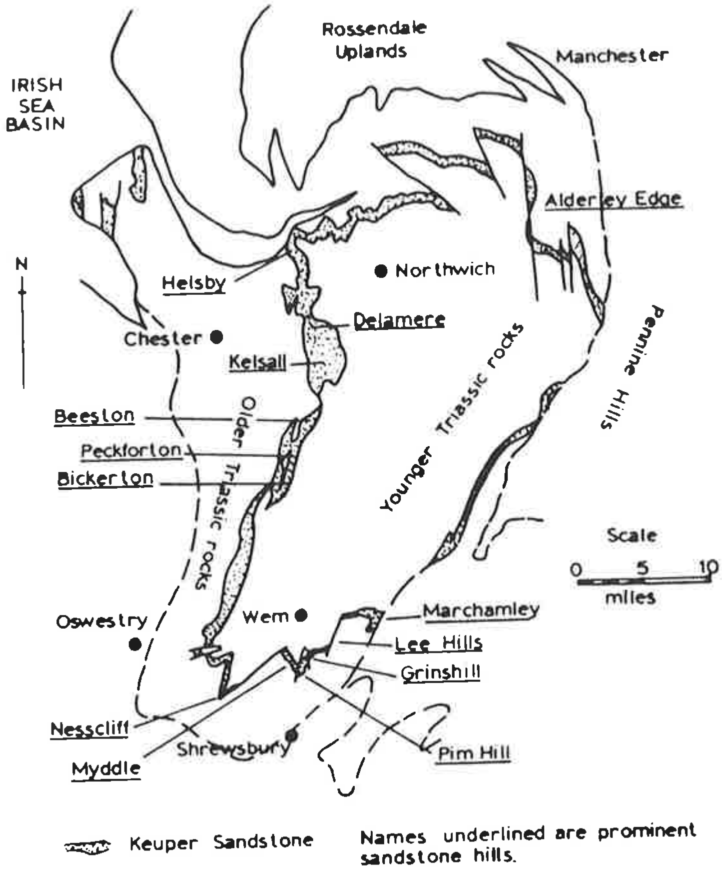
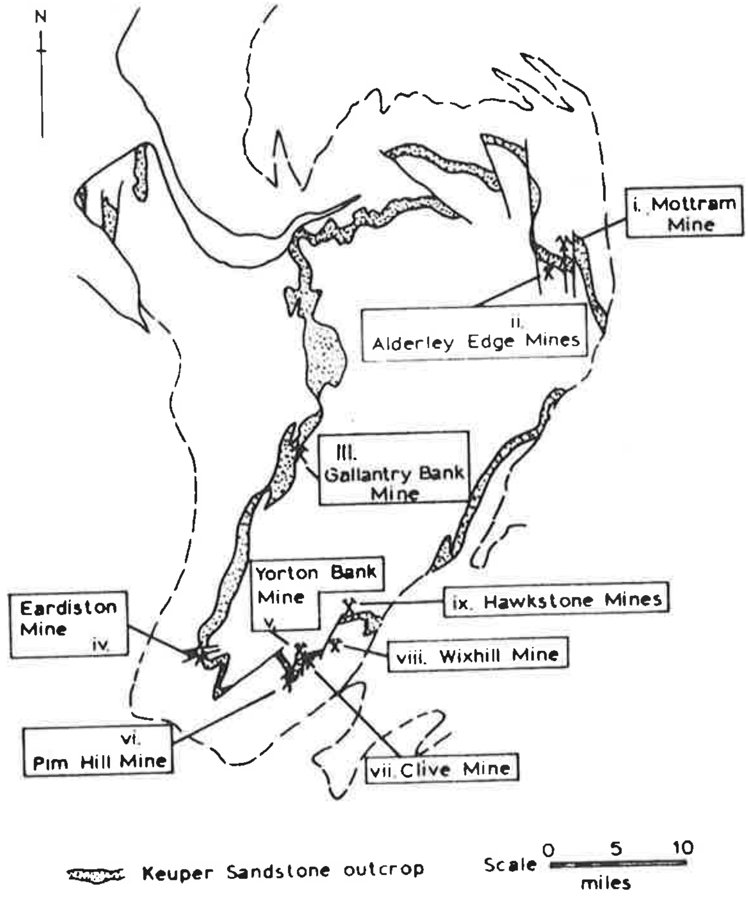


THE CHESHIRE-SHROPSHIRE BASIN

FIG I

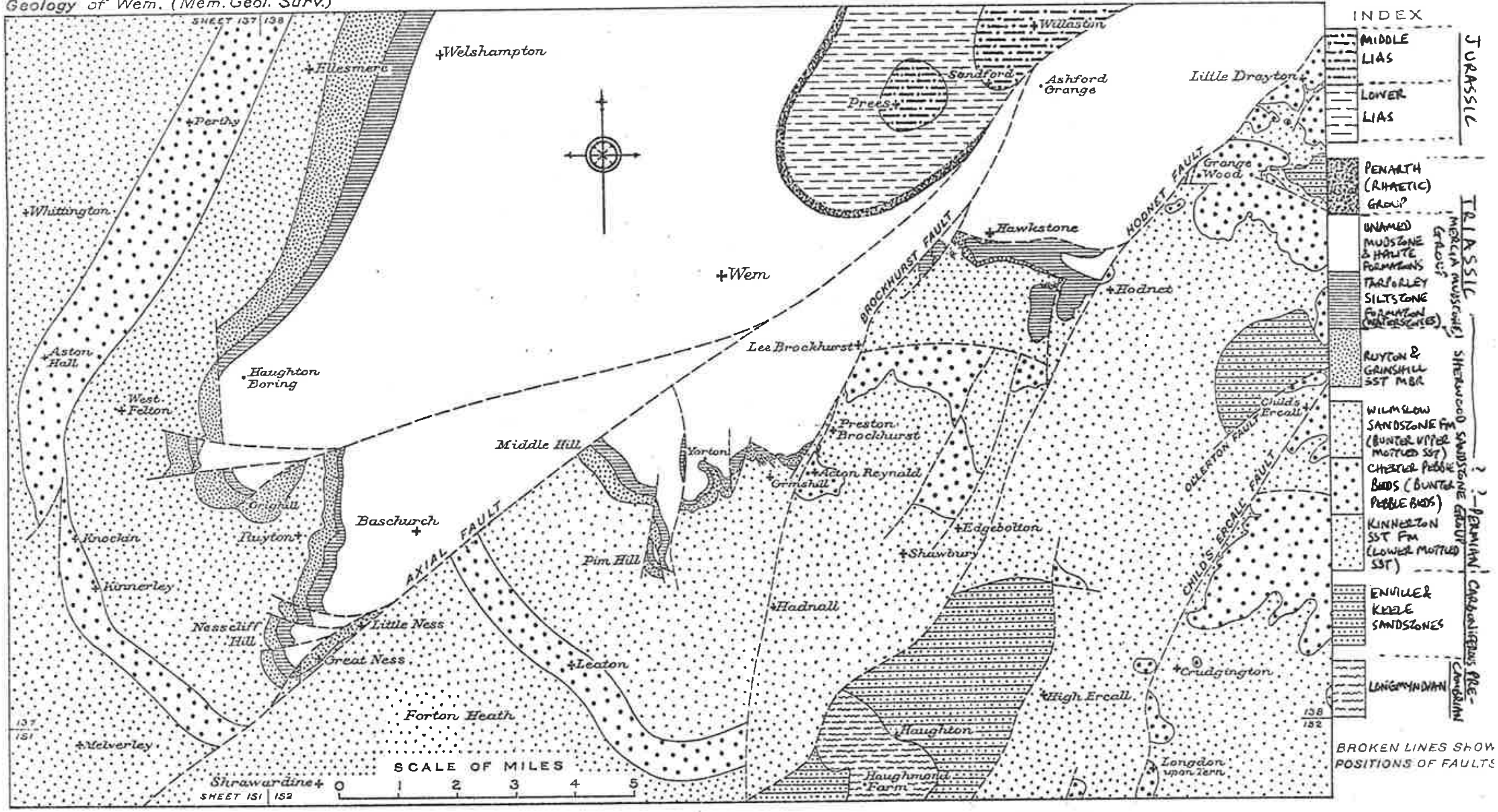


MINES IN THE CHESHIRE-SHROPSHIRE BASIN

FIG II

Geology of Wem. (Mem. Geol. Surv.)

Plate II.



TECTONIC MAP OF THE PERMO-JURASSIC BASIN OF NORTH SHROPSHIRE

From WILSON, A. A. in JAMES, J.W.C. 1983 The Sand and Gravel Resources of the Country around Prees, Shropshire Description of 1:25 000 Sheet SJ 53. London, H.M.S.O.

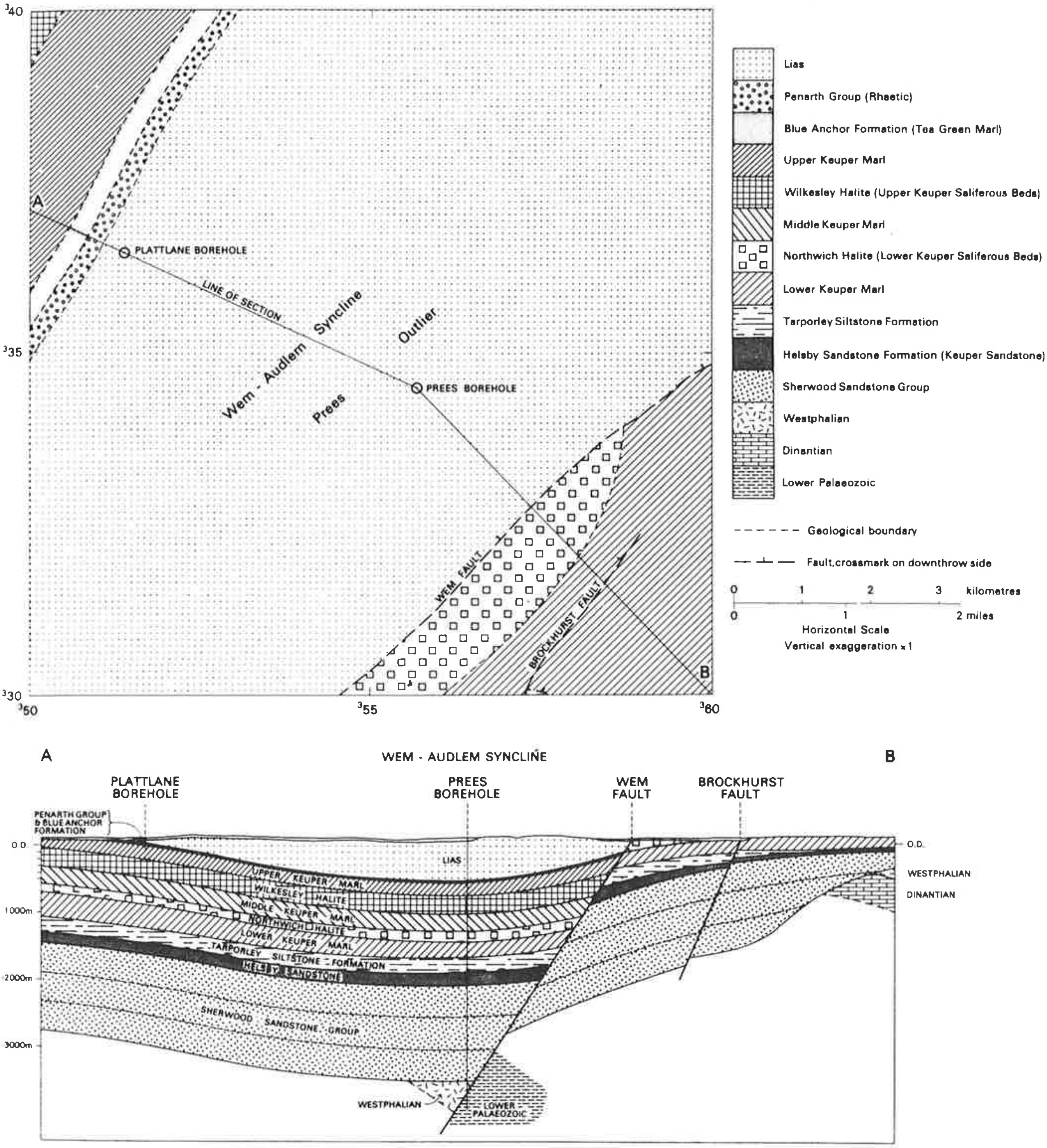
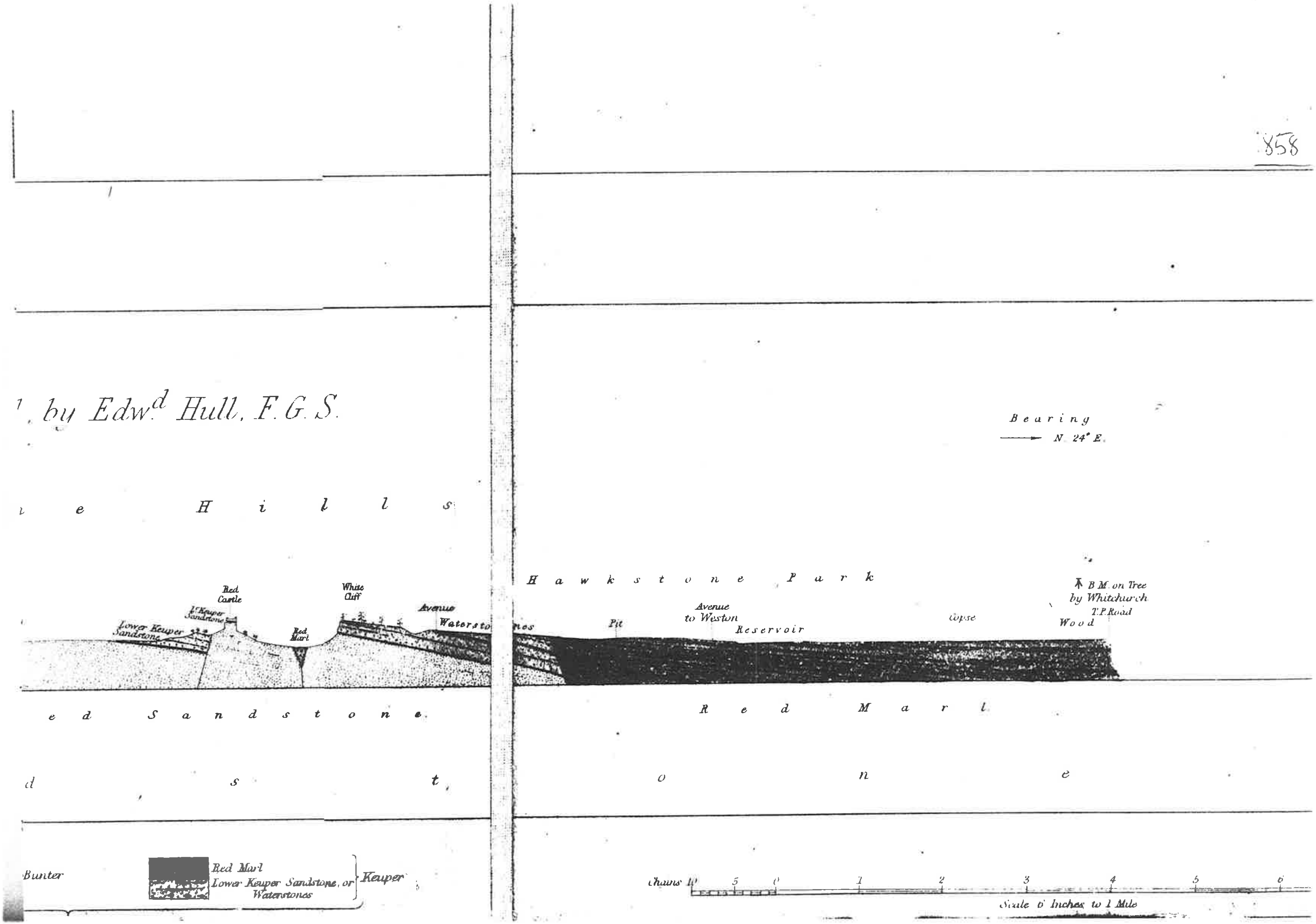


Figure 3 Solid geology


858
by Edwd Hull, F.G.S.
Bearing
N. 24° E.
e Hills
Hawkstone Park
Red Castle
Lr Keuper Sandstone
Lower Keuper Sandstone
Red Marl
White Cliff
Avenue
Waterstones
Pit
Avenue to Weston
Reservoir
Copse
Wood
B.M. on Tree by Whitchurch T.P. Road
ed Sandstone
Red Marl
d s t
o n e
Bunter
Red Marl
Lower Keuper Sandstone, or Waterstones
Keuper
Chains 10 5 0 1 2 3 4 5 6
Scale 6 Inches to 1 Mile

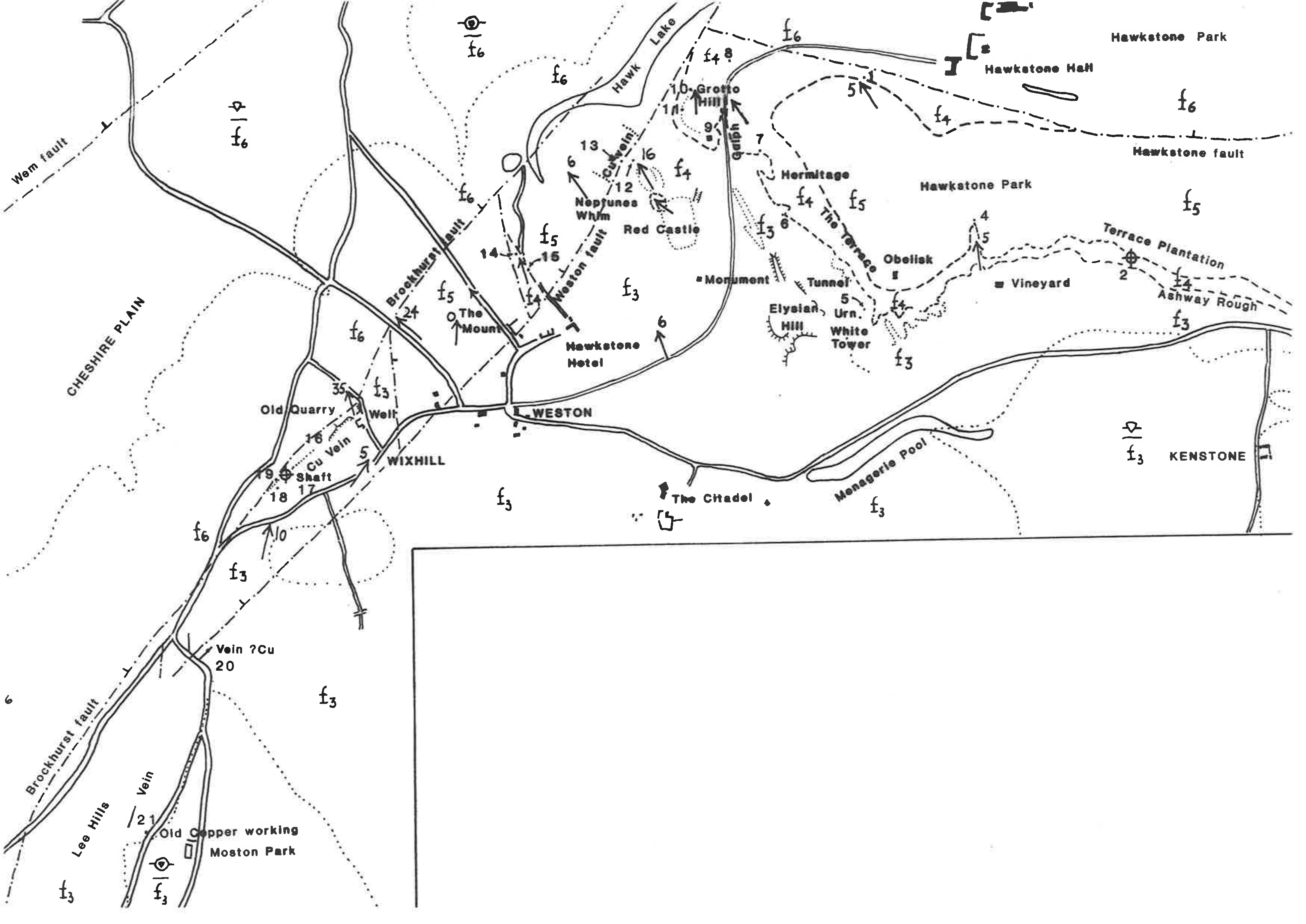

Hawkstone Park
Hawkstone Hall
Hawkstone fault
Hawkstone Park
Hawk Lake
Grotto Hill
Gulph
Hermitage
The Terrace
Obelisk
Terrace Plantation
Ashway Rough
Vineyard
Monument
Tunnel
Elysian Hill
Urn
White Tower
Cu vein
Neptunes Whim
Red Castle
Weston fault
Brockhurst fault
The Mount
Hawkstone Hotel
WESTON
Old Quarry
Well
Cu Vein
Shaft
WIXHILL
The Citadel
Menagerie Pool
KENSTONE
Wem fault
CHESHIRE PLAIN
Vein ?Cu
Brockhurst fault
Vein
Lee Hills
Old Copper working
Moston Park

TABLE ADVISERS TO LORD HILL, GEO. GILL, HIS AGENT.

DATE	MINE OWNERS CAPTAINS OF MINES	CHEMICAL TECHNOLOGISTS MINERAL PROCESSERS ANALYSTS	GEOLOGICAL SURVEY OFFICERS	GEOLOGISTS: GENTLEMEN GEOLOGISTS	GEOLOGISTS: ?PROFESSIONAL GEOLOGISTS	OTHER ADVISERS OF UNKNOWN AFFINITIES
1859	JAMES MITCHELL OF CORNWALL BRISTOL CHIEF SHAREHOLDER ALDERLEY EDGE & MOTTRAM MINES (In Burke's letter 8.12.1859)	R.C.W. WRIGHT RUABON Co. W. WRIGHT MOSTYN) of RUABON SPELTER Co. (In letter of Burke 8.12.1859)				W. BLAKLEY CHAPLAIN to LORD HILL AT HAWKSTONE (His letter of 8.12.1859)
1860	CAPTAIN FRANCIS PHILLIPS ALDERLEY EDGE MINES (Letter of Henderson 26.4.1860) AND MOTTRAM MINE (Letter of Henderson 26.4.1860) W. VIVIAN: LLANDUDNO, (His letter 20.8.1860)	F.E. CALVERT, ANALYST, OF MANCHESTER (In his own letter dated 22.2.1860) W.H. HENDERSON, OF ALDERLEY EDGE MINING Co (His letter 6.4.1860) AND MOTTRAM MINE (His letter 7 7 1860) BIBBY & Co OF ST. HELENS SMELTERS (In letter of Fryer 19.3.1860). MR – SIMPSON, ?ASSAYIST, (In letter of Fryer 19 8 1860) HUGH ROBERTS, ASSAY OFFICE, PARYS MT MINE, ANGLESEY (In letter of Fryer 19.8.1860)		BENJAMIN WATERHOUSE HAWKINS (His letter 4.5.1860)		ELIAS DORNING OF MANCHESTER (His letter 2.8.1860). JOHN TAYLOR OF PENDLEBURY WELL BORER (In letter of Dorning 2 8 1860) WILLIAM FRYER OF ALDERLEY EDGE & MANCHESTER (His letter 19 8 1860).
1862	MATTHEW FRANCIS OF DOLGELLY MINES (In letter of Blackley 17.10.1862) DAVID RICE, PRINCE OF WALES MINING Co (In letter of Blackley 10 1862	J. LONGMAID, ASSAY OFFICE, LONDON (His letter of 14.10 1862)		? ←	W. HANMER, CHESTER ST., SHREWSBURY (His letter of 15.11.1862	
1863					ISAIAH HILL MARSH END WEDNESFIELD (In his letter 17.4.1863) MR – BECKETT, (In letter of Hill 17.4.1863	
1865	MR – AINSWORTH, CLEATOR (MINES?) CUMBERLAND (In letter of Blackley 3 11.1865)					
1866	?					
1867	? (WIXHILL MINE OPEN 1865-1867)					

HAWKSTONE PARK

NOTES ON THE MINERALISATION OF THE AREA RECORDED ON THE FIELD MAPS (ON SCALE 1:1056

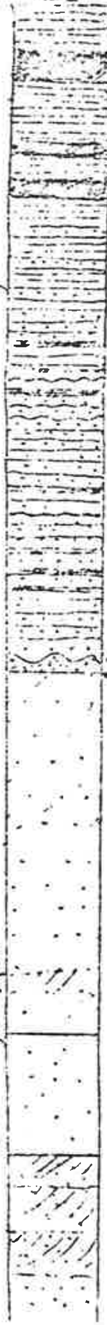
OF THE OFFIERS OF THE GEOLOGICAL SURVEY AND HERE KEYED TO LOCALITIES 1-22 ON FIG.

A clean copy of the map was made by the original surveyor R.W.Pocock in 1920; a standard map by R.W.P. was dated 11.1.1923 and approved on 30.6.1924 by the District Geologist , T.C.Cantrill. [PARA] The wording of these notes has been filled out where abbreviations were made on the original maps.

1. Red and grey flaggy sandstone on compact red and yellow sandstone with nests of barytes. Soft speckled sandstone cemented by barytes at the junction ? Esk Bed
2. Adit about 20 feet with short branches. Cu desseminated in soft white and yellow friable sandstone.
3. Old quarry in white freestone (=Marchamley Hill Quarry. This quarry shows geodes and nodules of barytes up to 3 cm in size DBT)
4. 24 feet of flag on freestone. Esk Bed about 1 foot at junction with much $BaSO_4$.
5. Red sandstone B SO_4.
6. White sandstone $BaSO_4$.
7. Cu and Ba along bedding (=$BaSO_4$ DBT).
8. Yellow and ?? sandstone with Ba. (=$BaSO_4$; barytes DBT)
9. Whitish sandstone with much $BaSO_4$ and Cu disseminated. Dip 24 to 260 (on cross-bedding DBT)
10. Whitish yellow sandstone ... $BaSO_4$.
11. Yellowish sandstone with much $BaSO_4$.
12. Reddish ... and yellow sandstone with $BaSO_4$.
13. Fault rock with Cu.
14. Yellow sandstone with much $BaSO_4$.
15. Pale yellow freestone with nests of barytes in cavities.
16. Vein Cu.
17. Old shaft worked 1865-67.
18. Yellowish sandstone.
19. Yellowish sandstone.
20. Veins (marked ? Cu on standard map).
21. Fault vein N 10degrees E.
22. Veins N 10 degrees E in soft fine-grained reddish sandstone.

TABLE 1 NAMES OF LEASEES OF EXPLORATION &/OR MINING RIGHTS IN NORTHEAST SHROPSHIRE 1643-1880

PLACE	DATE	LANDOWNERS & AGENTS	LEASEES & CONDITIONS	COMMENTS AND REFERENCES
Haremere Heath	1643	?	?	Gough 1875 pp.32-33. Gough in Hey (ed.) 1981 p62.
	1689-1693	CROWN MONOPOLY ON ORES WITH THE SLIGHTEST TENOR OF GOLD & SILVER		RESCINDED & MINING OPEN TO FREE ENTERPRISE
Wixhill-Weston	1697 14th Oct	Robert Jennings (in part) Landowners amongst partners? (in part) or [illegible] (Anon)	Articles of co-partnership Richard Corbet (Moreton Corbet) Thos Sandford (Sandford) Thos Hill (Soulton Hall) John Gardner (Sansaw Hall) Johnathan Brown (Sawbarthe)	SRO MS No 731 (Box 57 Bygott collection) Working their own land in part?
	1697	as above ?	Sir Philip Egerton (of Oulton Hall) Richard Smith (Agent) 21 yrs' lease royalty 1/8th	Carlon 1981a p.31.
	1698	as above ?	Richard Larkins 21 years' lease royalty 1/8th	Carlon 1981a p.32.
Myddle - Harmer Hill	1700	Earl of Bridgewater	Mr Walker and Derbyshire miners	Gough in Hey(ed.) 1981 p.62, p.312.
Dreapwood	pre-1703	?Thos.Spendlove(buried 1703)	Thomas Oswin of Dublin	Rees 1968 vol.2,p.661.
Myddle - Harmer Hill	1710 29th April	Countess of Bridgewater (Alexander Duncombe agent)	Abraham Darby & Company Richard Lloyd (?related to Edward Lloyd), ?Richard Hackett, P. ________(name unreadable)	SRO MS No. 212 Bridgewater Coll.
Clive	1711	?John Spendlow	Roger Acherley of Inner Temple, Lond Lease 1 mile round church. Royalty 1/5.	Rees 1968, Vol. 2, p.661.
	1720	?Roger Acherley	Working his own land?	Harley MSS
	1739	Vernon Esquire or Richard Vernon Esq.	John Payne of Droitwich	SRO MS No. 1578. SRO MS No. 2709/10.
	1739	______, Vernon.	?John or Thomas Spendlove write of trying to regain lease	See Spendlove Letter (refs. above);
Weston	pre-1740	Henry Tenison		Plymley 1803, 1813 p.52 quoting local MS (not extant)
	pre-1740		Rev Mr Snelson	ibid.
Clive	1858	Robert Gardner	Robert C.Wright & William Wright	SRO MS No.802 35,36 (3) Letter 7.7.1860. Hunt 1884, pp. 257-261.
Clive	1862	Robert Gardner	William Henderson & Co	SRO MS No. 802, 35, 36 (3).
Shotton	March 1863	Col. Watkins	George Hill (agent of Lord Hill)	Ditto
Clive	June 1863	Robt.Gardner	James Harris & Co.	Ditto
Pimhill	July 1863	Lady Tyrwhitt	Messrs Burd (Solicitor, Shrewsbury)	Ditto
Clive	pre-Dec 1863	Robt.Gardner	John Bennett & Co.	Ditto
Clive-Yorton-Shotton	after June 1864	Robert Gardner	Robt.Craven Wright, William Wright	Ditto
Clive-Yorton	March 1866	Robert Gardner	John Arthur Kendrick & Co	SRO MS No 731/229
Pim Hill	? 1875	?	?	Dewey & Eastwood 1925



Group	Divisions		Lithologies	Fossils	Environment
ENGLISH 'KEUPER' (← Passage →)	'KEUPER' MARL	MERCIA MUDSTONE GROUP	Red & green interbedded siltstones and mudstones - NaCl pseudomorphs, suncracks, ripple marks. Thin sandstones (skerries) more common at base.	fragmentary plants - unidentified.	TRANQUIL & LOWER LOW FLOW REGIME DEPOSITS ? LAKE & LAKE MARGINAL ? INTERTIDAL (MID TO UPPER FLATS)
ENGLISH 'KEUPER'	'KEUPER' WATERSTONES 3 - 13m mean 6.5m	MERCIA MUDSTONE GROUP; TARPORLEY SILTSTONE FM	Grey, light yellow, occ. green or pink fine grained flat bedded, thin bedded ssts interbedded with very thin green micaceous siltstone - mudstone laminae. Sole structures (prod, bounce, flute marks; load & flame casts); clay galls (intraformational); flat lamination with current lineation; cross lamination; asymmetric ripple marks of transverse straight and linguoid types; symmetric ripple marks; flat topped ripple marks; halite pseudomorphs; wrinkle marks; rill marks on crests of ripples. Mud laminae, drape structures. Mudcracks! Pinhole cavities after gypsum - anhydrite	? Bones of Rhynchosaurus articeps Owen (Ward 1839) Suite of trace fossils including Rhynchosauroides articeps Maidwell = Footprint D1 of Beasley	ALTERNATIONS OF LATERAL & VERTICAL ACCRETION DEPOSITS LOWER LOW FLOW REGIME ALTERNATES WITH DEPOSITION FROM SUSPENSION. QUIET ? FLUVIAL REGIME ? LAKE DEPOSITS INTERTIDAL DEPOSITS (LOWER SAND FLATS) AEOLIAN EPISODES (Adhesion ripples)
ENGLISH 'KEUPER' (? disconformity ?)	'ESK' BED 15cm - 45cm		Yellow grey sand and sst: ashy, incoherent, with some harder patches: speckled with MnO_2: sometimes barytic cement.		? SUPRATIDAL DEPOSIT ? CAVITIES AFTER EVAPORITES
ENGLISH 'KEUPER'	RUYTON & GRINSHILL SANDSTONE 16m - 45m	SHERWOOD SANDSTONE GROUP; HELSBY SST FM	Yellow, white, light red, generally dull reds. Massive, thick beds of even grain - hence in freestone. Hard or soft, hardening on exposure. Some v. large sets of cross bedding with some troughs and some signs of reactivation. In east Silicified joints: nodular barytes in the western parts near Clive. One clay horizon for a short distance. Basal parts cross bedded at Glat	? Bones of Rhynchosaurus articeps Owen a rhynchocephalian forerunner of the Tuatara Lizard (Sphenodon) in New Zealand. See papers of Walker (Newcastle) Proc. Roy. Soc.	? FLUVIAL DOMINANTLY LATERAL ACCRETION DEPOSITS OR ? AEOLIAN. PALAEOCURRENT FROM EAST = TRADE WIND (PALAEOMAGNETISM SHOWS 19°N OF EQUATOR ELSEWHERE AT THIS HORIZON)
← Passage →	PASSAGE BEDS 5m	SHERWOOD SANDSTONE GROUP	Red and yellow freestones		
BUNTER	BUNTER UPPER MOTTLED SST ? 200m	SHERWOOD SANDSTONE GROUP; WILMSLOW SST FORMATION	Bright deep red soft fine grained x-bedded ssts.		? FLUVIAL BRAIDED RIVER LATERAL ACCRETION DEPOSITS ? AEOLIAN EPISODES

THE DYKES

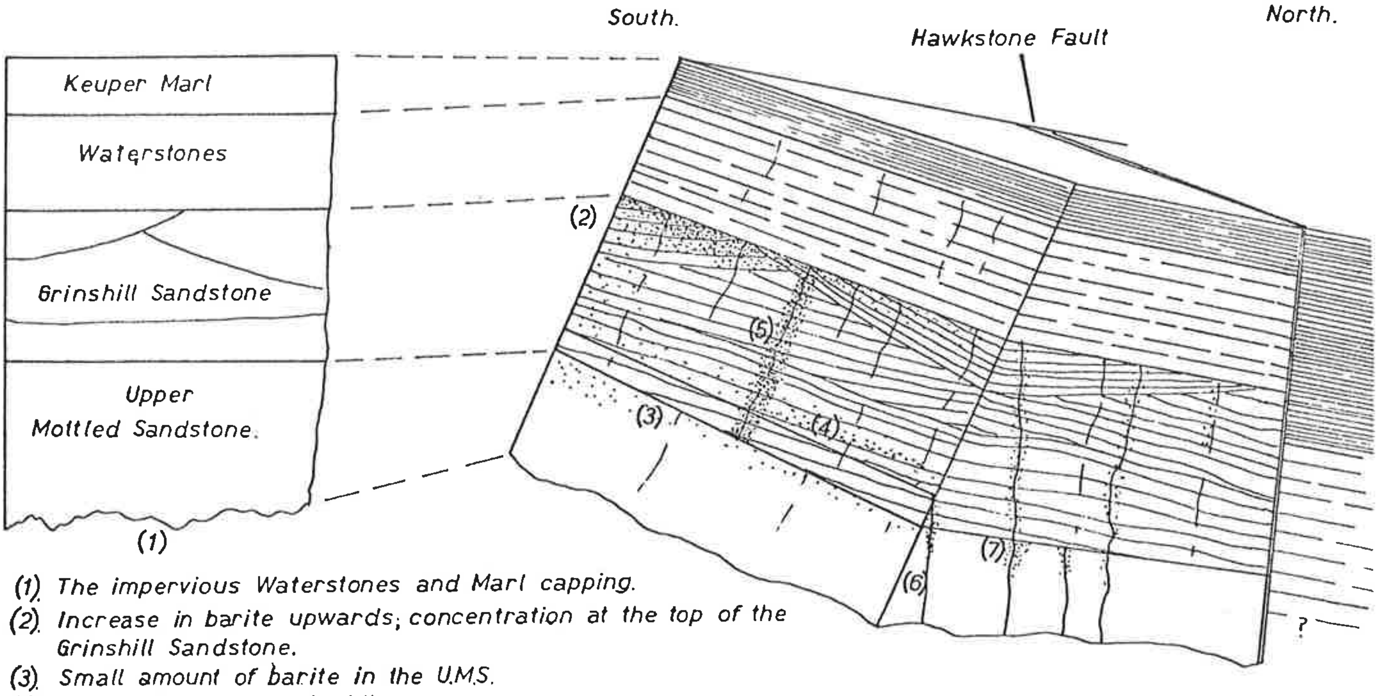
Discovered by Murchison (1835, 18.. at Acton Reynald. Extended distrib.. Geol Survey of 1920 (Pocock & Wray).. In two places the dyke trend is ?shifted by N-S faults. Dykes cut through LKM, KW, KS, BUMS, BPB.

Description by D. Flett:
A decomposed porphyritic dolerite fine grained towards its margins, .. small porphyritic felspars in a microcrystalline groundmass. Marginal areas are vesicular .. always much decomposed: Central portions are dark grey, with .. felspar phenocrysts up to 5mm. Rock is not well preserved: pyrox.. entirely replaced by secondary products, not possible to discov.. whether olivine present originall.. Felspar labradorite with compl.. twinning and slight zoned structu.. albitized in places. Feldspar in groundmass is labradorite. Magnetite, ilmenite frequent: leucoxene, apatite, pyrites, c.. chlorite, kaolinite, calcite, quartz (secondary) abundant.

MAY HAVE BEEN A THOLEIITIC DOLERITE. REGARDED IN 1930's PROBABLY TERTIARY IN AGE .. ASSOCIATED WITH BRITO-ICELA.. (THULEAN) IGNEOUS PROVINC.. ISOTOPIC AGE DATE 51-52 m.y. (EOCENE) (FITCH & MILLER) (1960.. ? THE DATE OF ALTERATION & MINERAL..

GRINSHILL AREA

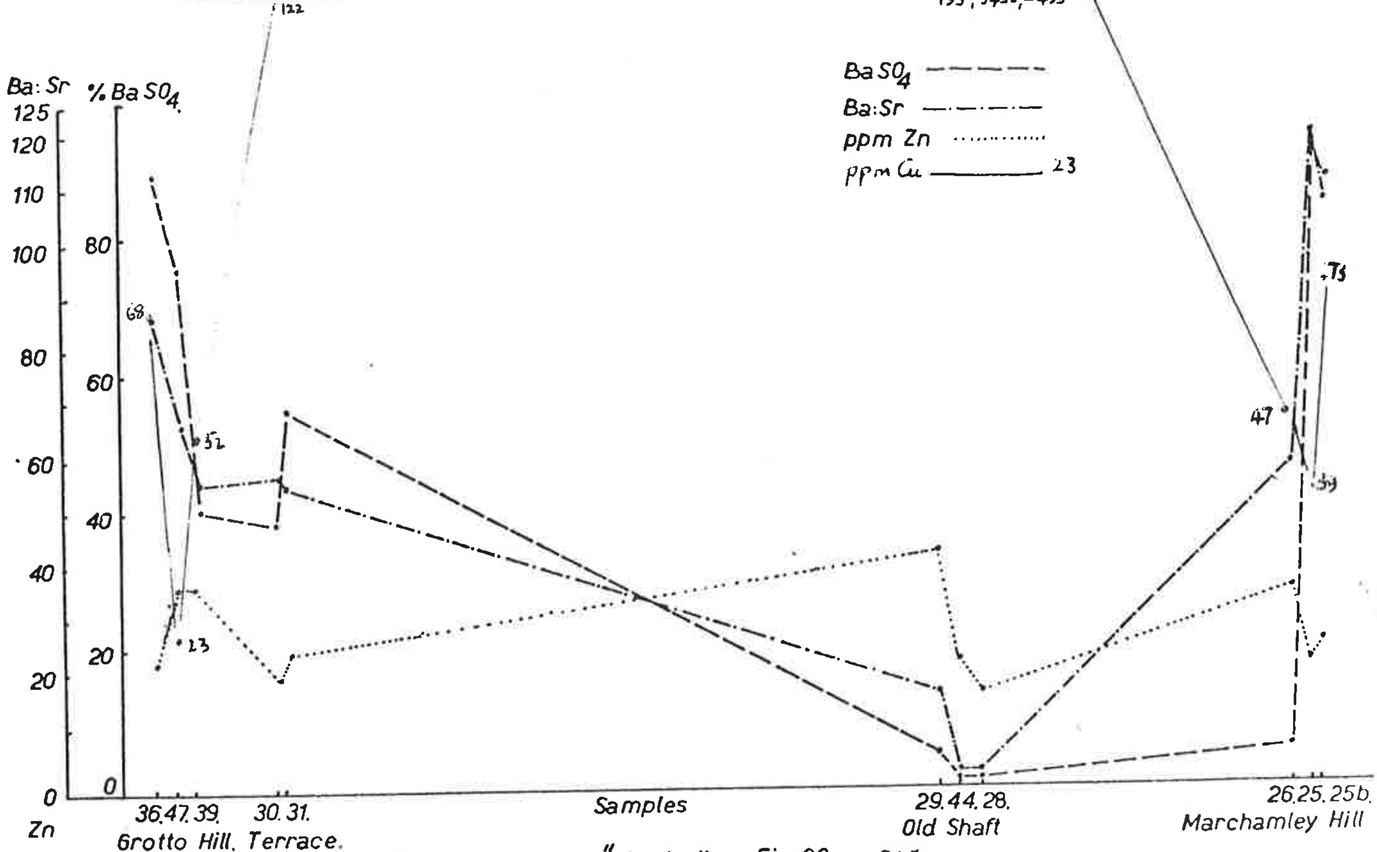
General features of barite mineralisation at Hawkstone Park.



(1) The impervious Waterstones and Marl capping.
(2) Increase in barite upwards; concentration at the top of the Grinshill Sandstone.
(3) Small amount of barite in the U.M.S.
(4) Barite along cross-bedding.
(5) " " certain joints.
(6) " veins traverse the sandstones.
(7) " " and concretions spatially associated.

Fig.82 p 193

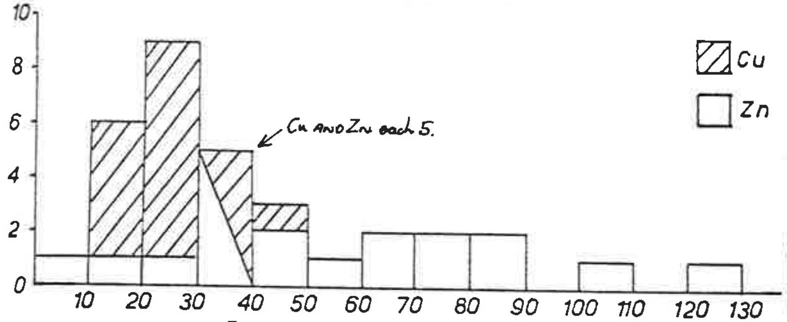
$BaSO_4$, Ba:Sr, and ppm {Copper, Zinc} variations from east to west, Hawkstone Park.



Horizontal scale 6" to 1 mile. Fig. 90 p 265

[All data from C J. Carlon PhD Thesis Manchester University 1975]

Anomalous { Copper 2495, 3458, 195, 389, 304. Zinc 259



Frequency histograms for Zn and Cu.

a.

Hawkstone Park.

Barite/zinc correlation. b.

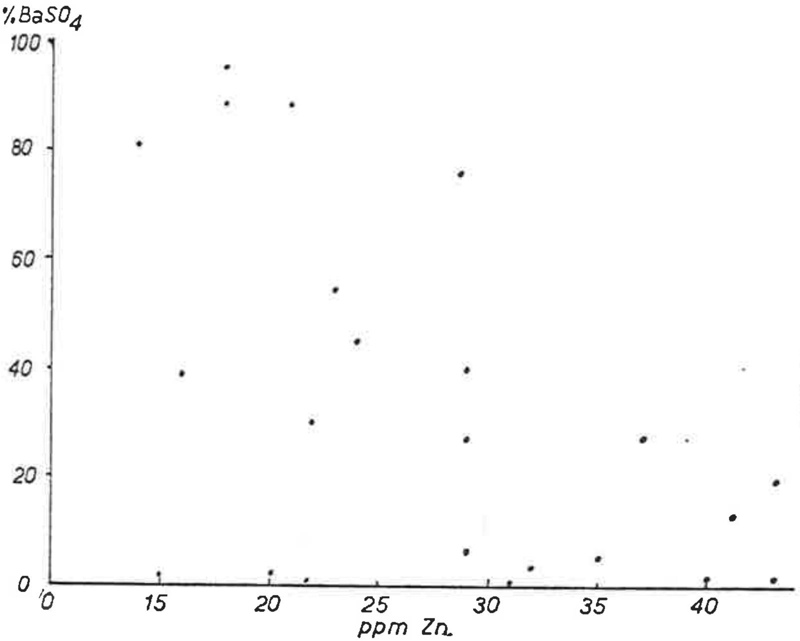
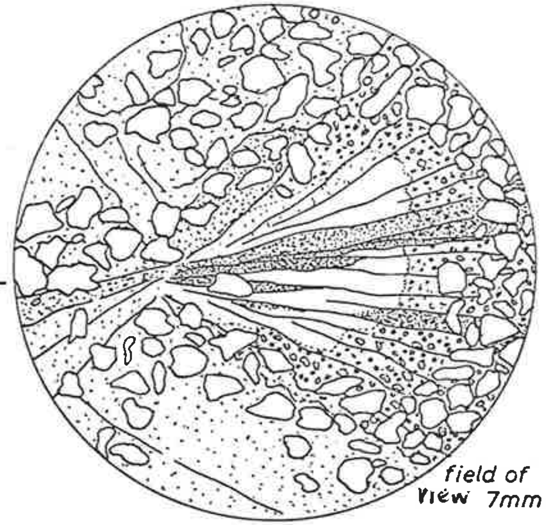
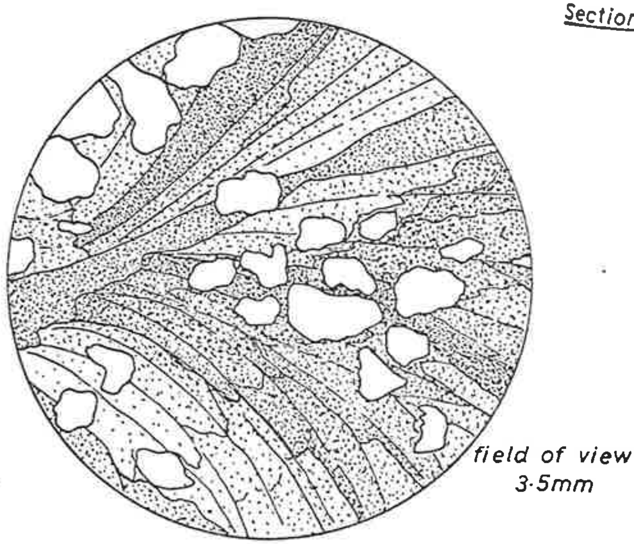


Fig. 94 p 213

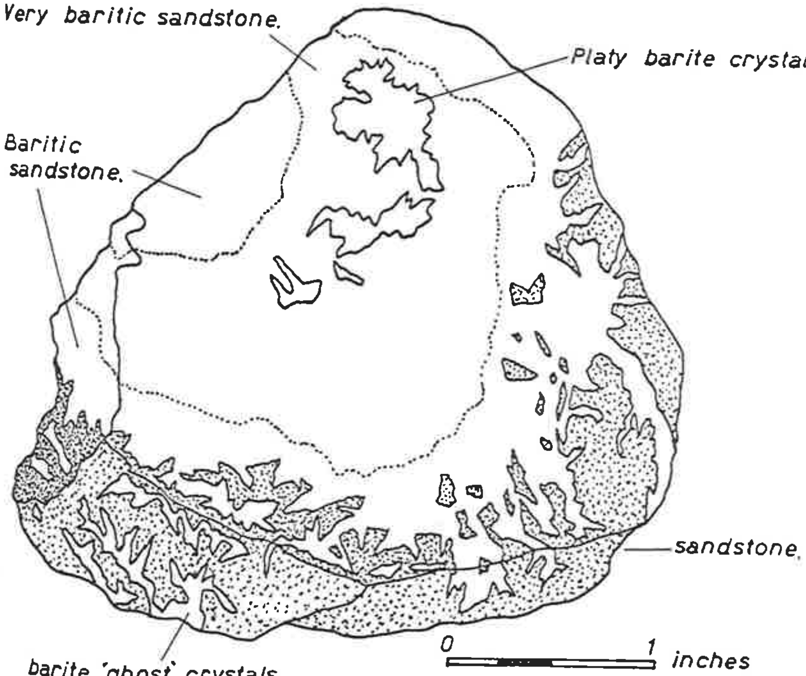
Barite 'fans'. fig 73 a. p 178



Barite crystal arrangement in a baritic nodule, Grinshill Sandstone, the Terrace.



Floating grains. fig 73 b



Section through a baritic concretion, Grotto Hill. Fig. 68. p 174

North

Rose diagram showing the trend of baritic veins in the Terrace, Grotto Hill, Red Castle area.

Readings on 32 veins; class interval 10°

Fig. 79. p 187

[All data from C.J. Carlon PhD Thesis Manchester University 1975]

c. Hawkstone Park.

THE ORIGINS OF THE MINERALISATION
(after C. J. Carlon PhD Thesis Manchester Univ 1975)

Any theory of origin for the barite must account for:

1. The concentration of barite at the top of the Grinshill Sandstone and its decrease in quantity downwards, with strontium increasing downwards.
2. The maximum concentration of barite at the intersection of two faults in a structural trap sealed by 'Keuper' Marl and capped by 'Keuper' Waterstones, both impervious.
3. The low Ba:Sr ratio of veins traversing the Upper Mottled Sandstone.
4. The higher Ba:Sr ratios in barite concretions than in barite veins. (42.9 average of 3 veins; 77.8 average of 8 concretions.)
5. Concentration of barite around certain joints.
6. That erratic strontium values could result from:
   a. The percentage barite precipitated from the aqueous phase,
   b. A multiphase origin.
   c. The lack of equilibrium between aqueous phase and barite precipitated.
7. The close association of nodular barite with barite/sand veins.
8. The variation in Ba:Sr ratios; wt% barite and ppm Cu and Zn across the scarp.

The following sequence of events appears to account for all these features:

1. The formation of the faults by block faulting.
2. The introduction of barite by fluids rising, possibly up the western fault. The impervious Marls and Waterstones would prevent downward percolation.
3. The ponding of the fluid under the Waterstones.
4. Precipitation of barite as nodular masses, the barite form changing downwards and precipitation continuing in that direction adjacent to joints. Movement of fluids may also have been lateral as indicated by the slight rise in strontium eastwards and the decrease in barite in that direction.
5. The E-W Hawkstone fault may well have formed at a later date due to sag between the two N-S faults. The parallel fractures and weaknesses created allowed a second generation of barite precipitating fluids, on entering the trap, to precipitate barite as planar or anastomosing veins, cutting the earlier nodules. Strontium, shown by the Ba:Sr ratios was increasing with time, possibly indicating changes in the Ba and SO_4 chemistry and strontium content of the two fluids, or indicating their introduction at different temperatures, the second fluid being introduced at a lower temperature.
6. The distribution of copper, reaching maximum concentrations at the top of Grotto Hill, shows a relationship to barite, as does the occurrence at 58702930, possibly along a master-joint.
7. Barite may have precipitated by cooling the initial aqueous phase or by mixing of fluids. Strontium values may therefore be the product of isothermal or changing temperature with constant or changing proportions of Ba, SO_4 and H_2O in the system.

p. 223 The barite deposits in the areas examined have formed in two ways:
1. In Mid-Cheshire Ridge. Downward percolation along faults ....
2. In Hawkstone Park and Grinshill.

By fluids rising up faults into a structural-lithological trap where cooling or mixing of aqueous phases precipitated barite in Grinshill Sandstone.

p 283 The Cheshire-Shropshire Basin. The following conclusions were reached;
1. Concentrations of barite and Ba:Sr ratios are not related to specific lithofacies.
2. Barite veins are related to faulting and concretions of barite within the sandstones are related to the barite veins and therefore to the faults.
3. Veins and concretions of barite have formed at several periods.
4. The maximum concentration of barite occurs within Delamere Pebbly Sandstone ('Keuper') and the Grinshill Sandstone ('Bunter'-'Keuper').
5. Barite is found in sandstones within a structural-lithological trap at Hawkstone Park and Grinshill.
6. Variations in the content of barite mask changes in strontium in the Ba:Sr ratios.
7. Zinc and copper display inverse and proportional relationships respectively to barite. Lead is below the detection limit in all samples.
8. Mineralization is believed to be epigenetic, and related to faults considered, but not proved, to be Tertiary.