UNIVERSITY OF KEELE

DEPARTMENT OF EDUCATION

KEELE SCIENCE AND TECHNOLOGY TEACHERS CENTRE:GEOLOGY SECTION

Fieldwork near the Potteries XI,The area north east and east of Cheadle Staffs

TUESDAY 5TH JUNE 1984 Meet at 5.45 pm outside Cheadle High School, Cheadle, Staffs.

Locality 1 High Shutt Quarry SK 0243. Hawksmoor Sandstone and Conglomerate Formation (?Scythian,Triassic)

Locality 2 View of Moneystones Quarry (British Industrial Sands) SK 0445 in the Staffordshire First Grit or Rough Rock (R_2,Yeadonian, Namurian, Carboniferous)

Locality 3 Entrance to Staffordshire Moorlands Council Rubbish tip at Ribden SK073473. In pebbly sands and clays of the "Pocket Deposits" (?Miocene-Pliocene). An interesting quarry lies across the road to the west. For entrance to this permission is needed from the farmer,Mr Campbell,at Ribden. The quarry shows heavily jointed shelf limestones, Kevin Limestones (Di Visean) with some signs of Pocket Deposits having been present above (see Walsh et. al. 1973, Walsh et. al. 1980).

Locality 4 The Road junction at Cauldon Low SK 073481. The old quarried faces and outcrops southeast of the road junction behind the post office display brecciated reef rocks and algally bound reef rock (?apron reef) in the Kevin Limestones (D_iVisean). Solution joints have ?Triassic sandstone infills, sometimes brecciated. Joints and cavities are mineralised, often dolomitised. Cavities contain laminae and linings of minerals like barite. The mineral incline(railway line) from Cauldon to Frogmore passes through this corner. The site of the Cauldon Low borehole,bottommed in?Devonian, is seen (SK 0804 4822) (see Bridge and Kneebone 1983 for details of the quality of the limestones hereabouts).

Locality 5 A quarry in the main limestone massif at SK 074485. Shelf limestones with abundant brachiopods of the Milldale Limestones (Arundian C_2S_i Visean). Much haematite staining; joints and cavities filled with ?Triassic Sandstones, breccias; rocks dolomitised and greatly mineralised.

Locality 6 Travel from Cauldon Low via Wardlow and Rue Hill across Milldale Limestones (Chadian, Arundian) and turn southeastwards at SK 109476 towards Stanton. Look for the wallstones to change from Milldale limestones to Namurian gritstones, to overlapping Triassic (?Scythian ? Anisian) Hollington Sandstones near the lane junction at SK 121468,.

Locality 7 Stanton Moor Quarry ST 122468 to 124465. An old overgrown quarry in the Hollington Sandstone Formation with crossbedded sandstones and occasional muddy interbeds (palaeocurrents to the NW and W). This is the quarry where the famous amphibian bones Cyclotosaurus leptognathus were found in the last half of the 19th century (Ward 1900, Paton 1974). Dip to the south into to Needwood Basin. The sandstones of the quarry are heavily baritised and veins of these minerals are seen to have affected the working of the quarry in one place. Travel, preferably walk, through Stanton village noticing the use of the local building stone and keeping an eye open for local outcrops.

Locality 8 Drive to and park at the bridge near Limestone Hill at SK 137462. Walk southwards through the stile alongside the eastern flank of the stream till the valley opens out near a picturesque waterfall. Here red sandstones and mudstones are dipping gently to the south into the Needwood Basin. They are crossed by at least one fault. Study the composition of the coarser clasts in the sandstones and the palaeocurrents of the crossbeds and determine whether the rocks should be placed in the Huntley Formation (locally derived clasts, local palaeocurrents) or the Scythian Hawksmoor Sandstone and Conglomerate Formation (distantly derived clasts, regional palaeocurrent to NW, west and north).
A local Holocene Tufa deposit is developed, together with its indigenous flora.

Locality 9 Retrace your steps northwards to the bridge and cross the road, over the stile, into the field and stream bed to the north to see the limestone beds of the Widmerpool Formation (largely D2 Brigantian, Visean) in the base of the stream and the lower banks and overlain by the Scythian Triassic deposits. The limestones may be of turbidite facies. Trace the junction of the limestones against the overlying red beds for 300 m along the stream and test the hypothesis that a 'slashed sleeve' inlier of carboniferous rocks is present. Cross the stream and walk up Limestone Hill to the west identifying every rock outcrop and waste from rabbit holes etc on the way. A prominent 1 m wide vein rock and baritised sandstone boulder (of the Hollington Formation) is supposed to have rolled downhill from the sc p to the west, but most outcrops are of limestone (dolomitised, brecciated, occasionally algal, and with cavities after brachiopods and crinoids; often mineralised with galena, malachite, barite).
Debris from rabbit holes at comparable heights to the south are of red pebbly sandstone which are undoubtedly from the Hawksmoor Formation.
Work out the relationship of the limestone to the valley, to the red sandstones and test the hypotheses that we have:
(a) a patch reef surrounded by limestone turbidites;
(b) inliers of both Widmerpool and Knoll-reef type;
(c) an unconformity with pronounced palaeorelief;
(d) two separate eposides of mineralisation.

In 1820 the Ribden Mining Company put a shaft down into the hill and drove an adit from the north. The Oakamoor and Stanton Moor Mining Company put a new shaft down in 1859 and abandoned it in the same year.

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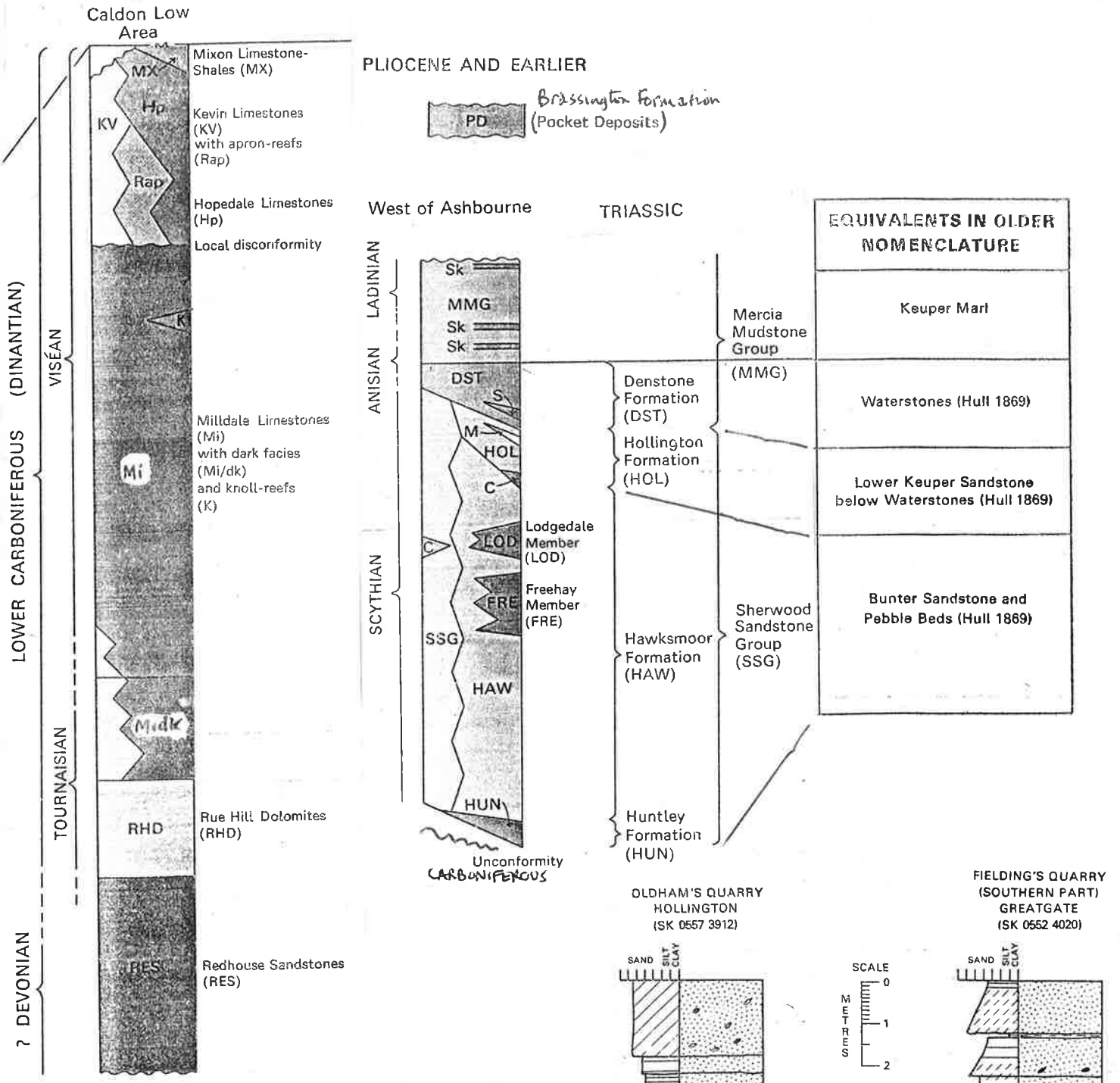
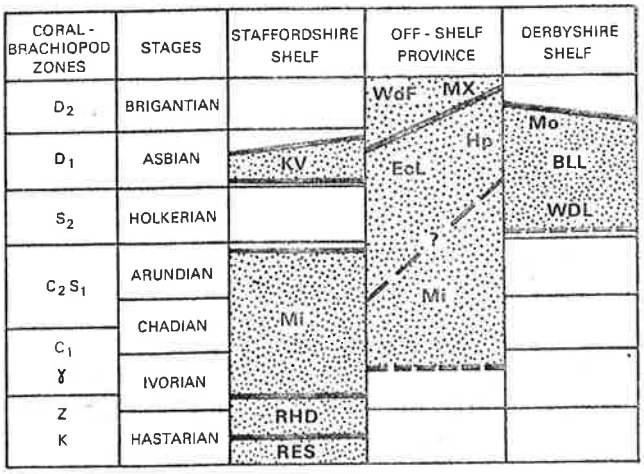


Table 1 Nomenclature and age relations of the Dinantian formations (based on Aitkenhead and Chisholm, 1982)



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

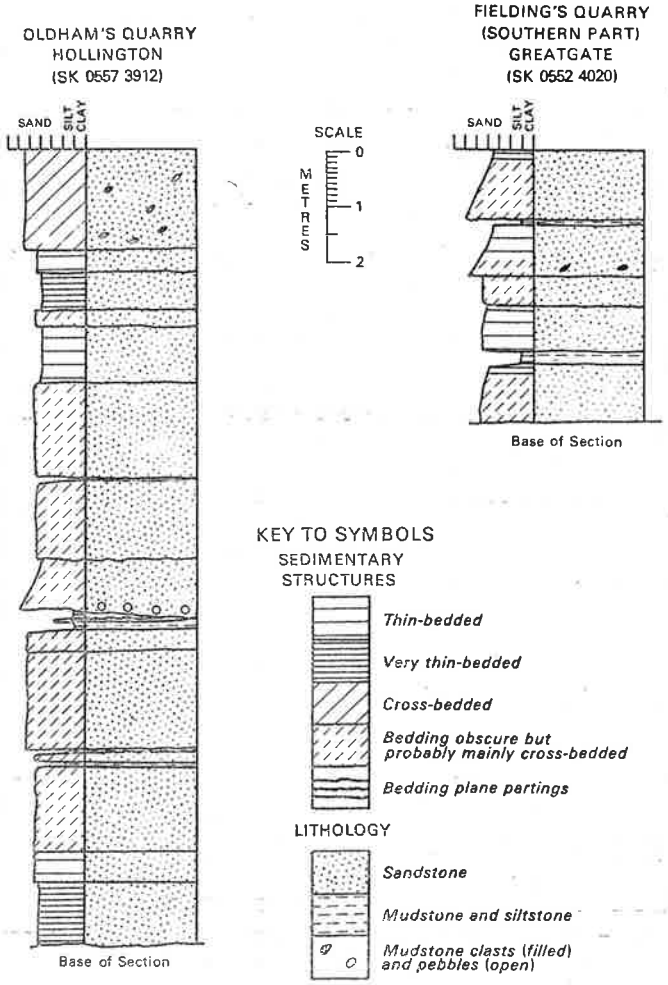


Figure 3 Typical sections in the Hollington Formation from quarries near Hollington and Greatgate (cf Stanton Moor)

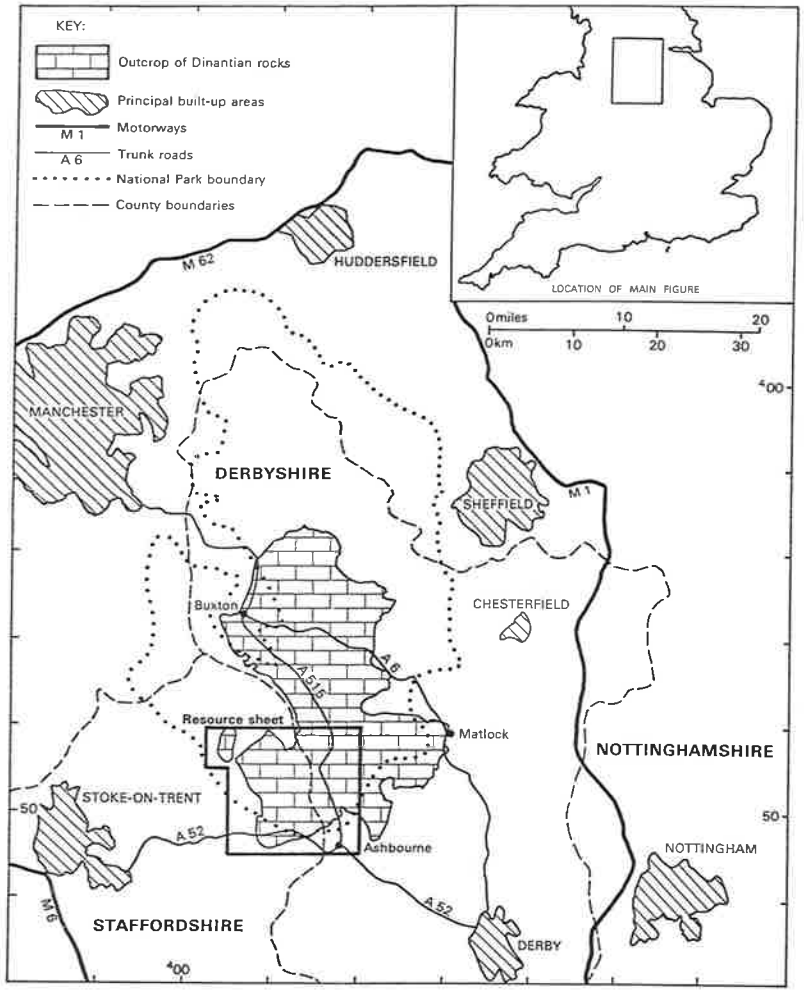
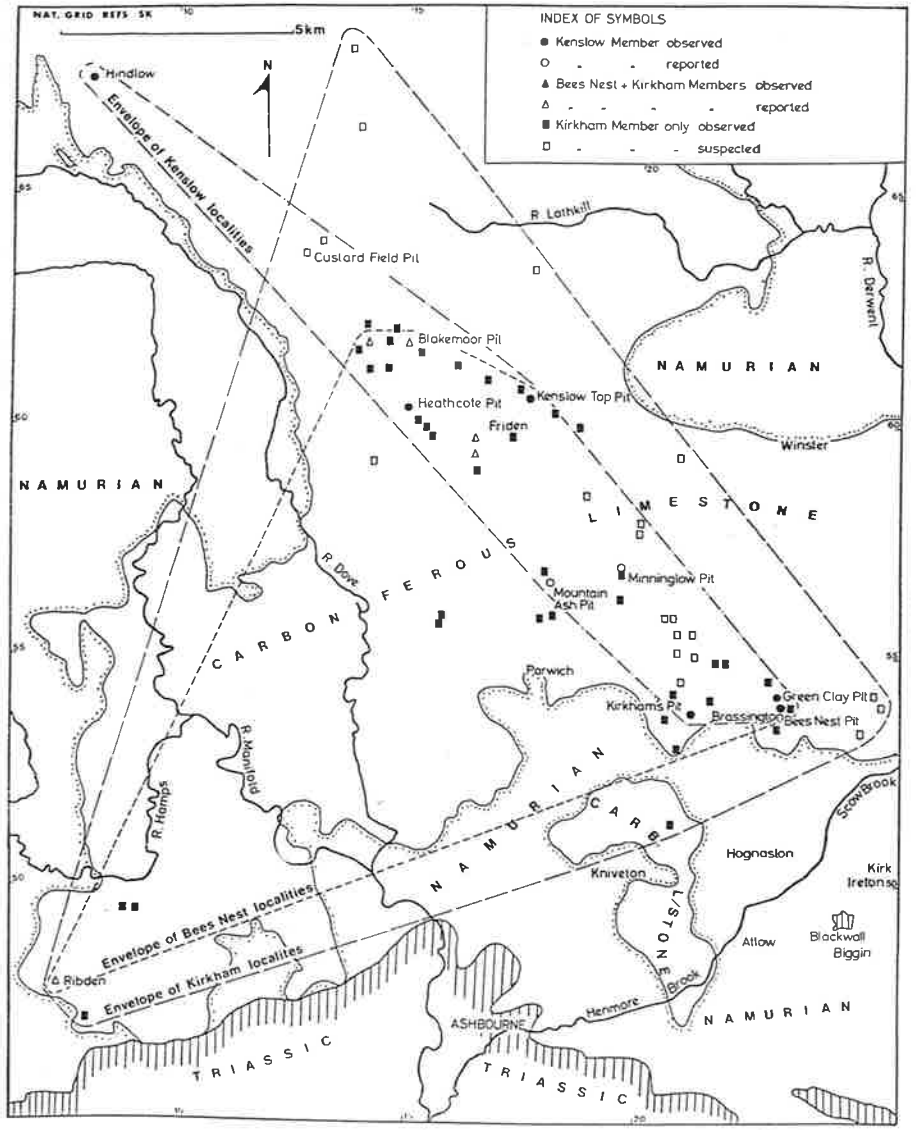
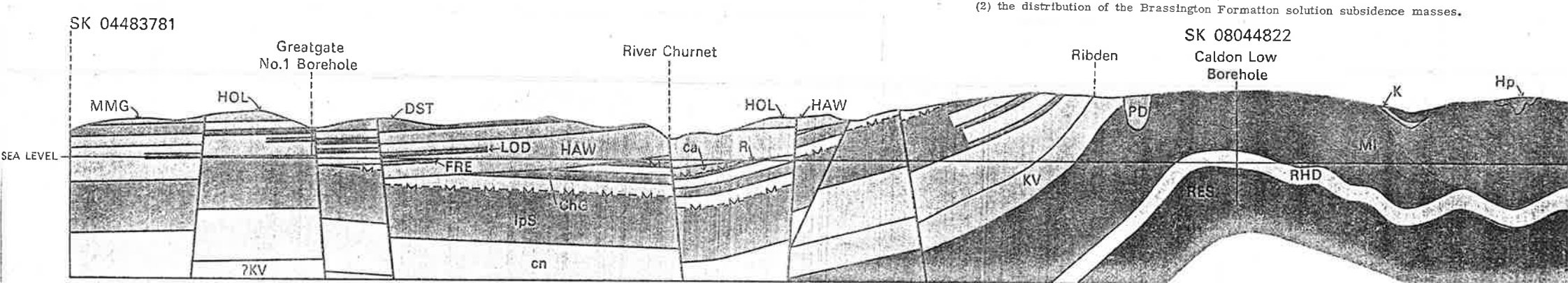


Figure 1 Location of the resource sheet area.



Text-fig. 1: Map to show –
(1) the localities mentioned in the text, and
(2) the distribution of the Brassington Formation solution subsidence masses.



OUTLINE OF GEOLOGY

? DEVONIAN

Redhouse Sandstones. Red-brown and grey-green feldspathic pebbly sandstones, with some mudstone and siltstone bands, were found beneath the Dinantian carbonates in the Caldon Low Borehole [0804 4822]. The oldest carbonates are mid-Tournaisian in age; the Redhouse Sandstones, though unfossiliferous, may be partly Devonian.

DINANTIAN

During Tournaisian and early Viséan (Chadian-Arundian) times a thick sequence of well-bedded marine carbonates, with knoll-reefs, was deposited. Events during the Holkerian Stage are still poorly documented but in Asbian and Brigantian times there evolved a clear differentiation between upstanding 'shelf' provinces of shallow-water limestone deposition and an 'off-shelf' province in which more varied lithologies were deposited.

The oldest carbonates are the **Rue Hill Dolomites**, thinly bedded fine-grained rocks with marine and brackish-water faunas. The formation is known only in the Caldon Low Borehole. The **Milldale Limestones** are a variable sequence of medium and dark grey well-bedded limestones with large knoll-reefs locally, especially in Dovedale. The reefs are distinguished on the map, as are some of the more extensive areas of dark limestone.

The Asbian and Brigantian strata are grouped into shelf and off-shelf provinces. The **Bee Low Limestones** on the Derbyshire shelf, and the **Kevin Limestones** on the Staffordshire shelf, are pale grey thickly bedded calcarenites; both pass laterally into apron-reefs at the shelf margins. In the intervening off-shelf province the **Hopedale Limestones**, well-bedded with some limestone conglomerates, were deposited in a current-swept area and the **Ecton Limestones**, well-bedded limestone turbidites, accumulated in deeper troughs. The two formations grade laterally into one another and on the map are shown by the same colour; their approximate areas of outcrop are distinguished by symbols. The succeeding formations in the off-shelf province are the **Mixon Limestone-Shales** in the north-west and the **Widmerpool Formation** in the south and east. Both consist of mudstone with limestone and less common sandstone turbidites.

The Widmerpool Formation locally includes submarine fragmented lavas (hyaloclastites), the **Tissington Volcanic Member.** In the shelf areas, deposits of equivalent age were almost all removed prior to deposition of the Namurian mudstones. The small patch of **Monsal Dale Limestones** that remains is dolomitised.

DOLOMITE: two episodes of dolomitisation have affected the Dinantian limestones. An earlier, penecontemporaneous phase gave rise to the Rue Hill Dolomites and some others in the lower part of the Milldale Limestones of the Caldon Low Borehole. A later, secondary phase, caused by downward percolation of magnesium-rich water during the Triassic or Permian periods, has mainly affected the Bee Low and Monsal Dale limestones around Brassington [230 543].

MINERALISATION: the limestone and dolomite around Brassington contain veins and flats bearing galena and sphalerite, together with the gangue minerals calcite, baryte and fluorite. Minor occurrences are known elswhere.

NAMURIAN

The Namurian rocks are interbedded grey mudstones, siltstones and sandstones. Thin goniatite bands in the mudstones enable precise correlations to be made throughout the area and form the basis for the division of the sequence into stages and zones. The earliest sandstones are fine-grained protoquartzites derived from a source area to the south. Most were deposited as sandstone-siltstone-mudstone turbidites in relatively deep water. Where the sandstone element predominates the names **Minn Sandstones** and **Hurdlow Sandstones** are used, but where the sandstones are subordinate the names given are **Minn Mudstones-with-Sandstones** and **Hurdlow Mudstones-with-Sandstones.** The **Ipstones Edge Sandstones**, divided locally into **Cheddleton Sandstones** and **Kniveden Sandstones**, are also protoquartzites derived from the south though they include coarse-grained beds and were laid down in shallow water. The **Brockholes Sandstones** are of similar type. The protoquartzites occur mainly in the area west of the Weaver Hills [094 463]: to the east the equivalent strata are mainly mudstones.

Feldspathic coarse-grained sandstones deposited by large rivers flowing from the east and north first appeared during Marsdenian times and thereafter dominate the sequence. The **Roaches Grit, Ashover Grit, Chatsworth Grit and Rough Rock** are all of this type.

WESTPHALIAN (COAL MEASURES)

The Westphalian rocks are interbedded mudstones, siltstones and sandstones, with coals and seatearths. The earliest sandstone, the **Woodhead Hill Rock**, is coarse-grained like those of the late Namurian but higher sandstones in the sequence, including the **Kingsley Sandstone**, are fine-grained. In the Cheadle Coalfield the best seams, the Woodhead and Dilhorne coals, have been worked to exhaustion in the area north of the Callowhill Fault, though they remain untouched in a deeper area of unknown extent to the south.

TRIASSIC

The Triassic strata are divided into two major lithostratigraphic units, the Sherwood Sandstone Group and the Mercia Mudstone Group. This nomenclature replaces that based on the terms 'Bunter' and 'Keuper', which carried an implication, now known to be invalid, of chronostratigraphic equivalence to the German sequence. The two groups have been subdivided locally into formations and members.

The Sherwood Sandstone Group consists of red-brown and yellow sandstones and conglomerates, with rare siltstone and mudstone bands. East of Ashbourne the group is not subdivided but farther west three formations and two members have been recognised. **The Huntley Formation** consists of pebbly sandstone or conglomerate in which there is a large proportion of locally-derived sub-angular pebbles. **The Hawksmoor Formation** consists mainly of cross-bedded pebbly sandstone, with two conglomerate units, the **Freehay** and **Lodgedale members**; both are worked for gravel. The **Hollington Formation** is made up of hard baryte- or calcite-cemented cross-bedded sandstones in fining-upwards units with intervening mudstone and siltstone bands. Pebbles are mainly confined to the bases of sandstone units.

The **Mercia Mudstone Group,** distinguished by the dominance of mudstone and siltstone over sandstone, consists of a basal unit, the Denstone Formation, and an undivided upper part. The **Denstone Formation** comprises thinly interlayered red-brown siltstones, fine-grained sandstones and mudstones, with ripple-marked or mica-covered surfaces, pseudomorphs after halite, calcite-encrusted vughs and mudcracks. The lithology is similar to that of the 'Waterstones' of some other areas.

The **undivided part of the Mercia Mudstone Group** consists of calcareous or dolomitic red-brown and grey-green siltstones and mudstones. Bands of harder siltstone ('skerries') form low escarpments.

PLIOCENE AND EARLIER

Sediments that have been preserved by collapse into sinkholes in the limestone are described collectively as **Pocket Deposits.** They include masses of Namurian mudstone, some Triassic siltstone and sandstone, and a sequence of soft deposits named the Brassington Formation. The latter comprises grey clays with Tertiary plant remains, on red and green mottled clays, on pebbly sands.

QUATERNARY

Superficial (or drift) deposits cover the solid rocks over a large part of the district especially in the area south and west of the limestone uplands.

ASHBOURNE GRAVEL: this appears to be an early fluvial deposit predating the tills. It contains clasts mainly of limestone and is strongly cemented by calcite.

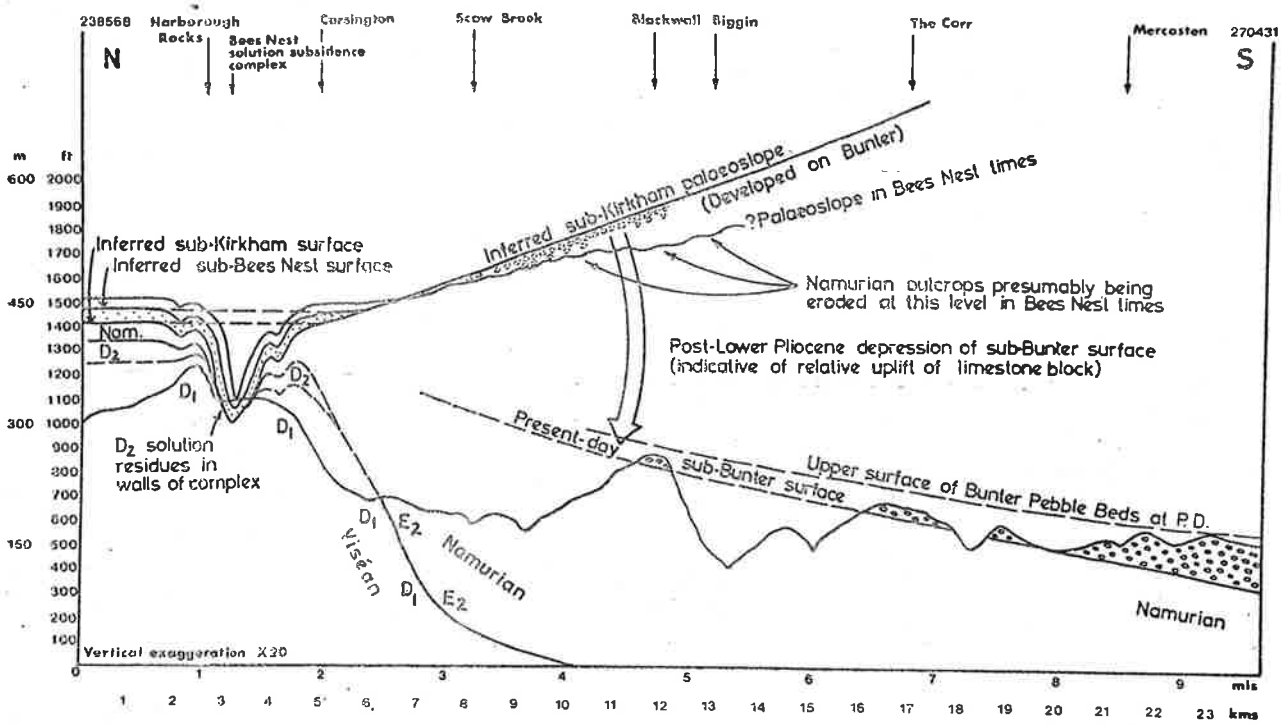
GLACIAL DEPOSITS: till (boulder clay), which may be clayey, sandy or gravelly, is widely distributed, while **glacial sand and gravel** is only locally present. Along the western margin of the district, deposits are present both in valleys and on interfluves, and are thought to have been introduced during the last glaciation (Devensian). Elsewhere tills, sands and gravels appear to have been deposited either during the penultimate glaciation (?Wolstonian) or, in the case of the deposits on the highest ground, the antepenultimate glaciation (?Anglian). The ?Wolstonian deposits are the most widespread; they are flint-bearing in the south-east (perhaps related to an advance of 'Eastern' ice) and dominated by Carboniferous rock-types (derived from the north-west and north-east) elsewhere.

FLUVIAL DEPOSITS: two river terrace deposits have been distinguished. The surface of the **higher river terrace** lies 3 to 8m above the recent alluvium; that of the **lower river terrace** lies 1 to 3m above the recent alluvium. Both terraces consist of poorly sorted, commonly argillaceous, gravels.

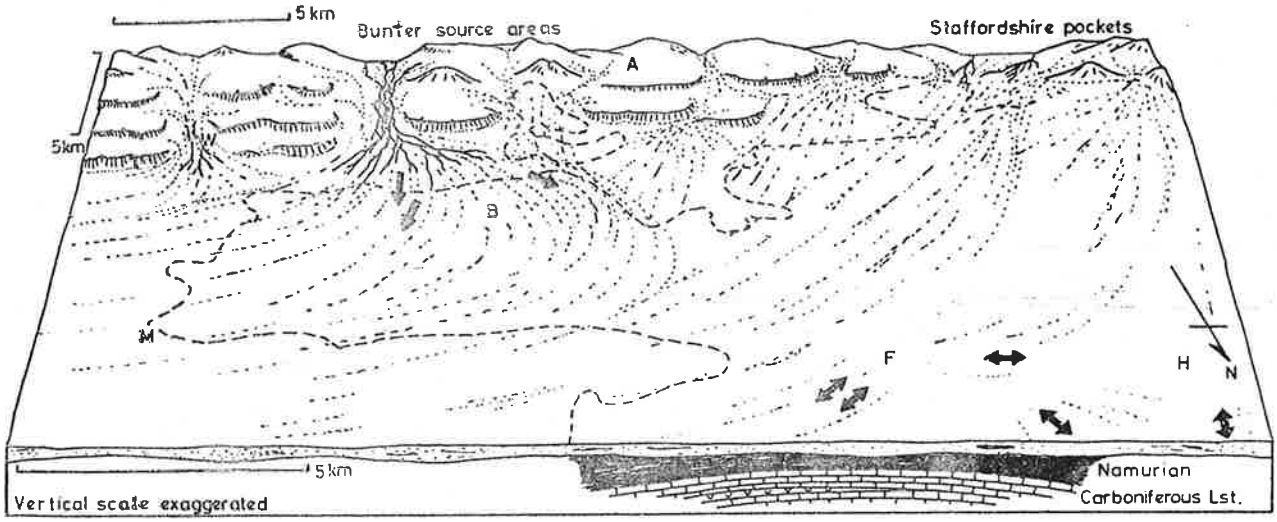
The main river valleys have spreads of post-glacial to recent **alluvium**, commonly gravel overlain by silt or fine-grained sand. In places the upper layer is made up of waterlogged peaty clay, but mappable **peat** deposits are rare.

PERIGLACIAL DEPOSITS: these are widespread but have been mapped only where they mask the underlying formations. **Head** results mainly from solifluction under periglacial conditions, and consists of an ill-sorted mixture of local upslope materials, fluvially reworked in places. Silty loam in hollows on the limestone outcrop is mapped as head, though it may be in part of aeolian origin. A few deposits of **scree**, attributed to frost-shattering, mainly during the late-Devensian period, occur in the limestone dales.

LANDSLIP: areas of landslip are moderately common in the northern half of the district, especially on Carboniferous mudstone. They generally consist of a slipped part with small scarps, and a lower part consisting of flowed material.



Text-fig. 16: Diagram to show –
(1) the present-day physiography of the southern end of the Pennines, and
(2) an hypothetical reconstruction of the physiography in Lower Pliocene (Brassington Formation) times.



A ASHBOURNE
B BRASSINGTON
F FRIDEN
H HARTINGTON
M MATLOCK
W WIRKSWORTH

Current directions in the Brassington area
Current trends in the Friden area
Present day junction of Carboniferous Limestone and Namurian

Text-fig. 15: Hypothetical reconstruction of the palaeography of the Brassington Formation basin of deposition in mid-Kirkham Member times (partly after T.D. Ford)

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

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

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

REFERENCES

ADAMS, A. E. 1980. Calcrete profiles in the Eyam Limestone (Carboniferous) of Derbyshire: petrology and regional significance. **Sedimentology**, Vol. 27, 651-660.

AITKENHEAD, N. and CHISHOLM, J. I. 1982. A standard nomenclature for the Dinantian formations of the Peak District of Derbyshire and Staffordshire. **Rep. Inst. Geol. Sci.**, No. 82/8.

BRITISH STANDARDS INSTITUTION. 1975. BS 812: **Methods for sampling and testing of mineral aggregates, sands and fillers.** (Part 3), 18 pp (London: British Standards Institution.)

COX, F. C., BRIDGE, D. McC, and HULL, J. H. 1977. A procedure for the assessment of limestone resources. **Miner. Assess. Rep. Inst. Geol. Sci.**, No. 30.

— and HARRISON, D. J. 1980. The limestone and dolomite resources of the country around Wirksworth, Derbysire: Description of parts of sheets SK 25 and 35. **Miner. Assess. Rep. Inst. Geol. Sci.**, No. 47.

EDMUNDS, W. M. 1971. Hydrogeochemistry of groundwater in the Derbyshire Dome with special reference to trace consituents. **Rep. Inst. Geol. Sci.**, No. 71/7.

FOLK, R. L. 1959. Practical petrographic classification of limestones. **Bull. Am. Assoc. Pet. Geol.**, Vol. 43, No.1, 1-38.

— 1962. Spectral subdivision of limestone types. In **Classication of carbonate rocks: a symposium**, HAM, W. E. (Editor). (Tulsa, Oklahoma: American Association of Petroleum Geologists).

INSTITUTE OF GEOLOGICAL SCIENCES, 1981b. IGS boreholes 1979. **Rep. Inst. Geol. Sci.**, No. 80/11

— 1978. IGS boreholes 1977. **Rep. Inst. Geol. Sci.**, No. 78/21.

— 1981a. **United Kingdom Mineral Statistics 1980.** (London: Her Majesty's Stationery Office.)

LUDFORD, A. 1951. The stratigraphy of the Carboniferous rocks of the Weaver Hills District, North Staffordshire. **Q.J. Geol. Soc. London**, Vol. 106, 211-230.

— 1970. The stratigraphy and palaeontology of the Lower Carboniferous rocks of northeast Staffordshire and adjacent parts of Derbyshire. Ph.D. Thesis (unpublished): University of London.

MOLINIA, B. F. 1974. A rapid and accurate method for analysis of calcium carbonate in small samples. **Q.J. Sediment. Petrol.**, Vol. 44, No. 2. 589-590.

PARKINSON, D. 1950. The stratigraphy of the Dovedale Area, Derbyshire and Staffordshire. **J. Geol. Soc. London.** Vol. 105, 265-294.

— and LUDFORD, A. 1964. The Carboniferous Limestone of the Blore - with Swinscoe District, northeast Staffordshire, with revisions to the stratigraphy of neighbouring areas. **Geol. J.** Vol. 4, Pt. 1. 167-176.

PRENTICE, J. E. 1951. The Carboniferous Limestone of the Manifold Valley region, North Staffordshire. **Q.J. Geol. Soc. London**, Vol. 106, 171-209.

RAMSAY, D. M. 1965. Factors influencing aggregate impact value in rock aggregates **Quarry Managers' J.**, Vol. 49, No. 4, 129-134.

ROBERTS, J. L. and DAVIS, A. E., 1977. Analysis of limestone survey samples by direct electron excitation X-ray spectrometry. **Rep. Inst. Geol. Sci.**, No. 77/3.

ROBEY, J. A., and PORTER, L. 1971. The metalliferous mines of the Weaver Hills, Staffordshire. **Bull. Peak Dist. Mines, Hist. Soc.** Vol. 4, Part 6, 417-428.

WALKDEN, G. M. 1974. Palaeokarstic surfaces in the Upper Viséan (Carboniferous) limestones of the Derbyshire Block, England. **J. Sediment. Petrol.** Vol. 44, 1232-1247.

BRIDGE, D. McC., and KNEEBONE, D. S. 1983. The limestone and dolomite resources of the country north and west of Ashbourne, Derbyshire. Description of 1:25000 sheet SK 15 and parts of SK 04, 05 and 14. Miner. Assess. Rep. Inst. Geol. Sci. No. 129. 83 pp + map.

ROGERS, P. J., PIPER, D. P. and CHARSLEY, T. J. 1981. The conglomerates of the Sherwood Sandstone Group of the country around Cheadle, Staffs. Resources sheet SK 04. Miner. Assess. Rep. Inst. Geol. Sci. No. 57.

CHARSLEY, T. J. 1982. A standard nomenclature for the Triassic formations of the Ashbourne District. Rep. Inst. Geol. Sci. No. 81/14. 18 pp.

REFERENCES

Anon. 1919. Fossils from the Keuper of Alton, Great Gate and Hollington. *Trans. North Staffordshire Field Club*, Vol. 53, pp. 102–103.

Arthurton, R. S. 1980. Rhythmic sedimentary sequences in the Triassic Keuper Marl (Mercia Mudstone Group) of Cheshire, northwest England. *Geol. J.*, Vol. 15, Pt. 1, pp. 43–58.

Barrow, G. 1903. The geology of the Cheadle Coalfield. *Mem. Geol. Surv. G.B.* 62 pp.

— **Gibson, W., Cantrill, T. C., Dixon, E. E. L. and Cunnington, C. H.** 1919. The geology of the country around Lichfield. *Mem. Geol. Surv. G.B.* 302 pp.

Beasley, H. C. 1914. Some fossils from the Keuper Sandstone of Alton, Staffordshire. *Proc. Liverpool Geol. Soc.*, Vol. 12, pp. 35–39.

Cummins, W. A. 1965. Sedimentary structures from the Keuper Sandstone of Alton, Staffordshire. *Mercian Geol.*, Vol. 1, pp. 153–160.

Elliott, R. E. 1961. The stratigraphy of the Keuper Series in southern Nottinghamshire. *Proc. Yorkshire Geol. Soc.*, Vol. 33, pp. 197–234.

Frost, D. V. and Smart, J. G. O. 1979. Geology of the country north of Derby. *Mem. Geol. Surv. G.B.* 199 pp.

Hains, B. A. and Horton, A. 1969. Central England (3rd edn.). *Br. Reg. Geol., Inst. Geol. Sci.* 142 pp.

Holland, C. H. and others. 1978. A guide to stratigraphical procedure. *Spec. Rep. Geol. Soc. London*, No. 10. 18 pp.

Hull, E. 1869. The Triassic and Permian rocks of the Midland Counties of England. *Mem. Geol. Surv. G.B.* 127 pp.

Institute of Geological Sciences. 1975. IGS Boreholes 1974. *Rep. Inst. Geol. Sci.*, No. 75/7.

Ireland, R. J., Pollard, J. E., Steel, R. J. and Thompson, D. B. 1978. Intertidal sediments and trace fossils from the Waterstones (Scythian–Anisian?) at Daresbury, Cheshire. *Proc. Yorkshire Geol. Soc.*, Vol. 41, pp. 399–436.

Mitchell, G. H. and Stubblefield, C. J. 1941. The geology of the Leicestershire and South Derbyshire Coalfield. *Wartime Pam. Geol. Surv. G.B.*, No. 22. 41 pp.

Paton, R. L. 1970. Capitosauroid labyrinthodonts from the Trias of England. *Palaeontology*, Vol. 17, pp. 253–289.

Sedgwick, A. 1829. On the geological relations and internal structure of the Magnesian Limestone, and the lower portions of the New Red Sandstone Series in their range through Nottinghamshire, Derbyshire, Yorkshire, and Durham, to the southern extremity of Northumberland. *Trans. Geol. Soc. London*, 2nd Series, Vol. 3, pp. 37–124.

Stevenson, I. P. and Mitchell, G. H. 1955. Geology of the country between Burton upon Trent, Rugeley and Uttoxeter. *Mem. Geol. Surv. G.B.* 178 pp.

Ward, J. 1900. On the occurrence of labyrinthodont remains in the Keuper Sandstone of Stanton. *Trans. North Staffordshire Field Club*, Vol. 34, pp. 108–112.

Warrington, G. 1970. The stratigraphy and palaeontology of the 'Keuper' Series of the central Midlands of England. *Q. J. Geol. Soc. London*, Vol. 126, pp. 183–223.

— **and others.** 1980. A correlation of Triassic rocks in the British Isles. *Spec. Rep. Geol. Soc. London*, No. 13. 78 pp.

Whitehead, T. H., Dixon, E. E. L., Pocock, R. W., Robertson, T. and Cantrill, T. C. 1927. The country between Stafford and Market Drayton. *Mem. Geol. Surv. G.B.* 128 pp.

Wills, L. J. 1948. The Palaeogeography of the Midlands. (1st edition), 144 pp. (University Press of Liverpool.)

— 1956. *Concealed Coalfields*. 208 pp. (London: Blackie and Son Ltd.)

Walsh, P. T. et. al. 1972. The preservation of the Neogene Brassington formation of the Southern Pennines, and its bearing on the evolution of upland Britain. J. geol. Soc. Lond. 128, 519–59.

Walsh, P. T. et al. 1980. Palaeocurrents directions and their bearing on the origin of the Brassington formation (Miocene–Pliocene) of the Southern Pennines. Mercian Geologist 8(1), 47–62.