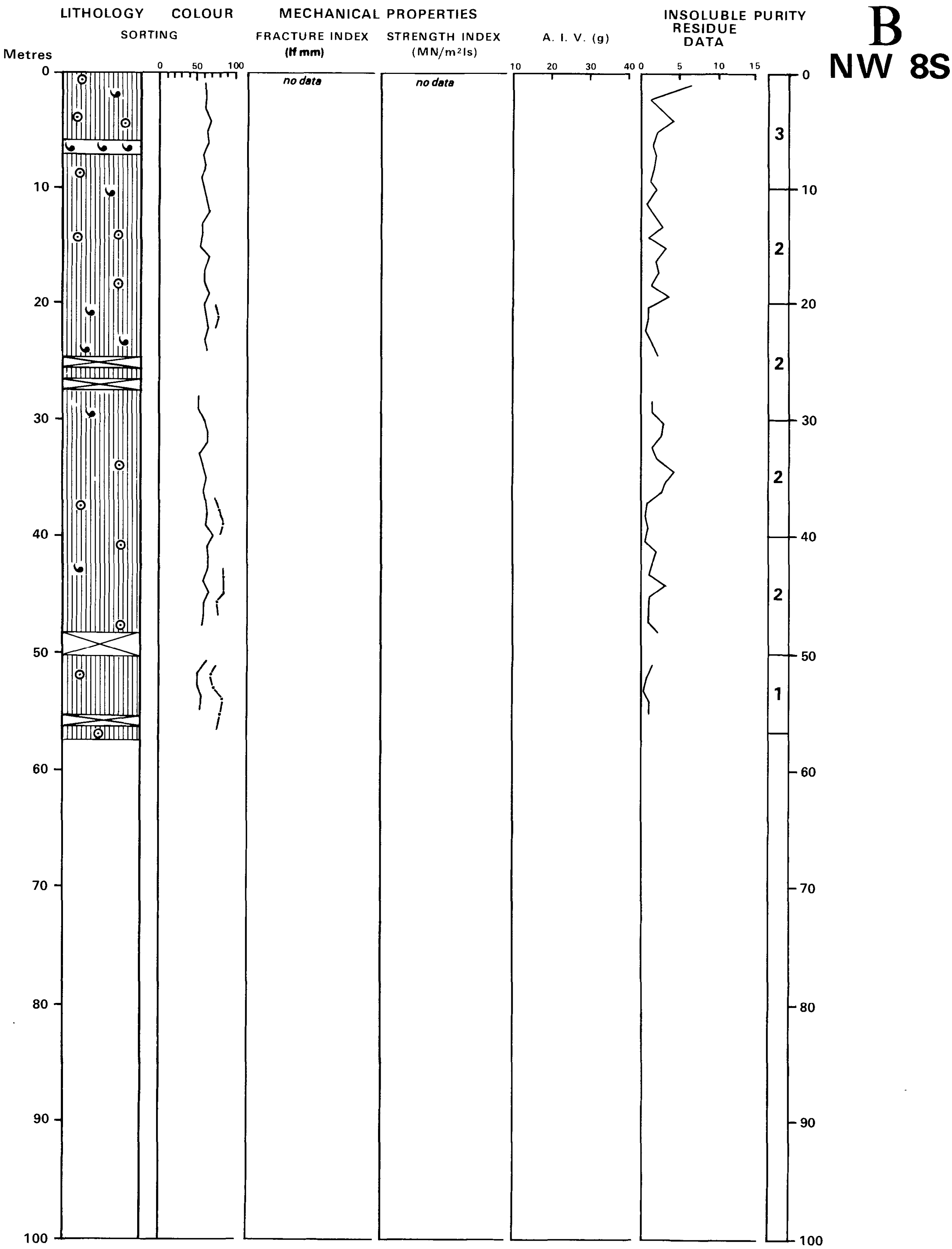
Base of section 57.60 m

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
3.00	32.80	0.0	0.04	0.02	0.09	19.10	0.06	0.04	0.02	0.07	2900
13.00	31.90	0.01	0.03	0.01	0.03	19.60	0.01	0.03	0.02	0.04	4300
32.00	31.00	0.02	0.04	0.01	0.0	21.10	0.02	0.03	0.0	0.04	3700
44.00	30.80	0.02	0.04	0.0	0.20	20.90	0.0	0.02	0.02	0.03	2300
53.00	30.60	0.02	0.04	0.0	0.0	20.20	0.01	0.02	0.01	0.03	2900

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
48.15	0	0	70	770	3.00
47.55	5	0	40	850	13.00
47.98	5	10	50	1000	32.00
48.21	5	0	30	650	44.00
48.00	5	10	40	1000	53.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX
(If mm)
STRENGTH INDEX
(MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
0
10
20
30
40
50
60
70
80
90
100
0 50 100
no data
no data
10 20 30 40
0 5 10 15
3
2
2
2
2
1
B
NW 8S

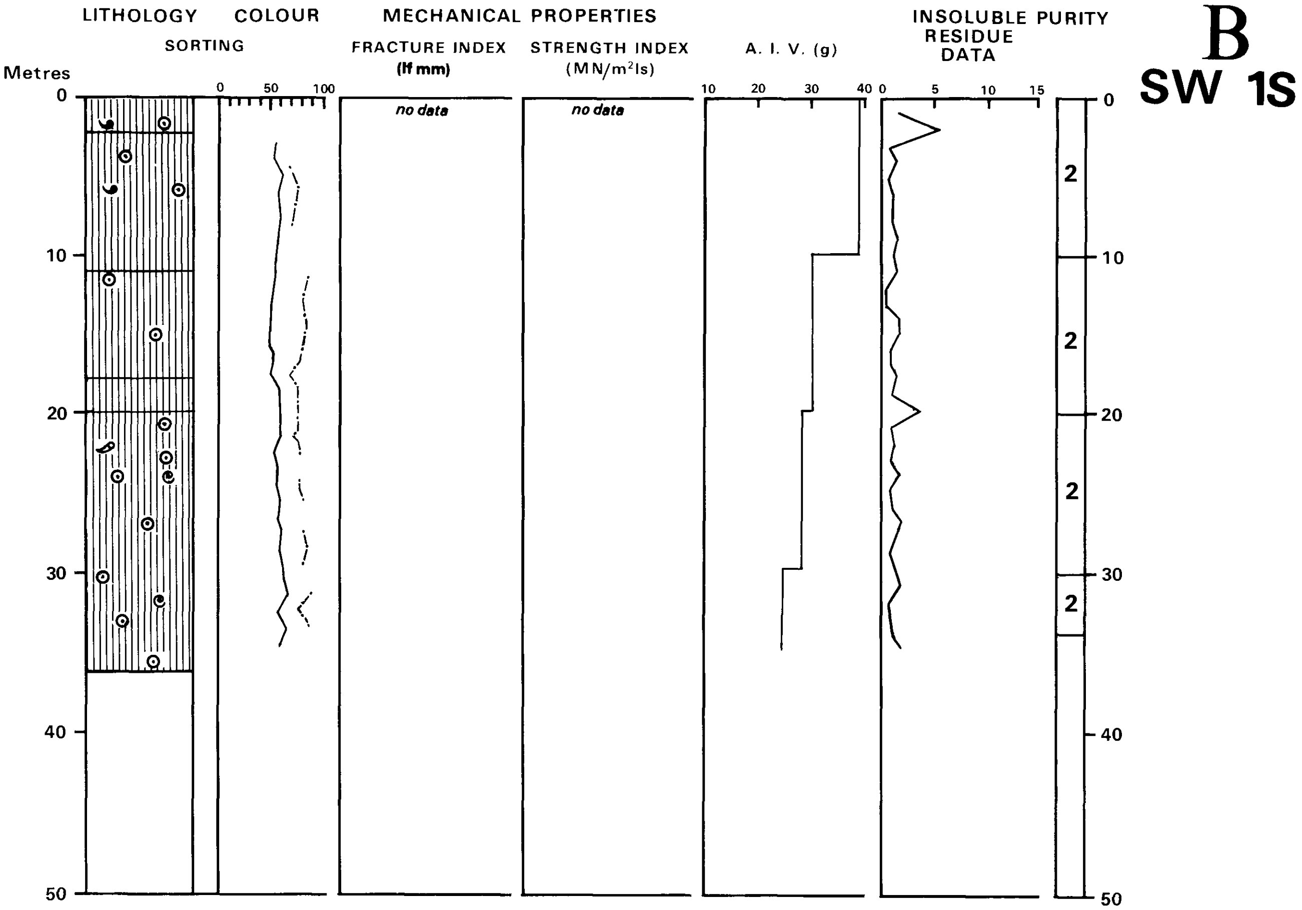
RESOURCE BLOCK B

SK 25 SW 1s 2189 5490 Rainster Rocks

Surface level +303.84 m

	Thickness	*Depth*
Bee Low Limestones: dolomite	m	m
Dolomite, buff-yellow, granular, vuggy, intense dolomitisation	2.20	2.20
Dolomite, buff-yellow, granular, vuggy, some crinoid, brachiopod and rare coral debris	33.95	36.15

Base of section 36.15 m



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
2.00	53.10	0.11	0.03	0.03	3.32	0.69	0.21	0.05	0.07	0.03	1500
5.00	32.20	0.01	0.03	0.02	0.16	19.10	0.0	0.0	0.02	0.03	3100
12.00	31.20	0.03	0.02	0.0	0.10	19.60	0.0	0.01	0.0	0.03	3400
20.00	30.90	0.0	0.04	0.01	0.02	19.70	0.0	0.0	0.01	0.07	3000
26.00	31.00	0.0	0.04	0.0	0.0	19.60	0.0	0.0	0.0	0.05	2200
31.00	32.00	0.0	0.02	0.01	0.02	18.90	0.0	0.0	0.0	0.10	3600

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
42.33	5	30	70	350	2.00
47.56	5	0	100	1500	5.00
47.49	5	0	40	1500	12.00
47.71	5	0	40	1700	20.00
47.95	5	0	20	1300	26.00
47.66	5	0	110	1400	31.00

RESOURCE BLOCK B

SK 25 SW 2s 2100 5420 Hipley Hill

Surface level +254.07 m

	Thickness m	*Depth* m
Bee Low Limestones: dolomite		
Dolomite, grey-yellow, vuggy, finely granular, some fine rudite crinoid and brachiopod debris	5.20	5.20
Gap	1.70	6.90
Dolomite, grey-yellow, vuggy, some fine rudite, shell, crinoid and coral debris	2.80	9.70
Gap	4.00	13.70
Dolomite, grey-yellow, vuggy, finely granular, rare bioclastic debris	2.40	16.10
Bee Low Limestones: apron-reef facies		
Biopelsparite, grey, fine to medium arenite pelletal and comminuted bioclastic debris, some rudite bioclasts, some *Koninckopora*, well sorted	2.10	18.20
Gap	2.70	20.90
Biomicrosparite, grey, some fine arenite comminuted crinoid, shell, foraminifera, pellet and bryozoan debris, microspar matrix, some geopetal cavities, some quartz euhedra	6.60	27.50
Pelsparite, medium grey, fine arenite pelletal and bioclastic debris, rare *Koninckopora* and *Girvanella* encrusted shell debris, well sorted	1.00	28.50
Biopelsparite algae, buff-grey, abundant medium arenite pellet and comminuted bioclastic debris, some rudite brachiopods, some *Koninckopora*, well sorted	2.50	31.00
Biomicrosparite, grey, rare coarse arenite–fine rudite shell and crinoid debris, some geopetal cavities	5.50	36.50
Biosparite bryozoa, buff-grey, abundant medium to coarse arenite brachiopod, bivalve, spine, crinoid, pellet, bryozoa, foraminifera, and *Girvanella* debris, well sorted	1.00	37.50
Biomicrolutite, grey, frequent lutite sized bioclasts, rare bryozoa, some geopetal cavities	2.00	39.50
Bee Low Limestones		
Biosparite Crinoid, grey, abundant fine arenite to medium rudite comminuted crinoid, brachiopod, foraminifera, and pelletal debris, common *Girvanella* encrusted shell debris, rare *Koninckopora* and bryozoa, intraformational breccia 39.50–40.50 m	5.00	44.50
Biopelsparite, buff-grey to grey-brown, fine to coarse arenite comminuted crinoid, shell, foraminifera, *Koninckopora* and pelletal debris, rare rudite crinoid debris, well sorted	12.00	56.50
Biosparite Crinoid, buff-grey, medium to coarse arenite comminuted crinoid and bioclastic debris	1.00	57.50

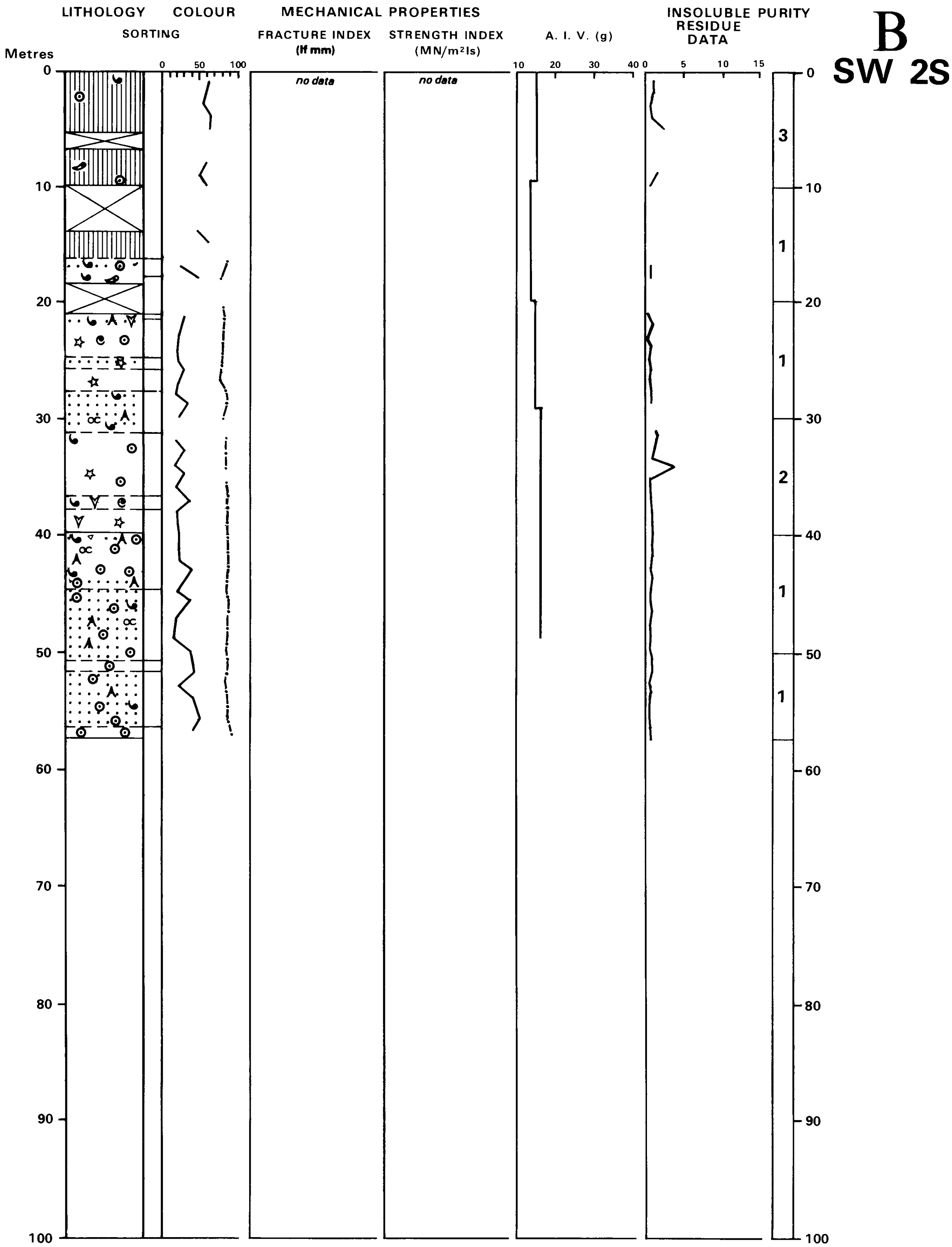
Base of section 57.50 m

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
3.00	30.70	0.01	0.03	0.02	0.27	19.40	0.03	0.01	0.01	0.07	1400
5.00	31.60	0.0	0.02	0.02	0.14	19.10	0.02	0.01	0.01	0.22	2400
14.00	31.80	0.01	0.05	0.02	0.18	18.60	0.04	0.02	0.01	0.11	1300
30.00	54.80	0.04	0.02	0.0	0.05	0.62	0.0	0.01	0.0	0.02	290
35.00	53.80	0.03	0.01	0.0	0.17	1.38	0.0	0.01	0.0	0.0	500
47.00	54.40	0.07	0.13	0.0	0.07	0.75	0.0	0.04	0.0	0.05	200

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
47.50	5	0	30	1200	3.00
47.14	10	30	100	2000	5.00
47.72	5	0	40	1100	14.00
44.05	0	0	10	210	30.00
44.17	0	0	30	370	35.00
43.98	0	0	10	130	47.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX
(If mm)
STRENGTH INDEX
(MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE
PURITY DATA
Metres
no data
no data
B
SW 2S

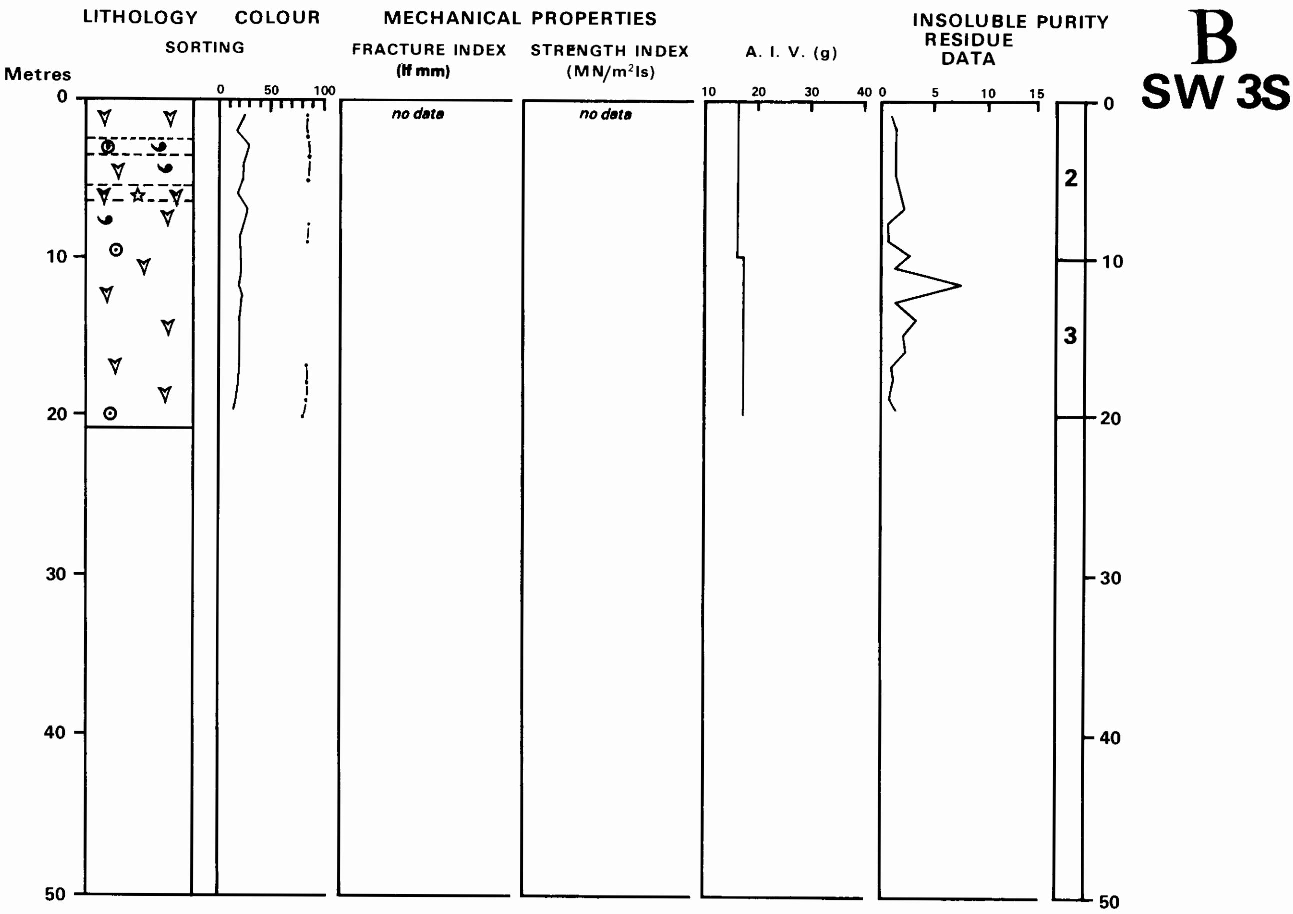
RESOURCE BLOCK B

SK 25 SW 3s 2482 5356 Carsington

Surface level +255.6 m

	Thickness m	*Depth* m
Bee Low Limestones: apron-reef facies		
Biomicrite Bryozoa, grey, rare fine arenite bioclasts	2.50	2.50
Biomicrite Crinoid, grey, some fine arenite to fine rudite crinoid debris, rare thin shelled brachiopod clasts	1.00	3.50
Biomicrite Bryozoa, grey, some arenite bryozoa, some geopetal cavities	3.00	6.50
Biomicrite bryozoa, grey, common fine to medium arenite comminuted thin-shelled brachiopod, bivalves, crinoid and bryozoan debris	14.30	20.80

Base of section 20.80 m



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
5.00	56.00	0.01	0.05	0.05	0.42	0.37	0.01	0.03	0.01	0.09	390
12.00	52.60	1.35	0.05	0.06	2.06	0.46	0.29	0.08	0.07	0.27	3500

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
43.75	5	50	20	310	5.00
40.63	50	80	110	320	12.00

RESOURCE BLOCK C

Source of data	*Registration number*	*Grid Reference*
IMAU boreholes (drilled by contractor)	NW 16	2209 5644
	NW 17	2219 5652
	NW 22	2125 5815
Major sections used in the assessment	NW 4s	2231 5608
	NW 10s	2051 5711
	NW 11s	2056 5763
	NW 12s	2337 5845

RESOURCE BLOCK C

SK 25 NW 16 2209 5644 Longcliffe

Surface level +337.11 m

	Thickness m	*Depth* m
Recent		
Topsoil, brown loamy clay	0.50	0.50
Clay, reddish brown with limestone fragments	1.50	2.00
Limestone, fragmented with red clay	1.28	3.28
Monsal Dale Limestones		
Biomicrite, buff-grey locally darker in bioturbational mottles, abundant medium arenite finely comminuted brachiopod, crinoid, spines and foraminifera, rare *Coelosporella* 3.28–4.00 m, *Girvanella* encrusted shell debris, rare coral and bryozoa at 4.27 m and 4.56 m. Some fine rudite brachiopod and crinoid debris, common euhedral quartz 4.51–4.60 m. Rubbly core, iron-stained, patchily silicified, and ochreous clay 4.60–10.30 m	7.02	10.30
Biopelsparite, medium grey-brown, medium arenite, some fine rudite brachiopod, crinoid and coral debris. Well sorted, fractured, iron-stained and patchily silicified	0.38	10.68
Biomicrite Crinoid, pale grey, alternating fine rudite, medium arenite bioclastic bands, current sorted, abundant crinoid debris, subordinate brachiopod and pelletal clasts	1.24	11.92
Biomicrite, buff-grey mottled bioturbations, common arenite shell, crinoid, foraminifera, spine and pelletal debris, some medium rudite thin-shelled brachiopods, rare *Coelosporella* 13.79 m. Some coral 13.95 m. Micrite matrix, spar developed in mottles. Patchily silicified bioclasts, rubbly core 14.17–17.20 m	5.28	17.20
Biomicrosparite, medium buff-grey, some bioturbational mottles, abundant fine to medium arenite comminuted crinoid, shell, spine, foraminifera and pellets, very fine spar matrix with patchy micrite, some coral, *Coelosporella* and rare bryozoa and *Girvanella*. Abundant pelletal debris 22.29–22.73 m	5.53	22.73
Lower Matlock Lava		
Basalt, altered, calcitised, ochreous clay at top and base	8.14	30.87
Monsal Dale Limestones		
Biosparite, silicified, mosaic of anhedral quartz crystals, rare arenite crinoid debris	0.15	31.02

Borehole complete at 31.02 m

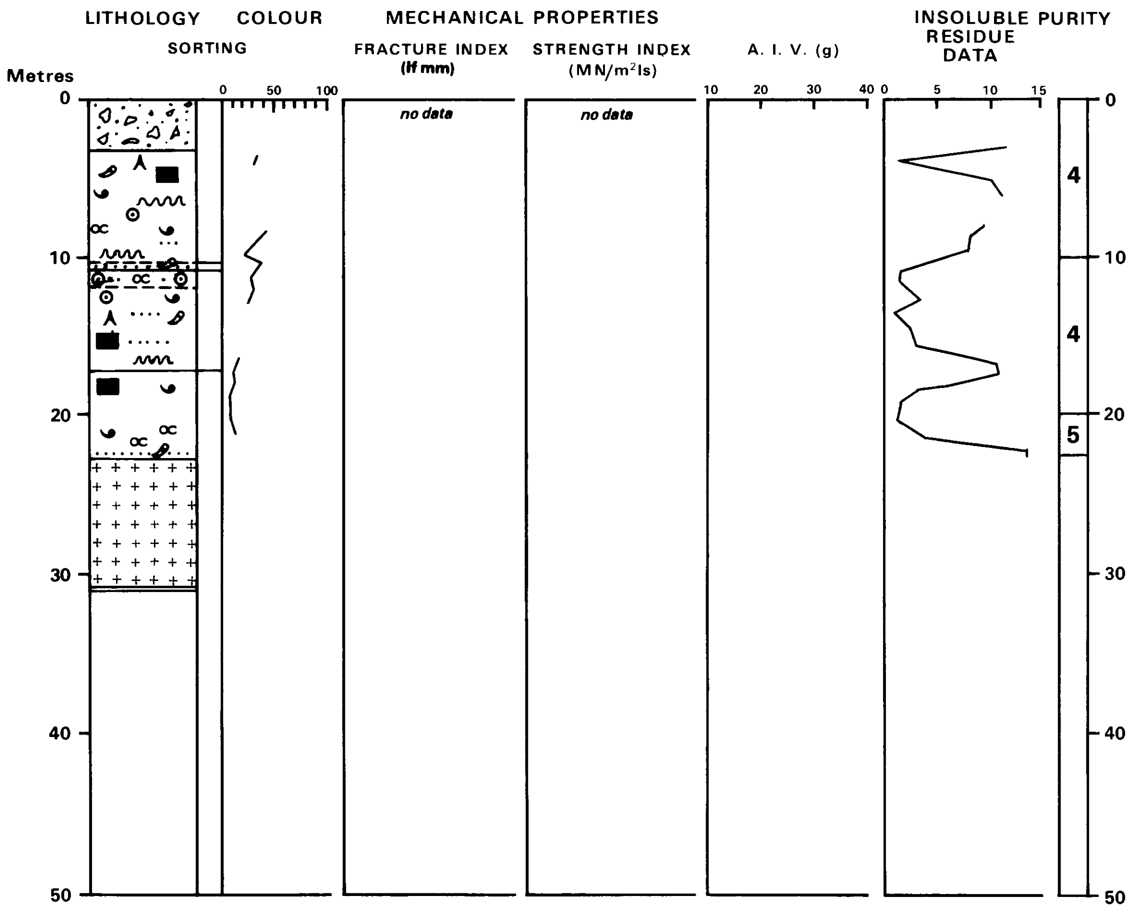
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
3.00	53.20	0.11	0.04	0.09	6.50	0.38	1.81	0.18	0.07	0.04	15200
9.00	52.60	0.01	0.02	0.55	6.00	0.19	0.29	0.04	0.03	0.01	5500
10.00	54.00	0.07	0.02	1.39	2.60	0.20	0.19	0.03	0.03	0.01	4800
11.00	55.40	0.01	0.0	0.31	0.80	0.23	0.04	0.01	0.02	0.02	1800
13.00	56.30	0.01	0.01	1.05	1.63	0.21	0.07	0.02	0.02	0.04	2300
19.00	54.30	0.09	0.01	0.19	2.00	0.38	0.24	0.04	0.07	0.02	3100
22.00	52.60	0.06	0.01	0.04	2.50	0.44	0.62	0.08	0.02	0.01	6900
23.00	45.00	0.13	0.05	0.03	9.50	4.00	0.26	0.02	0.01	0.01	6700
31.00	35.30	0.46	0.03	0.13	19.00	0.59	8.60	1.22	0.07	0.08	26200

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
39.35	20	150	250	1000	3.00
41.08	10	120	100	750	9.00
40.25	10	120	120	750	10.00
43.09	5	30	40	250	11.00
41.88	5	20	40	700	13.00
42.00	5	340	30	550	19.00
41.19	5	10	20	600	22.00
39.79	20	60	620	1900	23.00
30.68	20	0	50	1150	31.00

Resource Block C   SK 25 NW 16   2209 5644   Longcliffe



C
NW 16

RESOURCE BLOCK C

SK 25 NW 17 2219 5652 Longcliffe

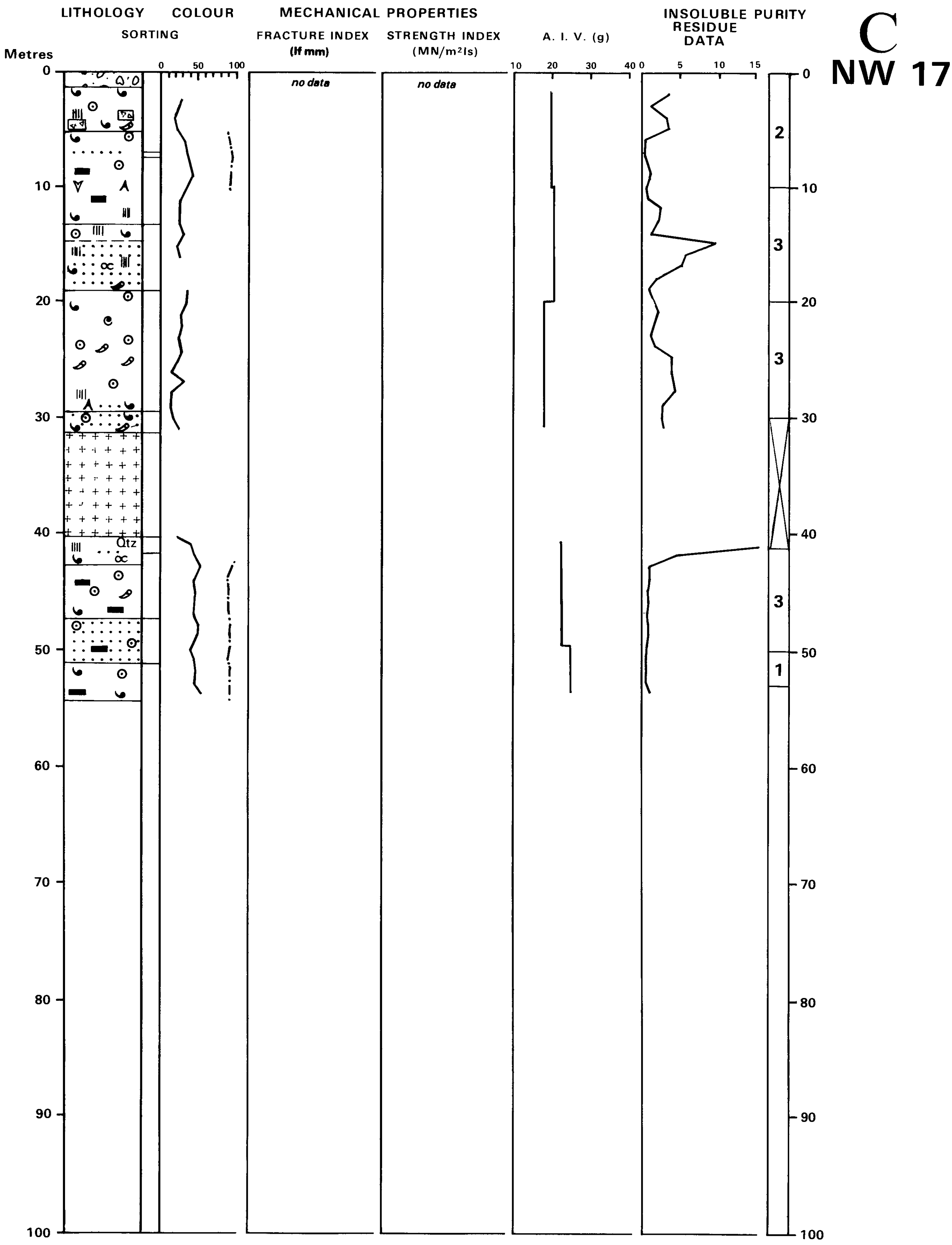
Surface level +337.11 m
Boyles Rig 74-mm diameter
February 1971

	Thickness m	*Depth* m
Recent		
Topsoil, brown loamy-clay with limestone fragments	1.00	1.00
Monsal Dale Limestones		
Limestone, chippings	1.30	2.30
Biomicrudite Brachiopod, buff-grey to grey-brown, abundant bioclasts, predominantly medium rudite thick-shelled brachiopods, fine rudite slender brachiopod debris, subordinate fine rudite crinoid debris, fine to medium arenite spines, foraminifera, comminuted shell and crinoid and pelletal debris. Colonial coral 4.66 m, patchily silicified shell debris, some thin leaves and patches of interbedded tuff 2.80–5.04 m, locally dolomitised below 3.61 m	2.74	5.04
Biomicrite Crinoid, buff-grey to medium grey in bioturbational mottles, abundant fine rudite brachiopod and crinoid debris, medium arenite spine, foraminifera and pelletal debris. Rare bryozoa at 7.70, 8.42, 10.47 m. Common *Coelosporella* 6.37, 8.78, 10.46 m. Some *Girvanella* encrusted bioclasts, some coarse rudite brachiopods 12.64–12.97 m, patchily dolomitised 12.24–13.21 m, rare silicified brachiopod debris	8.17	13.21
Biosparite Crinoid, grey-brown, coarse arenite crinoid and shell debris, subordinate pellet and coral clasts, patchily dolomitised, rare silicified brachiopod debris	1.43	14.64
Biopelsparite Brachiopod, grey-brown, medium arenite, some rudite brachiopod debris, rarely *Girvanella* encrusted, well sorted, locally intensely dolomitised 15.10–17.50 m	4.18	18.82
Biomicrite Crinoid Brachiopod coral, buff-grey, coarse arenite to fine rudite brachiopod, crinoid, spine, foraminifera and pelletal debris, coral band 23.44 m, 24.90 m and 25.28 m, some *Girvanella* encrusted brachiopod debris, common clay-filled stylolites 21.60–23.00 m, patchily silicified shell debris, patchy dolomitisation and saccharoidal quartz 26.50–29.00 m	10.62	29.44
Biopelsparite, medium grey becoming buff-grey, abundant fine arenite pelletal debris, common coarse arenite to fine rudite crinoid and shell debris, rare encrusting coral and encrusting *Girvanella,* well sorted, saccharoidal silicification in lower 0.1 m	1.62	31.06
Lower Matlock Lava		
Basalt, grey-green, amygdaloidal, calcitised, ochreous clay at top and base, abundant pyrite	9.16	40.22
Monsal Dale Limestones		
Biosparite, pale buff-grey, medium arenite crinoid and shell debris, common euhedral quartz, rare flecks of pyrite, patchy dolomitisation	2.55	42.77
Biomicrite, buff-grey, coarse arenite crinoid, shell, spines, foraminifera and rare bryozoa, locally intense bioturbational mottling	4.63	47.30
Biosparite Pellet, medium arenite crinoid debris, common pelletal debris, well sorted, local bioturbational mottling	3.70	51.00
Biomicrite, buff-grey, coarse arenite to fine rudite brachiopod and crinoid debris, locally bioturbated, some quartz euhedra	3.56	54.56

Borehole complete at 51.56 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
3.00	54.70	0.01	0.03	0.01	0.65	0.33	0.20	0.03	0.09	0.07	1300	43.56	5	0	20	90	3.00
6.00	55.00	0.0	0.03	0.01	0.38	0.24	0.05	0.01	0.07	0.06	1300	43.70	10	10	30	230	6.00
10.00	54.80	0.0	0.02	0.0	0.43	0.18	0.03	0.01	0.10	0.03	2300	43.68	5	0	20	420	10.00
13.00	53.90	0.01	0.03	0.01	0.59	1.41	0.08	0.01	0.03	0.07	7100	43.70	5	0	30	1200	13.00
20.00	55.00	0.01	0.02	0.0	0.95	0.27	0.06	0.01	0.01	0.08	1100	43.44	10	10	40	340	20.00
25.00	54.10	0.02	0.03	0.03	2.74	0.35	0.26	0.04	0.04	0.10	2100	42.39	10	75	70	610	25.00
30.00	54.10	0.05	0.02	0.01	1.08	0.42	0.31	0.04	0.02	0.07	2900	43.11	10	0	40	560	30.00
43.00	55.70	0.01	0.02	0.0	0.72	0.19	0.0	0.0	0.01	0.08	400	43.55	10	0	20	110	43.00
45.00	55.10	0.0	0.03	0.0	0.41	0.20	0.05	0.01	0.08	0.05	800	43.82	10	0	20	70	45.00
50.00	55.10	0.01	0.03	0.01	0.10	0.26	0.0	0.0	0.0	0.08	600	43.81	10	0	20	80	50.00
54.00	54.90	0.0	0.02	0.0	0.27	0.21	0.0	0.0	0.0	0.07	300	43.71	10	0	20	100	54.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX
(If mm)
STRENGTH INDEX
(MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
0
10
20
30
40
50
60
70
80
90
100
no data
no data
Qtz
2
3
3
3
1
C
NW 17

RESOURCE BLOCK C

SK 25 NW 22 2125 5815 Aldwark

Surface level +326.2 m
Dando 250 rig, waterflush, 47-mm core diameter
November 1975

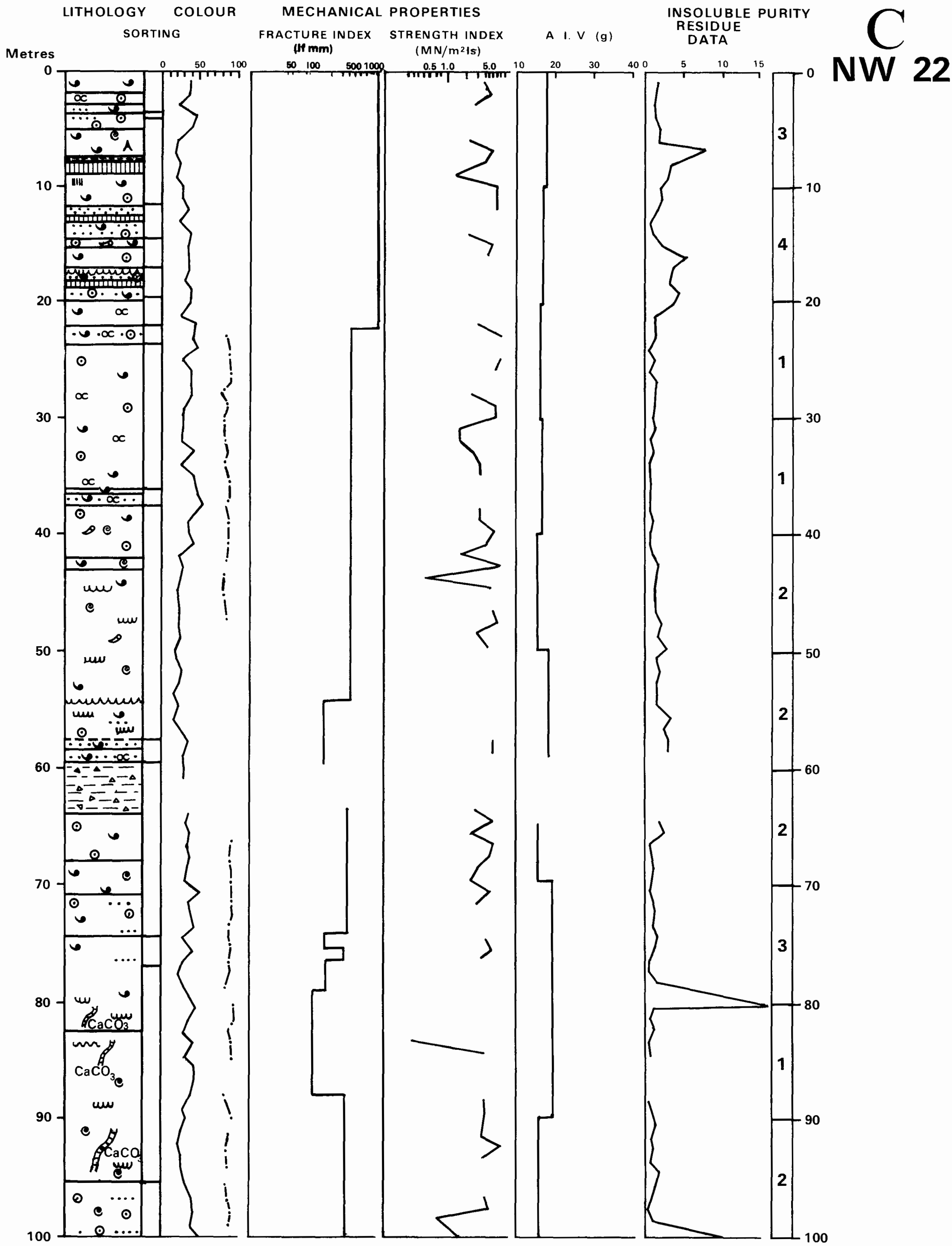
	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrite Brachiopod, pale grey, abundant medium arenite comminuted bioclasts, common rudite brachiopods, some crinoid debris	1.70	1.70
Biosparite Crinoid, pale grey mottled, medium arenite crinoid, algal encrusted brachiopods and foraminifera	1.04	2.74
Biosparite Brachiopod Pellet, medium grey, some rudite brachiopods	0.84	3.58
Biomicrite Crinoid, pale grey, fine to coarse arenite	1.47	5.05
Biosparite Brachiopod, medium grey, arenite brachiopod, crinoid and foraminiferal debris, rare rudite brachiopods	2.23	7.28
Mudstone, reddish-green	0.54	7.82
Dolomite, vuggy, iron staining	1.18	9.00
Biosparite Crinoid Brachiopod, pale grey mottled, fine arenite, patchy dolomitisation	2.59	11.59
Pelsparite, pale grey, fine arenite, well sorted	0.89	12.48
Dolomite, vuggy, iron stained	0.52	13.00
Biopelsparite, pale grey, fine to medium arenite pellet and comminuted crinoid and algal encrusted shell debris, well sorted	1.45	14.45
Biosparite Crinoid, pale grey, medium arenite, rare *Syringopora*	0.75	15.20
Biomicrite, pale grey, fine arenite	1.80	17.00
Biopelsparite, pale grey, fine arenite pellet, brachiopod and crinoid debris, thin grey clay parting 17.30 m, well sorted	1.07	18.07
Dolomite, granular, completely recrystallised	0.58	18.65
Biopelsparite, pale grey, fine arenite, well sorted	1.05	19.70
Biosparite Brachiopod algae, pale grey, abundant comminuted algae encrusted brachiopod debris, subordinate pelletal material, common quartz euhedra	2.20	21.90
Biopelsparite, pale grey, medium arenite comminuted brachiopod, crinoid debris and algae corroded pellets, well sorted	1.60	23.50
Biosparite Brachiopod, pale grey locally mottled, common algae corroded bioclasts, patchy dolomitisation adjacent to fissures	12.53	36.03
Biosparite, pale grey, very fine arenite, well sorted, laminated	0.47	36.50
Pelsparite algae, pale grey, common arenite rounded algae-corroded shell debris, well sorted	1.05	37.55
Biosparite Crinoid, pale grey, abundant arenite comminuted crinoid, shell, foraminifera and pelletal debris	4.45	42.00
Biosparite Brachiopod, medium grey, medium arenite	1.12	43.12
Biomicrite, medium to dark grey, fine to coarse arenite comminuted brachiopod, foraminifera and crinoid debris, some coral and pelletal material, common brown clay partings and clay infilled stylolites	14.38	57.50
Pelsparite, pale grey, fine arenite, some brachiopod and foraminiferal debris, well sorted	0.83	58.23
Biosparite Brachiopod Pellet, pale grey, medium arenite algae encrusted brachiopod and pellet debris, well sorted	1.12	59.35
Winstermoor Lava		
Clay, green and reddish brown with weathered basalt fragments	4.41	63.76
Bee Low Limestones		
Biosparite Crinoid, pale grey, medium arenite crinoid and algae encrusted brachiopod clasts	3.96	67.72
Biomicrite Brachiopod, pale grey, medium arenite	3.01	70.73
Biosparite Crinoid, pale grey, medium arenite crinoid, brachiopod and pelletal debris	3.67	74.40
Biosparite, pale grey, abundant lutite to fine arenite comminuted bioclasts, some quartz euhedra, rubbly, calcite mineralised with clay partings 79.80–82.70 m	8.30	82.70
Biomicrite, pale grey, lutite bioclasts, some arenite foraminifera, brecciated and calcite mineralised	13.17	95.87
Biosparite Crinoid, pale grey, abundant fine arenite comminuted crinoid, shell and pelletal debris, well sorted	4.52	100.39

Borehole complete at 100.39 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
7.00	53.00	0.02	0.01	0.06	4.56	0.30	1.20	0.17	0.08	0.0	4000	41.13	5	5	5	140	7.00
13.00	53.90	0.0	0.01	0.03	0.37	0.19	0.02	0.02	0.01	0.0	3800	44.18	5	0	35	890	13.00
27.00	55.50	0.32	0.0	0.01	0.42	0.20	0.03	0.02	0.05	0.0	1600	43.15	5	5	10	750	27.00
43.00	55.50	0.03	0.0	0.01	0.67	0.38	0.28	0.05	0.03	0.02	1300	43.54	5	10	10	110	43.00
50.00	55.10	0.17	0.0	0.03	0.96	0.46	0.31	0.07	0.05	0.04	4300	42.93	10	20	35	560	50.00
76.00	56.20	0.03	0.0	0.0	0.34	0.28	0.03	0.02	0.05	0.0	1700	43.77	10	0	10	460	76.00
80.00	50.20	0.25	0.02	0.06	6.05	0.35	2.96	0.03	0.08	0.05	18600	39.48	35	350	500	1220	80.00
95.00	55.10	0.04	0.0	0.01	0.93	0.24	0.57	0.09	0.03	0.0	1300	43.31	5	10	10	190	95.00

Resource Block C SK 25 NW 22 2125 5815 Aldwark



RESOURCE BLOCK C

SK 25 NW 4s 2231 5608 Hoe Grange Quarry

Surface level +341.32 m

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrosparite, buff-grey, common medium arenite crinoid and brachiopod debris, bioclasts selectively silicified, common chert nodules	2.50	2.50
Biomicrosparite Foraminifera, pale grey, frequent fine arenite foraminifera and comminuted shell and crinoid debris, bioclasts selectively silicified	2.10	4.60
Dolomite, grey-brown, vuggy, some crinoid and shell debris, patchily developed euhedral quartz	0.90	5.50
Biomicrosparite Dolomitised, grey, common fine to coarse arenite crinoid and shell debris, patchily dolomitised, shell debris patchily silicified	1.00	6.50
Biomicrite, pale grey, medium to coarse arenite crinoid and shell debris, common chert nodules, bioclasts selectively	2.30	8.80
silicified Clay	0.30	9.10
Biomicrite, grey, common fine arenite bioclastic debris, rare chert nodules	1.40	10.50
Dolomite, pale-buff, granular	1.40	11.90
Clay, greenish grey	0.05	11.95
Biomicrite, dark grey, common medium arenite to medium rudite patchily silicified brachiopod debris	2.45	14.40
Dolomite, pale grey	1.10	15.50
Biomicrite Crinoid Dolomitised, pale yellow-grey common medium arenite crinoid and shell debris	0.60	16.10
Gap	7.70	23.80
Biomicrite Brachiopod, pale and medium grey mottled, fine to coarse arenite bioclastic debris, brachiopods patchily silicified	1.00	24.80
Biointrasparite, pale grey, fine to medium arenite brachiopod, foraminifera and crinoid debris, frequent medium arenite rounded intraclasts, well sorted	3.00	27.80
Biomicrite, buff-grey, common fine to medium arenite brachiopod and crinoid debris	2.70	30.50
Clay, green, laminated	0.10	30.60
Biomicrosparite, buff-grey, abundant arenite brachiopod, crinoid and foraminiferal debris, rare pelletal and coral debris, brachiopods patchily silicified	4.90	35.50
Biomicrudite Brachiopod, pale buff–medium grey mottled, common medium arenite to medium rudite brachiopod, crinoid and foraminiferal debris	2.00	37.50
Biomicrosparite, medium grey, common fine arenite crinoid and comminuted shell debris	1.10	38.60

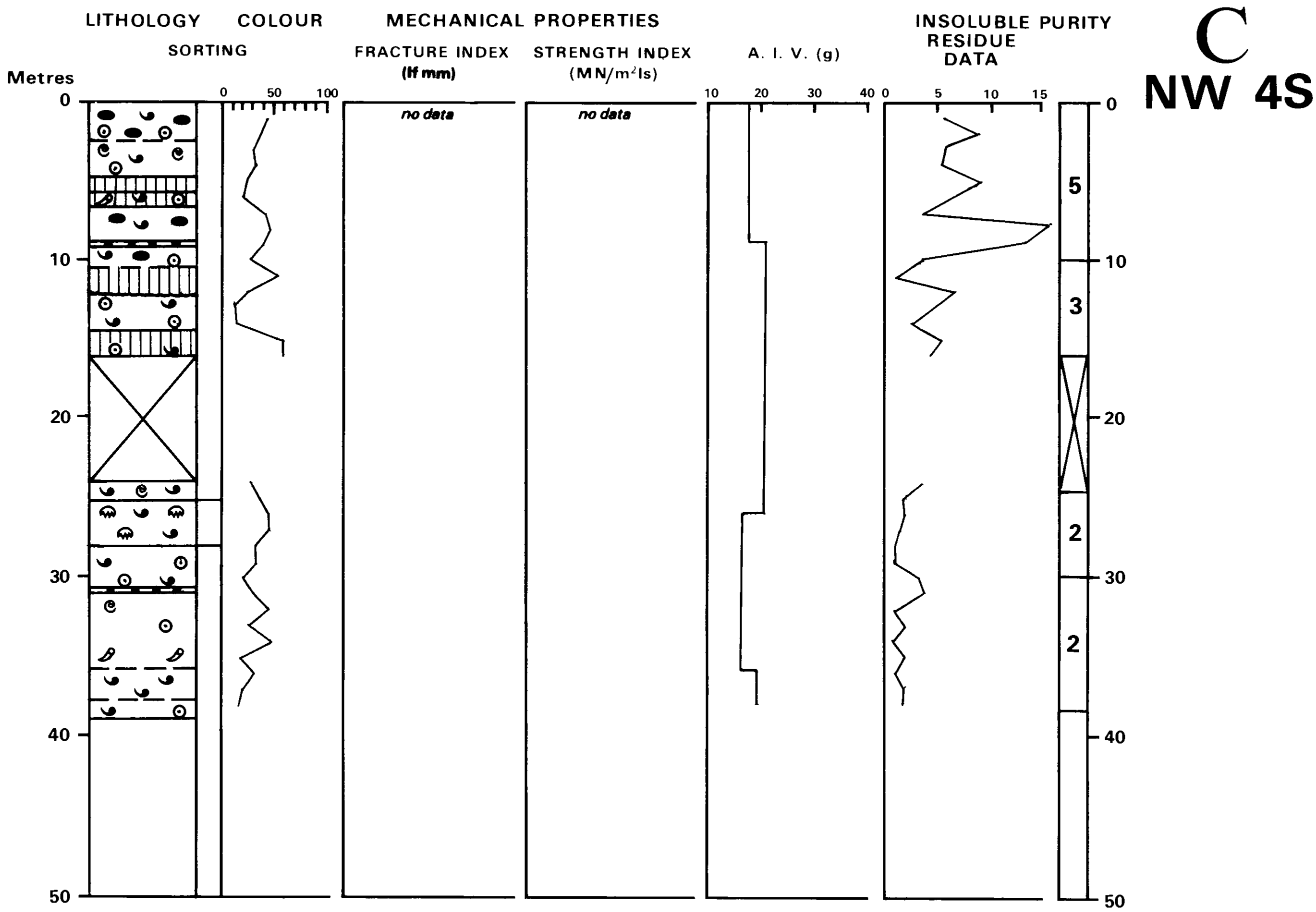
Base of section 38.60 m

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
2.00	51.40	0.0	0.01	0.01	8.30	0.29	0.40	0.07	0.09	0.06	7900
3.00	54.60	0.0	0.0	0.01	2.4[illegible]	0.30	0.18	0.03	0.06	p.04	2900
8.00	44.50	0.17	0.02	0.51	17.20	[illegible].68	0.60	0.13	0.12	0.05	6300
10.00	54.60	0.0	0.0	0.01	2.40	0.38	0.33	0.04	0.08	0.02	2100
11.00	54.30	0.07	0.01	0.04	2.61	0.55	0.36	0.04	0.09	0.03	4600
13.00	32.60	0.0	0.02	0.0	0.35	19.50	0.0	0.0	0.0	0.08	9400
15.00	30.80	0.0	0.04	0.05	3.61	18.60	0.36	0.06	0.0	0.05	5100
27.00	55.30	0.0	0.0	0.01	1.05	0.27	0.06	p.01	0.04	0.02	1300
31.00	53.70	0.0	0.0	0.0	3.02	0.27	0.17	0.02	0.04	0.01	1700
36.00	54.80	0.0	0.01	0.01	1.30	0.36	0.17	0.03	0.05	0.03	1200

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
39.98	0	30	60	730	2.00
42.78	0	10	40	190	3.00
33.46	5	100	310	870	8.00
42.80	0	10	10	110	10.00
47.05	0	0	20	850	11.00
42.60	0	10	20	140	13.00
45.61	0	80	80	650	15.00
43.51	0	0	30	150	27.00
42.43	10	120	30	370	31.00
43.40	0	10	10	110	36.00



LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX (If mm)
STRENGTH INDEX (MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE
PURITY DATA
Metres
0
10
20
30
40
50
0 50 100
no data
no data
10 20 30 40
0 5 10 15
5
3
2
2
C
NW 4S

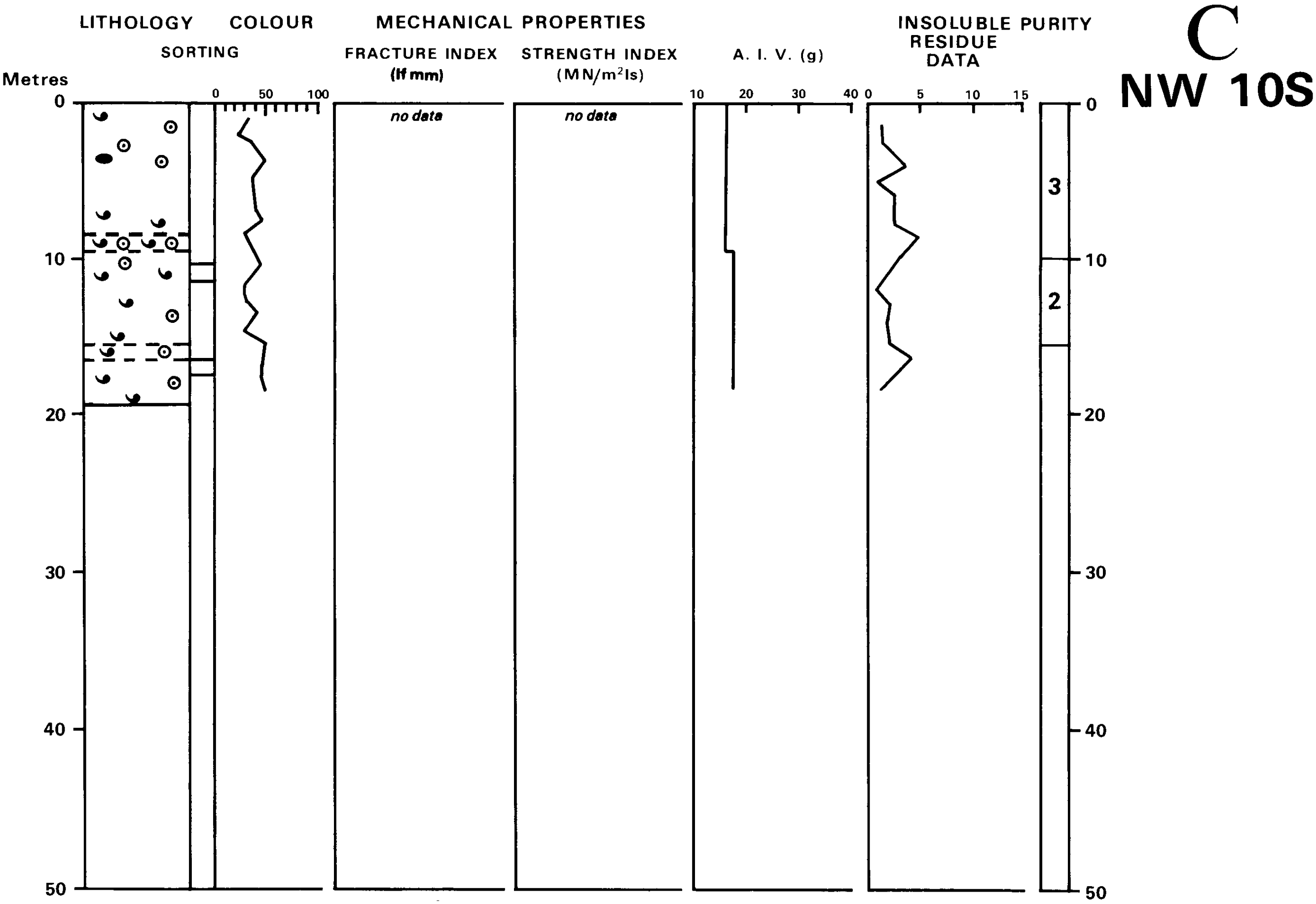
RESOURCE BLOCK C

SK 25 NW 10s 2051 5711 Roystone Grange Quarry

Surface level +331.25 m

Monsal Dale Limestones	*Thickness* m	*Depth* m
Biomicrite, grey mottled, fine to medium arenite bioclastic	2.50	2.50
Biosparite Crinoid, buff-grey, abundant fine to coarse arenite crinoid and brachiopod debris, some fine arenite foraminifera and pellets, patchy dolomitisation, rare nodular chert at 3.5 m	4.00	6.50
Biomicrosparudite Brachiopod, buff-grey, common medium rudite brachiopods, subordinate fine to medium arenite crinoid and comminuted shell debris	2.00	8.50
Biosparite Brachiopod crinoid, grey, fine to medium arenite bioclastic, patchily dolomitised	1.00	9.50
Biosparite, pale grey, locally mottled, abundant fine arenite to medium rudite comminuted bioclastic debris, locally well sorted, matrix predominantly spar with some admixed micrite	6.00	15.50
Biosparite, buff-grey, fine to medium arenite comminuted crinoid and brachiopod debris, patchily dolomitised	1.00	16.50
Biosparite, buff-grey, fine to coarse arenite brachiopod and crinoid debris	2.80	19.30

Base of section 19.30 m



Chemical analyses of major elements (percentages)

Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
1.00	54.30	0.10	0.01	0.0	1.17	0.34	0.08	0.04	0.04	0.03	2500	43.38	5	0	20	390	1.00
4.00	53.50	0.11	0.01	0.01	2.58	0.66	0.06	0.03	0.04	0.02	5700	42.56	5	0	10	770	4.00
9.00	52.90	0.12	0.0	0.02	2.70	0.75	0.28	0.06	0.04	0.04	4800	42.47	15	0	30	1150	9.00
13.00	54.40	0.18	0.02	0.02	1.24	0.39	0.30	0.06	0.08	0.05	2600	43.21	10	10	40	350	13.00
17.00	53.40	0.07	0.01	0.01	2.45	0.32	0.09	0.04	0.03	0.01	4900	42.60	10	0	10	1450	17.00

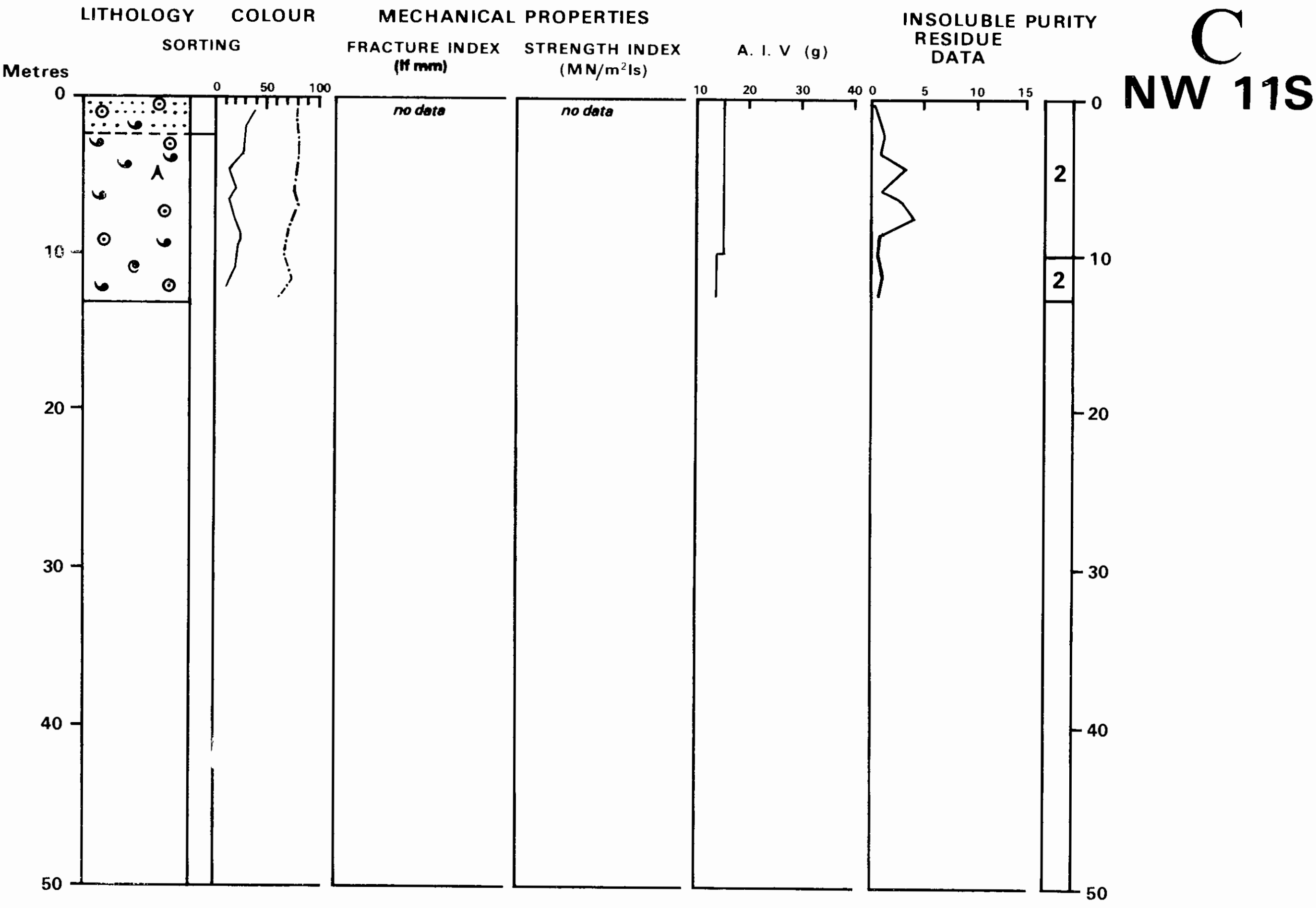
RESOURCE BLOCK C

SK 25 NW 11s 2056 5763 Minninglow Quarry

Surface level 340.68 m

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biopelsparite, buff, fine to medium arenite foraminifera, crinoid and shell debris, well sorted	2.50	2.50
Biosparite, buff-grey, common arenite brachiopod and crinoid debris, some rudite brachiopod debris, some arenite foraminifera and *Koninckopora*, matrix predominantly spar with minor microspar and micrite, locally patchily dolomitised	6.00	8.50
Biomicrite, buff-grey, dark grey at base, abundant arenite comminuted bioclasts, matrix predominantly micrite	4.65	13.15

Base of section 13.15 m



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
2.00	55.20	0.09	0.0	0.0	0.50	0.28	0.01	0.02	0.04	0.01	1800
5.00	54.60	0.10	0.01	0.02	1.31	0.43	0.06	0.03	0.04	0.04	3800
8.00	52.80	0.07	0.02	0.01	2.74	0.42	0.13	0.04	0.05	0.03	6000
12.00	54.60	0.07	0.01	0.02	0.54	0.46	0.14	0.05	0.06	0.04	2100

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
43.76	0	0	20	270	2.00
43.15	10	0	10	770	5.00
42.08	10	130	190	1150	8.00
43.72	10	30	30	230	12.00

RESOURCE BLOCK C

SK 25 NW 12s 2337 5845 Ivonbrook Quarry

Surface level 303.69 m

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biosparudite Brachiopod Crinoid, grey-brown, abundant coarse arenite to rudite brachiopod and crinoid debris	0.50	0.50
Biopelsparite, buff-grey, common fine to coarse arenite comminuted bioclastic debris, well sorted	3.00	3.50
Biopelsparite Brachiopod algal, brachiopod debris commonly encrusted with *Girvanella*	2.00	5.50
Biopelsparite Brachiopod, some rudite brachiopod debris, common euhedral quartz	3.00	8.50
Biopelsparite Brachiopod algal, brachiopod debris commonly corroded and encrusted with *Girvanella*	1.00	9.50
Biopelsparite, buff-grey, very fine arenite pelletal and comminuted bioclastic debris, bioclasts locally patchily silicified	4.30	13.80
Biosparite, buff-grey, abundant fine to medium arenite comminuted bioclastic debris, common spines 13.80–14.50 m, patchy silicification of shell debris	3.70	17.50
Biopelsparite Brachiopod algal, buff-grey, common fine arenite comminuted bioclastic and pelletal debris, common coarse arenite–fine rudite *Girvanella* encrusted, brachiopod debris, locally common euhedral quartz, patchy silicification of brachiopod debris	6.90	24.40
Biosparrudite Brachiopod, buff–grey, common rudite brachiopod debris and some crinoid debris, common arenite comminuted bioclasts	1.10	25.50
Biomicrite Brachiopod, pale grey, common coarse arenite–fine rudite brachiopod debris	0.70	26.20
Clay	0.25	26.45
Biosparite, buff-grey, abundant arenite comminuted bioclastic debris, abundant quartz euhedra	0.35	26.80
Clay	0.30	27.10
Pelsparite, medium grey, very well sorted, some quartz euhedra	1.00	28.10
Clay	0.50	28.60
Biosparite Pellet, buff-grey (darker in mottles), abundant fine arenite comminuted bioclastic debris, well sorted	0.30	28.90
Gap	9.80	38.70
Biopelsparite Brachiopod algal, buff, fine to coarse arenite bioclastic brachiopod debris commonly *Girvanella* encrusted, well sorted	0.80	39.50
Biosparite Brachiopod Pellet, buff-grey, fine arenite to medium rudite bioclastic, rare euhedral quartz	2.00	41.50
Pelsparite Brachiopod, fine to coarse arenite, well sorted	2.00	43.50
Biosparite Brachiopod Algal, buff-grey, coarse arenite, common *Coelosporella,* common tiny quartz euhedra	1.00	44.50
Biopelsparite, buff-grey, fine to coarse arenite, some *Girvanella* encrusted brachiopod debris, some *Coelosporella*	4.40	48.90

Base of section at 48.90 m

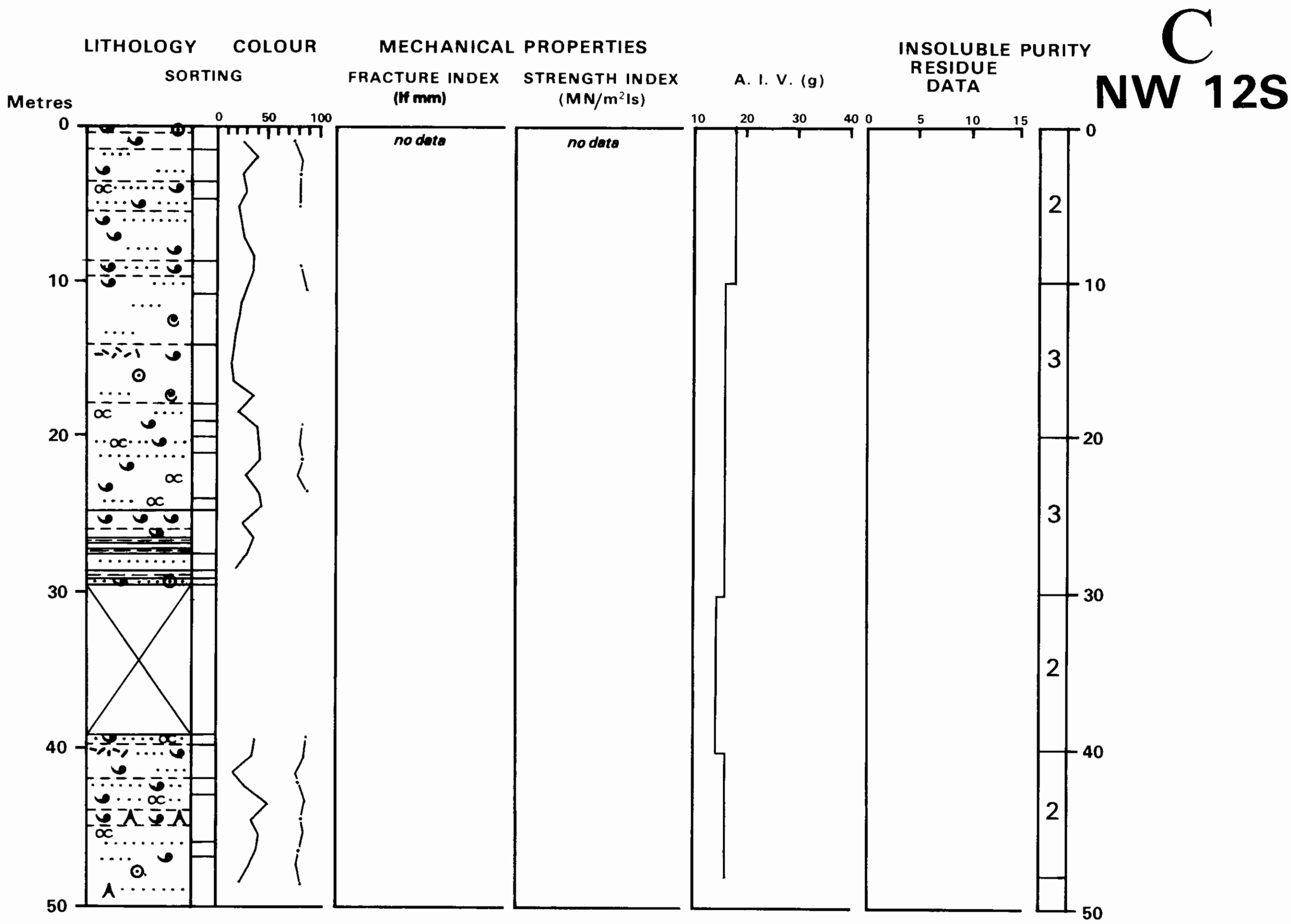
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
6.00	54.30	0.01	0.01	0.0	2.18	0.24	0.06	0.02	0.02	0.0	450
14.00	53.80	0.01	0.02	0.02	1.62	0.38	0.29	0.07	0.03	0.13	550
17.00	54.00	0.01	0.01	0.0	2.94	0.20	0.06	0.02	0.03	0.0	720
21.00	54.70	0.0	0.01	0.0	0.58	0.18	0.06	0.02	0.0	p.0	310
27.00	53.00	0.23	0.04	0.0	2.91	0.23	0.40	0.07	0.01	0.0	1800
43.00	54.50	0.0	0.01	0.0	1.78	0.16	0.02	0.01	0.0	0.0	250

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
42.84	0	0	20	150	6.00
43.07	0	0	30	180	14.00
42.47	0	60	40	220	17.00
43.72	5	0	20	180	21.00
42.11	5	0	10	160	27.00
43.23	0	0	20	110	43.00

Resource Block C SK 25 NW 12s 2237 5845 Ivonbrook Quarry



RESOURCE BLOCK D

Source of data	*Registration number*	*Grid Reference*
IMAU boreholes (drilled by contractor)	NE 41	2587 5795
Major sections used in the assessment	NE 9s	2650 5682

RESOURCE BLOCK D

SK 25 NE 41 2587 5795 Bottom Leys Farm

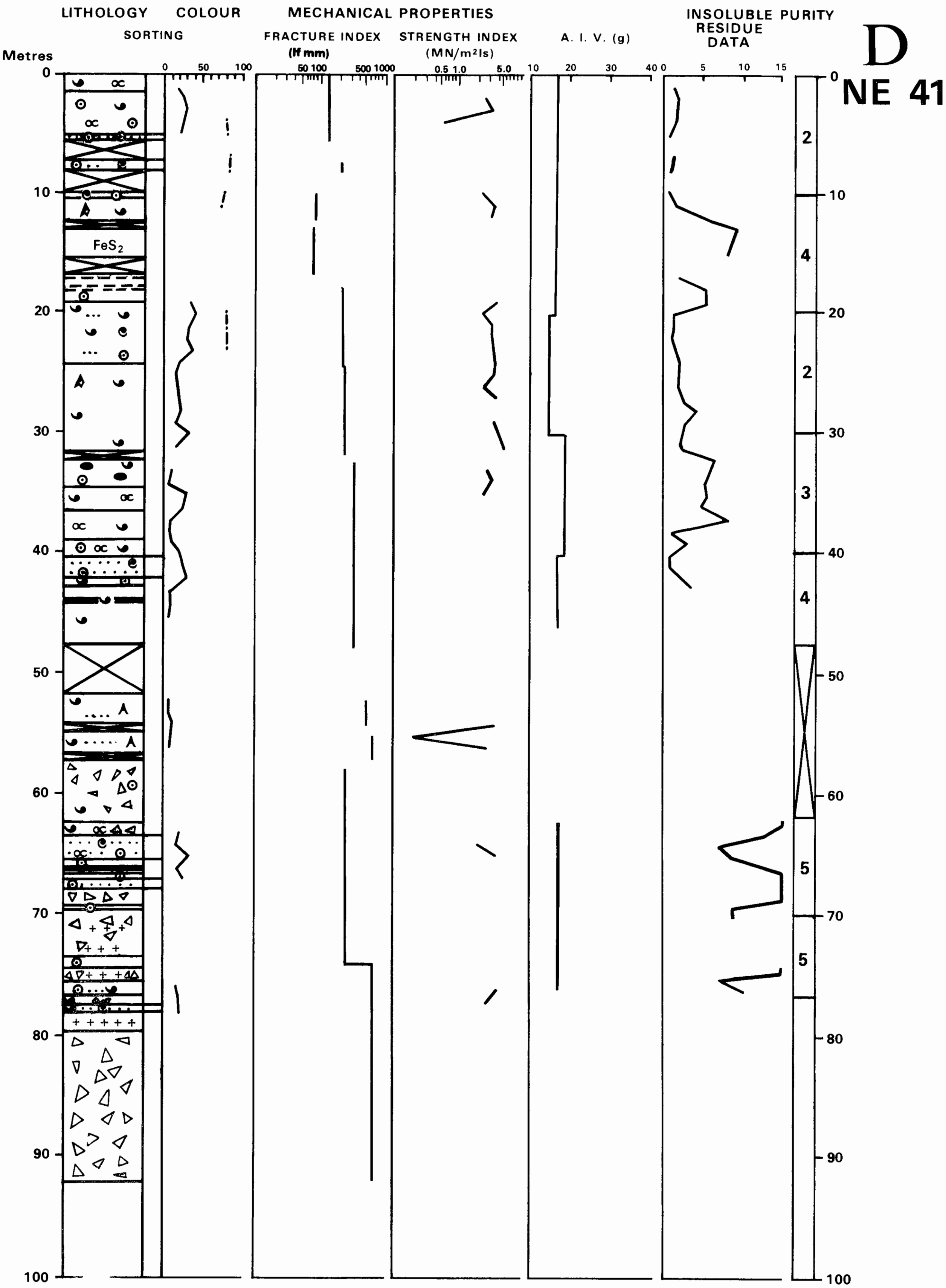
Surface level +321.89 m
Dando 250 rig, waterflush, 58-mm diameter
August 1975

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biosparite Brachiopod Algae, medium grey, medium arenite *Girvanella* encrusted brachiopods	1.55	1.55
Biomicrite Crinoid Brachiopod, pale grey, bioturbated, abundant coarse arenite algae encrusted brachiopod and crinoid debris	3.50	5.05
Biopelsparite, pale grey, medium arenite crinoidal, well sorted	0.47	5.52
Gap	1.70	7.22
Biomicrite, pale grey mottled, fine arenite crinoidal, well sorted	0.68	7.90
Gap	1.92	9.82
Biomicrite Crinoid, medium grey, medium arenite	0.50	10.32
Biomicrite, dark grey, some rudite gastropods and brachiopods patchily silicified	1.93	12.25
Gap	0.60	12.85
Biomicrite, rare bioclasts, abundant pyrite and hematite staining	2.65	15.50
Gap	1.23	16.73
Mudstone, black, ironstained	1.37	18.10
Biosparite, medium grey, arenite crinoid debris, abundant hematite, common quartz crystals	0.73	18.83
Biomicrite Brachiopod, pale grey, arenite brachiopod, crinoid and pelletal debris, mottled 19.50–24.23 m, patchy hematite staining	5.40	24.23
Biomicrite Brachiopod, medium to dark grey, arenite comminuted brachiopod debris, some gastropods, patchily silicified and iron stained	7.44	31.67
Gap	0.60	32.27
Biomicrite Brachiopod, dark grey, some *Girvanella* encrusted rudite brachiopods, locally common nodular chert	2.30	34.57
Biomicrite, pale grey, fine arenite algae encrusted shell debris, locally abundant pyrite and hematite	1.89	36.46
Biomicrite Crinoid, dark grey, medium arenite *Girvanella* encrusted brachiopod debris, locally silicified	2.65	39.11
Biomicrite Brachiopod Crinoid, pale grey, medium arenite, bioturbated	1.43	40.54
Pelsparite, pale grey, medium arenite pellet, foraminifera and crinoid debris, well sorted	1.70	42.24
Biomicrite Brachiopod, dark grey, fine arenite brachiopod and crinoid debris	0.76	43.00
Micrite, dark grey, common mudstone partings	1.18	44.18
Biosparite Brachiopod Pellet, dark grey, common quartz euhedra	0.20	44.38
Biomicrite, dark grey, fine arenite shell debris, abundant disseminated clay	3.40	47.78
Gap	4.22	52.00
Biomicrite, dark grey, fine arenite shell debris, some algal lamination, abundant disseminated clay	2.37	54.37
Gap	0.67	55.04
Biomicrite Pellet, dark grey, fine arenite shell and pelletal material, some algal lamination, abundant disseminated clay	1.72	56.76
Gap	0.54	57.30
Tuff, abundant fragments of crinoid, brachiopod and basaltic material	4.90	62.40
Biosparite Tuffaceous, medium grey, arenite *Girvanella* encrusted brachiopod debris, common tuffaceous material	1.27	63.67
Pelsparite, pale grey, fine arenite, well sorted	2.03	65.70
Biomicrite, dark grey, fine arenite, well sorted	0.04	65.74
Biosparite crinoid, pale grey, coarse arenite	0.54	66.28
Tuff, green, calcareous, fragments of basalt and limestone	0.04	66.32
Biomicrite, very dark grey, coarse arenite crinoid debris, mudstone laminae	0.48	66.80
Mudstone, pale grey	0.20	67.00
Tuff, green	0.10	67.10
Biosparite Pellet, pale grey, fine arenite, tuffaceous, well sorted	0.85	67.95
Tuff, green to grey	1.40	69.35
Biosparite Crinoid, pale grey, tuffaceous	0.45	69.80
Tuff, dark green with minor interbedded basaltic lava	3.80	73.60
Biomicrite Crinoid, pale grey, coarse arenite, tuffaceous	1.10	74.70
Tuff, green with basalt bombs	1.05	75.75
Biosparite Crinoid, pale grey, coarse arenite, tuffaceous	1.33	77.08
Limestone Tuffaceous, recrystallised, reddish-brown, shelly	0.67	77.75
Pelsparite, pale grey, coarse arenite brachiopods, foraminifera and tuffaceous material	0.65	78.40
Shothouse Spring Tuff		
Basalt, amygdaloidal, highly altered	1.60	80.00
Tuff	12.27	92.27

Borehole complete at 92.27 m

Chemical analyses of major elements (percentages) — Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
3.00	55.90	0.07	0.03	0.0	1.25	0.28	0.04	0.02	0.0	0.0	550	43.34	5	0	60	170	3.00
11.00	54.80	0.20	0.04	0.01	0.74	0.41	0.12	0.02	0.0	0.01	3900	43.44	0	0	10	300	11.00
19.00	55.00	0.07	0.03	0.0	0.97	0.27	0.20	0.02	0.0	0.0	11600	43.04	0	0	40	950	19.00
28.00	54.20	0.07	0.03	0.01	2.68	0.26	0.22	0.02	0.03	0.06	9500	42.22	5	0	80	380	28.00
37.00	51.60	0.35	0.04	0.0	0.83	2.84	0.12	0.03	0.0	0.02	17700	43.65	5	0	60	450	37.00
63.00	49.40	0.11	0.03	0.0	5.70	0.98	1.91	0.04	0.02	0.0	33900	38.80	110	0	70	450	63.00
74.00	45.30	0.0	0.03	0.01	14.90	0.64	1.85	0.35	0.05	0.0	15500	35.15	5	20	10	870	74.00



LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX
(If mm)
STRENGTH INDEX
(MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
FeS2
D
NE 41

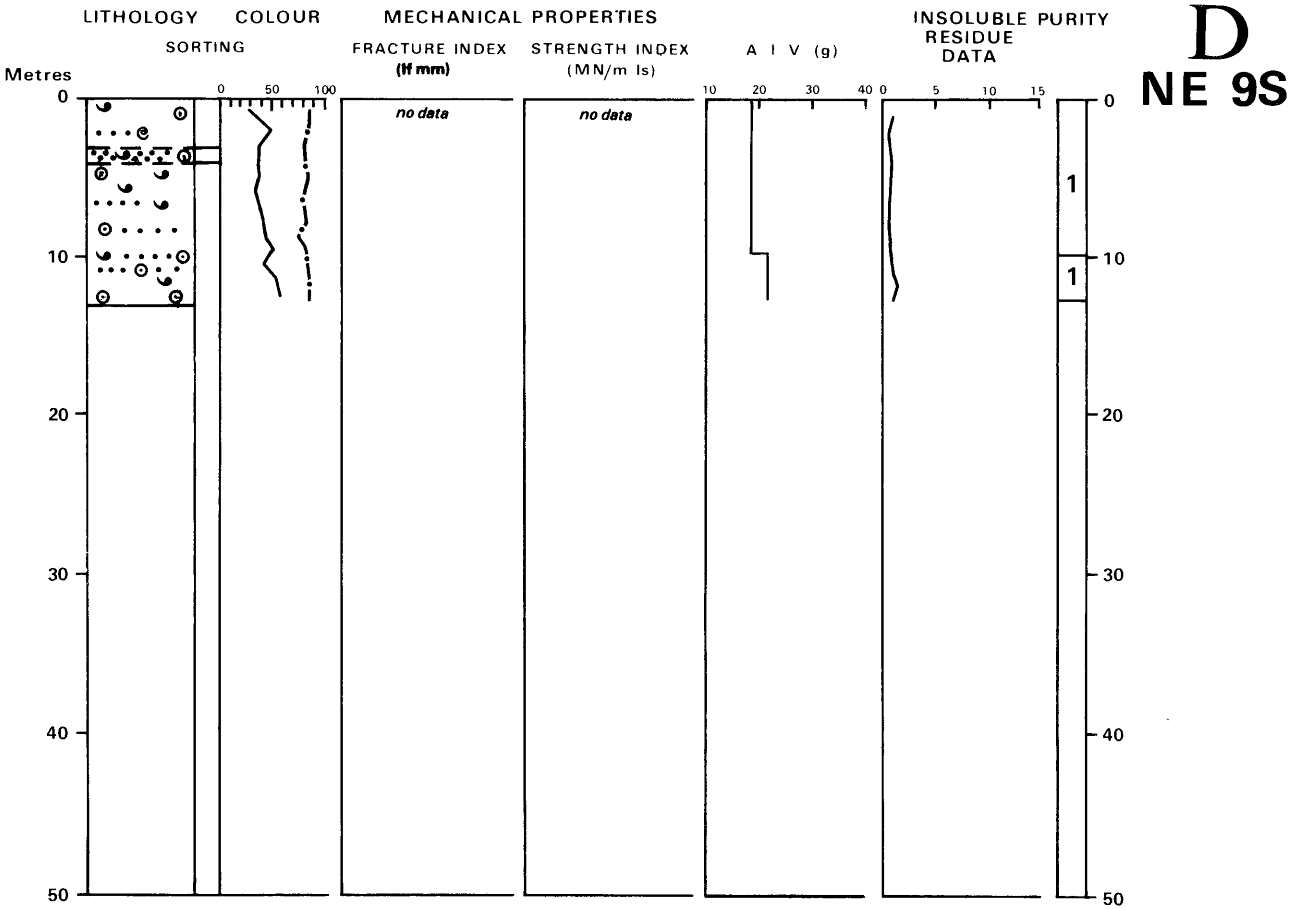
RESOURCE BLOCK D

SK 25 NE 9s 2650 5682 Cotterhole Quarry

Surface level +262.4 m

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biosparite, buff-grey, abundant fine to coarse arenite comminuted bioclastic debris, spar–microspar mixed matrix, local mottling due to bioturbation	3.50	3.50
Biopelsparite, buff-grey, fine to medium arenite, well sorted	1.00	4.50
Biosparite Brachiopod Crinoid, buff-grey, abundant fine to coarse arenite brachiopod, crinoid, foraminifera and pelletal debris. Local mottling due to bioturbation	9.00	13.50

Base of section 13.50 m



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
3.00	56.00	0.0	0.0	0.0	0.18	0.36	0.03	0.05	0.0	0.01	1100
10.00	56.00	0.0	0.0	0.0	0.12	0.36	0.0	0.05	0.0	0.0	200

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
43.88	5	100	40	120	3.00
43.97	0	70	25	140	10.00

RESOURCE BLOCK E

Source of data	*Registration number*	*Grid Reference*
Major sections used in the assessment	NE 4s*	2638 5573
	NE 6s	2878 5512
	NE 7s	2712 5510
	NE 8s*	2874 5628
	NE 10s	2741 5579
	NE 12s	2775 5552
	SE 1s	2854 5404
	SE 2s	2799 5498

*Part common to Block A, see Block A for Log.

RESOURCE BLOCK E

SK 25 NE 6s 2878 5512 Shaw's Quarries

Surface level +205.50 m

	Thickness m	*Depth* m
Eyam Limestones		
Biomicrite, dark grey, thinly bedded, fine arenite, some comminuted shell debris	0.60	0.60
Biosparite Crinoid foraminifera, medium to dark grey, fine to medium arenite	1.50	2.10
Eyam Limestones: apron-reef facies		
Biosparrudite Crinoid brachiopod, grey, abundant medium to coarse rudite crinoid debris, subordinate fine to coarse arenite brachiopod, bryozoa, foraminifera and *Koninckopora*	5.40	7.50
Biosparite Crinoid bryozoa, grey, medium to coarse arenite. Patchy silicification of bioclasts, some quartz euhedra	2.00	9.50
Biomicrite Crinoid bryozoa, grey, fine to coarse arenite	1.00	10.50
Biosparrudite Crinoid bryozoa, grey, common fine to coarse rudite crinoid debris, common arenite bryozoa and brachiopod debris	2.00	12.50
Biomicrudite Crinoid bryozoa, grey, common rudite crinoid debris, common arenite bryozoa and brachiopod debris	2.00	14.50
Biosparite Crinoid, grey, abundant medium to coarse arenite crinoid debris	6.00	20.50
Biosparrudite Crinoid Brachiopod bryozoa, grey, common medium to coarse rudite crinoid debris, subordinate arenite to rudite brachiopods and fine to medium arenite bryozoa	2.00	22.50
Biosparite Crinoid, medium grey, medium to coarse arenite comminuted crinoid, brachiopod and foraminiferal debris	1.00	23.50
Biosparrudite Crinoid, medium grey, common coarse rudite crinoid debris, subordinate arenite comminuted crinoid, brachiopod and bryozoa debris	1.70	25.20
Monsal Dale Limestones		
Biomicrite, medium grey, medium arenite crinoid and brachiopod debris. Common nodular and bedded chert	1.10	26.30
Clay	0.05	26.35
Biosparite Foraminifera pellet, medium grey, common fine arenite foraminifera, common pelletal debris	1.15	27.50
Biosparite, pale grey, medium arenite comminuted crinoid and shell debris	1.60	29.10

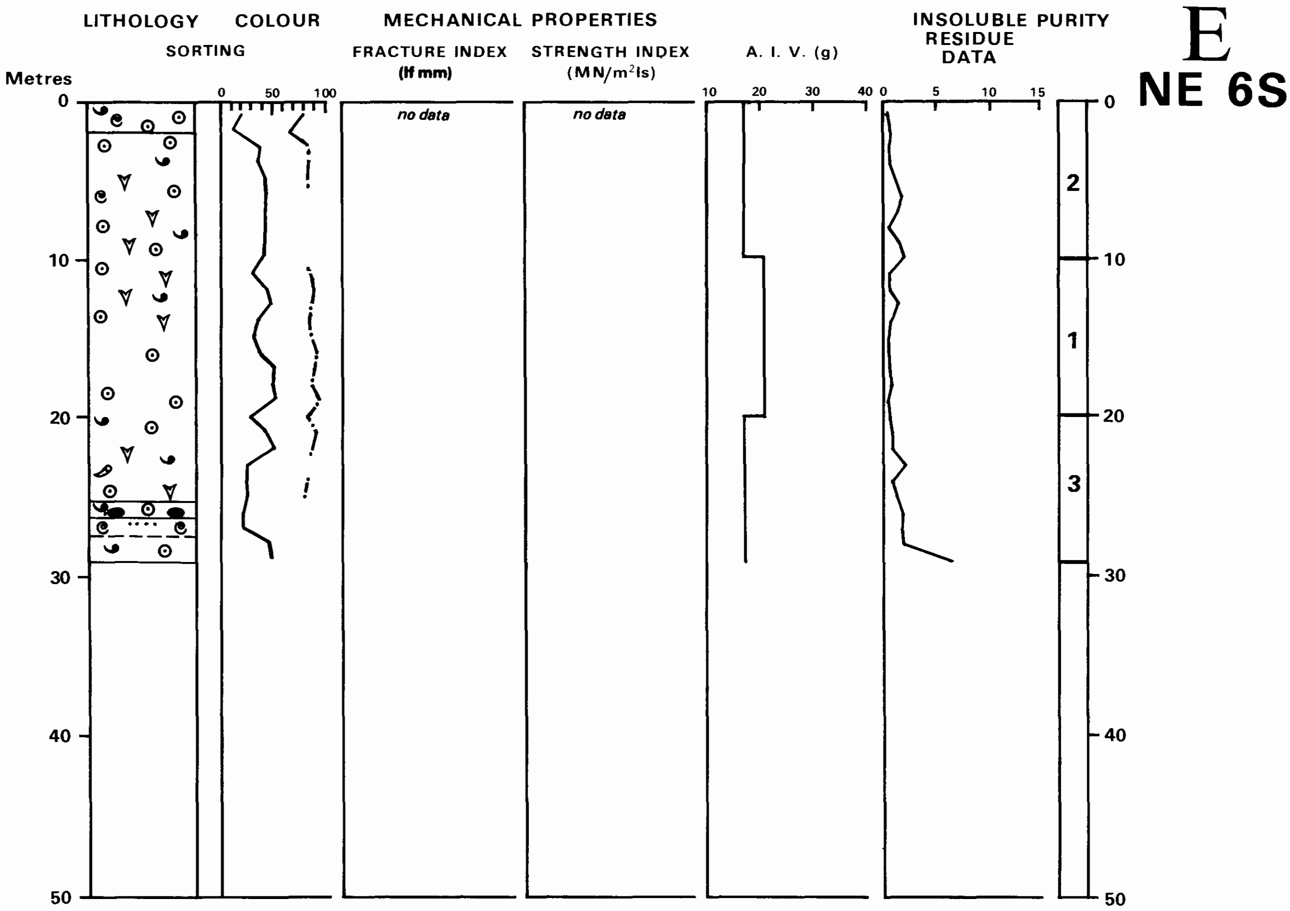
Base of section 29.10 m

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
1.00	56.00	0.0	0.0	0.02	0.09	0.54	0.0	0.05	0.01	0.02	1400
10.00	55.20	0.0	0.0	0.01	1.19	0.46	0.0	0.05	0.0	0.09	3100
23.00	55.30	0.19	0.0	0.26	0.73	0.54	0.31	0.07	0.0	0.17	6200
29.00	54.30	1.06	0.0	0.01	1.35	0.52	0.17	0.06	0.07	0.05	4000

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
43.80	0	10	5	240	1.00
43.04	10	10	85	240	10.00
42.89	40	10	100	160	23.00
41.07	5	790	35	130	29.00


LITHOLOGY
COLOUR
SORTING
MECHANICAL PROPERTIES
FRACTURE INDEX
(If mm)
STRENGTH INDEX
(MN/m²Is)
A. I. V. (g)
INSOLUBLE RESIDUE DATA
PURITY
Metres
0
10
20
30
40
50
0
50
100
no data
no data
10
20
30
40
0
5
10
15
2
1
3
E
NE 6S

RESOURCE BLOCK E

SK 25 NE 7s 2712 5510 Intake Quarry

Surface level +341.29 m

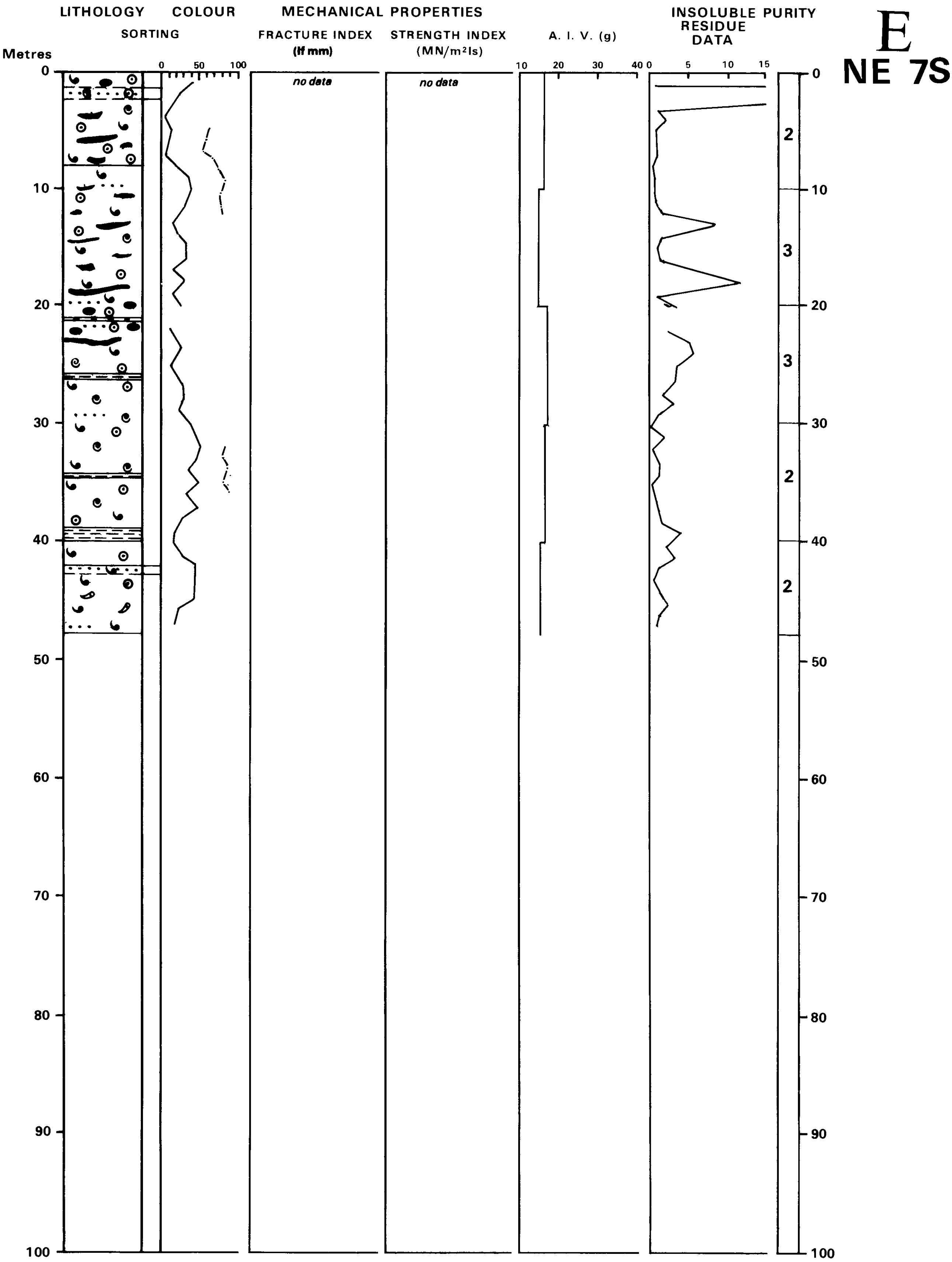
	Thickness m	*Depth* m
Eyam Limestones		
Biosparite, grey-pale grey, fine to medium arenite comminuted crinoid, brachiopod and foraminiferal debris, common bedded and nodular chert	1.50	1.50
Biosparite Pellet, grey, fine to medium arenite, common bedded and nodular chert, well sorted	1.00	2.50
Biomicrosparite, dark grey, commonly fine to medium arenite, comminuted brachiopod and crinoid debris, common bedded and nodular chert	5.70	8.20
Monsal Dale Limestones		
Biomicrosparite, pale grey, fine to medium arenite foraminifera, brachiopod and crinoid debris, matrix predominantly fine spar with patchy micrite, common bedded and nodular chert	4.30	12.50
Biomicrite, dark grey, fine to medium arenite bioclastic, common bedded and nodular chert	1.00	13.50
Biomicrosparite, buff-grey, common fine to medium arenite comminuted brachiopod, crinoid and foraminiferal debris, some coarse arenite to fine rudite brachiopod and crinoid debris, common bedded and nodular chert	3.00	16.50
Biosparite, medium to dark grey, fine to medium arenite bioclastic, common bedded and nodular chert, shell debris patchily silicified	2.00	18.50
Biomicrite, dark grey, fine to coarse arenite, common bedded and nodular chert, shell debris patchily silicified	1.00	19.50
Biomicrosparite, buff-grey, fine arenite bioclastic, some fine rudite crinoid and brachiopod debris, common nodular chert and patchily silicified shell debris	1.60	21.10
Mudstone	0.20	21.30
Biosparite, grey, fine to medium arenite crinoid, brachiopod, foraminifera and pelletal debris, some chert nodules, patchy silicification of shell debris	2.20	23.50
Biomicrosparite, grey to dark grey, fine arenite comminuted bioclasts and foraminifera, common bedded and nodular chert	2.35	25.85
Mudstone and clay	0.30	26.15
Biosparite, grey, fine to medium arenite crinoid, foraminifera and comminuted bioclastic debris, shell debris patchily silicified	8.05	34.20
Clay	0.30	34.50
Biosparite, pale grey, medium arenite crinoid and brachiopod, fine arenite comminuted bioclastic, foraminifera and subordinate pelletal debris	4.20	38.70
Mudstone	1.05	39.75
Biomicrite Brachiopod, medium to dark grey, fine arenite to fine rudite brachiopod and crinoid debris, locally haematite stained	2.15	41.90
Biopelsparite, pale, fine to medium arenite, some fine rudite brachiopods, well sorted	0.60	42.50
Biosparite, pale to medium grey, fine to medium arenite brachiopod, crinoid, coral and rare pelletal debris, matrix predominantly spar with some admixed micrite	5.10	47.60

Base of section 47.60 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
2.00	44.30	0.0	0.0	0.0	20.00	0.43	0.01	0.05	0.0	0.0	150	32.16	5	80	5	90	2.00
13.00	52.90	0.0	0.0	0.0	5.98	0.54	0.29	0.07	0.02	0.05	190	40.66	0	10	0	40	13.00
18.00	51.40	0.0	0.0	0.0	8.39	0.46	0.05	0.05	0.02	0.04	190	39.11	5	10	10	70	18.00
24.00	53.30	0.0	0.0	0.0	5.31	0.51	0.10	0.05	0.01	0.03	600	41.28	0	35	10	150	24.00
33.00	55.30	0.0	0.0	0.0	0.63	0.46	0.07	0.05	0.0	0.0	370	43.64	5	10	5	80	33.00
39.00	54.00	0.0	0.0	0.03	1.68	0.57	0.79	0.12	0.0	0.02	3900	42.88	5	50	40	140	39.00

Resource Block E SK 25 NE 7s 2712 5510 Intake Quarry



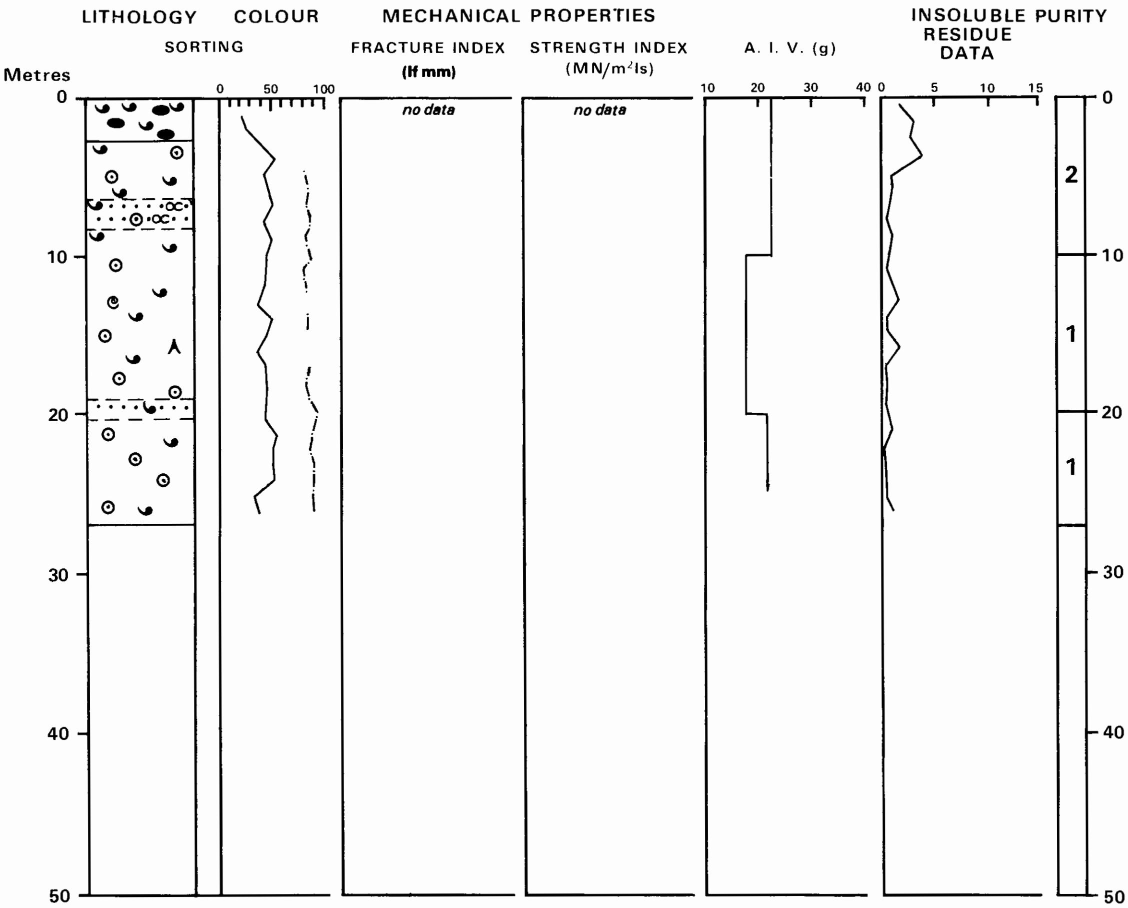
RESOURCE BLOCK E

SK 25 NE 10s 2741 5579 New Hoptonwoodstone Quarry

Surface level +333.39 m

	Thickness	*Depth*
Monsal Dale Limestones	m	m
Biomicrosparite Brachiopod, grey to medium grey mottled, fine arenite to medium rudite brachiopod and comminuted bioclastic debris, common chert nodules, patchily silicified brachiopod debris	2.90	2.90
Biomicrosparite Brachiopod, pale grey, arenite comminuted bioclastic debris, matrix predominantly microspar with patchy fine spar and micrite, some silicified shell debris	3.60	6.50
Biopelsparite Crinoid Brachiopod algal, pale, medium to coarse arenite bioclastic debris, rare *Girvanella*, pale grey, abundant medium to coarse arenite brachiopod and crinoid debris, common fine to medium arenite comminuted bioclasts, foraminifera and rare *Koninckopora,* matrix predominantly spar with patchy microspar and micrite, some silicified brachiopod debris	2.00	8.50
Biopelsparrudite Brachiopod, grey, abundant fine arenite pelletal debris, some rudite brachiopods, some medium to coarse arenite brachiopod and crinoid debris	12.00	20.50
Biosparite Crinoid Brachiopod, pale grey, fine arenite to fine rudite crinoid, brachiopod, foraminifera and comminuted bioclastic debris	6.30	26.80

Base of section 26.80 m



E
NE 10S

Chemical analyses of major elements (percentages)

Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
4.00	54.60	0.80	0.03	0.01	1.52	0.22	0.05	0.03	0.02	0.01	1100	42.14	10	210	25	130	4.00
13.00	55.80	0.06	0.02	0.0	1.18	0.28	0.15	0.04	0.0	0.0	300	43.31	5	30	25	90	13.00
16.00	55.30	0.06	0.03	0.0	1.01	0.21	0.06	0.02	0.0	0.0	520	43.22	5	140	20	80	16.00
21.00	55.60	0.03	0.02	0.0	0.47	0.20	0.0	0.01	0.0	0.0	340	43.70	0	100	20	110	21.00

RESOURCE BLOCK E

SK 25 NE 12s 2775 5552 Hoptonwoodstone Quarry

Surface level +312.23 m

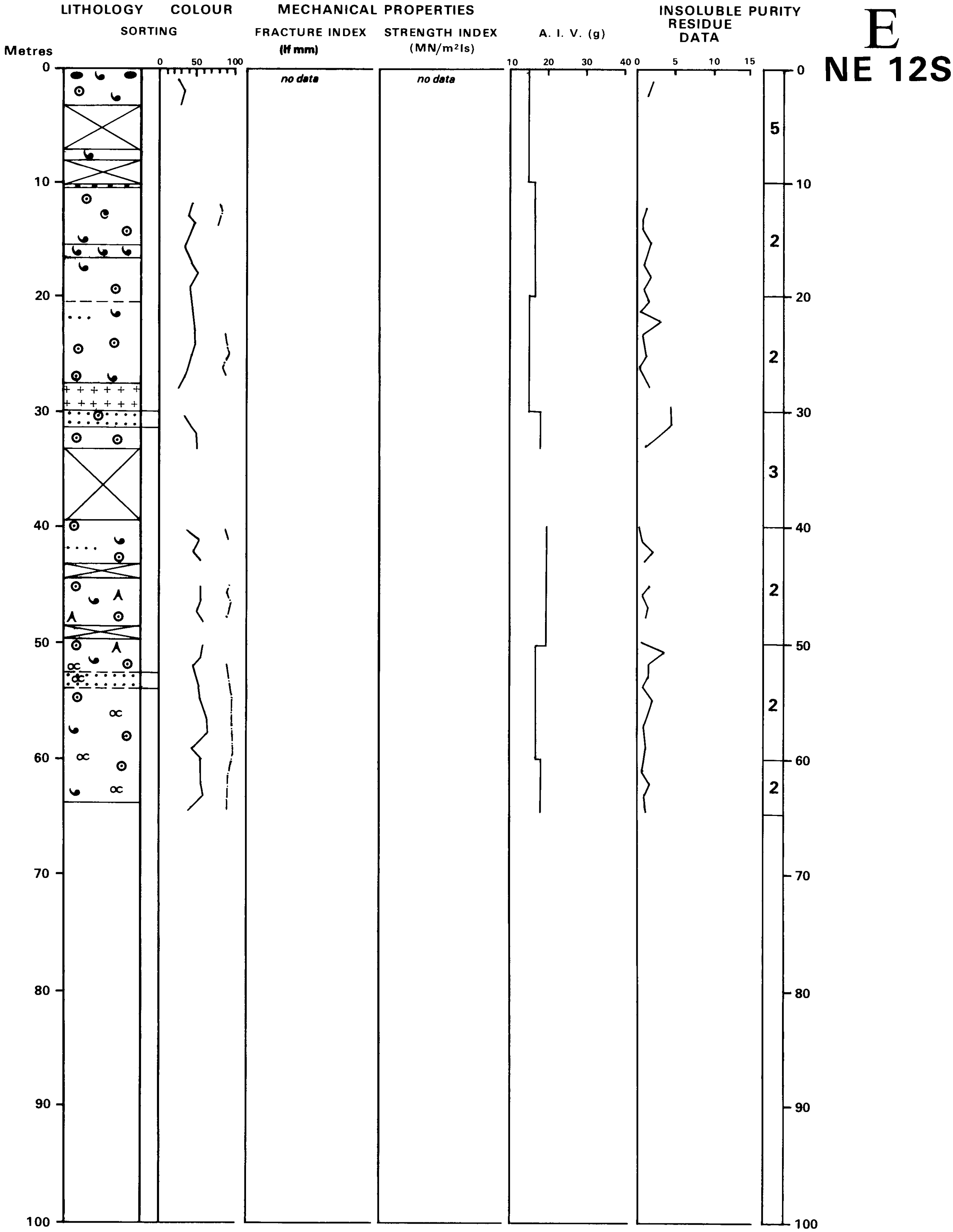
	Thickness m	*Depth* m
Monsal Dale Limestones		
Biomicrite, medium grey, fine to coarse arenite crinoid and brachiopod debris, some foraminifera, some nodular chert and silicified bioclasts	3.20	3.20
Gap	4.20	7.50
Biomicrite, grey, arenite comminuted bioclastic debris, some silicified brachiopods	1.00	8.50
Gap	2.00	10.50
Clay	0.20	10.70
Biosparite Crinoid, pale grey, medium arenite bioclastic	5.05	15.75
Biomicrudite Brachiopod, grey, common rudite brachiopod and crinoid debris	0.80	16.55
Biomicrite, pale to medium grey mottled, abundant arenite comminuted bioclasts, bioturbated	4.05	20.60
Biosparite, pale grey, abundant arenite comminuted shell and crinoid debris, subordinate pelletal debris. Bioclasts patchily silicified	2.65	23.25
Biomicrite Crinoidal, pale grey becoming darker towards base, abundant arenite comminuted brachiopod and crinoid debris, some rudite brachiopods, rare *Girvanella* encrusted bioclasts	4.75	28.00
Lower Matlock Lava		
Basalt	2.00	30.00
Bee Low Limestones		
Pelsparite crinoid, pale grey, medium arenite, some crinoid and *Girvanella* encrusted brachiopod debris, well sorted, common quartz euhedra	1.50	31.50
Biosparite Crinoid, pale grey, medium arenite, common crinoid debris, subordinate shell and pelletal debris	1.50	33.00
Gap	6.50	39.50
Biomicrite Crinoid, pale grey, abundant medium arenite comminuted bioclastic debris, bioturbated, micrite with patchy spar matrix	4.00	43.50
Gap	1.00	44.50
Biosparite, pale grey, medium arenite comminuted crinoid and *Girvanella* encrusted brachiopod debris	4.00	48.50
Gap	1.00	49.50
Biosparite, pale grey, medium arenite comminuted crinoid and *Girvanella* encrusted brachiopod debris	3.00	52.50
Pelsparite, pale grey, fine arenite, some *Girvanella* encrusted bioclasts	1.00	53.50
Biosparite, pale grey, medium to coarse arenite *Girvanella* encrusted crinoid and shell debris	10.50	64.00

Base of section 64.00 m

Chemical analyses of major elements (percentages) — Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
3.00	43.40	0.02	0.04	0.06	21.80	0.40	1.48	0.21	0.12	0.03	2800	31.86	15	0	60	50	3.00
22.00	55.70	0.10	0.03	0.01	1.39	0.36	0.30	0.05	0.0	0.0	2400	43.14	5	20	140	220	22.00
42.00	56.00	0.42	0.03	0.0	0.35	0.27	0.0	0.02	0.02	0.01	130	43.29	0	0	10	50	42.00
51.00	55.10	0.03	0.02	0.0	2.03	0.22	0.10	0.03	0.0	0.01	380	43.22	0	0	15	50	51.00
60.00	56.40	0.05	0.02	0.0	0.13	0.18	0.0	0.01	0.0	0.0	360	43.78	0	0	10	80	60.00

Resource Block E SK 25 NE 12s 2775 5552 Hoptonwoodstone Quarry



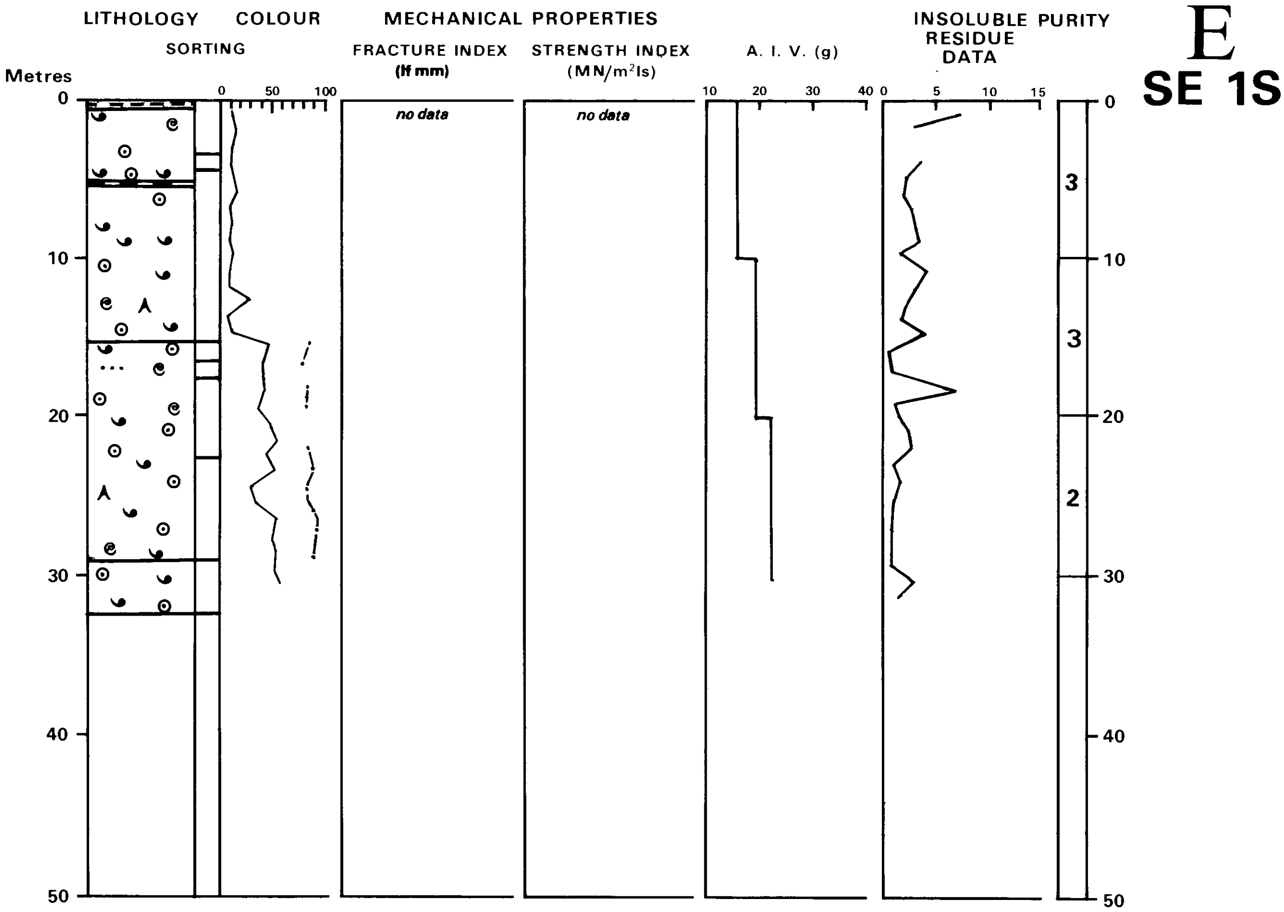
RESOURCE BLOCK E

SK 25 SE 1s 2854 5404 Dale Quarry

Surface level +185.7 m

	Thickness m	*Depth* m
Monsal Dale Limestones		
Shale, black, reddish iron-staining	0.50	0.50
Biomicrite, dark grey, thinly bedded, some fine to medium arenite comminuted brachiopod, crinoid, foraminifera and rare *Koninckopora* debris, common thin interbedded black shales and shale partings, common rudite brachiopod debris 4.50–5.20 m	4.70	5.20
Shale and thin rubbly limestone	0.14	5.34
Biomicrite, dark grey, thinly bedded, some fine to coarse arenite brachiopod, crinoid, coral and foraminiferal debris, rare *Koninckopora*. Local development of massive richly fossiliferous knoll-reef, common thin interbedded black shales	9.96	15.30
Bee Low Limestones		
Biosparite, buff-grey, abundant fine arenite to fine rudite brachiopod and crinoid debris, subordinate foraminifera and pelletal debris, rare *Koninckopora,* locally well sorted	13.50	28.80
Biosparite, pale grey, common arenite comminuted crinoid and brachiopod debris, well sorted	3.35	32.15

Base of section 32.15 m



Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
4.00	53.10	0.27	0.03	0.04	2.77	0.52	0.22	0.04	0.01	0.26	1500
9.00	54.00	0.14	0.04	0.04	1.75	0.46	0.41	0.08	0.03	0.05	1000
11.00	54.20	0.20	0.02	0.42	2.09	0.47	0.18	0.04	0.04	0.02	1100
15.00	53.60	0.17	0.02	0.08	2.42	0.42	0.24	0.04	0.03	0.05	1100
18.00	53.70	0.02	0.01	0.02	4.54	0.27	0.0	0.01	0.03	0.0	200
22.00	55.10	0.07	0.03	0.0	2.15	0.23	0.01	0.01	0.01	0.01	290
30.00	55.80	0.03	0.01	0.0	1.80	0.17	0.0	0.01	0.01	0.02	140

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
42.19	15	340	1100	500	4.00
43.41	5	10	70	270	9.00
42.07	10	0	80	390	11.00
42.35	10	0	50	460	15.00
41.71	10	0	50	130	18.00
42.90	5	50	220	150	22.00
43.15	5	0	40	60	30.00

RESOURCE BLOCK E

SK 25 SE 2s 2799 5498 Middlepeak Quarries

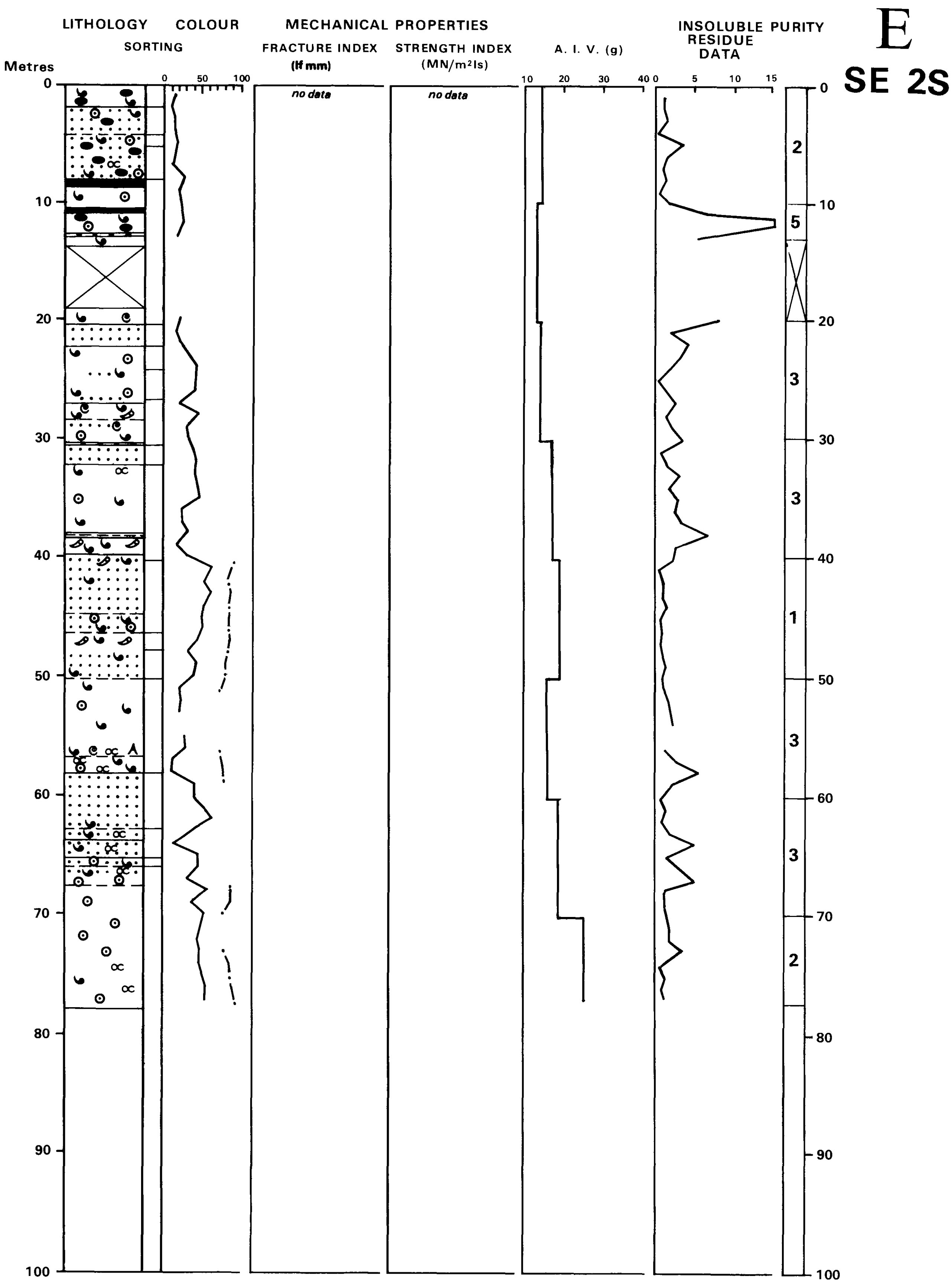
Surface level +293.72 m

	Thickness m	*Depth* m
Eyam Limestones		
Biosparite, dark grey, common coarse arenite thin-shelled brachiopod and crinoid debris, very fine spar matrix, disseminated black clay, trace silicification of allochems, common black nodular chert	2.20	2.20
Biopelsparite, dark grey, fine to medium arenite comminuted crinoid, shell and pelletal debris, well sorted, common nodular chert, some quartz euhedra	2.30	4.50
Biomicrite, grey, some coarse arenite to fine rudite brachiopod, commonly *Girvanella* encrusted, and crinoid debris, common nodular chert and silicified brachiopod debris	1.00	5.50
Biopelsparite, dark to pale grey, abundant fine arenite pelletal debris, common coarse arenite to fine rudite shell and crinoid debris, well sorted, common black nodular chert, patchy silicification of shell debris	3.00	8.50
Monsal Dale Limestones		
Biosparite, buff-grey, abundant fine arenite to fine rudite comminuted bioclasts, predominantly brachiopod, crinoid and pelletal debris with some admixed micrite, common black nodular chert, bedded chert 8.5–9.0 m, 10.0–10.5 m, patchily silicified shell debris	5.00	13.50
Clay	0.20	13.70
Biomicrite, medium grey, medium to coarse arenite shell debris, laminated, patchily silicified bioclasts	0.80	14.50
Gap	5.00	19.50
Biosparite, grey, some rudite brachiopod debris, common arenite foraminifera and finely comminuted bioclasts, patchily silicified brachiopod debris	1.00	20.50
Pelsparite, grey, abundant fine arenite pelletal debris, some fine rudite slender shell debris, well sorted, thin clay at base	1.50	22.00
Biosparite, grey mottled, abundant fine arenite to fine rudite bioclasts predominantly brachiopod, crinoid, and pelletal debris, rare patchily silicified shell debris, some euhedral quartz	5.00	27.00
Biomicrudite Brachiopod, buff, common fine to medium rudite brachiopods, rare encrusting coral	1.50	28.50
Biomicrite, buff-grey mottled, abundant very fine arenite to fine rudite bioclasts, predominantly brachiopod, pellet, crinoid and foraminiferal debris, micrite matrix with patchily developed fine spar, some flecks of pyrite at base	2.00	30.50
Clay	0.20	30.70
Pelsparite, buff-grey, medium arenite, very well sorted	1.80	32.50
Biomicrudite Brachiopod, buff-grey, abundant fine arenite to medium rudite bioclasts, predominantly brachiopod, crinoid and pelletal debris, brachiopod debris commonly *Girvanella*, rarely coral, encrusted. Micrite and fine spar mixed matrix, patchily silicified bioclasts, some quartz euhedra	5.00	37.50
Clay	0.30	37.80
Biomicrudite Brachiopod Coral, buff-grey, common rudite brachiopod and coral debris, common encrusting coral, patchily pyritisation of brachiopod debris	1.70	39.50
Biopelsparite, buff-grey, abundant fine to medium arenite pellet and finely comminuted bioclastic debris, some coarse arenite–fine rudite brachiopod and crinoid debris, rare coral, predominantly well sorted, scattered euhedral quartz	11.00	50.50
Biosparite, medium grey, common fine arenite comminuted bioclasts, rare rudite brachiopod debris, fine spar and micrite matrix, rare euhedral quartz	6.00	56.50
Biosparite, dark grey, abundant fine arenite to fine rudite brachiopod and crinoid debris, former commonly *Girvanella* encrusted, some foraminifera, rare bryozoa, patchily silicified shell debris, abundant finely disseminated black clay	2.00	58.50
Pelsparite, buff-grey, fine arenite, very well sorted, grading to biopelsparite below 62.50 m, abundant quartz euhedra	5.00	63.50
Biomicrite Brachiopod, dark grey, some medium rudite brachiopods thickly encrusted with *Girvanella*. Disseminated black clay	1.30	64.80
Bee Low Limestones		
Biopelsparite, pale grey, fine to medium arenite shell, crinoid and pelletal debris, well sorted	0.70	65.50
Biosparite, buff-grey, abundant fine arenite to fine rudite crinoid and brachiopod debris, subordinate pelloidal debris, some *Girvanella* encrusted bioclasts. Occasional quartz euhedra, thin pyritous clay parting at 67.00 m	11.90	77.40
Base of section 77.40 m		

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_2	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
5.00	53.70	0.03	0.03	0.02	2.74	0.41	0.49	0.07	0.02	0.07	260	42.52	5	20	40	140	5.00
12.00	52.50	0.01	0.02	0.0	5.31	0.37	0.17	0.03	0.03	0.02	240	41.11	5	10	30	110	12.00
27.00	54.50	0.01	0.02	0.01	1.59	0.38	0.48	0.06	0.05	0.02	500	43.14	5	0	30	100	27.00
38.00	52.50	0.01	0.02	0.01	4.55	0.30	0.50	0.09	0.02	0.0	2000	41.17	5	110	80	490	38.00
48.00	54.90	0.05	0.02	0.01	0.67	0.37	0.24	0.04	0.0	0.02	500	43.60	10	60	70	130	48.00
58.00	53.50	0.53	0.02	0.03	2.41	0.47	0.76	0.09	0.03	0.02	4800	42.00	5	40	130	450	58.00
64.00	53.70	0.33	0.03	0.03	2.11	0.42	0.62	0.06	0.02	0.03	2100	43.10	5	150	120	500	64.00
67.00	53.40	0.17	0.03	0.04	2.26	0.46	1.32	0.15	0.03	0.16	1900	42.20	5	0	100	160	67.00
73.00	54.50	0.0	0.01	0.0	2.74	0.21	0.02	0.01	0.08	0.01	110	42.56	5	0	30	40	73.00

Resource Block E SK 25 SE 2s 2799 5498 Middlepeak Quarry



RESOURCE BLOCK F

Source of data	*Registration number*	*Grid Reference*
IMAU borehole (drilled by contractor)	NE 17	2621 5940

RESOURCE BLOCK F

SK 25 NE 17 2621 5940 Brightgate

Surface level +328.6 m
Reich Rig, 74-mm diameter
February 1971

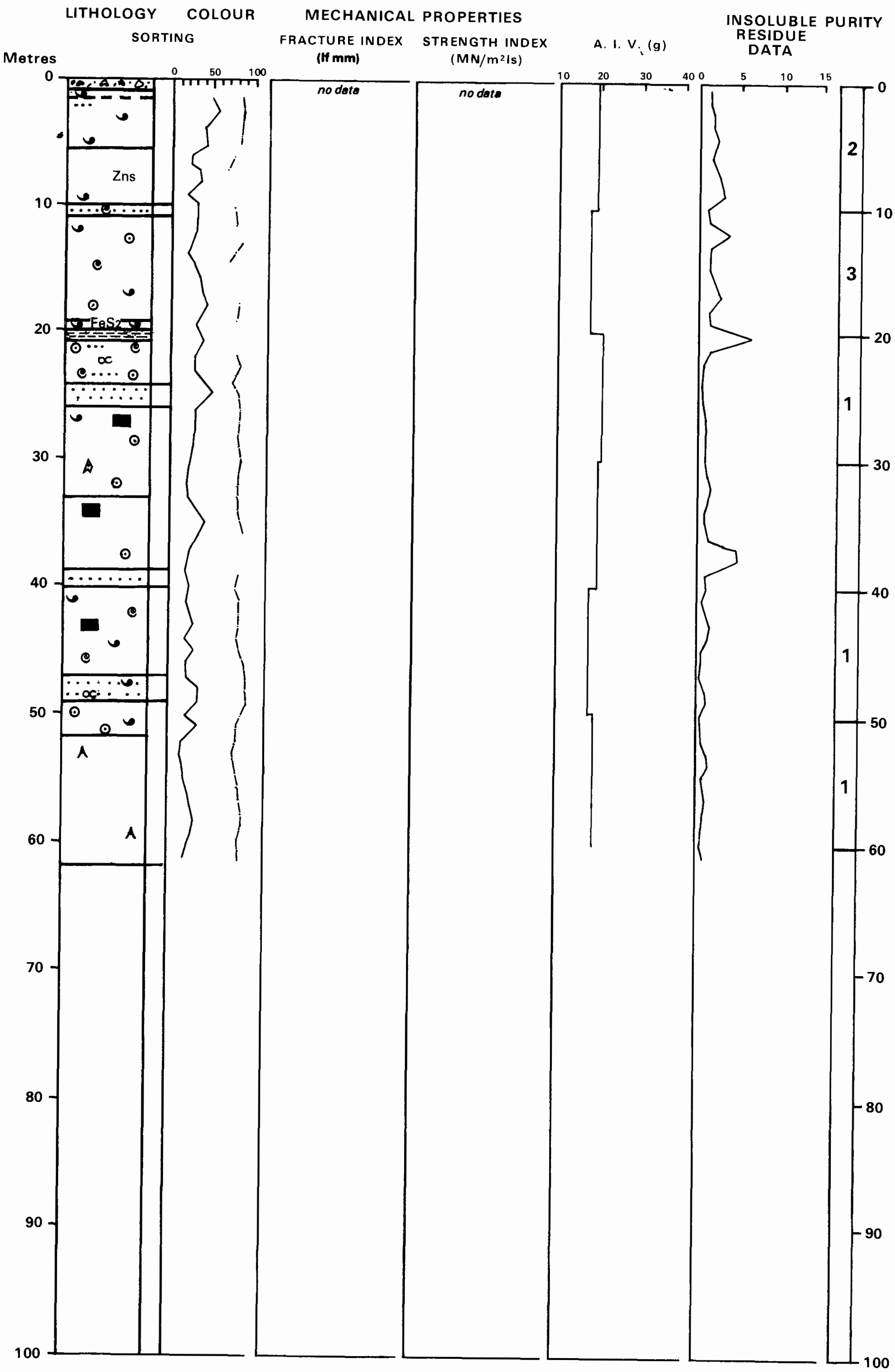
	Thickness m	*Depth* m
Recent		
Topsoil, reddish brown sandy clay	0.80	0.80
Monsal Dale Limestones		
Biosparite Brachiopod, pale grey, abundant finely comminuted bioclasts, common coarse arenite to fine rudite brachiopods	0.95	1.75
Biosparite, pale to medium grey, abundant fine arenite comminuted allochems, some pellets and scattered coarse arenite brachiopod debris, some quartz euhedra	3.79	5.54
Biomicrite, medium to pale grey, some lutite bioclasts, some arenite brachiopod and gastropod debris, pyrite lined vugs common	4.35	9.89
Pelsparite, pale, medium arenite pellets, foraminifera, crinoid debris and rare encrusting algae, well sorted	0.98	10.87
Biomicrite, pale grey, medium arenite crinoid, brachiopod and foraminifera debris, some thin calcite veins	8.48	19.35
Biomicrite, Brachiopod pale grey, common medium arenite brachiopod debris, common disseminated pyrite and silicified stylolites	0.65	20.00
Mudstone, black, calcareous with disseminated pyrite	0.60	20.60
Biosparite, pale grey, fine to coarse arenite crinoid, *Girvanella* encrusted shell, foraminifera and pelloidal debris	3.64	24.24
Pelsparite, pale grey, fine to medium arenite pellet, *Girvanella* encrusted shell debris and spines, well sorted	1.66	25.90
Biomicrite, pale grey mottled, abundant arenite crinoid and brachiopod debris, rare gastropods, bioturbated, some quartz euhedra	6.86	32.76
Biomicrite, pale grey mottled, bioturbated, some fine arenite and lutite bioclasts, common stylolites, some silicified	5.84	38.60
Pelsparite, grey, fine arenite, well sorted	1.50	40.10
Biosparite, grey mottled, medium arenite shell and foraminiferal debris, bioturbated, some quartz euhedra	6.90	47.00
Biopelsparite, pale grey, abundant fine to medium arenite algae encrusted shell debris, dasycladacean algae, and pellets, well sorted	1.99	48.99
Biosparite, pale grey, abundant medium arenite crinoid and comminuted shell debris, some fine rudite brachiopods	2.74	51.74
Biomicrite, medium to pale grey, some calcilutile bioclasts, some dasycladacean algae	10.02	61.76

Borehole complete at 61.76 m

Chemical analyses of major elements (percentages) / Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
3.00	53.50	0.02	0.02	0.0	1.00	0.16	0.01	0.01	0.10	0.01	200	43.53	5	0	10	150	3.00
7.00	54.80	0.01	0.01	0.0	0.80	0.20	0.07	0.02	0.10	0.01	1800	43.48	10	0	10	130	7.00
12.00	55.60	0.01	0.02	0.96	0.55	0.26	0.16	0.03	0.12	0.01	600	42.44	10	0	10	160	12.00
17.00	55.40	0.01	0.01	0.52	0.76	0.15	0.07	0.02	0.12	0.01	300	42.83	10	0	20	140	17.00
20.00	52.80	0.24	0.03	0.02	2.86	0.33	1.46	0.26	0.13	0.01	4500	41.37	10	70	10	170	20.00
25.00	56.40	0.0	0.02	0.01	0.04	0.14	0.0	0.0	0.09	0.0	400	43.85	10	0	10	120	25.00
30.00	55.20	0.0	0.01	0.0	0.43	0.22	0.05	0.01	0.11	0.0	600	43.73	10	0	10	90	30.00
38.00	53.70	0.46	0.03	0.0	1.86	0.33	1.02	0.13	0.12	0.0	3600	41.83	10	0	10	130	38.00
40.00	54.80	0.01	0.02	0.0	0.35	0.19	0.20	0.02	0.08	0.0	500	43.82	10	0	10	100	40.00
45.00	55.50	0.0	0.01	0.0	0.09	0.15	0.04	0.01	0.09	0.0	200	43.93	10	0	10	80	45.00
50.00	55.10	0.01	0.03	0.0	0.40	0.19	0.05	0.01	0.08	0.0	200	43.76	5	0	10	80	50.00
55.00	55.20	0.01	0.03	0.0	0.23	0.23	0.07	0.02	0.10	0.0	300	43.77	10	0	10	90	55.00
60.00	55.10	0.01	0.01	0.0	0.25	0.21	0.07	0.01	0.09	0.0	200	43.70	10	0	10	100	60.00

Resource Block F SK 25 NE 17 2621 5940 Brightgate



F
NE 17

RESOURCE BLOCK G

Source of Data	*Registration number*	*Grid Reference*
IMAU boreholes (drilled by contractor)	NW 21	2248 5965
	NE 43	2845 5844
Other boreholes	NE 28	2788 5989
	NE 29	2770 5994
Major sections used in the assessment	NE 1s	2978 5820
	NE 2s	2865 5914
	NE 11s	2869 5750

RESOURCE BLOCK G

SK 25 NW 21 2248 5965 Elton

Surface level +303.8 m
Dando Pendant and Dando 250 rigs, waterflush, 58-mm core diameter
July 1975

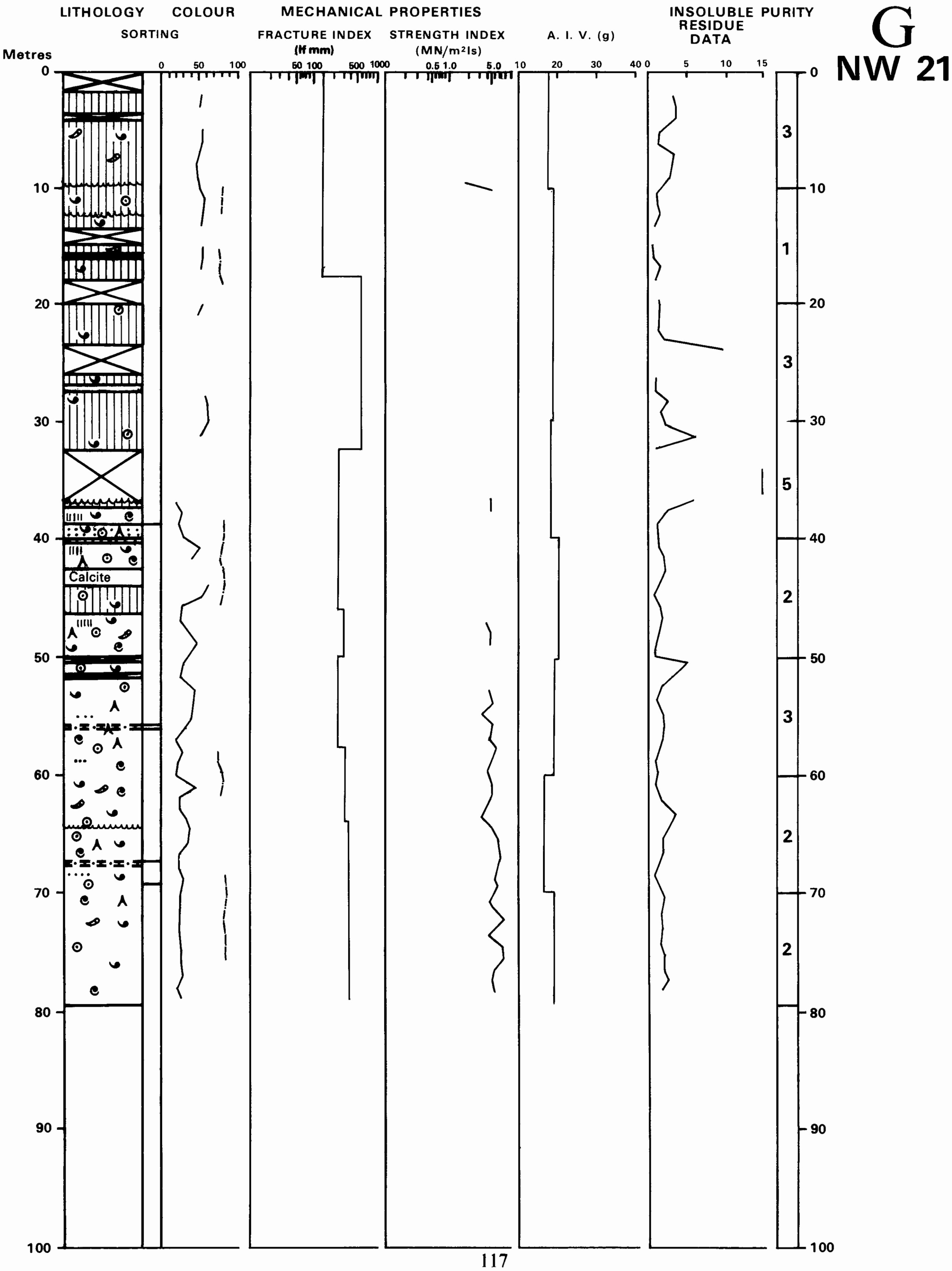
	Thickness m	*Depth* m
Open hole	1.56	1.56
Monsal Dale Limestones: dolomite		
Dolomite, pale buff-grey, granular, vugs, original texture destroyed	1.72	3.28
Gap	0.79	4.07
Dolomite, pale brown, vuggy, local patchy calcite, some brachiopod, crinoid and coral debris. Thin grey clays 9.50 and 12.05 m. Thin fluorite vein 13.10–13.30 m	9.23	13.30
Gap	1.35	14.65
Dolomite, grey-brown, rare coral, some fluorite-filled vugs	0.63	15.28
Gap	0.57	15.85
Dolomite, yellow-brown, common fine to coarse arenite brachiopod and crinoid debris	1.90	17.75
Gap, poor core recovery, traces of brown clay	1.85	19.60
Dolomite, yellow-brown, finely granular, locally vuggy, some crinoid and shell debris	3.75	23.35
Gap	2.55	25.90
Dolomite, pale yellow-brown, vuggy, some fine rudite brachiopod debris	0.70	26.60
Gap	0.77	27.37
Dolomite, yellow-brown, some fine to medium arenite brachiopod and crinoid debris, some calcite and fluorite-infilled vugs	4.93	32.30
Gap	4.41	36.71
Clay, brown with fragments of dark grey dolomitic limestone	0.07	36.78
Biosparite Brachiopod Foraminifera, dark grey, fine to coarse arenite brachiopod, crinoid and foraminiferal debris	0.10	36.88
Bee Low Limestones		
Limestone Dolomitised, grey, some arenite crinoid, foraminifera and comminuted shell debris, spar matrix	0.39	37.27
Biosparite, medium grey, fine to medium arenite comminuted brachiopod, crinoid and foraminiferal debris, patchily dolomitised, locally intensely	0.96	38.23
Biopelsparite, grey, fine to coarse arenite comminuted brachiopod, crinoid, foraminifera and pelletal debris, rare *Koninckopora*, patchily dolomitised, well sorted	1.59	39.82
Limestone Dolomitised, grey, some medium arenite crinoid debris, fine spar matrix	0.37	40.19
Biosparite, grey, abundant fine to medium arenite comminuted crinoid and brachiopod debris, subordinate foraminiferal, pellets and *Koninckopora*. Patchily dolomitised and silicified	2.39	42.58
Calcite, vein mineral	1.39	43.97
Dolomite, yellow-brown, vuggy, rare unaltered brachiopod and crinoid debris, locally intense silicification	2.23	46.20
Biosparite, grey, abundant arenite comminuted bioclasts, some rudite brachiopod, crinoid and coral debris, fine spar matrix, patchily dolomitised	3.73	49.93
Gap	0.39	50.32
Biosparite, grey, fine to coarse arenite comminuted bioclasts, some quartz euhedra, and quartz filled stylolites	1.00	51.32
Gap	0.51	51.83
Biosparite, grey, abundant fine to medium arenite comminuted crinoid, brachiopod and foraminiferal debris, come *Koninckopora*, pellets and coral debris, fine spar matrix, patchily dolomitised	3.87	55.70
Biopelsparite, grey, fine arenite, some *Koninckopora*	0.27	55.97
Biosparite, grey, abundant fine to medium arenite comminuted bioclasts, rare rudite brachiopod and coral debris, local bioturbational mottling, rare *Hexophyllia* at 61.00 m, patchy dolomitisation and silicification	8.60	64.57
Clay, grey and ochreous	0.10	64.67
Biosparite, pale grey, fine to coarse arenite crinoid and brachiopod debris, some foraminifera and pelletal material, fine spar matrix, patchily dolomitised and silicified, some quartz euhedra and hematite staining	2.58	67.25
Biopelsparite, grey, fine to medium arenite pelletal and comminuted shell	0.18	67.43

Chemical analyses of major elements (percentages) — Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
7.00	30.70	0.0	0.04	0.01	1.30	20.19	0.0	0.01	0.01	0.02	6300	46.63	5	180	460	1170	7.00
17.00	31.00	0.01	0.04	0.02	0.93	21.1	0.02	0.01	0.01	0.06	4300	46.89	10	20	580	1030	17.00
22.00	31.00	0.01	0.02	0.04	0.66	20.50	0.01	0.02	0.0	0.03	2500	47.15	5	5	210	820	22.00
28.00	31.10	0.00	0.03	0.05	0.72	21.20	0.03	0.02	0.01	0.02	2000	47.16	5	30	530	820	28.00
39.00	52.20	0.15	0.01	0.04	0.46	2.96	0.15	0.02	0.0	0.0	2300	43.95	5	5	110	540	39.00
48.00	55.20	0.02	0.01	0.01	0.68	0.77	0.05	0.03	0.05	0.0	2300	43.63	5	0	40	440	48.00
51.00	54.70	0.02	0.01	0.31	2.60	0.31	0.04	0.03	0.03	0.0	1500	41.84	10	50	240	560	51.00
57.00	55.00	0.04	0.01	0.02	0.85	0.95	0.11	0.03	0.05	0.0	2400	43.53	5	30	250	760	57.00
71.00	55.30	0.18	0.0	0.02	0.66	0.28	0.02	0.02	0.03	0.0	160	43.44	5	0	10	60	71.00

and foraminiferal debris, well sorted		
Biosparite, grey, abundant fine to medium arenite comminuted bioclasts, rare fine rudite brachiopod and coral, rare bioturbations, well sorted 67.43–69.07 m, patchily silicified	11.99	79.42

Borehole complete 79.42 m



RESOURCE BLOCK G

SK 25 NE 43 2845 5844 Ember Farm

Surface level +299.38 m
Dando 250 rig, waterflush, 58-mm diameter
September 1975

	Thickness m	*Depth* m
Monsal Dale Limestones		
Biosparite, medium to dark grey, fine arenite crinoid, foraminifera and pelletal debris, frequent quartz euhedra, well sorted	2.60	2.60
Pelsparite, medium grey, very fine arenite, well sorted	0.12	2.72
Biosparite Pelletal, medium to dark grey, arenite bioclasts, abundant quartz euhedra, patchily silicified and ironstained, fluorite-calcite vein 5.97–6.55 m	3.83	6.55
Biomicrite, medium grey, medium arenite algae encrusted brachiopod, crinoid and foraminiferal debris, silicified bioclasts, common quartz euhedra	1.52	8.07
Biosparite, medium grey, medium arenite foraminifera, shell and pellet debris, patchily dolomitised, silicified and hematite stained, common quartz euhedra	4.43	12.50
Pelsparite, medium grey, fine arenite, common pyrite and quartz euhedra, well sorted	0.91	13.41
Biosparite Pelletal, medium grey, fine arenite pellet and foraminiferal debris, common quartz euhedra and pyrite, well sorted	1.07	14.48
Clay, ochreous with green streaks	0.04	14.52
Biomicrite, medium grey, very fine arenite, some oxidised pyrite	1.83	16.35
Clay, ochreous with green streaks	0.48	16.83
Limestone Silicified, intense silicification, brecciated, iron stained	1.92	18.75
Clay, pale brown	0.08	18.83
Limestone, intense silicification	0.68	19.51
Clay, ochreous	0.45	19.96
Biomicrite, medium grey, fine arenite brachiopod and crinoid fragments, some quartz euhedra	0.33	20.29
Pelsparite, medium grey, fine arenite, very well sorted, some quartz euhedra	1.50	21.79
Biosparite, Bryozoa pale to dark grey, fine arenite, common bryozoa, patchily silicified	2.27	24.06
Clay, ochreous grey	1.20	25.26
Biosparite, pale grey, fine arenite foraminifera and pellets, patchily siliceous	0.91	26.17
Clay, ochreous	0.06	26.23
Biosparite, pale grey, medium arenite crinoid, brachiopod and pelletal debris, patchy silicification	1.11	27.34
Pelsparite, pale grey, fine arenite, well sorted	0.26	27.60
Biosparite Pellet, pale grey mottled, fine arenite foraminifera and pellets, common coelosporella, some *Girvanella* encrusted rudite brachiopods, rare coral	4.16	31.76
Biosparite Foraminifera, pale to medium grey mottled, arenite algal nodules and dasycladacean algae	0.70	32.46
Bee Low Limestones		
Biomicrite, pale to medium grey mottled, fine arenite brachiopod and foraminiferal debris, some *Coelosporella*. bioturbated, some quartz euhedra	9.36	41.82
Biomicrite, medium grey mottled, fine arenite foraminifera, brachiopod debris, and spines, common quartz euhedra	1.88	43.70
Biomicrite, Coral Brachiopod, pale grey, coarse arenite coral and brachiopod debris	0.50	44.20
Clay, reddish, ochreous	0.96	45.16
Pelsparite, medium grey mottled, medium arenite, well sorted	0.41	45.57
Biosparite Pellet, pale grey, medium arenite shell, crinoid, pellet, foraminifera and encrusting algae debris, common quartz euhedra, well sorted	5.12	50.69
Biosparite, medium grey, fine arenite shell, foraminifera and crinoid debris, common euhedral quartz, rare coral	3.62	54.31
Biomicrite, pale grey mottled, fine arenite spines, foraminifera, crinoid and brachiopod fragments, common pyrite and silicification 56.31–57.11 m	2.80	57.11
Mudstone, grey, non-calcareous	0.89	58.00
Biosparite Pellet, pale grey, fine arenite foraminifera, shell and spine debris, locally abundant quartz euhedra, common flecks of pyrite, some mudstone partings	20.74	78.74
Mudstone, grey	0.20	78.94
Mudstone Tuffaceous, dark grey, abundant disseminated pyrite, some fragments of bryozoa biomicrite with dasycladacean algae and crinoid debris 78.94–79.45 m	3.74	82.68
Biosparite, medium grey, fine arenite foraminifera and shell debris, some quartz euhedra and disseminated pyrite	0.47	83.15
Mudstone, pale grey, abundant pyrite	0.84	83.99
Biosparite, medium grey, fine arenite foraminifera and shell debris, some quartz euhedra and disseminated pyrite	0.74	84.73

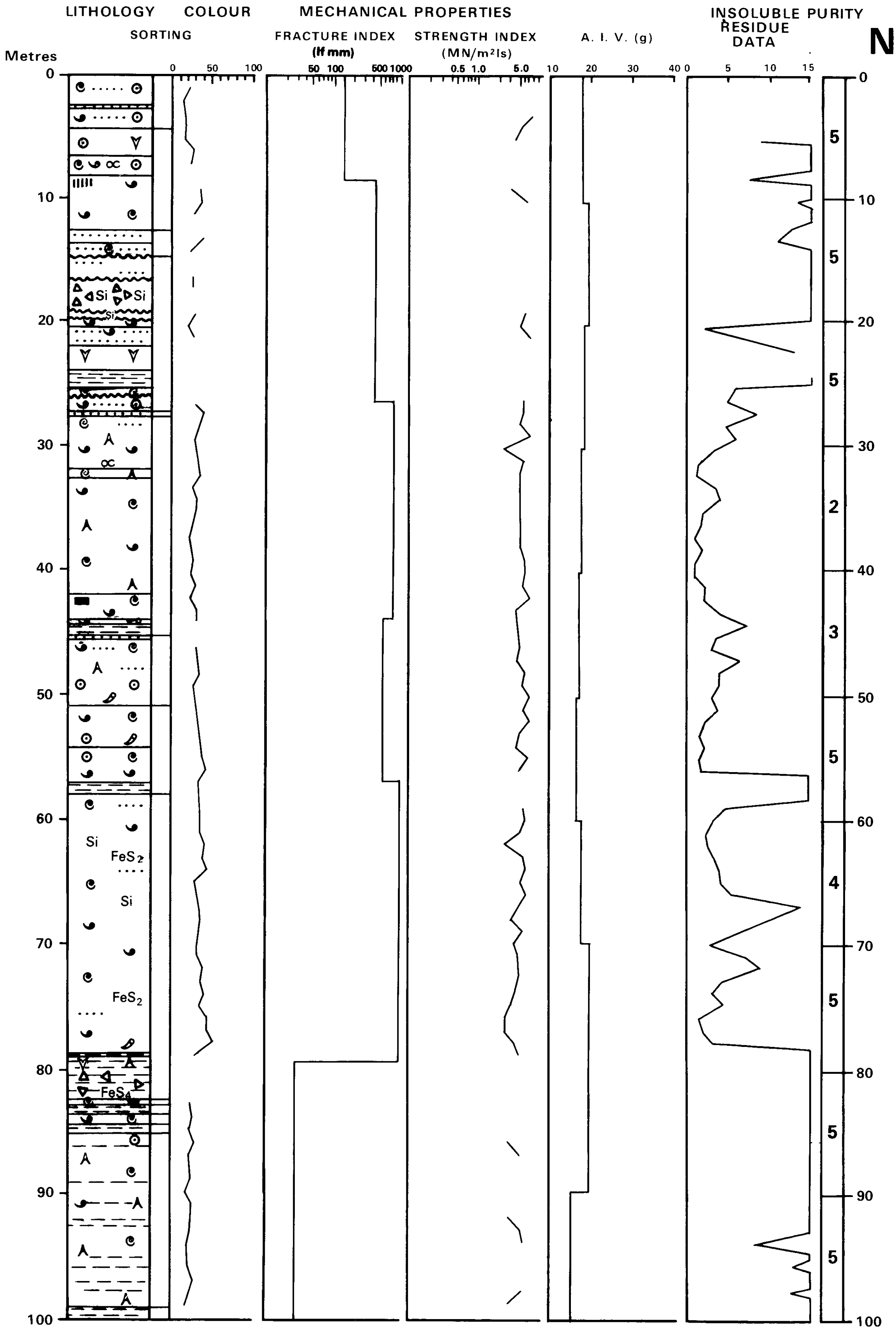
Chemical analyses of major elements (percentages) — Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
3.00	55.20	0.06	0.02	0.33	2.82	0.27	0.0	0.03	0.0	0.0	820	42.13	5	10	10	370	3.00
9.00	49.90	0.01	0.03	6.50	14.20	0.17	0.04	0.03	0.08	0.0	8800	28.30	5	140	70	460	9.00
16.00	53.10	0.04	0.03	7.40	8.60	0.25	0.71	0.16	0.08	0.01	9900	29.81	5	0	90	440	16.00
27.00	52.60	0.07	0.02	0.05	7.40	0.30	0.04	0.13	0.06	0.01	200	40.36	0	80	10	110	27.00
34.00	54.70	0.06	0.02	0.21	2.97	0.29	0.13	0.04	0.03	0.0	420	41.68	5	0	20	160	34.00
44.00	52.90	0.12	0.03	0.02	3.64	0.39	1.64	0.01	0.07	0.0	3100	41.38	0	0	20	170	44.00
47.00	53.30	0.01	0.02	0.02	5.60	0.18	0.0	0.02	0.03	0.0	200	40.95	0	0	5	100	47.00
67.00	53.60	0.01	0.02	3.50	6.60	0.17	0.01	0.02	0.05	0.0	530	36.66	0	0	10	100	67.00
72.00	53.10	0.0	0.02	0.47	6.40	0.21	0.04	0.03	0.04	0.0	410	40.11	0	0	70	170	72.00
90.00	41.50	5.80	0.08	0.07	10.90	0.53	2.29	0.97	0.07	0.03	35200	26.36	15	0	10	150	90.00

Mudstone, pale grey, abundant pyrite	0.55	85.28
Biomicrite, medium grey, fine arenite foraminifera, spines, brachiopod and *Coelosporella* debris, common pyrite, patchy silicification, common mudstone wisps and partings	13.82	99.10
Mudstone, pale grey	1.20	100.30

Borehole complete 100.30 m

G
NE 43



RESOURCE BLOCK G

SK 25 NE 28 2788 5989 Snitterton

Surface level +188.9 m
1973

	Thickness m	*Depth* m
Monsal Dale Limestones: dolomite		
Dolomite, vuggy, completely recrystallised, some brachiopod debris, some chert nodules	12.93	12.93
Clay, greenish-grey	0.20	13.13
Dolomite, pale grey, vuggy, iron stained, trace pyrite at base	2.66	15.79
Upper Matlock Lava		
Basalt, weathered in part, pyritous	23.74	39.53
Monsal Dale Limestones		
Biomicrite, dark grey, medium arenite brachiopod and foraminiferal debris, pyritous	0.12	39.65
Mudstone, greenish-grey, pyritous	0.03	39.68
Biomicrite, medium grey, medium arenite, brachiopods, foraminifera and spines, some fine rudite, patchily silicified fine rudite brachiopods, some flecks of pyrite	1.67	41.35
Pelsparite, pale grey, medium arenite, some crinoid, brachiopod and foraminiferal debris, well sorted, bioclasts patchily silicified	0.94	42.29
Biosparite Pellet, pale grey, fine arenite pellets, medium to coarse arenite brachiopod, crinoid and foraminiferal debris	2.71	45.00
Biosparite, medium to dark grey, fine to medium arenite *Girvanella* encrusted shell debris, crinoid, foraminifera and pelletal debris, rare *Coelosporella*, bioturbated, some thin fluorite veins with associated pyrite	7.91	52.91
Mudstone, green shaly	0.18	53.09
Biomicrite, medium grey, mottled, fine arenite comminuted brachiopods, crinoid, pellet and ostracod debris, bioturbated, patchy silicification and occasional flecks of pyrite	8.06	61.15
Biopelsparite, medium grey, medium arenite brachiopod and crinoid debris, commonly encrusted with algae	1.17	62.72
Biomicrite, medium to dark grey, coarse arenite *Girvanella* encrusted brachiopods	0.28	63.00
Pelsparite, pale grey, fine arenite, well sorted	0.50	63.50
Biomicrite Foraminifera, medium to dark grey mottled, medium arenite comminuted brachiopod debris, common foraminifera, rare coral, some flecks of pyrite	4.92	68.42
Biosparite Crinoid, pale grey, medium arenite crinoid and corroded shell debris, rare *Coelosporella*	5.33	73.75
Biomicrite, pale grey becoming dark grey at base, medium arenite comminuted crinoid and shell debris, rare *Syringopora*, thin green clay at 78.22 m, some rudite brachiopods and disseminated pyrite below 80.00 m	7.44	81.19
Lower Matlock Lava		
Tuff	3.89	85.08

Borehole complete at 85.08 m

Chemical analyses of major elements (percentages)

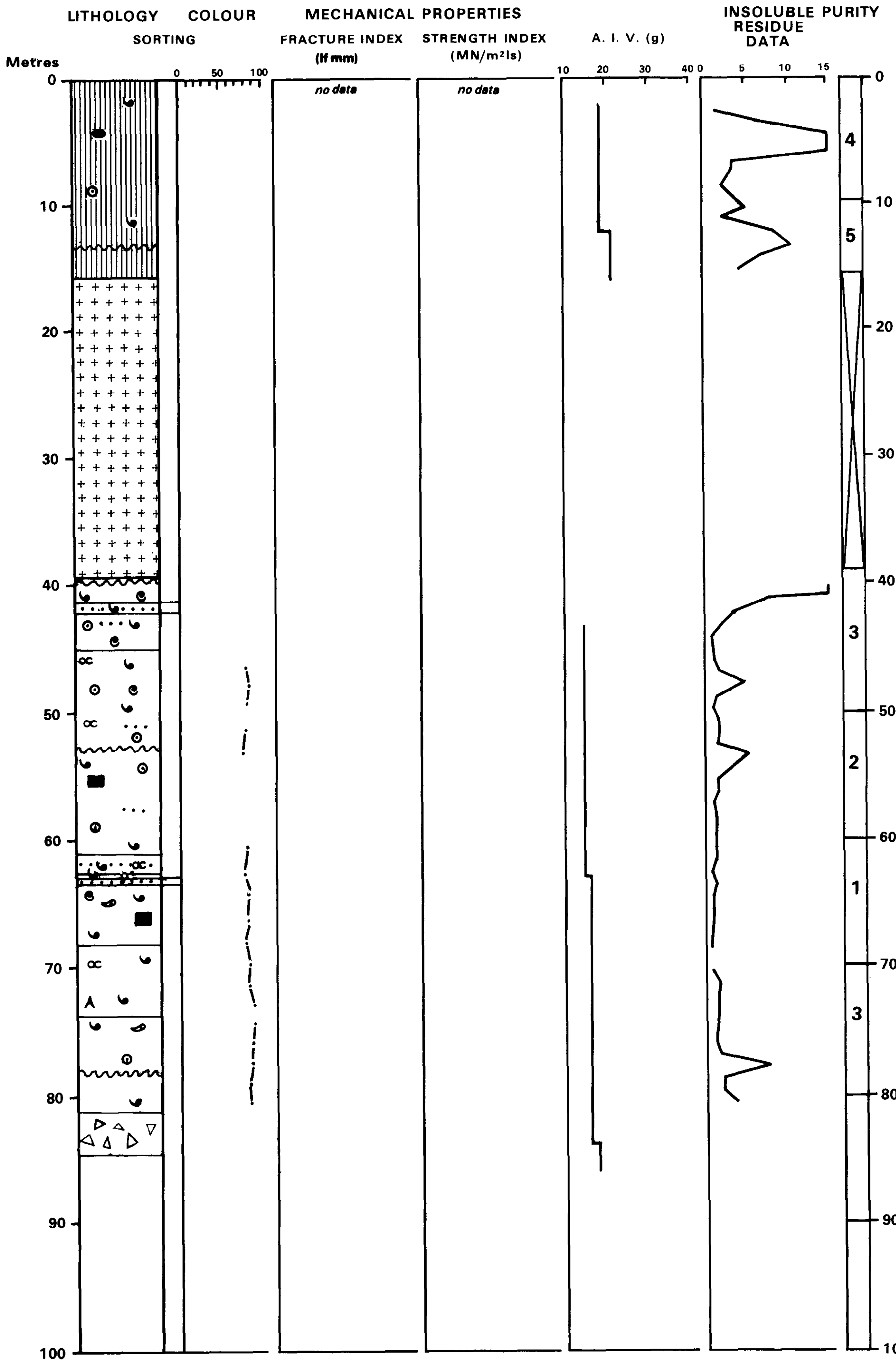
Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
6.00	29.50	0.0	0.03	0.0	12.40	16.90	0.28	0.06	0.08	0.01	1800
12.00	31.70	0.02	0.03	0.0	1.01	19.70	0.10	0.03	0.01	0.08	2200
47.00	55.60	0.07	0.02	0.0	0.49	0.33	0.08	0.03	0.02	0.06	500
57.00	55.20	0.07	0.02	0.01	0.86	0.30	0.05	0.02	0.02	0.01	890
76.00	56.30	0.20	0.03	0.06	0.28	0.20	0.01	0.02	0.04	0.01	790
83.00	54.00	0.70	0.04	0.59	3.12	0.28	0.59	0.04	0.01	0.01	2700

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
40.44	5	15	20	510	6.00
47.00	10	5	65	680	12.00
43.61	5	5	15	180	47.00
43.47	5	0	0	170	57.00
42.84	5	45	95	220	76.00
40.13	5	10	1500	590	83.00

Resource Block G SK 25 NE 28 2788 5989 Snitterton

G
NE 28



RESOURCE BLOCK G

SK 25 NE 29 2770 5994 Snitterton

Surface level +187.39 m

	Thickness m	*Depth* m
Monsal Dale Limestones: dolomite		
Dolomite, recrystallised mosaic of dolomite crystals, common thin baryte veins	2.75	2.75
Biomicrosparite, medium grey, common comminuted arenite brachiopod debris	1.47	4.22
Dolomite, original texture completely destroyed, thin baryte vein 7.25 m, green clay 8.51 m, common chert nodules 11.96–13.87 m	9.65	13.87
Clay	0.03	13.90
Biosparite Dolomitised, medium to dark grey, fine to medium arenite shell and foraminiferal debris	0.24	14.14
Dolomite, recrystallised mosaic, calcite, baryte and fluorite vein	3.17	17.31
Monsal Dale Limestones		
Biomicrite, dark grey, fine arenite crinoid, brachiopod and foraminifera, some chert nodules, and quartz euhedra	1.90	19.21
Biosparite, pale grey, medium arenite algae encrusted shell debris, crinoid and some ostracod debris. Pyritous in lower 0.15 m	4.04	23.25
Upper Matlock Lava		
Basalt, green and grey, chlorite and calcite amygdales	22.25	45.50
Monsal Dale Limestones		
Biomicrite, pale grey, dark grey in upper 0.1 m, medium arenite brachiopod and crinoid debris, common disseminated pyrite, patchily silicified shell debris	1.81	47.31
Biosparite, pale grey, medium arenite brachiopod and subordinate pelloidal material, some quartz euhedra, silicified shell debris, thin pyrite veins, tuffaceous in upper 0.2 m	8.25	55.56
Biopelsparite, pale grey, arenite foraminifera, pellets and rounded shell debris, well sorted	1.54	57.10
Biomicrite, dark grey, medium arenite	0.30	57.40
Biopelsparite, pale grey, arenite shell and foraminiferal debris, well sorted, rare flecks of pyrite	0.51	57.91
Biomicrite, tuffaceous	0.56	58.47
Biomicrite, pale grey, fine arenite crinoid debris, rare pyrite	0.50	58.97
Clay, green	0.03	59.00
Biomicrite, pale grey, fine to medium arenite, some quartz euhedra and flecks of pyrite	0.18	59.18
Pelsparite, pale grey, fine arenite, some quartz euhedra and pyrite	0.58	59.76
Biosparite, pale grey, medium arenite brachiopods, crinoids and pelletal material, some quartz euhedra	0.96	60.72
Pelsparite, pale grey, medium arenite comminuted brachiopod, crinoid, foraminifera and dasycladacean algae material, abundant pellets, well sorted	2.63	63.35
Biopelsparite, pale grey, bioturbated, mottled, abundant arenite comminuted brachiopod, crinoid, encrusting algae, foraminifera, coral and bryozoan debris, common pelletal material	1.90	65.25
Biomicrite, pale grey, fine arenite comminuted brachiopod, spine and foraminifera debris, patchily silicified	5.68	70.93
Pelsparite, pale grey, very fine arenite, well sorted	0.49	71.42
Biosparite, pale grey to medium grey, abundant medium arenite brachiopod, foraminifera, crinoid and encrusting algae debris, some bryozoa and pellets	8.33	79.75
Biomicrite, pale grey, medium arenite *Girvanella* encrusted shell debris, crinoid and foraminiferal debris	2.34	82.09

Borehole complete at 82.09 m

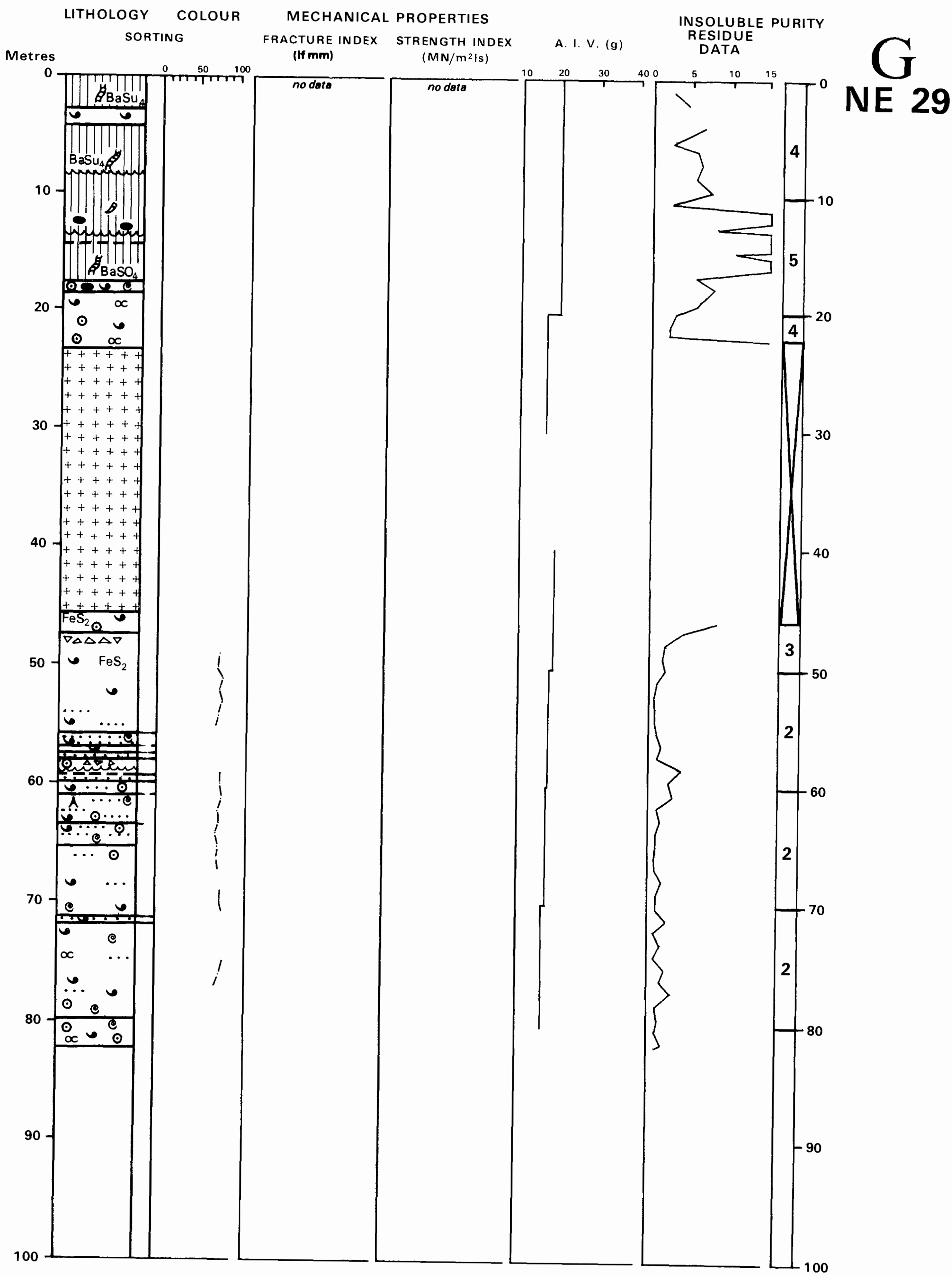
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
6.00	37.00	0.03	0.05	0.05	2.58	15.60	0.11	0.04	0.06	0.04	2300
11.00	27.00	0.30	0.04	0.0	19.70	16.30	0.22	0.05	0.13	0.07	2400
20.00	55.10	0.07	0.02	0.0	1.27	0.38	0.19	0.05	0.04	0.0	1400
48.00	56.10	0.62	0.03	0.27	0.55	0.25	0.09	0.03	0.05	0.05	3200
60.00	55.70	0.03	0.03	0.0	0.74	0.20	0.0	0.02	0.01	0.01	250
74.00	55.80	0.10	0.05	0.79	0.98	0.26	0.05	0.03	0.01	0.02	500

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
45.28	5	15	115	1030	6.00
37.03	5	5	140	760	11.00
43.25	5	0	0	450	20.00
42.23	5	10	10	310	48.00
43.63	0	30	30	100	60.00
42.52	5	15	15	100	74.00

Resource Block G SK 25 NE 29 2770 5994 Snitterton



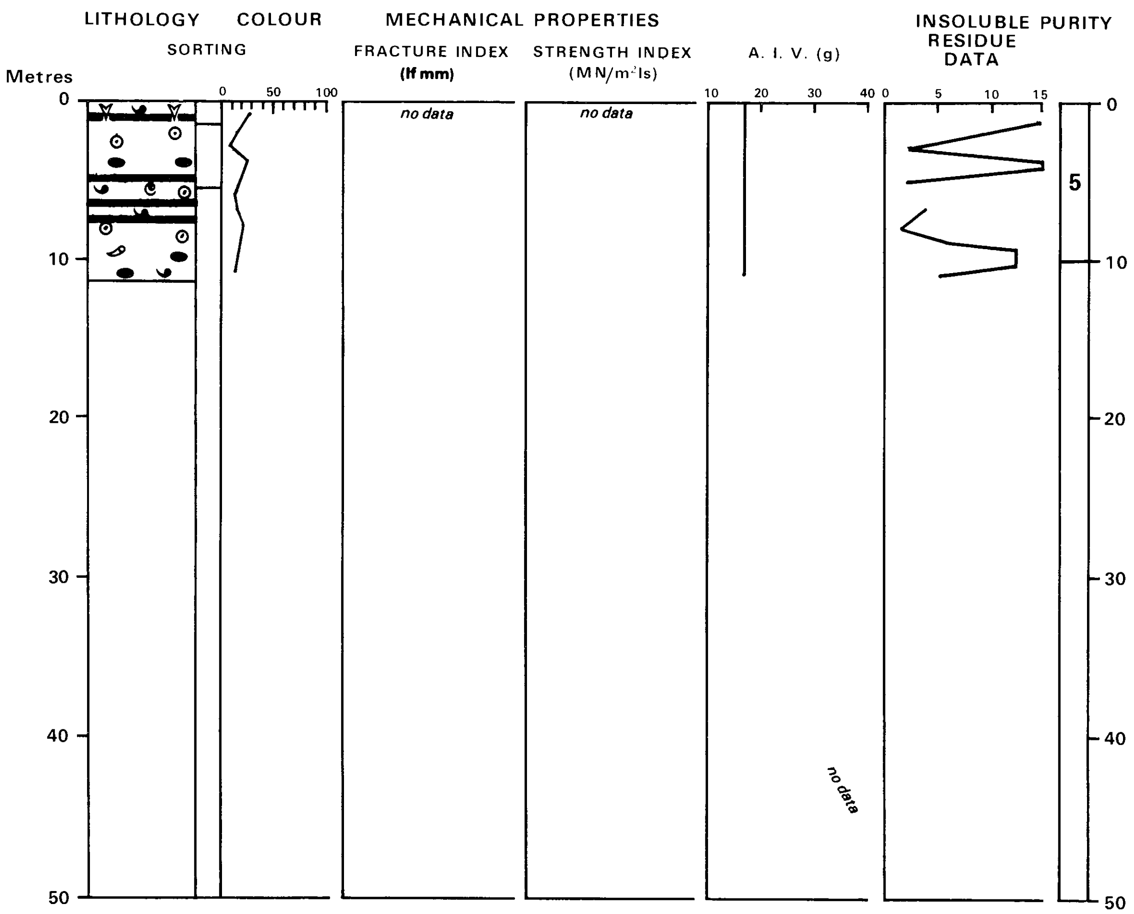
RESOURCE BLOCK G

SK 25 NE 1s 2978 5820 Station Quarry

Surface level +103.64 m

Eyam Limestones	*Thickness* m	*Depth* m
Biosparite bryozoa, dark grey-brown, medium to coarse arenite comminuted bioclastic debris, some bryozoa. Common regular chert bands and chert nodules	1.50	1.50
Biosparite Crinoid, medium arenite, well sorted, minor amounts of disseminated clay minerals, some flecks of pyrite	1.00	2.50
Biomicrosparite, dark grey, fine arenite to fine rudite bioclastic debris, chiefly shell, crinoid and foraminiferal debris, common bedded and nodular chert, common black clay partings, bioclasts patchily silicified	5.00	7.50
Biosparrudite Crinoid, grey-brown, mottled, medium arenite–medium rudite, scattered chert nodules, patchy silicification of bioclasts	2.00	9.50
Biosparite, grey-brown, to dark grey, medium arenite to fine rudite, scattered chert nodules, brachiopod debris locally silicified	1.75	11.25

Base of section 11.25 m



G

NE 1S

Chemical analyses of major elements (percentages)

Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	orO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
2.00	51.30	0.18	0.0	0.08	7.18	0.69	0.68	0.13	0.07	0.24	6000	39.78	35	75	680	680	2.00
8.00	55.00	0.02	0.0	0.0	0.80	0.58	0.15	0.04	0.05	0.04	170	43.48	5	10	10	160	8.00

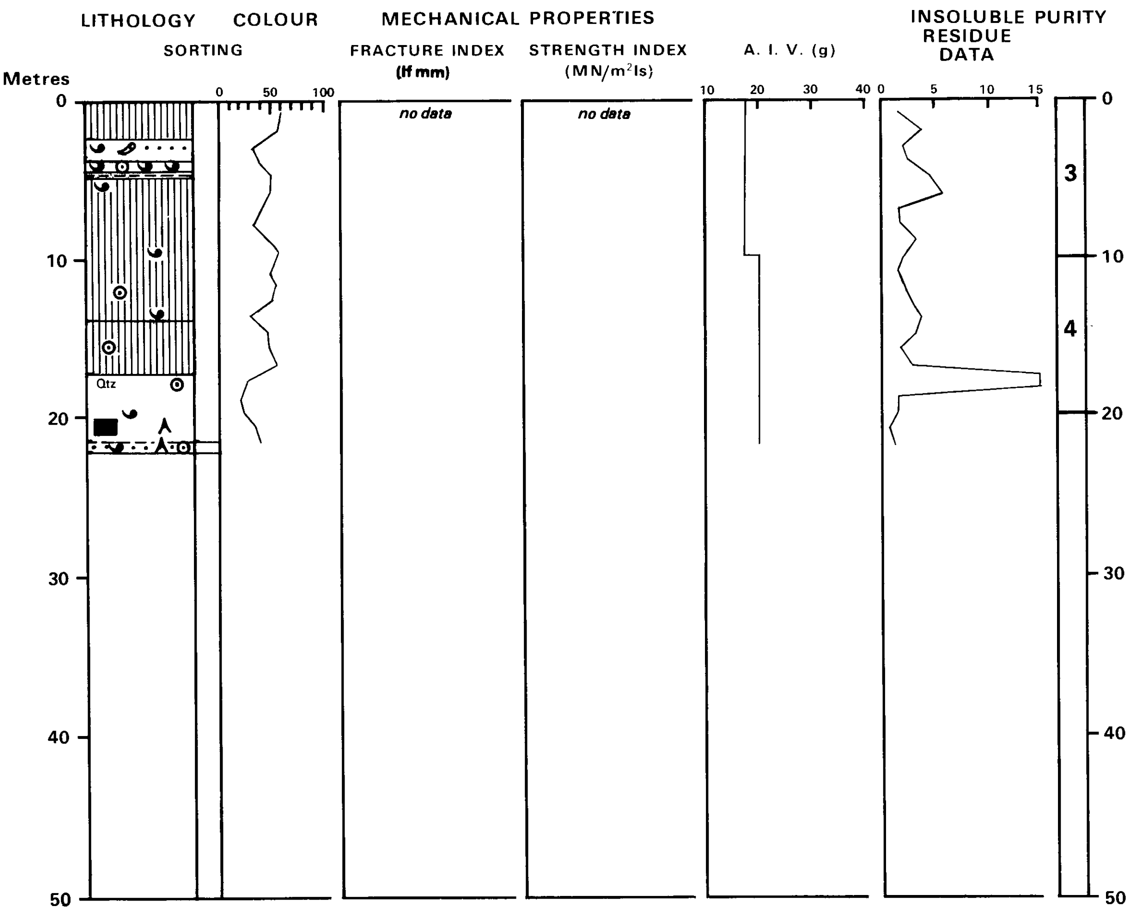
RESOURCE BLOCK G

SK 25 NE 2s 2865 5914 Masson Hill Quarry

Surface level +329.15 m

	Thickness	*Depth*
Monsal Dale Limestones: dolomite	m	m
Dolomite, buff-yellow, granular, vuggy	2.25	2.25
Biomicrosparite, grey, fine arenite to fine rudite bioclastic	1.50	3.75
Biosparite, buff-grey, common arenite crinoid and brachiopod debris, rare coarse rudite brachiopods	0.60	4.35
Clay	0.30	4.65
Dolomite, grey-yellow, vuggy, scattered rudite crinoid and shell debris	9.25	13.90
Limestone Dolomite, vuggy, patchy silicification	0.60	14.50
Dolomite, scattered coarse arenite–fine rudite crinoid debris	2.80	17.30
Biosparite, medium grey, fine to coarse arenite bioclastic, texture obscured by silicification and abundant quartz euhedra, mottled, rare *Coelosporella* from 20.50–21.50 m	4.20	21.50
Biopelsparite, grey-brown, common fine arenite pelletal debris, some coarse arenite–fine rudite bioclastic debris, rare *Coelosporella*, rare *Girvanella*, well sorted	0.70	22.20

Base of section 22.20 m



G
NE 2S

Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†
3.00	56.00	0.0	0.0	0.0	1.43	0.58	0.07	0.04	0.05	0.01	1200	43.20
8.00	33.60	0.0	0.01	0.15	0.51	19.10	0.10	0.04	0.0	0.10	4000	46.87

Trace elements (ppm)

Cu	Pb	Zn	MnO	Depth
5	5	35	190	3.00
5	55	410	790	8.00

RESOURCE BLOCK G

SK 25 NE 11s 2869 5750 Ball Eye Quarry

Surface level +189.36 m

	Thickness m	*Depth* m
Monsal Dale Limestones: dolomite		
Limestone Dolomitised, pale yellow-grey, rare fine to medium arenite shell debris	1.00	1.00
Gap	1.50	2.50
Dolomite, grey, finely granular, vuggy, some medium to coarse arenite crinoid and shell debris, rare nodular black chert at 6.00 m	5.00	7.50
Gap	1.00	8.50
Dolomite, grey-brown, coarsely granular, vuggy, some altered crinoid and shell debris, abundant nodular and bedded black chert 12.50–22.50 m	14.00	22.50
Monsal Dale Limestones		
Biomicrite Dolomitised, dark grey, fine to medium arenite brachiopod, crinoid and foraminiferal debris, some nodular black chert and patchily silicified shell debris	1.00	23.50
Biomicrite, dark grey, fine to medium arenite comminuted bioclastic debris, rare nodular black chert and patchily silicified shell debris	3.00	26.50
Biomicrosparite Brachiopod, grey, abundant fine to coarse arenite brachiopod, crinoid, foraminifera and rare pelloidal debris, some coarse rudite brachiopods, rare nodular chert and some patchily silicified shell debris	1.50	28.00
Clay	0.20	28.20
Gap	4.30	32.50
Dolomite, grey, finely granular, vuggy	2.00	34.50
Biomicrite, dark grey, some fine arenite foraminifera and brachiopod debris	1.00	35.50
Biopelsparite, medium grey, fine to medium arenite, well sorted	1.00	36.50
Biosparrudite Brachiopod, dark grey, common medium rudite thick-shelled brachiopods, common arenite comminuted brachiopod, crinoid and foraminifera, rare encrusting coral	2.00	38.50
Biomicrite, grey to dark grey mottled, some fine arenite foraminifera and comminuted brachiopod and crinoid debris, some patchily silicified shell debris, rare streaks of bitumen	10.00	48.50
Clay	0.20	48.70
Biomicrite, grey to dark grey, fine to coarse arenite comminuted brachiopod, crinoid and foraminiferal debris, rare coral, micrite and microspar mixed matrix. Some silicified shell debris, rare nodular chert, rare bitumen-filled stylolites	14.20	62.90
Clay	0.90	63.80
Biosparite, buff-grey, fine to medium arenite comminuted bioclastic debris, some pelletal debris, fine spar and microspar mixed matrix, common bioturbational mottling	4.40	68.20

Base of section 68.20 m

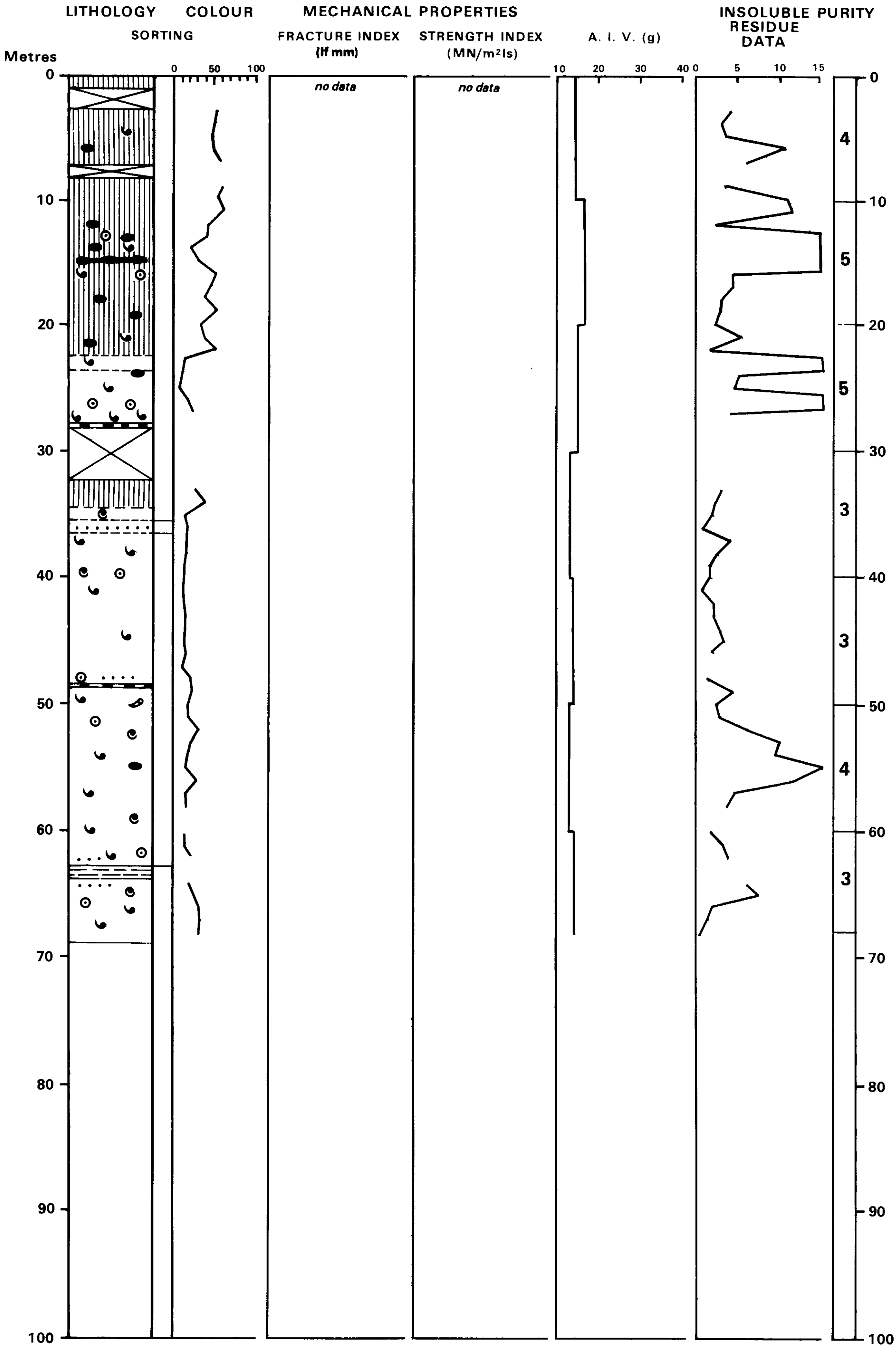
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
6.00	29.40	0.03	0.05	0.01	8.10	18.10	0.13	0.04	0.0	0.17	2900
11.00	30.50	0.0	0.05	0.0	6.50	17.90	1.01	0.11	0.0	0.06	3700
14.00	7.40	0.0	0.05	0.0	82.00	3.11	0.17	0.02	0.27	0.0	800
42.00	54.80	0.11	0.03	0.01	1.93	0.50	0.21	0.06	0.01	0.08	1200
55.00	51.30	0.06	0.03	1.88	11.80	0.24	0.03	0.02	0.04	0.0	470
65.00	52.90	0.02	0.02	0.03	5.60	0.28	0.01	0.02	0.0	0.0	500

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
42.54	5	0	140	900	6.00
43.10	30	10	180	860	11.00
6.64	10	0	40	130	14.00
43.25	0	0	70	150	42.00
36.19	10	0	80	160	55.00
40.96	5	0	30	380	65.00

Resource Block G SK 25 NE 11s 2869 5750 Ball Eye Quarry



G

NE 11S

RESOURCE BLOCK H

Source of data	*Registration number*	*Grid Reference*
IMAU boreholes (drilled by contractor)	SW 5	2131 5150
	SW 18	2125 5252
	SW 19	2122 5087

RESOURCE BLOCK H

SK 25 SW 5 2131 5150 New House, Kniveton

Surface level +256.34 m
April 1971

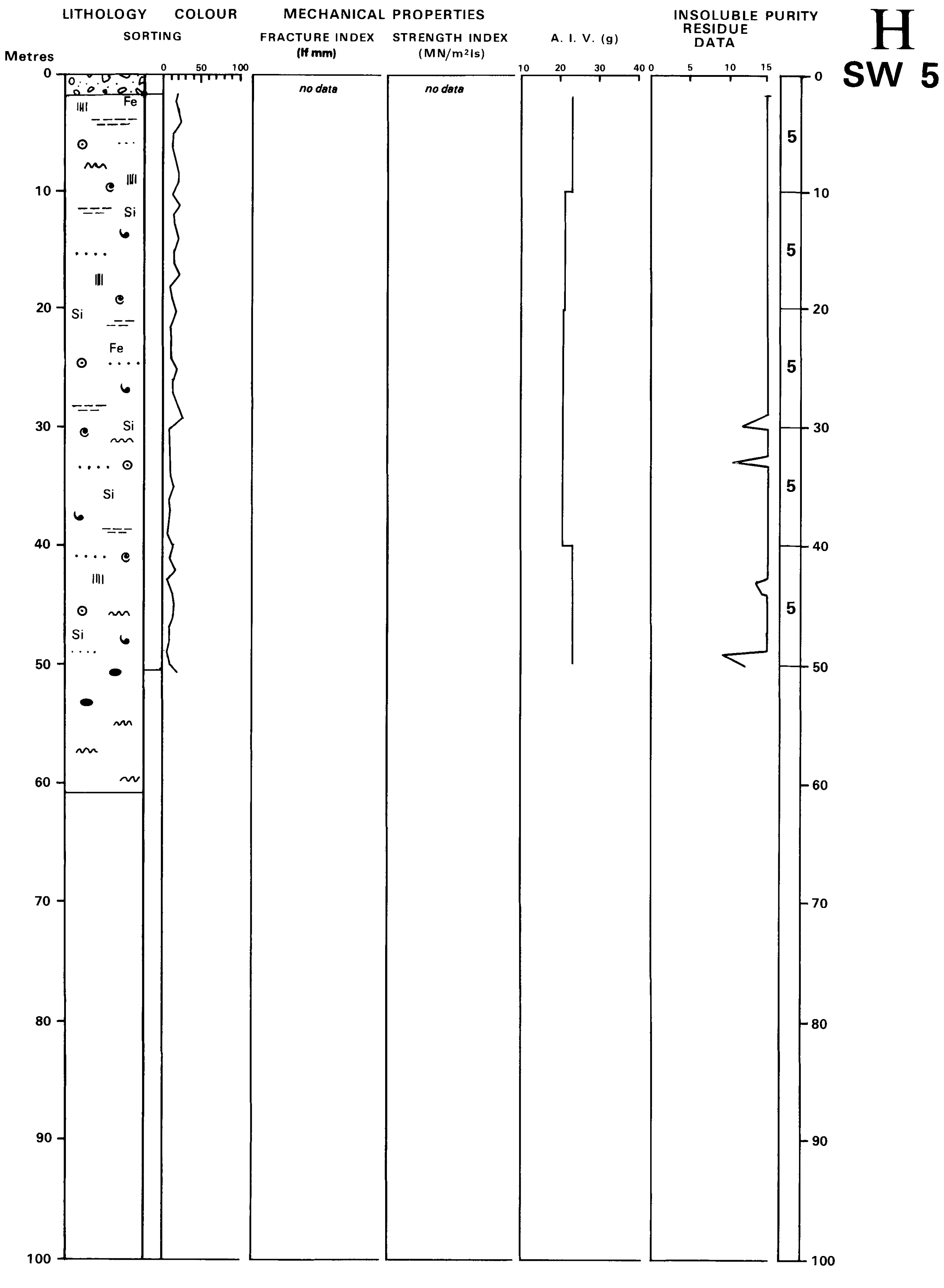
	Thickness m	*Depth* m
Recent		
Topsoil, reddish-brown loamy clay with abundant limestone fragments	1.60	1.60
Milldale Limestones		
Biosparite, brecciated, dark grey angular fragments with yellow, red and black shale, thin calcite veins, rubbly core	2.16	3.76
Biosparite, dark grey, fine arenite comminuted shell, crinoid, foraminifera and pelloidal debris, matrix predominantly fine spar but micrite is locally prominent, some thin blue-grey and reddish mudstones 3.76–19.00 m, some black shale partings 20.50 m–61.00 m, patchily silicified bioclasts, patchily silicified mudstone and shale partings, locally abundant quartz euhedra. Thin chert band at 50.96 m. Patchy dolomitisation and hematite staining. Common calcite veins, some baryte veins, poor recovery, rock chips 50.96–61.00 m	57.24	61.00

Borehole complete at 61.00 m

Chemical analyses of major elements (percentages) — Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
6.00	43.70	0.0	0.03	0.15	14.30	1.86	1.38	0.32	0.12	0.15	21500	36.61	5	0	10	660	6.00
9.00	42.80	0.0	0.04	0.15	15.70	1.61	1.60	0.38	0.11	0.15	28500	35.65	5	0	0	640	9.00
15.00	45.90	0.0	0.01	0.06	15.30	0.41	0.55	0.13	0.16	0.06	11700	35.58	0	0	0	830	15.00
20.00	46.60	0.0	0.02	0.05	11.70	0.73	1.76	0.44	0.13	0.05	8000	37.46	5	0	10	870	20.00
33.00	50.20	0.0	0.01	0.07	7.80	0.58	0.66	0.16	0.10	0.07	15100	39.77	0	0	10	970	33.00
40.00	44.30	0.0	0.03	0.11	14.30	0.72	2.72	0.66	0.14	0.11	23200	36.06	0	0	10	810	40.00
49.00	49.90	0.0	0.01	0.04	7.20	0.58	0.62	0.16	0.10	0.04	12500	40.03	0	0	0	1100	49.00

Resource Block H SK 25 SW 5 2131 5150 New House, Kniveton



SK 25 SW 18 2125 5252 Bradbourne

Surface level +662.9 m
Dando 250 rig, waterflush, 47-mm diameter
December 1975

	Thickness	*Depth*
Hopedale Limestones	m	m
Biosparite, dark grey, fine arenite shell debris, patchy disseminated clay	1.67	1.67
Gap	0.37	2.04
Pelsparite, dark grey, patchily silicified	0.04	2.08
Biomicrite, medium to dark grey, some medium arenite to fine rudite crinoid, brachiopod and coral debris, common black mudstone partings, some chert nodules, some green weathered volcanic fragments, patchily dolomitised 15.37–17.32 m	15.24	17.32
Dolomite, pale grey, intense dolomitisation predominates, some coral, crinoid and brachiopod debris, common black mudstone partings, vuggy	21.32	38.64
Biomicrite Crinoid Dolomitic, medium grey, common mudstone partings	1.36	40.00
Pelsparite Dolomitic, medium grey, common arenite crinoid debris, some black mudstone partings, well sorted	3.03	43.03
Dolomite, pale grey, locally dark grey, intense dolomitisation, some crinoid debris, patchy iron-staining.	12.73	55.76
Biosparite Crinoid Pellet Dolomitic, pale to dark grey, common arenite crinoid, pellet, brachiopod and coral debris, local intense patchy dolomitisation	16.24	72.00
Pelsparite Dolomitic, medium to dark grey, fine arenite crinoid, pellet foraminifera and spine debris, well sorted, common calcite veins	14.40	86.40
Biosparite Crinoid Pellet Dolomitic, pale to medium grey, arenite to fine rudite crinoid and brachiopod debris, arenite pellet, foraminifera and spine debris, common black mudstone partings	13.60	100.00

Borehole complete 100.00 m

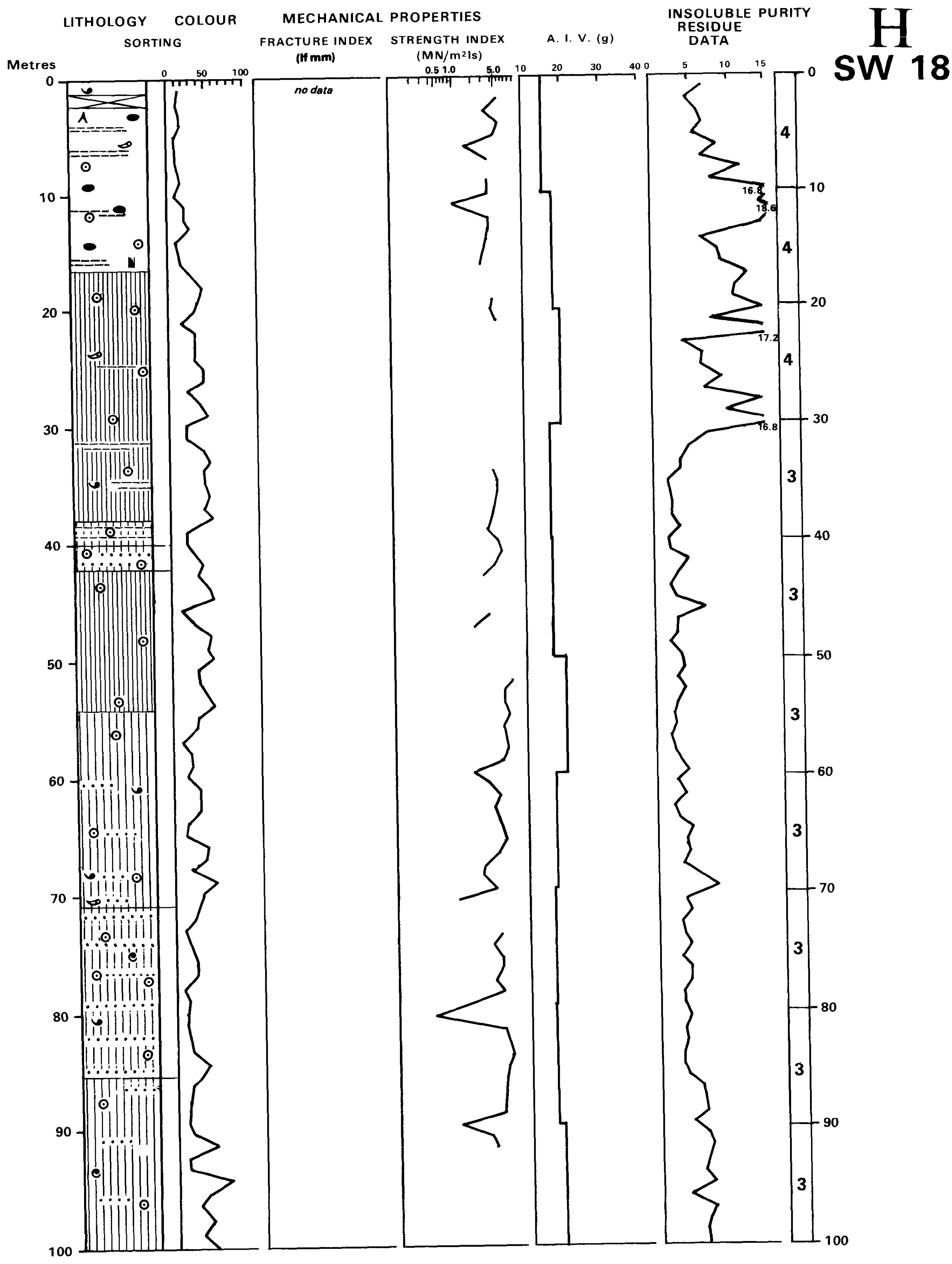
Chemical analyses of major elements (percentages)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*
6.00	51.90	0.31	0.04	0.04	5.10	0.66	0.95	0.22	0.01	0.17	2500
12.00	48.10	0.64	0.06	0.07	11.80	0.75	2.02	0.46	0.04	0.07	5900
26.00	30.40	0.04	0.07	0.01	5.80	18.30	1.41	0.29	0.07	0.08	8000
37.00	32.60	0.03	0.06	0.0	1.16	19.40	0.21	0.05	0.03	0.11	2800
42.00	48.20	0.02	0.04	0.0	1.35	5.60	0.17	0.05	0.0	0.04	5500
46.00	43.90	0.0	0.04	0.0	1.59	8.70	0.35	0.08	0.0	0.05	12299
60.00	44.90	0.02	0.04	0.0	1.74	7.90	0.37	0.09	0.0	0.02	12100
77.00	53.10	0.06	0.06	0.0	2.31	1.44	0.50	0.11	0.0	0.02	3500
92.00	46.60	0.04	0.04	0.02	3.84	5.20	0.97	0.02	0.0	0.02	7900

Trace elements (ppm)

Loss†	Cu	Pb	Zn	MnO	Depth
40.61	10	5	65	280	6.00
36.56	15	5	70	230	12.00
43.92	10	20	65	970	26.00
46.95	5	40	20	880	37.00
44.25	0	5	15	1090	42.00
44.32	5	30	40	2280	46.00
44.18	5	5	20	1930	60.00
42.71	5	5	105	860	77.00
42.51	5	0	10	2020	92.00

Resource Block H SK 25 SW 18 2125 5252 Bradbourne



SK 25 SW 19 2122 5087 Standlow Quarry, Kniveton

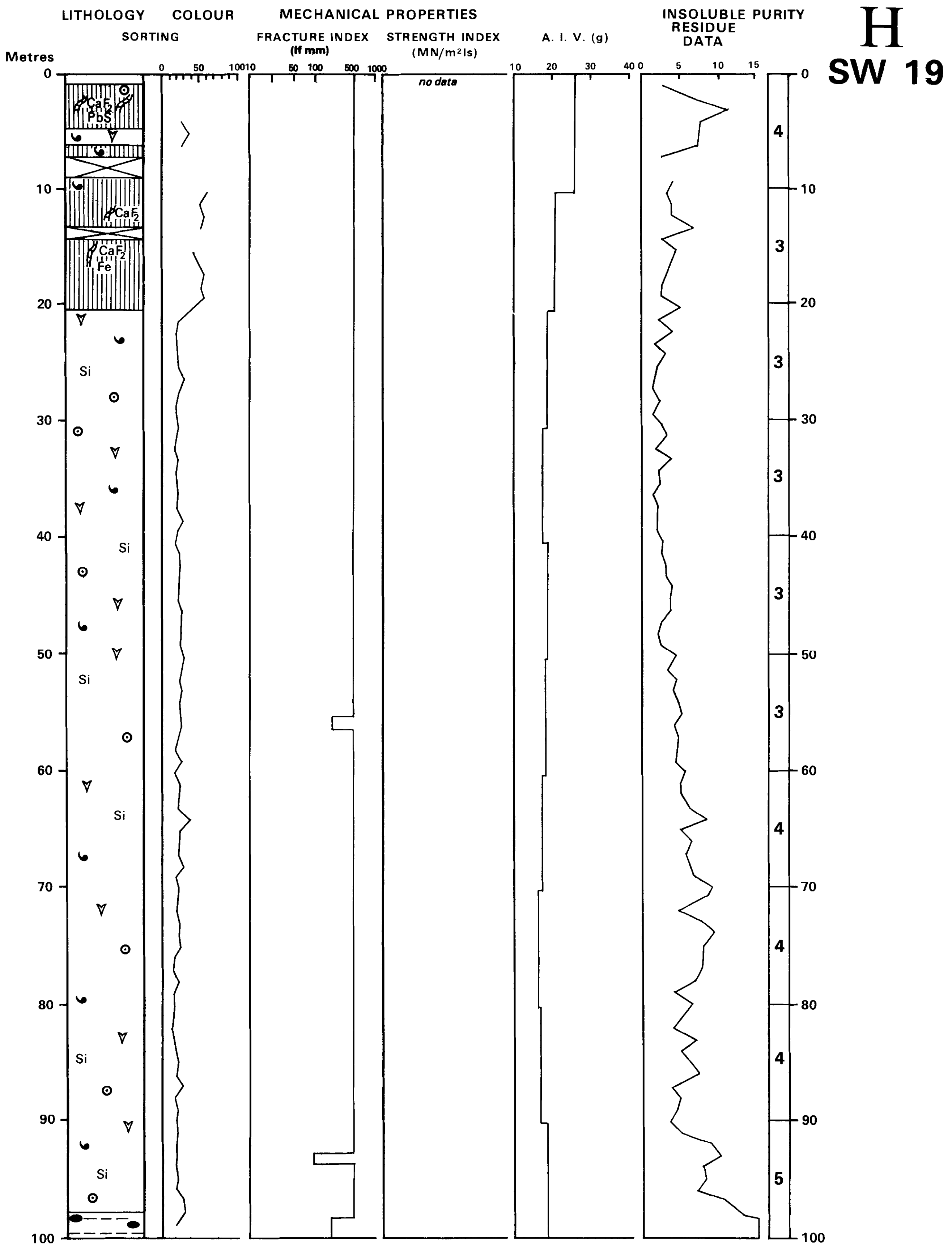
Surface level +251.61 m
Dando 250 rig, waterflush, 47-mm diameter
January 1976

	Thickness m	*Depth* m
Recent		
Topsoil	0.50	0.50
Milldale Limestones		
Dolomite, buff-grey, vuggy, some crinoid debris, some galena calcite and fluorite veins, patchy limonite staining	4.49	4.99
Biosparite Bryozoa, medium and dark grey mottled, common bryozoa and brachiopod fragments, patchy dolomitisation and silicification	1.48	6.47
Dolomite, intense alteration, rare brachiopod debris	0.52	6.99
Gap	2.24	9.23
Dolomite, pale grey, vuggy, common calcite and fluorite veins, patchy iron-staining	4.52	13.75
Gap	1.05	14.80
Dolomite, pale grey, vuggy, locally brecciated patchily iron-stained	6.04	20.84
Biomicrite Bryozoa, medium to dark grey, mottled, fine to medium arenite brachiopod, bryozoa, spine and crinoid debris, bioclasts, patchily silicified, patchy dolomitisation to 37.00 m. Hematite staining, rare flecks of pyrite	77.46	98.30
Micrite, dark grey, common black mudstone partings, some nodular chert, bituminous	1.56	99.86

Borehole complete at 99.86 m

Chemical analyses of major elements (percentages) — Trace elements (ppm)

Depth	CaO	SO_3	Na_2O	F	SiO_2	MgO	Al_2O_3	K_2O	SrO	P_2O_5	Fe*	Loss†	Cu	Pb	Zn	MnO	Depth
7.00	32.10	0.0	0.05	0.02	1.49	19.70	0.15	0.05	0.02	0.06	3700	46.76	5	470	350	1260	7.00
13.00	41.50	0.0	0.04	0.06	1.92	11.40	0.23	0.07	0.0	0.03	11600	42.51	30	190	770	1540	13.00
18.00	34.10	0.02	0.05	0.04	0.92	18.10	0.11	0.04	0.02	0.06	4100	46.68	5	0	270	1470	18.00
24.00	39.20	0.03	0.03	0.01	0.81	13.50	0.06	0.03	0.0	0.03	13100	45.77	5	0	120	2410	24.00
35.00	53.40	0.04	0.01	0.0	1.27	1.58	0.17	0.06	0.01	0.02	1600	43.49	5	0	0	210	35.00
46.00	52.10	0.03	0.01	0.0	2.57	2.13	0.17	0.06	0.02	0.02	1300	42.92	5	5	20	280	46.00
58.00	51.60	0.07	0.0	0.0	3.13	2.62	0.27	0.08	0.03	0.01	2000	42.69	5	10	30	470	58.00
70.00	50.20	0.02	0.01	0.0	5.14	2.76	0.14	0.05	0.04	0.01	1500	41.73	5	5	20	280	70.00
82.00	53.80	0.04	0.02	0.0	2.47	0.69	0.13	0.05	0.02	0.0	500	42.72	5	10	10	260	82.00
93.00	51.20	0.55	0.02	0.03	7.00	0.82	0.91	0.23	0.07	0.12	4400	39.54	5	5	10	240	93.00
99.00	47.80	0.07	0.02	0.03	14.60	0.65	0.52	0.13	0.10	0.03	2000	36.16	5	20	10	240	99.00


LITHOLOGY
COLOUR
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MECHANICAL PROPERTIES
FRACTURE INDEX (If mm)
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APPENDIX D

AGGREGATE IMPACT VALUE: TESTING PROCEDURE

It has been pointed out that the aggregate impact values (AIVs) quoted in this report appear to differ significantly from the results obtained in other laboratories using similar test materials.

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 the potential source of error. Although the results obtained by following this modification in procedure were internally consistent, they were difficult to relate directly to those obtained using the British Standard test procedure (BS 812, part 3: 1973). It has been decided therefore to return to the British Standard procedure to ensure comparability with the results from other laboratories.

A number of samples have been tested using both wooden and concrete bases and conversion constants from previously obtained 'wooden-base' values to their equivalent British Standard values have been obtained (Table 24).

Table 24 AIV conversion constants

AIV with wooden base	Conversion factor to BS AIV
10–13	+6
14–18	+7
19–27	+8

These results were obtained by testing 21 samples, the data for which are plotted in Figure 24. As the British Standard (BS 812, part 3, paragraph 6.1) expresses doubt about the acceptance of AIVs greater than 30, the three AIVs ('concrete-base') which exceeded 30 were not included in estimating the lower-value conversion factors.

A number of non-geological factors may also affect the values obtained in this test.

1 The aggregate impact test machine used by the Institute is constructed to the specification in BS 812: 1967 and is not the metricated version of BS 812, part 3: 1973. The later standard states, however, that the older machines will be deemed to comply with the new requirements as a temporary measure.

2 Previous results were obtained from samples graded on Imperial sieves of the old British Standard. Although these have slightly different mesh sizes (Table 25), no significant difference was observed in AIV results.

Table 25 Comparison of sieve mesh sizes

Old mesh size	New mesh size
12.70 mm	14 mm
9.52 mm	10 mm
2.40 mm	2.36 mm

3 The method of crushing has considerable effect on the AIVs obtained. All samples were crushed using the same laboratory rock crusher, which has a variable jaw width. Material for crushing was derived from cores of diameters 95 mm, 76 mm and 47 mm, and each core was cut in half before testing. The two larger cores were crushed through a 15-mm jaw, and parts of the samples obtained were recrushed at 12 mm and 9 mm. AIVs were obtained for all samples using both wood and concrete bases. The results are summarised in Table 26.

Table 26 AIVs for large-diameter cores crushed through different jaw-widths

Half-core from borehole 16 NE 9

Depth	Size of core	*Wooden base* Jaw width (mm)			*Concrete base* Jaw width (mm)		
m	mm	9	12	15	9	12	15
3.6–10	95	13	15	21	—	21	28
10–17	95	10	13	18	16	21	26
17–28.5	76	12	14	19	20	20	26
28.5–36	76	15	14	17	21	20	26

The considerable differences in AIVs obtained are probably due to variation in the shape (Ramsay, 1965) and size of the original +10 –14 mm particles. The mean diameter of the chippings produced by crushing is directly related to the distance between the jaws. A more important factor is the shape of the particles. The 15-mm crushed core is much more flaky and elongate than the 12-mm crushed material. There was not enough rock remaining to measure flakiness of the 9-mm crushed core, but another core crushed to 9 mm gave a similar flakiness index to the 12-mm crushed core (Table 27).

Table 27 Flakiness and Elongation indices (BS 812, part 1: 1973)

Half core from borehole 16 NE 9

Depth	Size of core	*Flakiness Index* Jaw width (mm)			*Elongation Index* Jaw width (mm)		
m	mm	9	12	15	9	12	15
3.6–10	95	—	16%	45%	—	21%	42%
17–28.5	76	—	21%	51%	—	19%	39%
composite*	47	18%	—	—	23%	—	—

* Core from borehole 15 NE 7

It may be concluded from these results that the physical characteristics of particles (which are imparted by the crushing method) are very important in AIV tests. The Institute's assessment programme currently uses 47-mm cores, all of which are crushed to 9 mm.

4 The state of repair of the machine may also affect the accuracy of AIVs. A small amount of play was found between the hammer and the guide runners on the Institute's test machine. This caused the hammer to strike the bevelled top of the cup a glancing blow on some drops, so that the momentum of the hammer was reduced. In spite of this, very little variation was obtained from repeated tests on the same sample, indicating that only a small amount of energy was being lost this way. The vertical guide runners were bolted tightly to the base throughout all tests. Ramsay and others (1973) showed that slightly loose runners may greatly affect the values obtained.

5 The British Standard states that the initial weight of the sample and the sum of the final sieved fines and +2.36-mm fractions should be within 1 g. Although only 35% of the results were within 1 g, over 80% were within 2 g and only very clayey limestones gave differences of over 2 g. Results with a difference greater than 1 g should be discarded, according to the current British Standard. It can be seen that much of the loss in weight results from the escape of fines from the cup during impact testing.

6 The British Standard states that at least 15% of the rock for testing be crushed to within +10 –14 mm size range. In the three boreholes tested in these experiments the percentage varied between 10% and 23%. The samples giving values

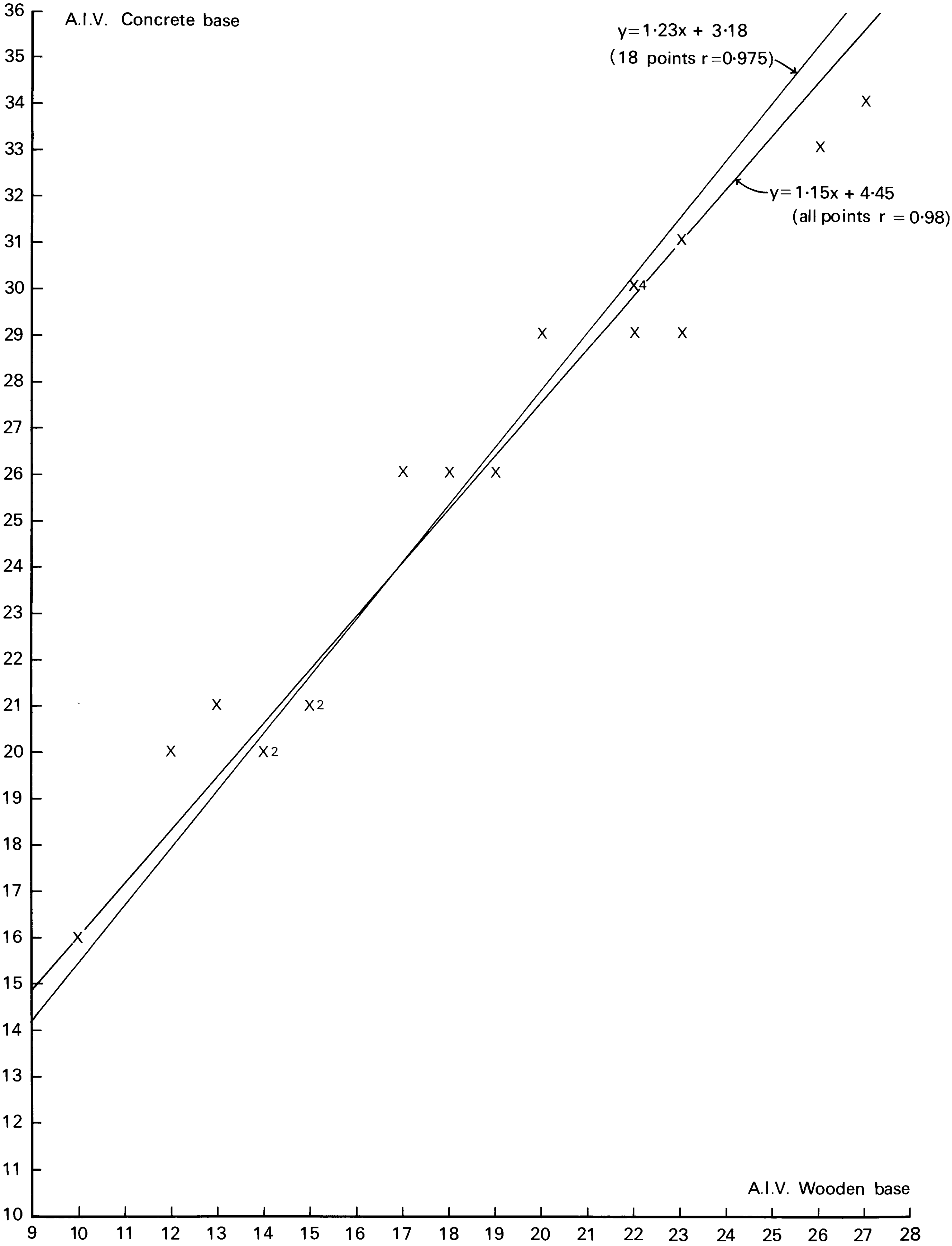

Figure 24 Aggregate impact values for Carboniferous limestones tested on concrete and wooden bases

below 15% are from the larger core sizes (paragraph 3 above) which produce flaky and elongate pieces when crushed. The smallest core (47 mm) tends to produce slightly higher percentage values (Tables 28 and 29).

Table 28 Percentage +10 –14 mm after crushing 95-mm and 76-mm cores (borehole 16 NE 9)

Depth m	Core size mm	Jaws width on crusher (mm)	+10 –14 mm %
3.6–10	95	9	10
3.6–10	95	12	14
3.6–10	95	15	12
10–17	95	9	9
10–17	95	12	12
10–17	95	15	11
17–28.5	76	9	10
17–28.5	76	12	10
17–28.5	76	15	14
28.5–36	76	9	12
28.5–36	76	12	17
28.5–36	76	15	13

Table 29 Percentage +10 –14 mm after crushing 47-mm cores

Borehole				
15 SW 7		15 NE 7		
Depth m	+10–14 mm* %	Depth m	Jaw width on crusher (mm)	+10–14 mm %
1–10	17	1–20	9	22
11–20	19	1–20	12	22
21–30	17	21–40	9	23
31–40	17	21–40	12	23
41–50	15	41–60	9	23
51–60	14	41–60	12	23
61–70	15	61–80	9	20
71–80	15	61–80	12	22
81–90	12	81–101	9	19
91–101	15	81–101	12	21

CONCLUSIONS

1 The data in Figure 24 give a guide to the difference between the values obtained using a wooden base and a concrete base. From these results constants have been calculated (Table 24) and should be applied to the AIV results contained in this report.

2 In future reports all cores from which test samples are obtained will be of standard diameter and all will be crushed in the same way (through a 9-mm jaw).
The results should therefore be internally consistent.

3 Checks are now to be made for each borehole on the percentage of the sample in the +10 –14 mm size range, and also on the error in initial and final weights.

4 Although the small losses of energy caused by the hammer striking the edge of the cup do not greatly affect the values obtained, regular servicing will ensure this defect does not arise.

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INSTITUTE OF GEOLOGICAL SCIENCES

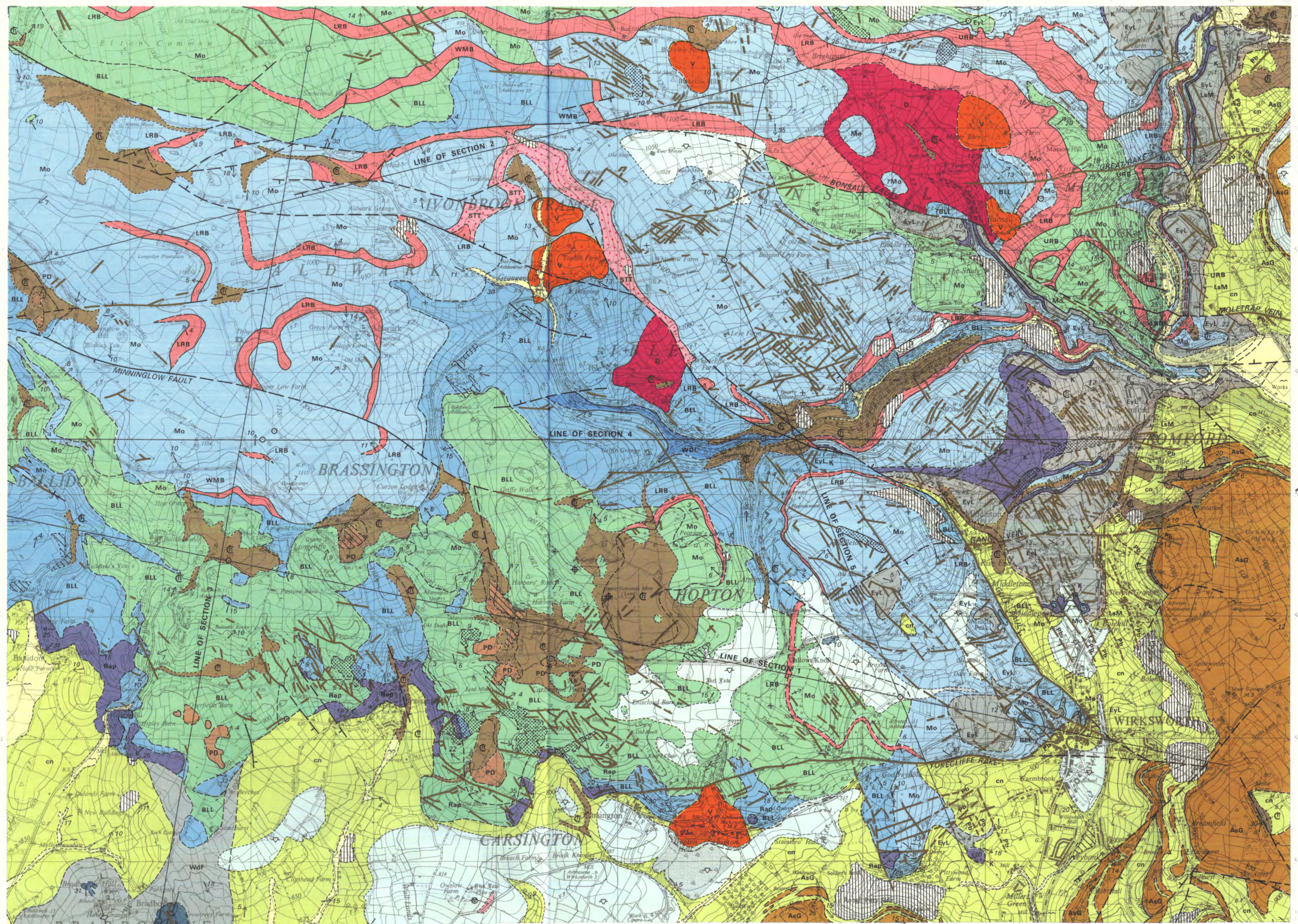
INDUSTRIAL MINERALS ASSESSMENT UNIT

THE LIMESTONE AND DOLOMITE RESOURCES OF PARTS OF SHEETS SK 25 & 35 (WIRKSWORTH, DERBYSHIRE).

47

THE LIMESTONE AND DOLOMITE RESOURCES OF PARTS OF SHEETS SK 25&35 (WIRKSWORTH, DERBYSHIRE).

GEOLOGY



IGNORE THIS MAP!

INDEX AND EXPLANATION OF GEOLOGY

Landslip

DRIFT : QUATERNARY

- Alluvium
- Calcareous Tufa
- Head
- Glacial Sand and Gravel
- Boulder Clay

SOLID

- PD — Pocket Deposits-sediments of Pliocene age and earlier, infilling swallow holes
- Areas where limestone is dolomitised
- cn — Namurian mudstone
- AsG — Ashover Grit (Namurian)
- D — Dolerite (intrusive)
- V — Vent agglomerate

See also Generalized Vertical Sections

- Horizontal strata
- Gently inclined strata
- Inclined strata, dip in degrees
- Anticlinal axis (shown in areas of strong folding only)
- Geological boundary, Drift
- Geological boundary, Solid
- Fault at surface, crossmark indicates downthrow side
- Mineral vein; where veins are also faults, crossmark indicates downthrow side
- Concealed crop of mineral vein beneath mudstone cover
- General area of mineral working at surface

Broken lines denote uncertainty

- Borehole site } only a selection is shown
- Mine shaft, abandoned
- Made ground (mainly quarry tips)

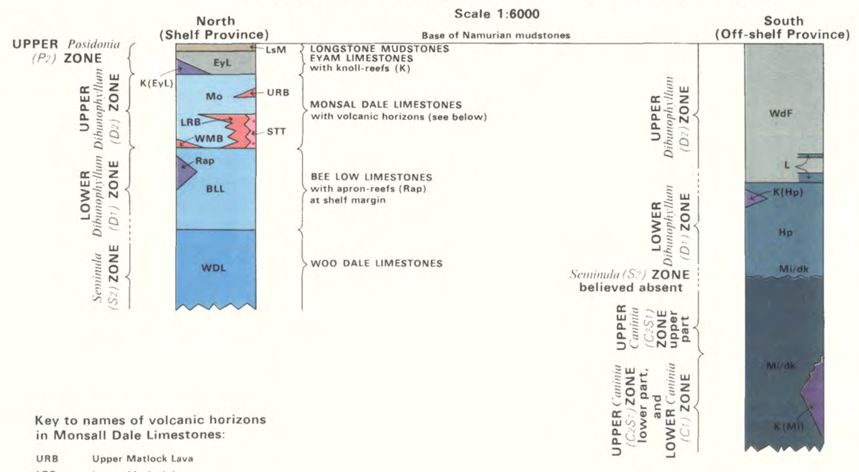
Scale 1:25 000

0 1 2 3km

0 5 000 10 000ft

GENERALIZED VERTICAL SECTIONS OF DINANTIAN ROCKS

Scale 1:6000



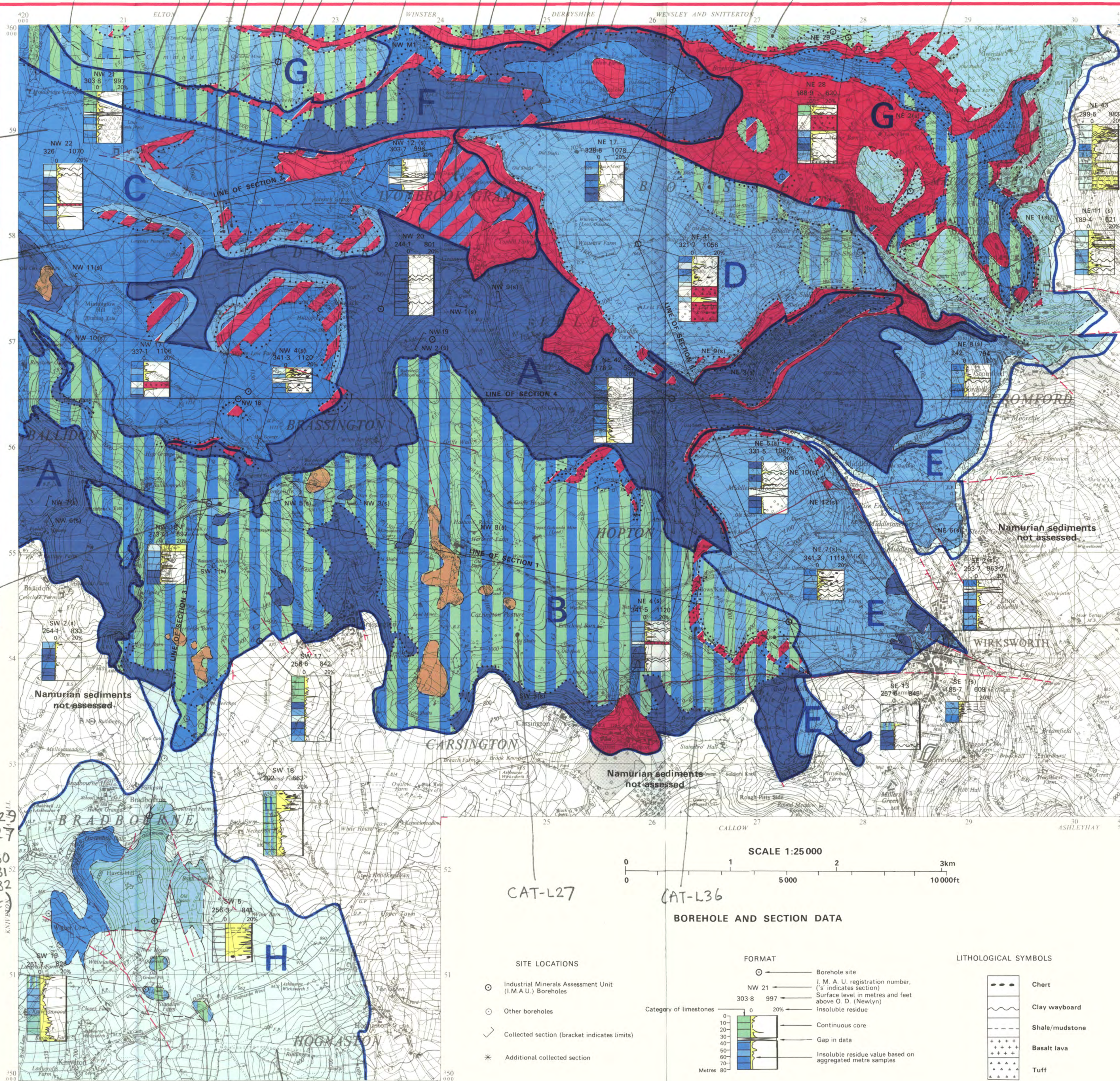
Key to names of volcanic horizons in Monsall Dale Limestones:

URB	Upper Matlock Lava
LRB	Lower Matlock Lava
STT	Shothouse Spring Tuff
WMB	Winstermoor Lava

VERY HIGH CAT-L35
HIGH CAT-L36
MEDIUM CAT-L37
LOW CAT-L38
IMPURE CAT-L39
(SEE MAP FACE)

Eastern part of the sheet resurveyed on the six-inch scale by R. A. Eden and G. H. Rhys, 1952-6 and by D. V. Frost and N. Aitkenhead, 1965-6, primary six-inch survey of western part by D. Price, I. P. Stevenson and N. Aitkenhead, 1969-75, minor revisions by I. P. Stevenson and J. I. Chisholm in 1974-6.
W. N. Edwards, D. R. A. Ponsford, W. B. Evans and E. G. Smith, District Geologists.
Published 1978 A. W. Woodland, C.B.E., Director, Institute of Geological Sciences.
Made and published by the Director General of the Ordnance Survey, Southampton, for the Institute of Geological Sciences.

RESOURCE



CAT-L27 CAT-L30 CAT-L37 CAT-L36 IGR-8 CAT-L36 CAT-L27 CAT-L29 CAT-L36 CAT-L27 CAT-L36 IGR-8 CAT-L35 CAT-L1 CAT-L2 CAT-L30 CAT-L31 CAT-L28 CAT-L27 CAT-L2 CAT-L36 CAT-L30 CAT-L37 CAT-L27 CAT-L36 CAT-L30 CAT-L21

INDEX AND EXPLANATION OF MINERAL RESOURCES

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

CATEGORIES OF ROCK LIMESTONES		Composition (%$CaCO_3$)
CAT-L1	Very high purity	> 98·5
CAT-L2	High purity	97·0-98·5
CAT-L19	Medium purity	93·5-97·0
CAT-L20	Low purity	85·0-93·5
CAT-L21	Impure	< 85·0

LIMESTONES LIKELY TO BE AFFECTED BY DOLOMITIZATION

VERY HIGH CAT-L29
HIGH CAT-L27
MEDIUM CAT-L30
LOW CAT-L31
IMPURE CAT-L32
(SEE MAP FACE)

DOLOMITE — DOL-5

AREAS OF LIMESTONE AFFECTED BY OTHER ROCKS (within uppermost 10 metres)

Igneous rocks

NON-CARBONATE SEDIMENTS

POC-1 — Pocket deposits (sands and clays)

IGNEOUS ROCK (thickness >10 metres)

IGR-8 — Dolerites, basalts and tuffs

BOUNDARY LINES

- ✓ Boundary between categories
- ✓ Boundary of zone of intermixing
- ✓ Resource block boundary (blocks designated by letters A to H)

STRUCTURAL SYMBOLS

- ✓ Fault at surface, crossmark indicates downthrow side

CAPTURE ✓

Compiled from 6" sheets last fully revised 1913-20.
Other partial systematic revision 1937-49 has been incorporated.
Major roads revised 1965

Limestone and Dolomite survey by F. C. Cox and D. J. Harrison 1975-77
R. G. Thurrell, Head, Industrial Minerals Assessment Unit.

SCALE 1:25 000

0 1 2 3km

0 5 000 10 000ft

BOREHOLE AND SECTION DATA

SITE LOCATIONS

- Industrial Minerals Assessment Unit (I.M.A.U.) Boreholes
- Other boreholes
- Collected section (bracket indicates limits)
- Additional collected section

FORMAT

- Borehole site
- NW 21 — I. M. A. U. registration number, ('s' indicates section)
- 303·8 997 — Surface level in metres and feet above O. D. (Newlyn)
- Category of limestones
- 0 20% — Insoluble residue
- Continuous core
- Gap in data
- Insoluble residue value based on aggregated metre samples

LITHOLOGICAL SYMBOLS

- Chert
- Clay wayboard
- Shale/mudstone
- Basalt lava
- Tuff

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

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

SECTIONS SHOWING THE GENERAL RELATIONS OF THE ROCKS ALONG THE LINES DRAWN ACROSS THE MAP

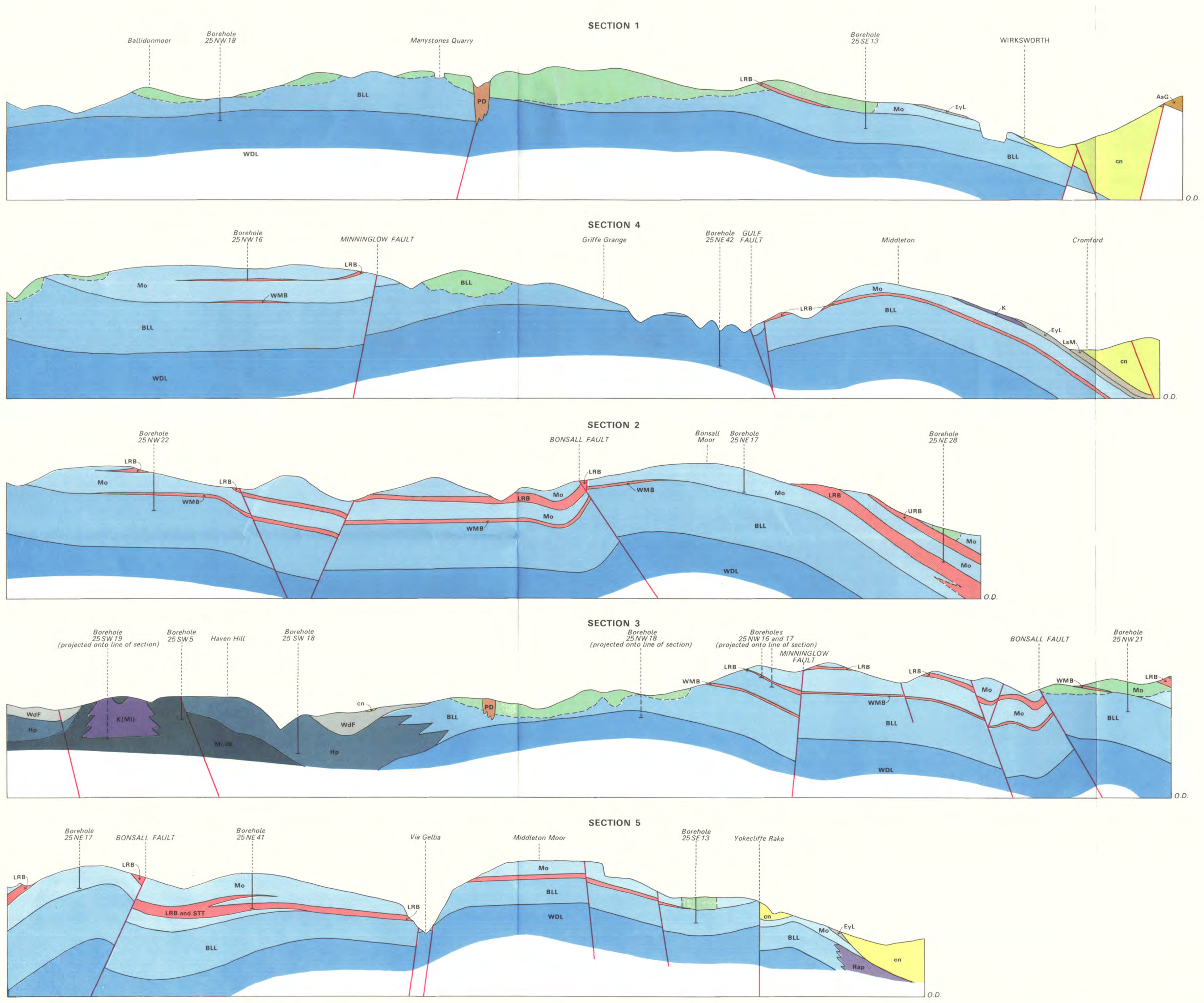
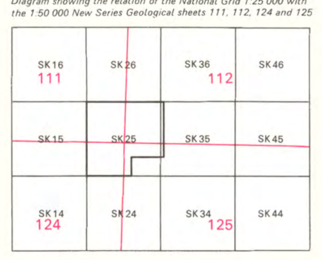


Diagram showing the relation of the National Grid 1:25 000 with the 1:50 000 New Series Geological sheets 111, 112, 124 and 125

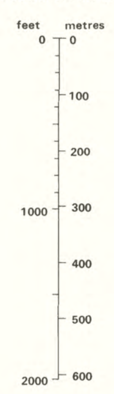


Horizontal Scale 1:25 000

0 1 2km

0 1000 2000 yds

Vertical Scale: 3 x the horizontal



1:25 000 Limestone and Dolomite Resource sheet published 1981
G. M. Brown D.Sc., F.R.S., Director, Institute of Geological Sciences

SECTIONS SHOWING THE GENERALIZED LIMESTONE CATEGORIES OF THE ROCKS ALONG THE LINES DRAWN ACROSS THE MAP