NORTH STAFFS GROUP OF THE GEOLOGISTS ASSOCIATION OF LONDON

KEELE SCIENCE AND TECHNOLOGY TEACHERS CENTRE

Alastair – For the records 12 present.

FIELD EXCURSION TO ALDERLEY EDGE, WEDNESDAY 7TH JUNE 1989

Meet at the National Trust Car Park immediately east of the Wizard Restaurant at 5.30 pm Walk westwards to Castle Rocks.

1. Castle Rocks SJ.856780 Pebbly sandstone and conglomerate (Helsby Sandstone Formation HSF: Engine Vein Conglomerate Member EVC; Upper Scythian, Lower Triassic) overlies Wilmslow Sandstone Formation (WSF). Discuss the environment of deposition of the two formations and their relationships (conformable, unconformable); the provenance of the pebbles; the structure and mineralisation of the outcrop; the reasons for the scarp.
2. Walk westwards tracing the boundary of the formations and observing lateral variations in the Engine Vein Conglomerates until Wizards Well is reached (SJ854780. Discuss the nature of the basal surface of the EVC; the structure of the rocks; Wizards Well adit; mineralisation; the nature and origin of the well.
3. Retrace one's steps eastwards past Castle Rocks and walk along the base of the crags observing the two faults near Sculpted Face (SJ 857779), the position of the boundary between HSF and WSF, especially around the Reservoir and Alderley Beacon (SJ 859777). Locate and discern the significance of a small adit north of the Beacon at SJ
4. Walk towards Holy Well via a small quarry: discuss whether the rock is HSF or WSF in the quarry (SJ 859777).
   Observe the rock formations at Holy Well (SJ 859778) and their geometry in relation to the main scarp to the southwest. Suggest hypotheses to account for the relationships and the origin of the two wells and the fallen blocks of HSF (EVC).
5. Climb down northwards then steeply upwards towards Twin Shafts (SJ 859779). Identify the rock formations present and the relationships of these to the main scarp and Holy Well.
   Suggest reasons why there are two shafts here and a further one at Lower Twin Shafts. Collect minerals (gaugue and ore) from the spoil heap.
6. Traverse eastwards towards Stormy Point (SJ 860779) and observe the splendid work of the Derbyshire Caving Club in tracing the history of mining. Work out the geology of the area around Stormy Point, Glaze Hill and Saddlebole (SJ 860780). Discuss the alternative geological maps provided by Trotter (1963) Broadhurst (1966) and Thompson (1966).
7. Walk eastwards to the area of Doc and Pillar Mines (SJ 861779) and work out the geology of that area.
   Collect mineral specimens from the spoil heaps of these mines.
8. Return southwards via Opencast (SJ 861777), Old Alderley Quarry (SJ 867777), Engine Vein Mine (SJ 860775), Beacon Lodge (HSF Beacon Lodge Sandstone Member BLSM) (SJ 858776), Church Quarry (SJ 859779) (HSF Wood Mine Conglomerate Member) to the Wizard. View the shaft leading to the Alderley Cobalt Mine (SJ 859773) (1809-1811) relatively recently rediscovered by the Derbyshire Caving Club.

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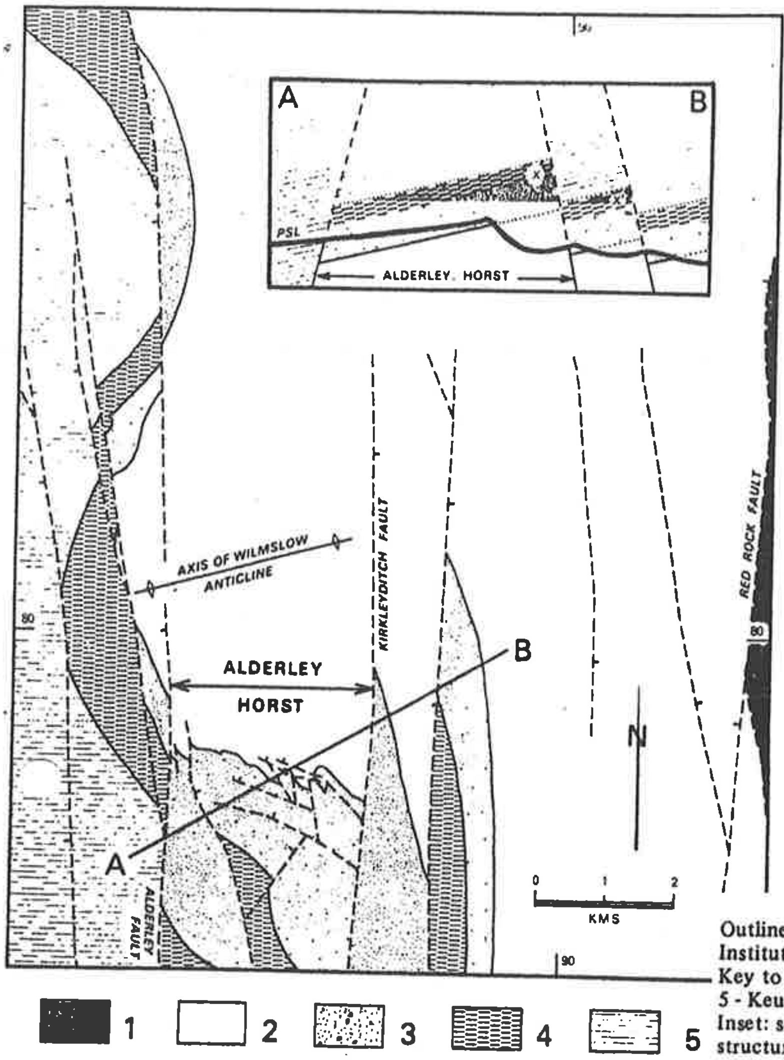


Outline structure and solid geology of the Alderley area (based, with permission, upon Institute of Geological Sciences 1:50000 Sheet 98, Stockport; 1977).
Key to ornament: 1 - Carboniferous, 2 - Bunter, 3 - Keuper Sandstone, 4 - Waterstones. 5 - Keuper Marl.
Inset: schematic section, on line A - B on the geological map, showing potential structural traps for hydrocarbons and other fluids beneath a cap-rock of Keuper Marl (See appendix 1 for recent changes in the names of 2 to 5) in the Alderley horst (X) and an adjacent faulted block (x^1); PSL - present surface level (shown by thick line), all features in the section above that level have been removed by erosion and are projected from the geological map.

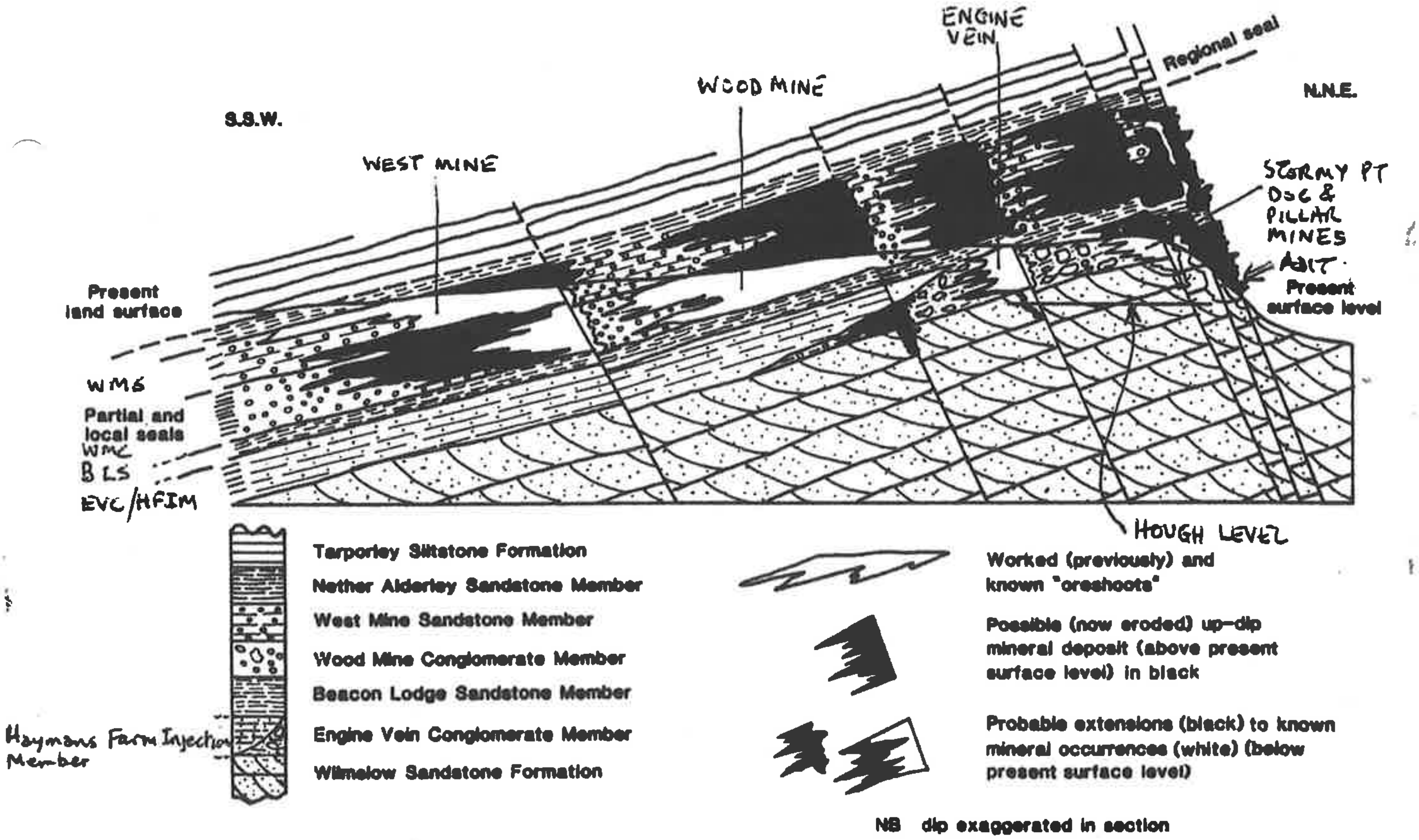
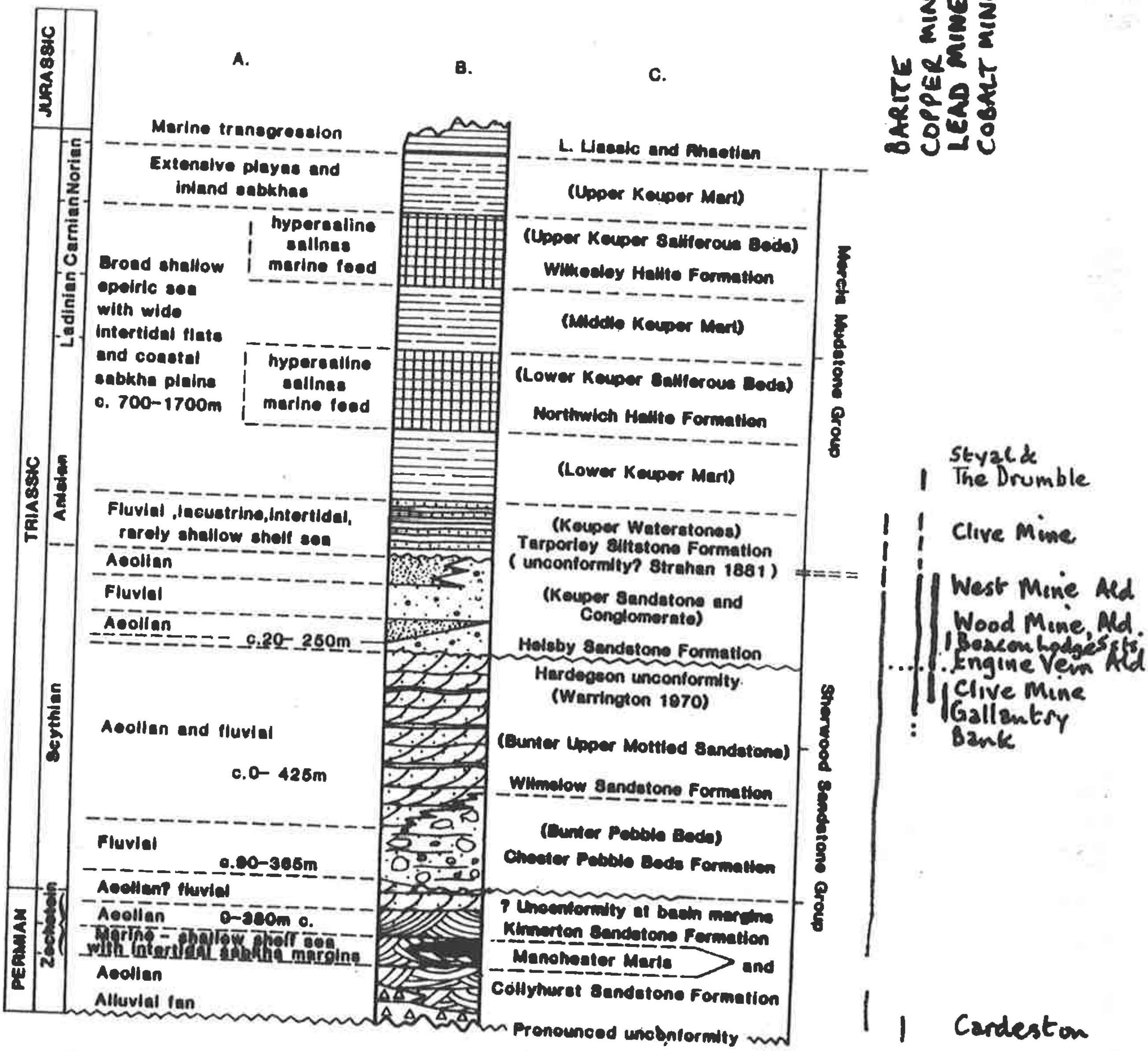
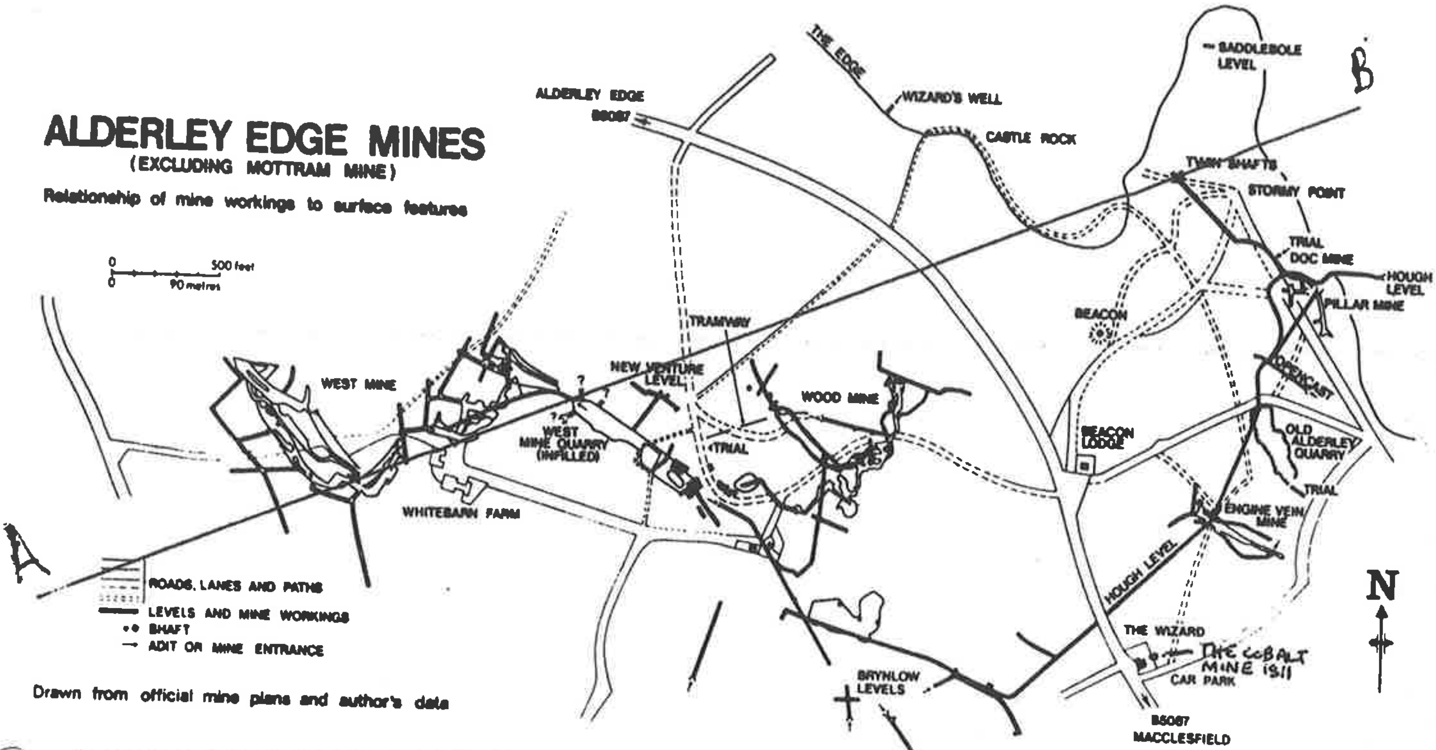


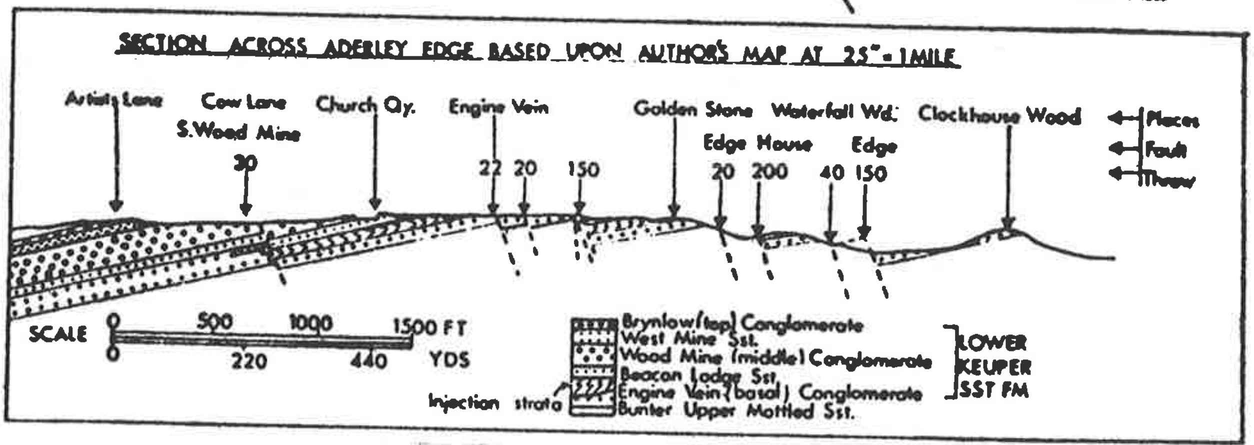
Figure 12B. Diagrammatic section showing relationships between structure, stratigraphy and mineralisation in the Wilmslow and Helsby Sandstone Formations at Alderley Edge. (in part with courtesy of Dr. C.J. Carlon)

Figure 3. Generalised stratigraphic succession and environments of deposition. A. Possible environments. B. Lithology. C. Stratigraphic divisions. (old terminology in brackets)



From D. B. Thompson
1983 Field Excursions
in the Cheshire and Irish
Sea Basins





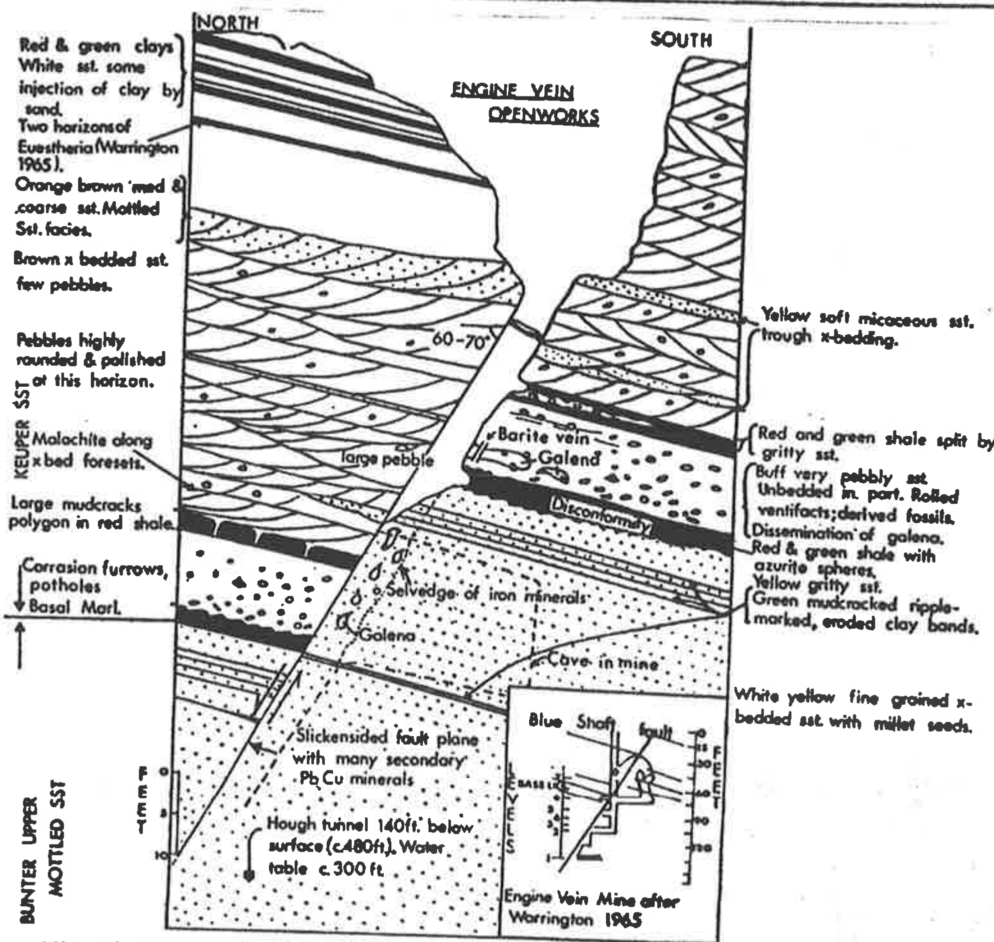


Fig. 13. Diagrammatic section across Engine Vein, Locality 11 of Fig. 12.

MINERAL SPECIES REPORTED FROM ALDERLEY EDGE & MOTTRAM ST. ANDREWS MINES UP TO END OF 1987

RB = DR R.S.W. BRAITHWAITE
I&V = DR ROB IXER & PROF D. VAUGHAN
AK = ARTHUR KINGSBURY
PR = PETER ROBINSON
GH = Dr G. HARWOOD
RI = DR ROB IXER
JRK = J. R. KNIGHT
N = NAYLOR et al (1989) IN PRESS

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COPPER MINERALS Cu +

ELEMENTS	S								CO_3		SiO_2		As					SO_4 / CO_3						P_2O_5 / O_2			Pb V Zn	CO_3 Zn
PLACES \ MINERALS	CHALCOPYRITE	BORNITE	CHALCOCITE	COVELLITE	BLAUBLEIBENDER COVELLITE	DJURLEITE	IDEATITE	TENNANTITE	MALACHITE	AZURITE	CHRYSOCOLLA	PLANCHEITE	ENARGITE	POSNJAKITE	LIROCONITE	OLIVENITE	TYROLITE	ANTLERITE	BROCHANTITE	LANGITE	CALEDONITE	LINARITE	PISANITE	LIBETHENITE	CUPRITE	NATIVE COPPER	MOTTRAMITE	AURICHALCITE
WEST MINE	• RB								•	•	• RB						• RB											
NEW VENTURE LEVEL									•	•																		
WOOD MINE	•	?	?	?	?	?	? (see I&V p.489)		•	•	•					•	• RB		• RB						?			• RB
ENGINE VEIN	•	•	•	•	•	•	•		•	•	•	• AK	•	•	?	•		• RB	• RB	• RB	?	•	•	•	• PR	• PR		
OPENCAST									•	•																		
DOC AND PILLAR MINE									•	•									• RB									
STORMY POINT	•	?	?	?	?	?	? (see I&V p.489)		•	•															?			
TWIN SHAFTS																												
KIRKLEY-DITCH									•	•																	•	
UNSPECIFIED LOCALITIES							•																				•	

LEAD MINERALS Pb+

ELEMENTS	S	CO_3 + SO_4			O_2		P_2O_5		Wo	V	Zn+ S	Zn+ Si	Zn+ CO_3
PLACES \ MINERALS	GALENA	CERRUSITE	LEADHILLITE	ANGLESITE	MINIUM	MASSICOT	PYROMORPHITE	As-PYROMORPHITE	WULFENITE	VANADINITE	SPHALERITE	HEMIMORPHITE	SMITHSONITE
WEST MINE	•	•							• RB	* • GH			
NEW VENTURE LEVEL	•	•											
WOOD MINE	•	•		? I&V			•	• RB	• RB			• RB	? I&V
ENGINE VEIN	•	•	• RB	•	•	•	•	• RB	• RB		•	• RB	• RI
OPENCAST	•	•											
DOC AND PILLAR MINE	•						•						
STORMY POINT	•			? I&V							•		? I&V
TWIN SHAFTS	•												
KIRKLEY-DITCH	•	•					•			•			
UNSPECIFIED LOCALITIES	• N									?	• N		

ELEMENTS	Fe+ S		Fe+ S Ni Co	Fe+ As	Fe+ H_2O	Fe+ SO_4	Ag		Mn Ni Co+ H_2O		As	S	OTHER MINERALS including GANGUE						
PLACES \ MINERALS	MARCASITE	PYRITE	BRAVOITE	(Ni-Co-Fe SULPH-ARSENIDES)	PHARMACOSIDERITE	LIMONITE	SCORODITE	ARGENTIAN TETRAHEDRITE	NATIVE SILVER	WAD	ASBOLITE	ERYTHRITE	NICKEL ARSENIDES	BARITE	WITHERITE CO_3	GYPSUM	CALCITE	JAROSITE	NATIVE SULPHUR	HYDROCARBONS
WEST MINE						•				•	•			•						
NEW VENTURE LEVEL						•				•	•			•						
WOOD MINE		•	•			•		? I&V		•	•	• RB		•						
ENGINE VEIN	•	•	•	•	• RB	•	•	• RI	• JRK	•	•	•	• RI	•	•	•	•	• RB	• RB	
OPENCAST						•				•	•			•						
DOC AND PILLAR MINE						•								•						
STORMY POINT	•	•	•	•		•		•						•						
TWIN SHAFTS						•								•						
KIRKLEY-DITCH						•				•	•			•						?
UNSPECIFIED LOCALITIES																• N				

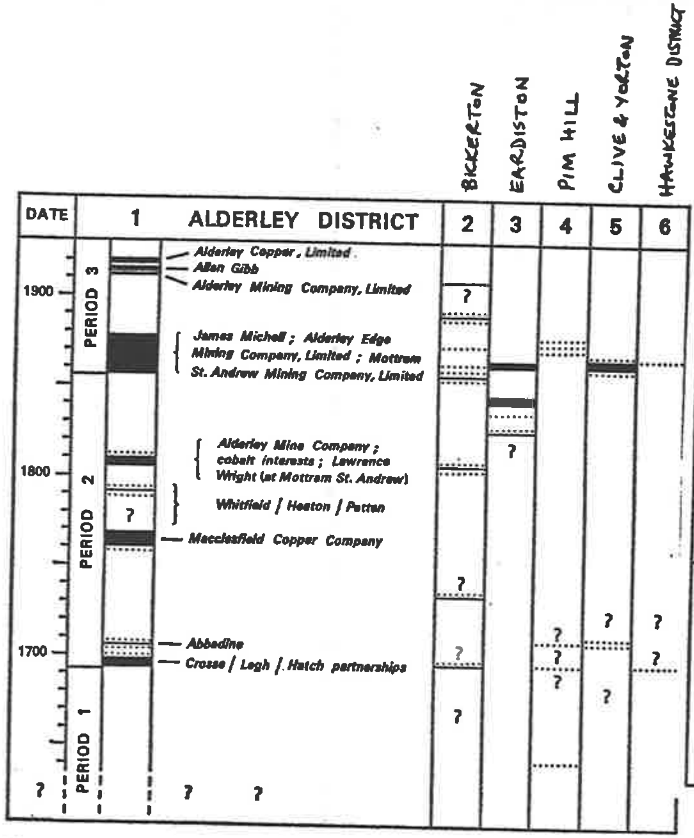


Fig. 3 — Chronology of mining activity in the Alderley district (1), with comparative summaries of activity in other non ferrous mining districts (2-6) in Cheshire and northern Salop (localities as in Figure 1). (Based upon Warrington, 1980b, Fig. 1, p. 10, and *J. Shrops. Caving Min. Club* (for 1980), 1981, p. 13)
Full black — periods of documented activity. Stipple — periods (approximate) of inadequately documented activity. ? — periods during which mining may have taken place.

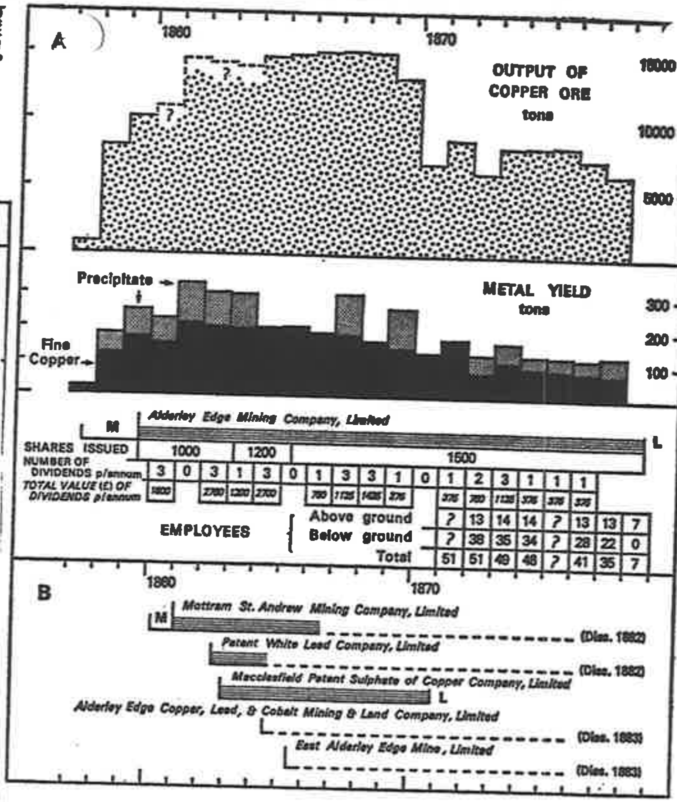


Fig. 4 — Aspects of the activity of the Alderley Edge Mining Company, Limited, (A), with a synopsis (B) of companies involved with mining and related enterprises in the Alderley district in the mid 19th century
Production figures (for the A.E.M.C.L.) from R. Hunt, 'Mineral Statistics of the United Kingdom' (*Mem. geol. Surv. Gt Br.*), and the *Reports of the Inspectors of Mines*, for the relevant years. Ore output for 1860-63 (inclusive) is estimated from the yield of precipitate and metal recorded for those years.
Periods of active existence (from date of incorporation) — horizontal ruling. M — private activity by Michell and associates. L — voluntary liquidation. 'Diss.' — Company dissolved (with date). Sources of company information cited in text.
A.E.M.C.L. share and dividend records compiled from company records (cited in text) and the *Mining Journal*.
Numbers of employees at the Alderley Edge mines in 1871, from census returns from the Alderley and adjacent parishes; for subsequent years, from the *Reports of the Inspectors of Mines* for the relevant years (all employees were male).

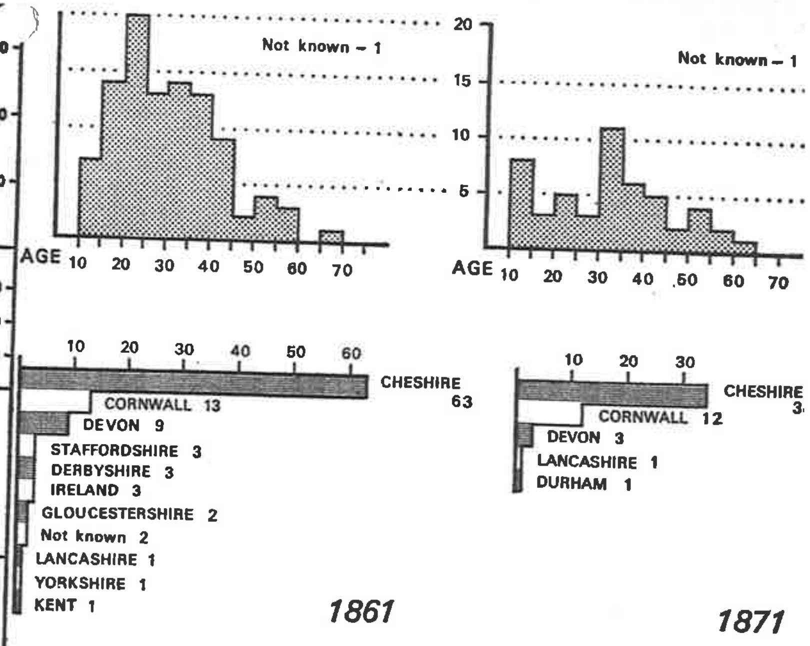


Fig. 5 — Numbers of persons directly involved in mining in the Alderley district in 1861 and 1871
Information from the census returns from the Alderley and adjacent parishes.
Above — numbers of persons by age (in 5 year categories; the age of one person in each census is unknown and, therefore, not represented). Below — numbers of persons by county of origin.
All persons listed in the census returns as involved with mining activity were male.

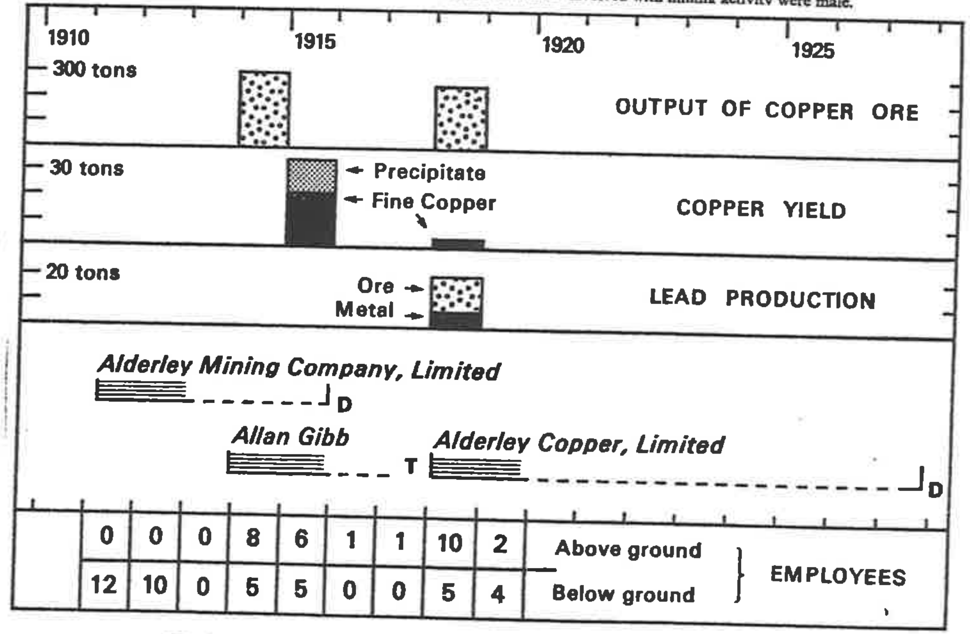
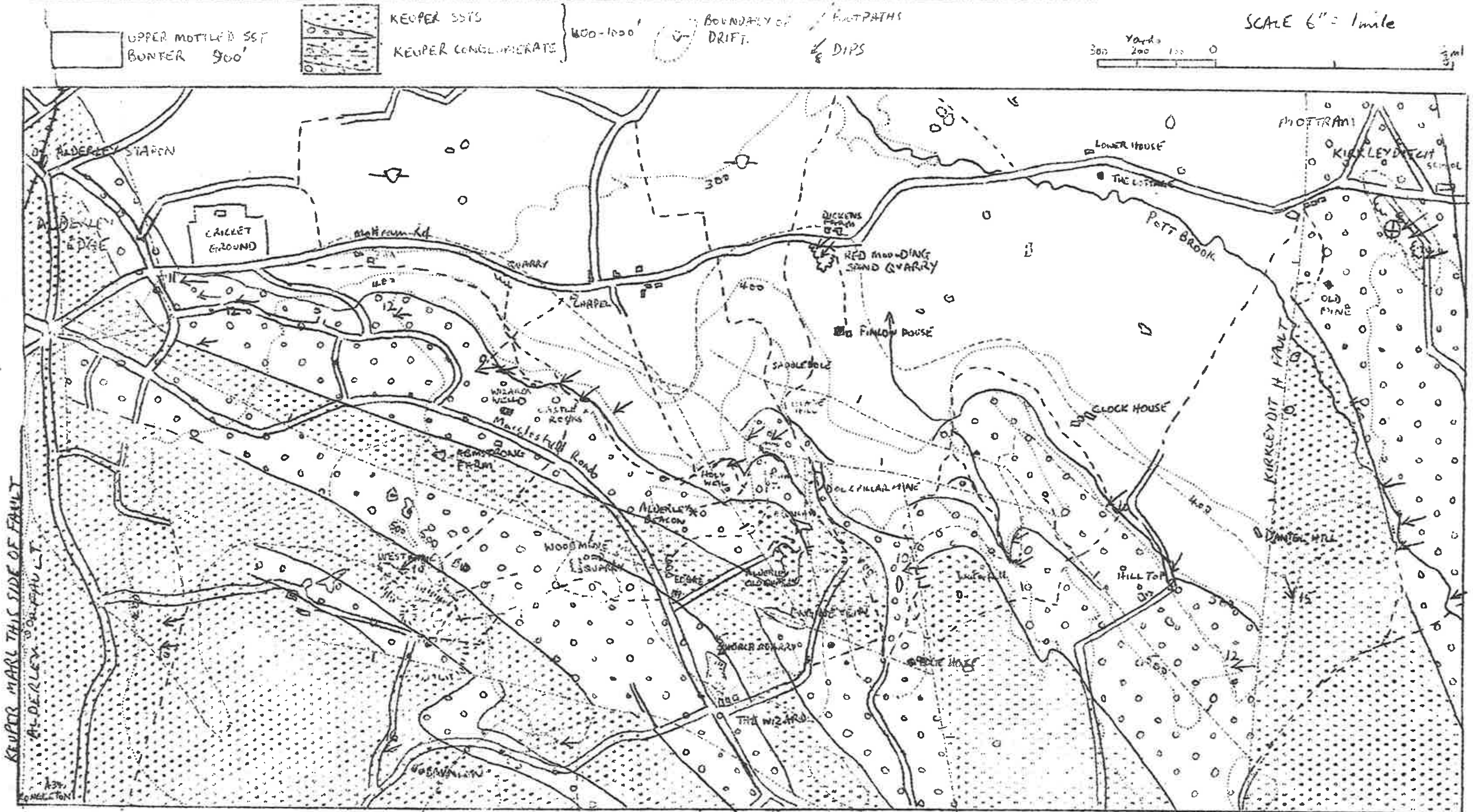


Fig. 6 — Aspects of mining activity in the Alderley district in the early 20th century
Production figures from *Home Office, Mines & Quarries: General Reports with Statistics* for the relevant years.
Periods of active existence of mining concerns (from date of incorporation or equivalent) — horizontal ruling; remainder of existence shown by broken line. T — transfer of interest. D — Company dissolved.
Numbers of employees from *Home Office: List of Mi*

GEOLOGICAL MAP OF ALDERLEY EDGE AREA AFTER GEOLOGICAL SURVEY SHEET 98 NEW SERIES STOCKPORT AREA



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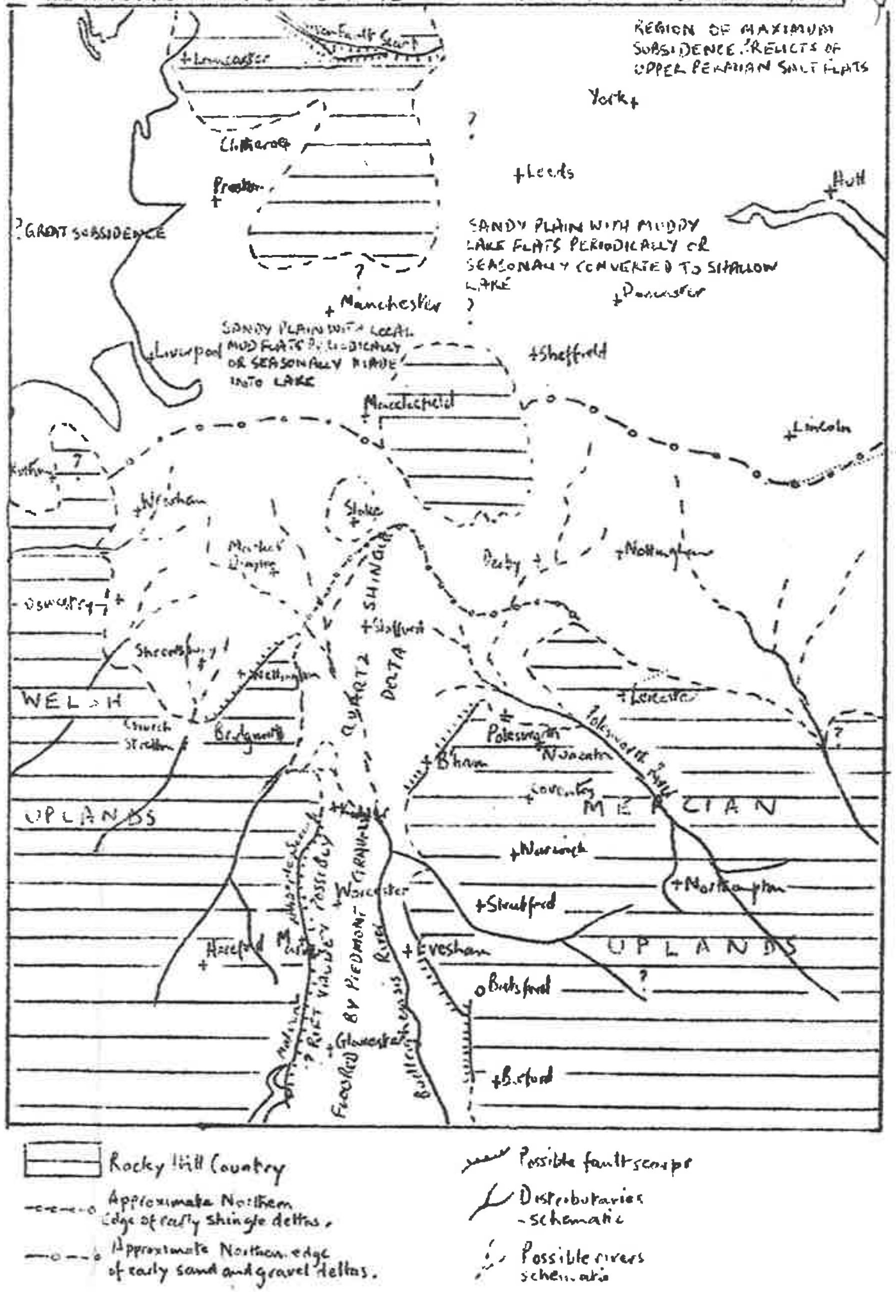
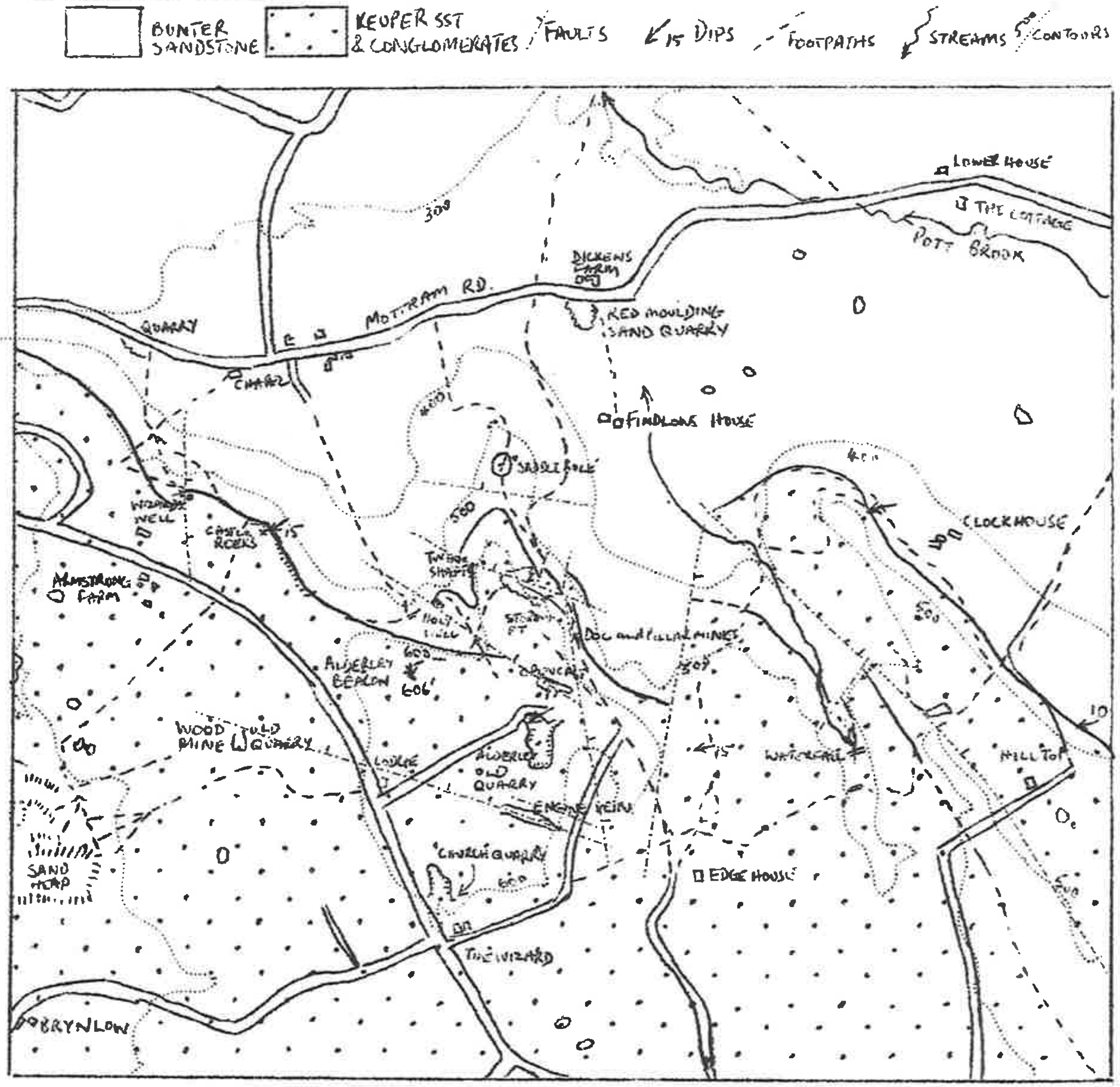
THE PALAEOGEOGRAPHY OF THE BUNTER PEBBLE BEDS after Wills (Concealed Coalfields p 111)



A GEOLOGICAL MAP OF THE ALDERLEY EDGE AREA AFTER Dr F.M. BROADHURST and W. CHESWORTH SCALE 6" = 1 mile



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Notes on the Geology of Alderley Edge Cheshire

PREPARED BY
G. WARRINGTON
(Institute of Geological Sciences, Leeds)
for the National Trust 1972

The rocks present in the Alderley area were formed during the Triassic period of geological time (approx. 230 to 180 million years ago). The sequence of Triassic rocks visible at Alderley consists of the following formations (oldest first); the Bunter Upper Mottled Sandstone (1200 feet thick), the Keuper Sandstone (460 feet thick), the Waterstones (400 feet thick) and the Keuper Marl. At Alderley Edge the rocks are tilted south westwards to dip at an angle of about 12°; as a result the oldest visible formation (Upper Mottled Sandstone) is seen on the north side of the Edge while the overlying younger deposits (Keuper Sandstone) form a capping to the hill and the youngest deposits are found on the southern side. Alderley Edge, as a topographical feature, results from the uplift of a block of the Upper Mottled and Keuper Sandstones between two north-south trending faults to the east and west of which occurs the geologically younger Keuper Marl. The hard Keuper Sandstones which cap the hill are resistant to erosion and thus the uplifted block stands above the surrounding plain which is underlain by the softer mudstones to the east and west. The 'faults' are planes along which adjacent rock masses have moved relative to one another. Many minor faults occur within the block which forms Alderley.

The north side of Alderley Edge is steep and nearly parallel to several of these minor faults; it may be regarded as a fault scarp which has been slightly modified by erosion.

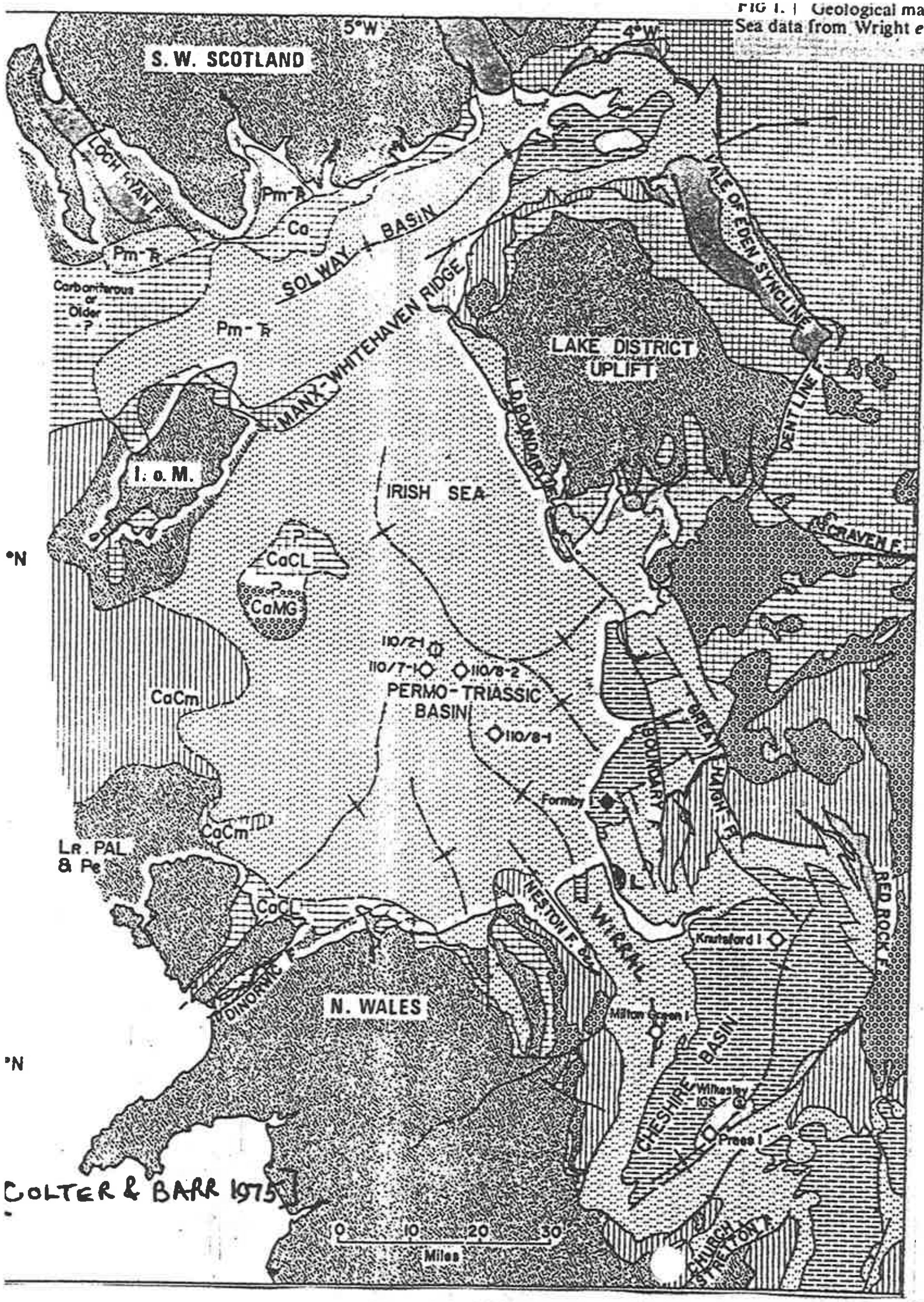
The bright red-brown Upper Mottled Sandstone originated as sandy sediments laid down largely by streams and rivers which flowed in a generally northerly direction. Some of the sands may have accumulated as sand dunes formed under the influence of easterly winds however. The Keuper Sandstone consists of a basal conglomerate which forms the main erosion-resistant capping of the Edge and is overlain by a sequence of softer sandstones in which two less important conglomerates occur. These deposits were laid down as pebbly and sandy sediments by northward-flowing meandering streams and rivers which formed part of a delta system. Thin bands of mudstone in this sandy sequence represent the deposits of swamps and pools which existed alongside the main river channels. The Keuper Sandstone passes upwards via the alternating sandstones and mudstones of the Waterstones into the mudstones of the Keuper Marl which, elsewhere in Cheshire, contain thick beds of rock salt (halite) and are regarded as having been laid down in a sea in which salt was concentrated. The Waterstones represent a passage from the fresh water river environment of the Keuper Sandstone to the salty environment in which the Keuper Marl accumulated.

The climate in Britain during the Triassic was probably hot and dry as the area then lay near to the equator. The rivers which supplied the sediment of the Upper Mottled and Keuper Sandstones may have been, like those in some arid parts of the world today, rather irregular or seasonal in flow. Plants and animals were scarce in this unfavourable environment and fossils are rare in the Triassic rocks of the Alderley area. Footprints of reptiles occur in the Upper Mottled Sandstone and Keuper Sandstone and traces of worms and other invertebrates occur in the Keuper Sandstone and Waterstones. Fossil water fleas and plant microfossils occur in the Keuper Sandstone and the Keuper Marl. A fossil insect wing has been found in the Keuper Marl near Alderley.

The Alderley copper mines are well known and may have been worked in pre-Roman and Roman times; mining was definitely in progress in the 16th Century but was most highly developed in the 18th and 19th Centuries; Mining ceased in 1920. The area has yielded ores of copper (malachite, azurite, chrysocolla) and lead (galena, cerrusite) and other elements such as cobalt, nickel, arsenic and manganese. Sulphides (galena and chalcopyrite) occur on or near fault planes but carbonates (malachite, etc) are found further from the faults. The ores occur mainly in the conglomerates of the Keuper Sandstone and are accompanied by considerable quantities of barytes. The ores probably originated from mineral solutions which rose up fault planes to produce sulphide ore bodies. Subsequent oxidation of these ores and the effects of circulating groundwater have distributed minerals throughout the rocks around the faults and produced a wide variety of secondary minerals.

3

FIG 1.1 Geological map of the Irish Sea—Cheshire Basin region. (Based on IGS "Ten-mile" Geological Map of Great Britain, and Irish Sea data from Wright *et al.*, 1971.) It should be noted that the sub-divisions of the Permo-Triassic as mapped are not entirely in accord with the stratigraphy adopted in this paper as presented in Figs 3 and 4.



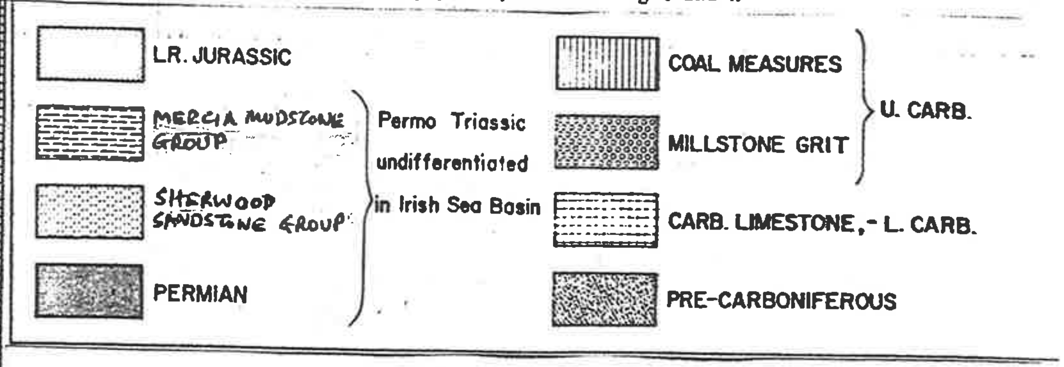
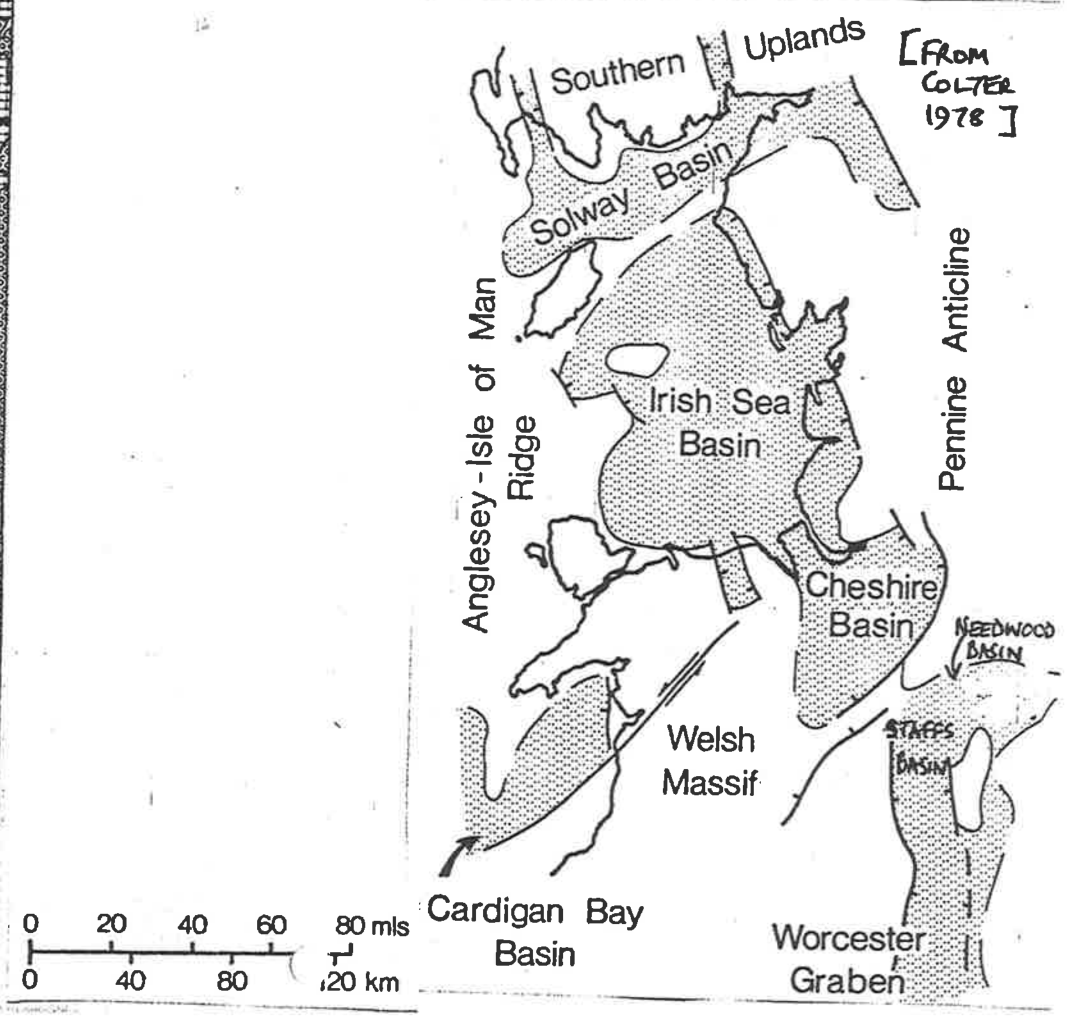


Fig. 1
Schematic relationships of Permo-Triassic basins around the Irish Sea.



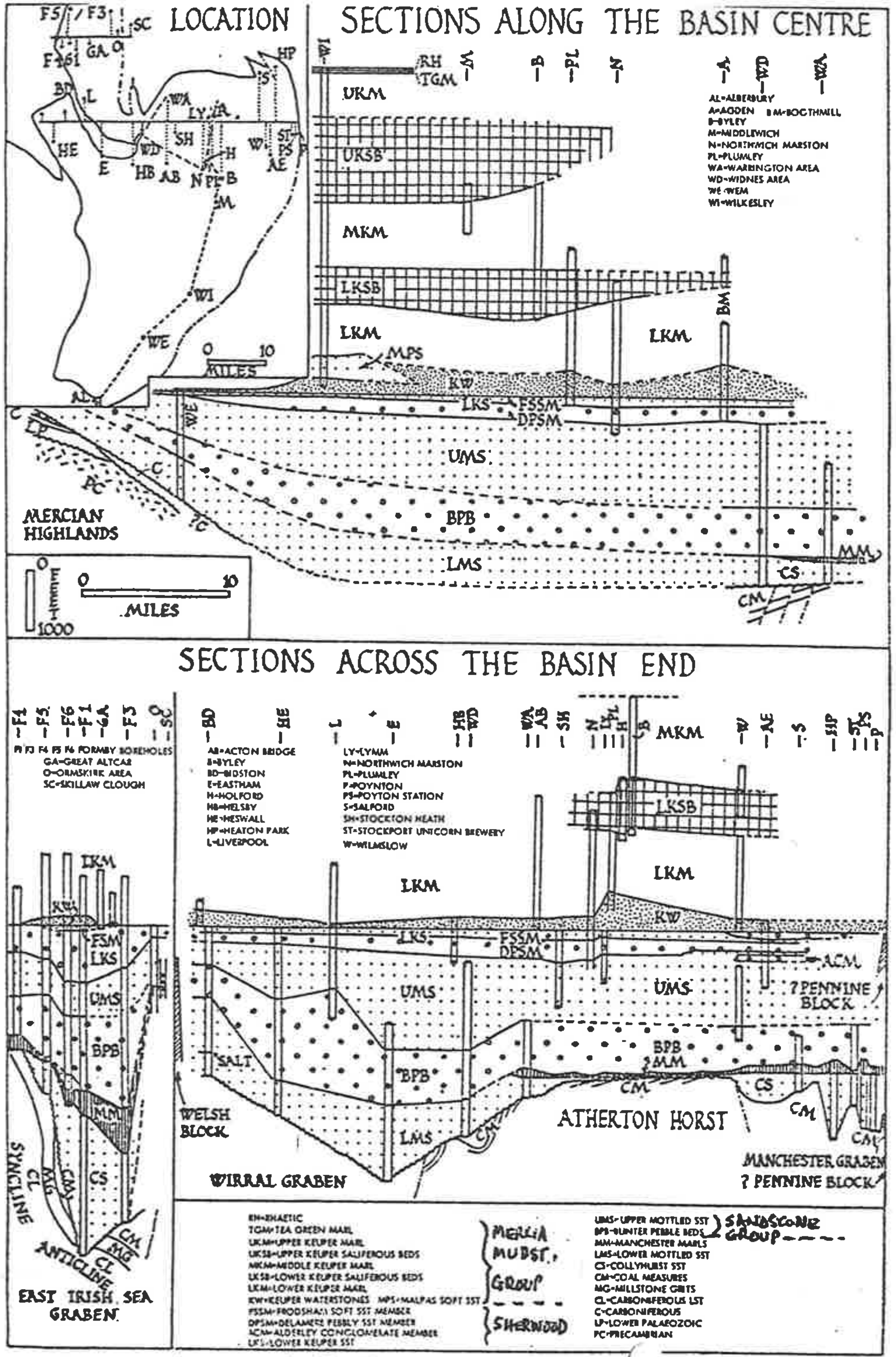
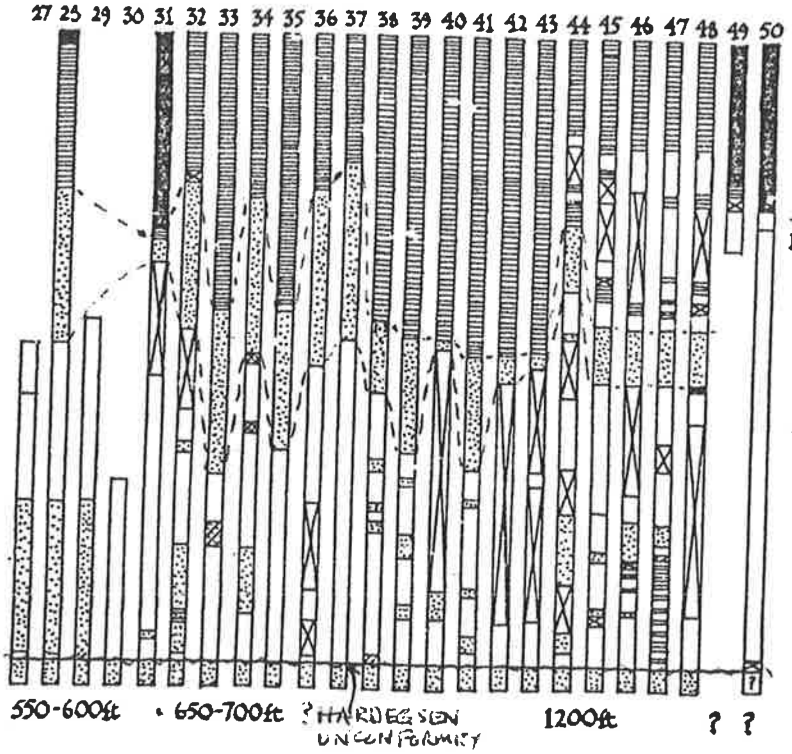


Fig. 2. Sketch sections across the Cheshire Basin based upon a few sel[illegible]ed successions to illustrate the nature of the basinfill. The base of the Waterstones is taken as a datum. Red Pebbly magnalithofacies is shown by open circles; Soft Sandstone magnalithofacies by small equally spaced dots

FIG. 3. An outline lithofacies distribution utilizing the earliest recorded Red Pebbly Sandstone lithofacies as the datum. The numbers refer to the localities which are enumerated and described in the captions to Figs. 4 and 5. Legend as follows: black, Keuper Marl; horizontal lines, Waterstones; blank, Red Pebbly Sandstone; dotted, Soft Sandstone; crosses, gaps in succession. The upper parts of the sections above the uppermost Red Pebbly Sandstone or Soft Sandstone facies are completed in a generalized way using information from nearby boreholes and Geological Survey *Memoirs.* The data is not as accurate as in the lower parts of the column. The areas of Soft Sandstone lithofacies of columns 16 and 17 represent the Malpas Sandstone of Poole & Whiteman (1966).



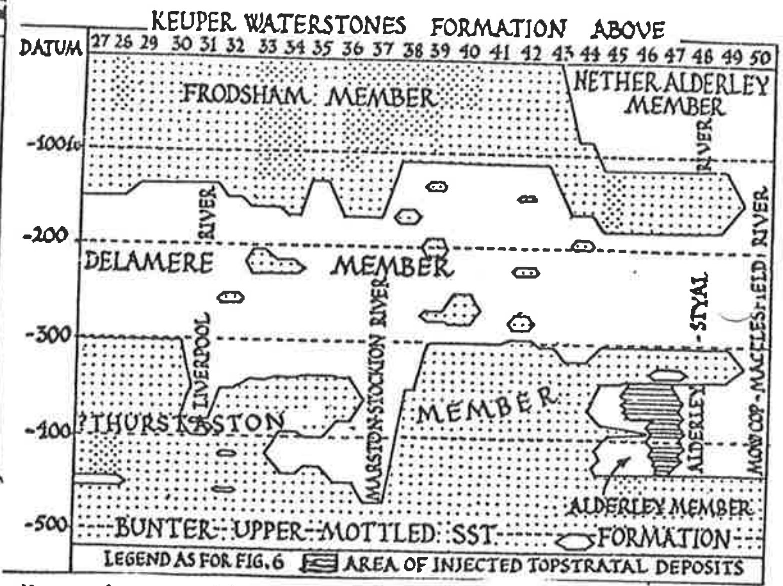


FIG. 6. Outline environmental interpretation of the Keuper Sandstone Formation defined in Fig 4, with names of Members proposed in this paper. Names of local groups of beds, e.g. in the Alderley Succession, Engine Vein Conglomerate, Beacon Lodge Sandstones, Wood Mine Conglomerates, West Mine Sandstones in the Keuper Sandstone Formation; Finlows Sandstone in the Keuper Waterstones Formation (Warrington 1965; Thompson, thesis, 1966), are necessary for local description and mapping, but are not included here. For ease of drafting, full names of Members defined are not given, but are included in Table 1.

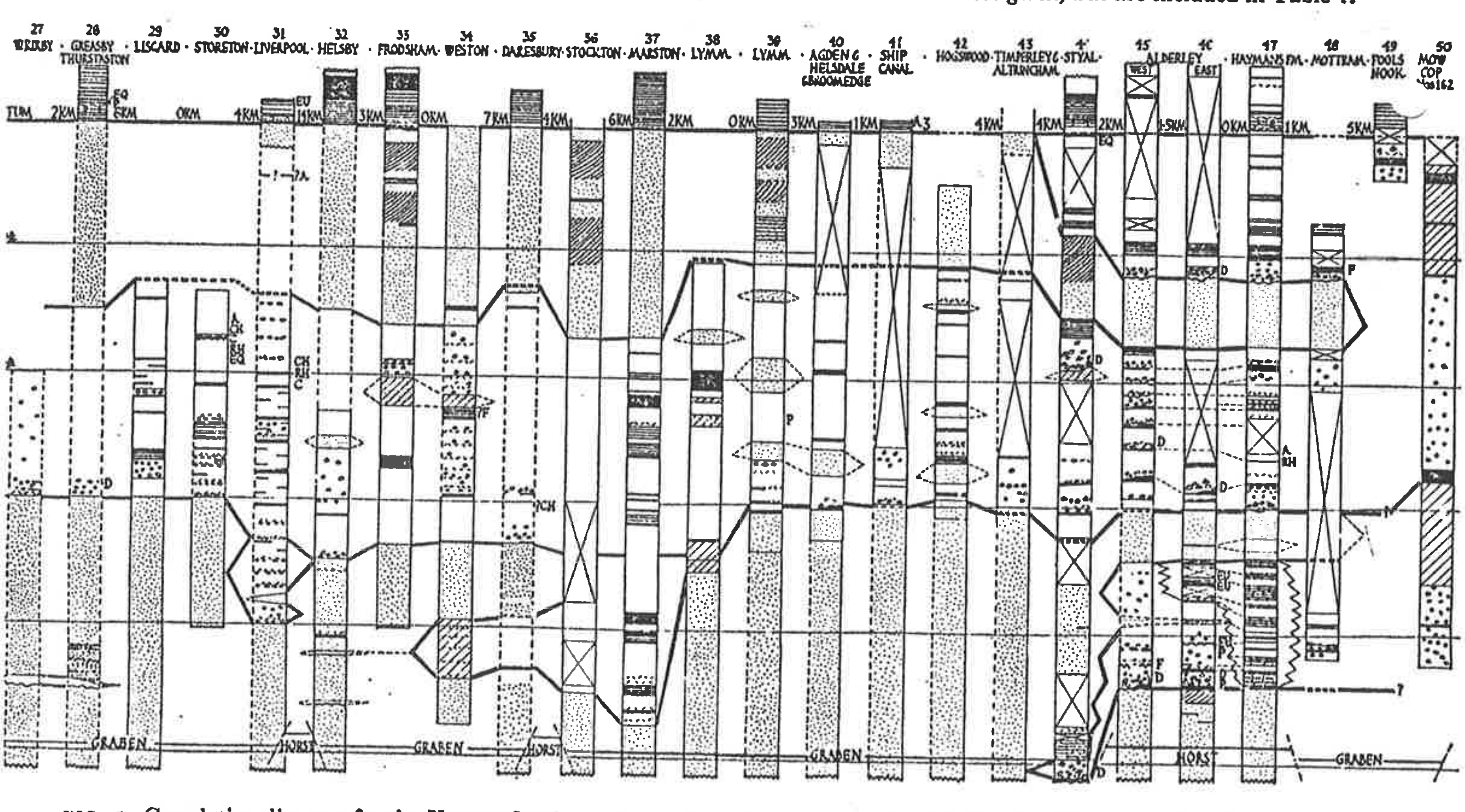
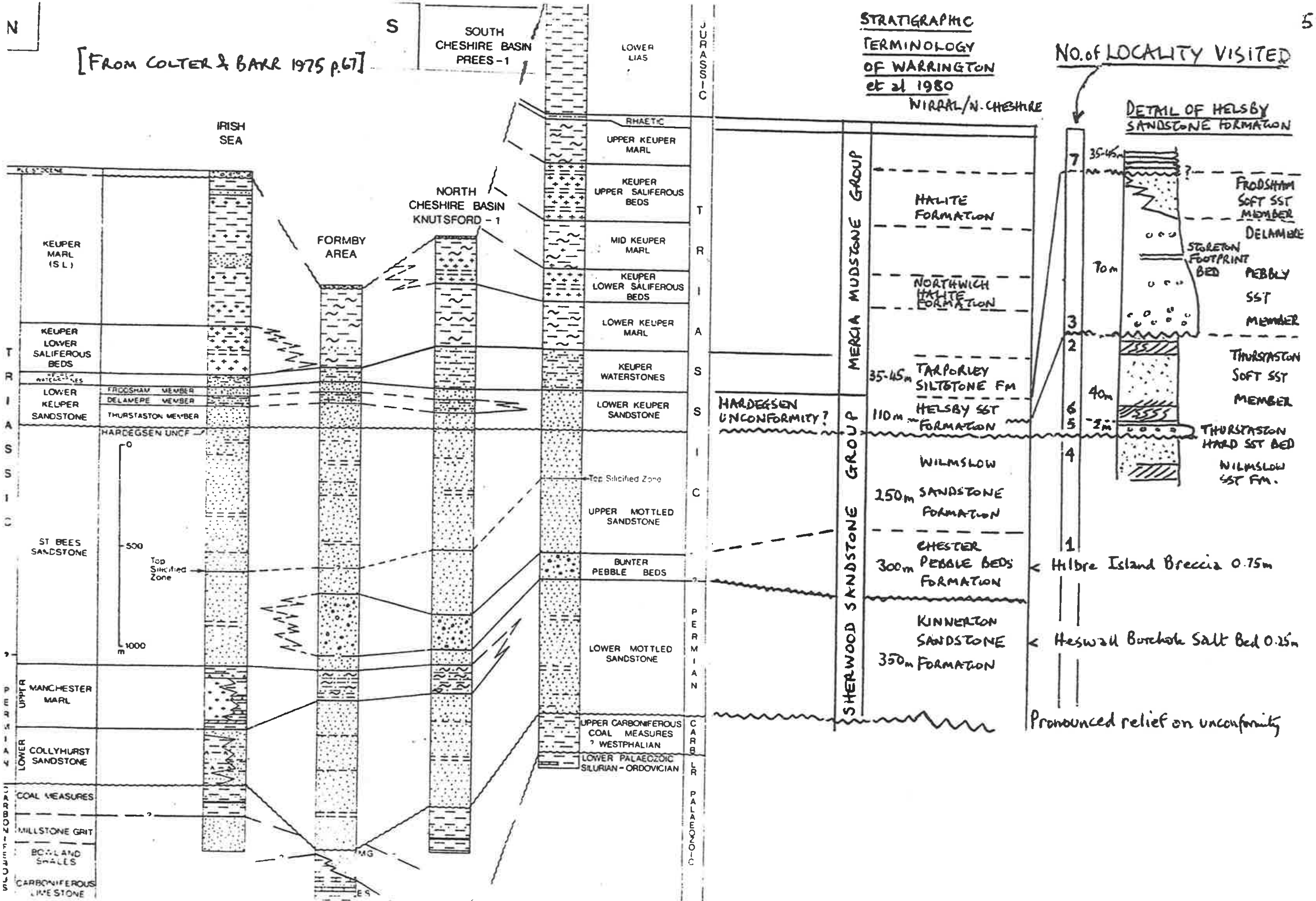


FIG. 5. Correlation diagram for the Keuper Sandstone Formation. The numbers placed before localities are utilized in Figs. 3, 6.



4. Correlation diagram based on well data: Irish Sea and Cheshire Basins. Refe[illegible]ce datum = base Lower Keuper Sandstone (Hardegsen unconformity).

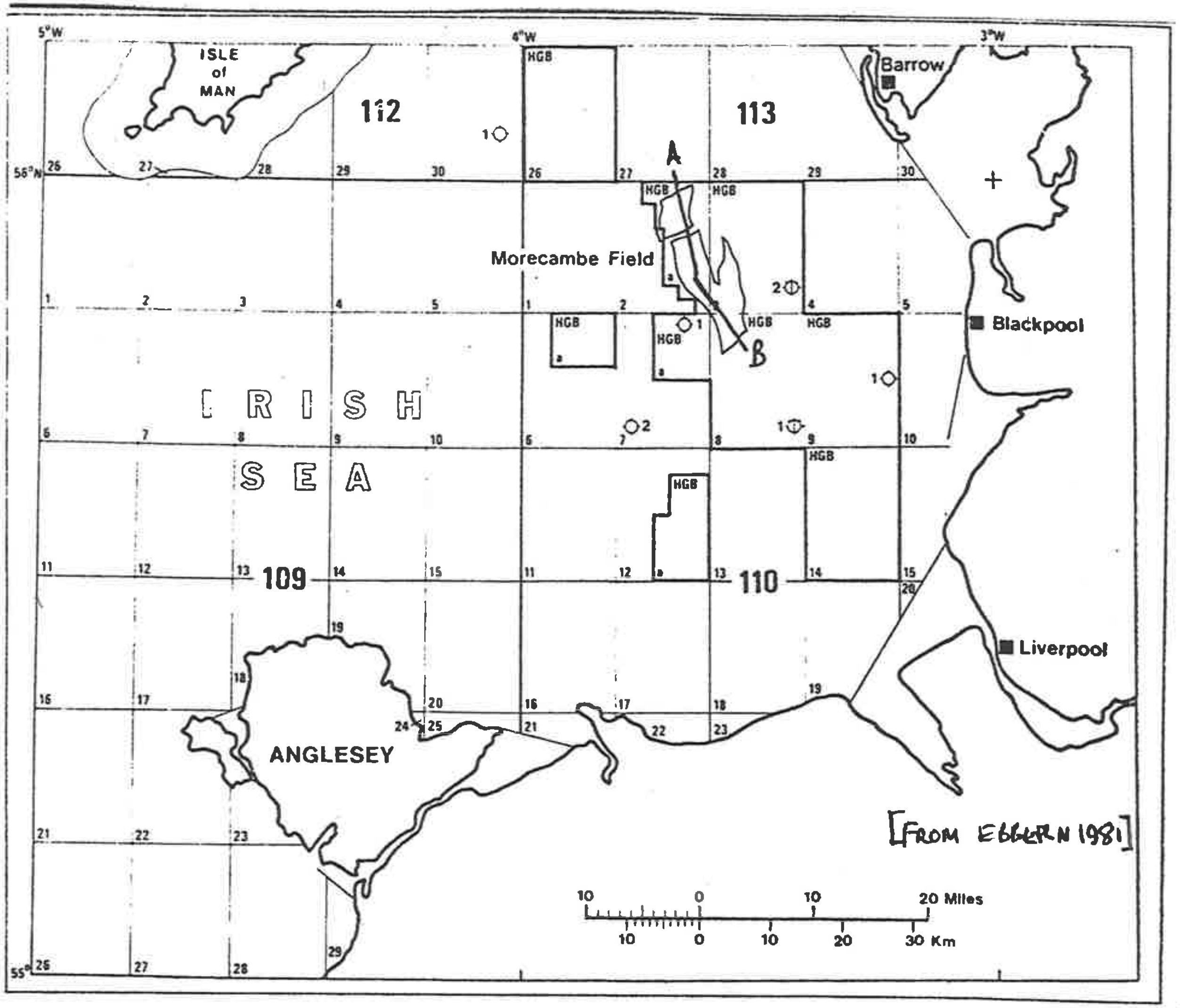
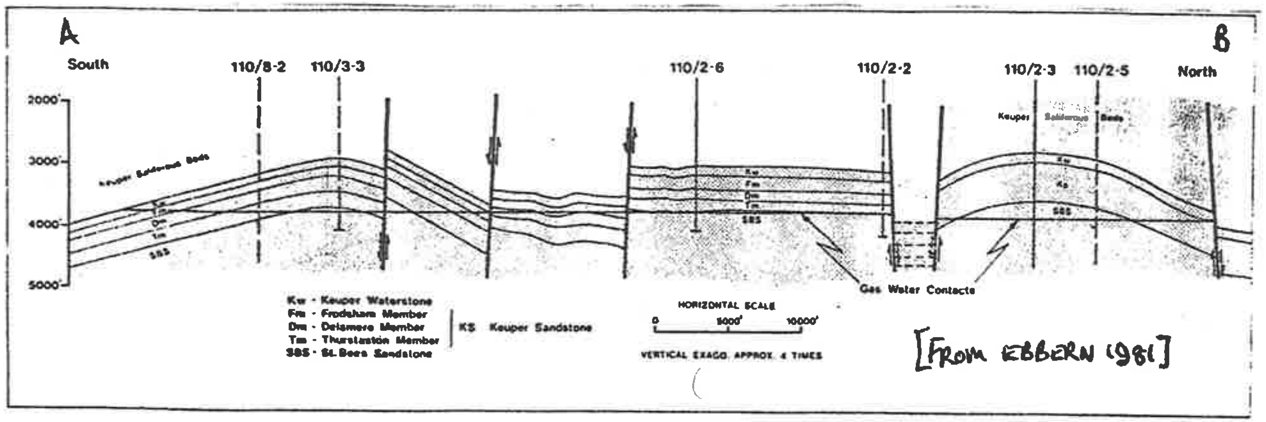


Fig. 1. Location map.



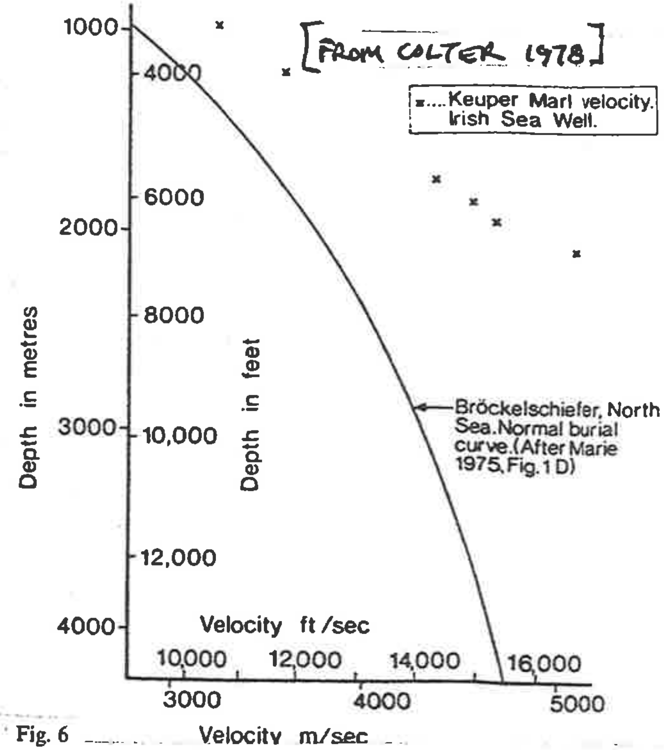


Fig. 6
Sonic velocities of shales versus present depth of burial for an Irish Sea well drilled on the fault block with reduced Permian-Triassic Sandstone section in figure 5. and the Bröckelschiefer of the southern North Sea.

The Irish Sea well might at one time have been buried to more than 4000 m, i.e. 2000 m + deeper than at present.

As a check on this estimate, spore colouration and vitrinite reflectance measurements were commissioned from Robertson Research International Ltd. for Carboniferous material from the same well, assuming a geothermal gradient of 2.55 °C/100 m (1.4 °F/100 ft).

These studies independently came up with a similar original depth of burial (± 4,500 m) to those estimated from the sonic velocities, supporting the view that this fault block has lost some thousands of metres of section.

As a further comparison, spore colouration and vitrinite reflectance measurements were carried out on Carboniferous material from another well about 20 km away on a different fault block, with an apparently 'normal' Permo-Trias succession. These studies suggest original depths of burial of 5,000 + m, with corresponding amounts of more recent uplift and erosion in the vicinity of this well.

The likelihood exists, then, that the whole Irish Sea Basin was once the site of a much thicker Mesozoic section, including probably Jurassic and maybe Cretaceous sediments. The only remnants of such a regional sedimentary cover appear to

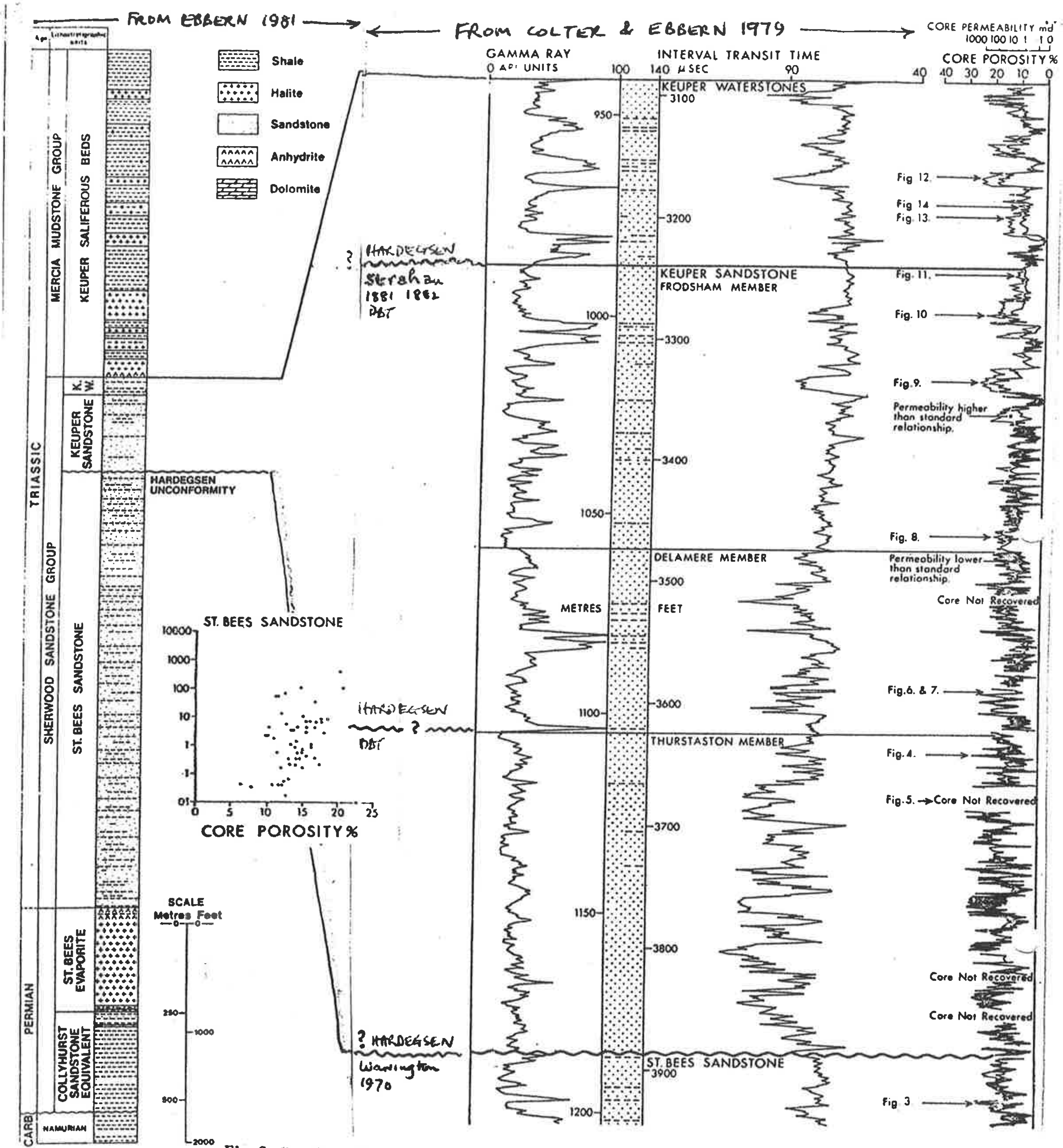
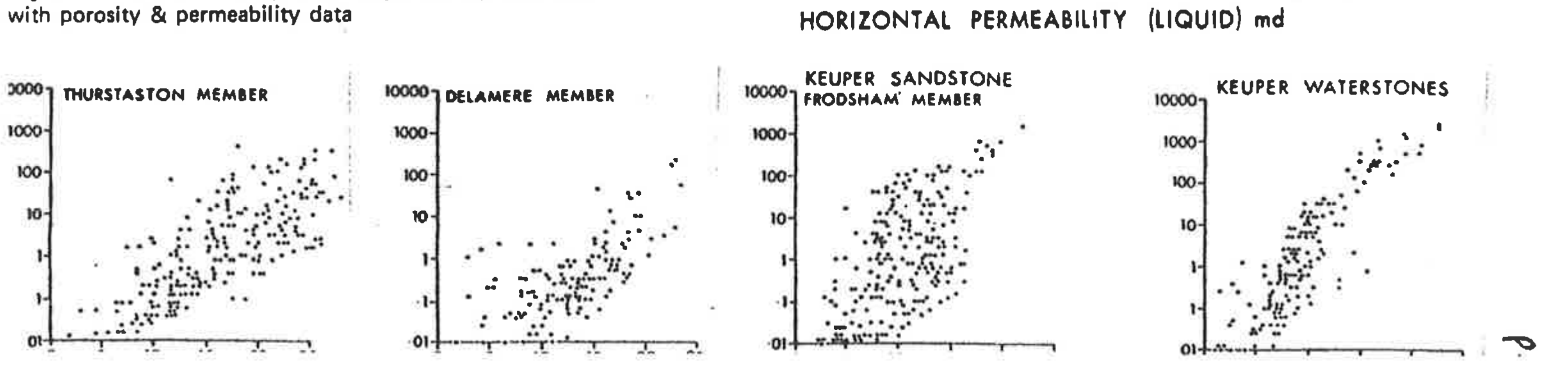


Fig. 2. Stratigraphic section of the Irish Sea, with gamma-ray-sonic log of the reservoir sandstones in Well 110/2-6.

Fig. 2. Well 110/2-6. Comparison of gamma-ray/sonic logs with porosity & permeability data



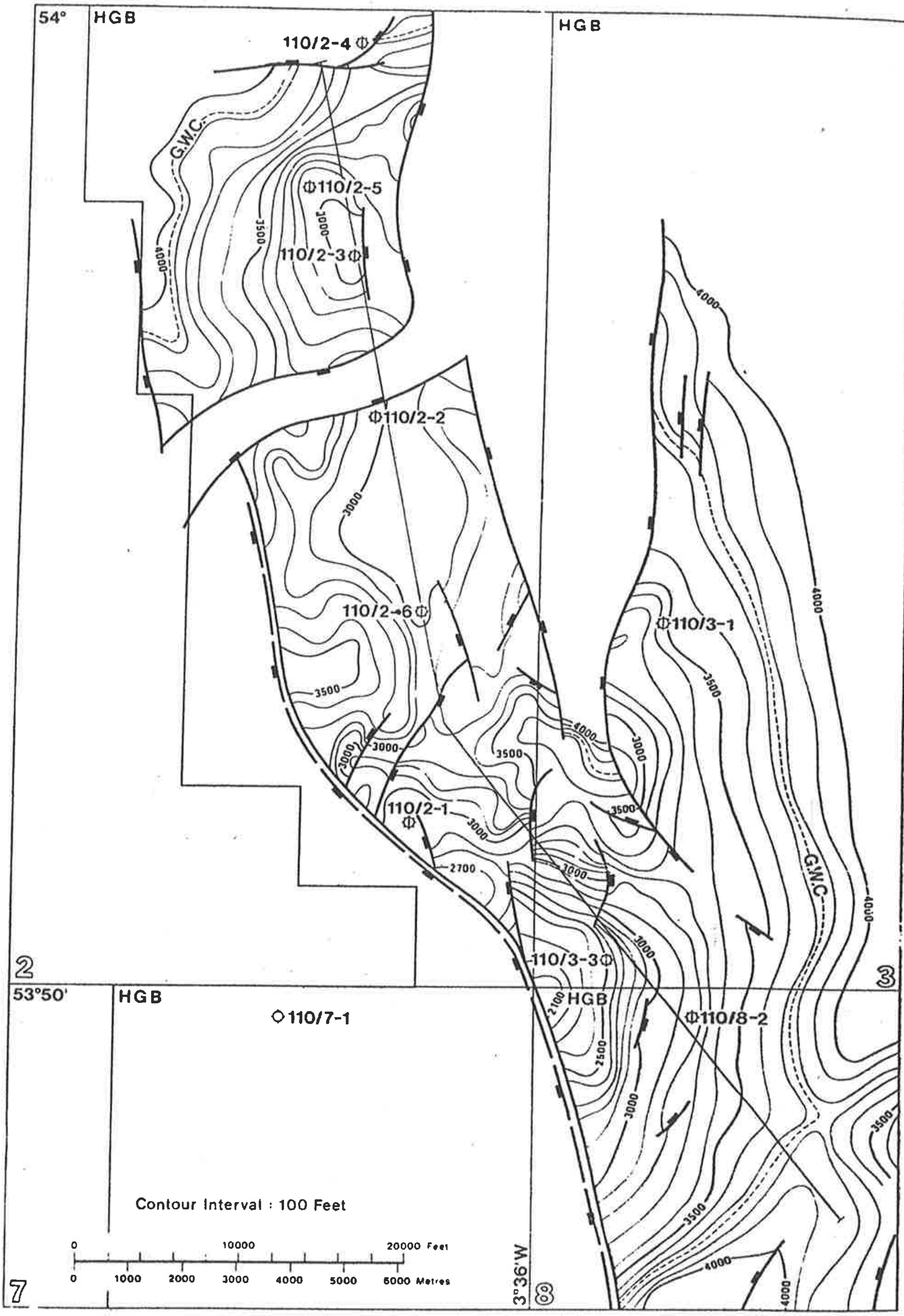


Fig. 3. Structure at top reservoir sandstone level, showing line of section.

(FROM EBBERN 1981)

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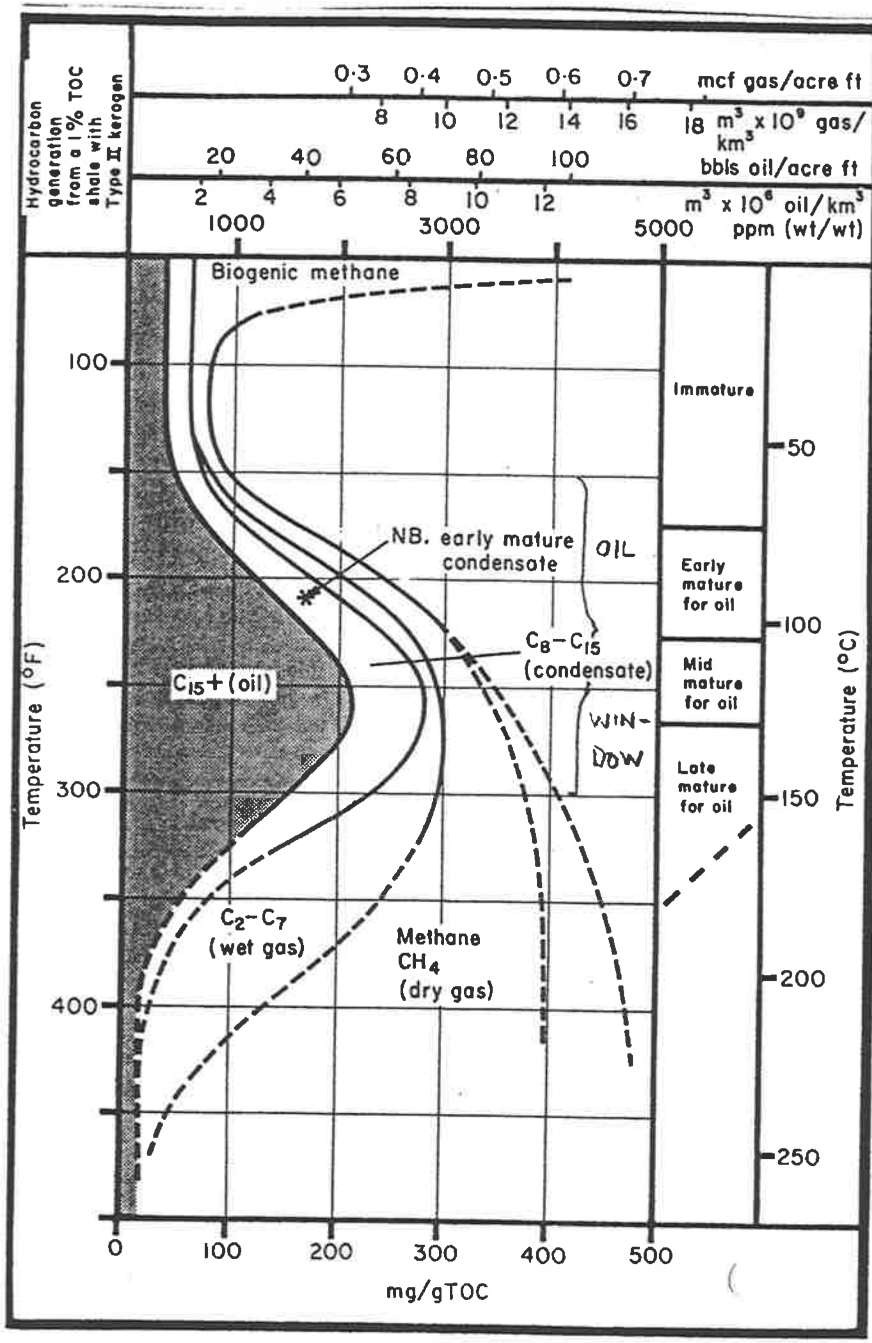

OIL PRONE COMPONENTS — FRESHWATER OR MARINE ALGAE BACTERIALLY DEGRADED TO AMORPHOUS SAPROPEL (LIPTINITE PETROGRAPHICALLY)

CONDENSATE PRONE COMPONENTS — TERRIGENOUS SPORE POLLEN, CUTICLE RESIN (EXINITE PETROGRAPHICALLY)

GAS PRONE COMPONENTS — TERRIGENOUS, HERBACEOUS, WOODY, LIGNO-CELLULOSE TISSUE RELATIVELY UNALTERED PARTICULATE OR AMORPHOUS (VITRINITE PETROGRAPHICALLY)

AS ABOVE BUT ALTERED BY OXIDATION IN SOIL OR TRANSPORT OR BY FOREST FIRE (INERTINITE)

Fig. 9.7. Qualitative generation of oil and condensate: m³ oil/km³ of 1% TOC source-rock (bbls/acre ft); and gas: m³CH₄/km³ of 1% TOC source-rock (mcf/acre ft), as a function of down-hole temperature for oil-prone kerogen. For details see Brooks, Cornford and Archer (in press). Note the possible generation of larger quantities of early mature condensate from spore/pollen/cuticle/resin rich sediments, and expulsion if drainage is good. To convert to a specific hydrocarbon type of density ρ_i, use ppm wt/wt × (rock bulk density/ρ) = ppm vol/vol. ρ-oil ≈ 0.8-0.9; ρ-methane = 7.1×10^{-4} at standard temperature and pressure); 1bbl = 5.614 cu ft = 159 litres; 1 acre ft = 1233.5 m³.

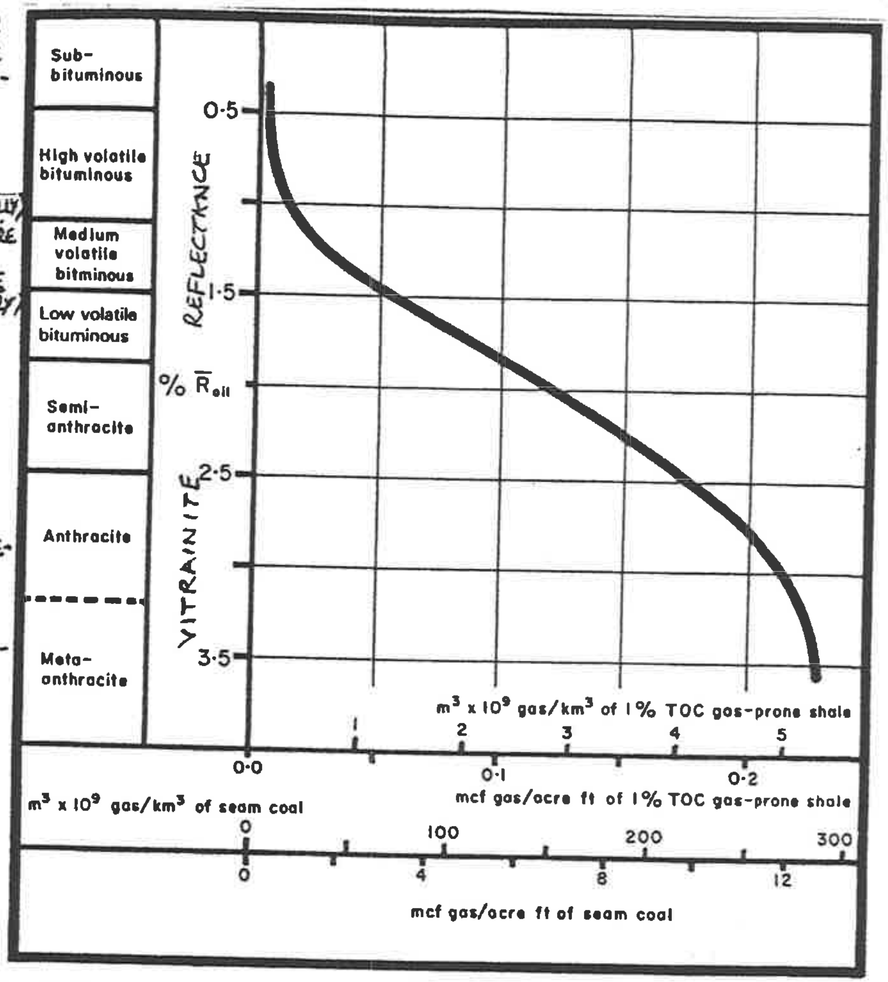

Fig. 9.8. Cumulative methane generation in m³/km³ (millions of cu ft/acre ft) from 1% TOC gas-prone shale (upper horizontal scale) and coal (lower horizontal scale) as a function of maturity measured in terms of coal rank and vitrinite reflectance. Since methane is highly mobile, the stated volumes of gas will not be present in the coal or shale, but will start to migrate out as soon as generated. The curve is based on laboratory data of Juntgen and Karweil (1966) and stochiometric calculations based on the change of hydrogen content with rank. Strictly, the plot can be used only for vitrinite-rich coals and kerogens, for example, the Westphalian of N.W. Europe

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