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With a review of mining in the Triassic rocks of the Shropshire – Cheshire Basin.

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by

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NB
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PART ONE

MINING IN THE CHESHIRE-SHROPSHIRE BASIN

INTRODUCTION

Cheshire, unlike Cornwall or Derbyshire, is not blessed with extensive metalliferous mineral deposits, nor famed for its history of metal mining. The county does not possess metal bearing hydrothermal vein deposits, and the rocks underlying Cheshire have been described as monotonous, uninteresting, barren red sediments. This is not to say however that useful commodities have never been searched for or exploited from the rocks of Cheshire.

In 1670. while searching for coal at Marbury near Northwich, prospectors found rock salt. This discovery, which explained the origin of the brine springs already used for centuries, led to the growth of the Cheshire salt
industry and placed the county firmly on the map as Britain’s main salt producer.

The importance of salt in the geology, history and economics of the county has tended to overshadow the fact that metals have also been produced. The rocks bearing these metals floor nearly all of Cheshire and pass over the border into north Shropshire, which for completeness can be considered here.

The Cheshire-north Shopshire metal mines were generally small, marginally profitable operations whose history, production· and mining detail was often not committed to paper, or is difficult to investigate. The one feature common to them all is the type of ore worked; copper bearing sandstone.

With little to see ‘on-site’ and next to nothing generally available in print, this monograph is intended to give an overall view of the Cheshire- north Shropshire mines (Part One) and a detailed account of one Cheshire copper mine (Part Two). The intention is also that it should complement those accounts already available; also (Carlon 1979),[1] and (Carlon In Press).[2]

Geology

Cheshire, north Shopshire and parts of adjacent counties are underlain by a group of rocks which in places exceeds 8,000 feet in thickness and constitutes Britain’s greatest on-shore development of Triassic sedimentary strata. Deposited as sediments some 230-190 million years ago, the Triassic rocks of this region comprise a series of red or redbrown, chocolate-brown, grey or cream coloured coarse, pebbly conglomerates, pebbly sandstones, sandstones, shales, mudstones and siltstones. The lower half of the succession or sedimentary pile is predominantly pebbly and sandy, while the upper half is mainly fine grained, with muddy and silty strata, containing beds of rock salt towards the top of the succession.

The arrangement of this thick, sedimentary pile is important for an understanding of the metallic-non metallic mineral distribution. The lower sandy part of the Triassic succession is generally porous and permeable. permitting the ingress and movement of sub-surface water, while the upper muddy part of the succession is relatively impervious and will not transmit water easily or at all. For this reason groundwater has not been able to penetrate the muddy rocks and remove the salt beds other than on a local scale. The distribution of the metallic-non metallic minerals in these rocks clearly demonstrates the deposition from a ‘fluid’ medium, their location being in the porous, permeable sandstones, not the impermeable mudstones.

Subsequent to deposition the Triassic rocks, which floor an area of some 1,500 sq. miles, have been folded into a broad ‘downfold’ or basin. The younger, upper part of the succession is preserved, as a consequence, towards the middle of the region, around Prees and in mid-Cheshire. Progressively older Triassic rocks, lower in the succession, are exposed towards the periphery of the Basin. This pattern of rock distribution is shown in Figure 1. by the outcrop of the Keuper Sandstone Formation.

The Keuper Sandstone Formation is the ‘highest’ sandy unit of importance within the succession, and lies immediately below the lowest, regionally developed ‘muddy’ unit, the Waterstones Formation. Faults are also important in relation to the mineralisation. These fractures, along which adjacent rock masses have moved, post-date the Triassic rocks, and displace blocks of ground with predominantly vertical movements measurable in tens, hundreds or even thousands of feet. Movement along the faults has now ceased.

In terms of mineral deposit formation, the faults are particularly important when they ‘throw’ porous, permeable sandstone (particularly the Keuper Sandstone Formation or the underlying Mottled Sandstone Formation) into contact with far less permeable shales or mudstones (notably the Waterstones or overlying Mar! Formations).

The faults have in places elevated blocks of Triassic sandstone above the general level of the plain. Being more resistant to atmospheric agencies of weathering and erosion than the softer sediments, these rocks stand out as escarpments, rising 200-300 feet above the general level of the plain. The surface of the Cheshire Plain is covered by extensive deposits of clay and sand left by ice-sheets and meltwater during the Ice Ages of the last 43,000 years. The faulted hills are therefore some of the few places where Triassic rocks can be observed, principally the Mottled Sandstone, Keuper Sandstone and Waterstones Formations. They bear a widespread mineralisation, and localised metallic concentrations, and within these scenically beautiful wooded hills are the sites of the Cheshire- north Shropshire mines.

The minerals and their distribution

The Triassic rocks within the Basin are essentially silica rich sediments cemented by silica (SiO_2), calcite ($CaCO_3$) and iron oxides/hydroxides, the latter imparting the characteristic red colouration. A considerable number of other minerals occur in the rocks including feldspars and clay minerals, but the ones of interest in the mining areas were compounds containing copper, lead, cobalt or silver. All of these elements were mined at one time or another in the region.

The principal minerals are malachite, azurite and chysocolla (copper); galena, pyromorphite and cerussite (lead); asbolite (cobalt, nickel and manganese); wad (manganese) and barite (barium sulphate). Occurring with these metals are arsenic, silver, vanadium, and molybdenum. A list of minerals so far recorded from the region is presented in Table I.

TABLE 1. Minerals recorded or reported from the metalliferous deposits of the Cheshire-Shropshire Basin. Dominant species * (As known in 1979).

COPPER	Native Copper	**LEAD** *	*Galena	**IRON**	Pyrite
	Chalocite		Massicote		Haematite
	Chalopyrite		Minium		Goethite
	Bornite		*Cerussite		Limonite
	Enargite		*Pyromorphite		Turgite
	Cuprite		Arsenical pyromorphite		Pisanite
	*Malachite		Anglesite		Scorodite
	*Azurite				Beudantite
	Chysocolla	**MANGANESE**			
	Tyrolite		Pyrolusite	**ZINC**	Sphalerite
	Plancheite		*Wad		
	Olivenite			**MOLYBDENUM**	
	Brochantite	**COBALT**	*Asbolite		Wulfenite
	Libethanite		Erythrite		
	Liroconite		Bravoite	**BARIUM**	*Barite
	Caledonite				Witherite
	Langite	**VANADIUM**	Roscoelite		
			Vanadinite		
			Mottramite		

The metallic minerals occur with a barite ‘gangue’ as disseminations within the sandy and pebbly Triassic rocks, coating sand grains, infilling pore-spaces and forming a patchy rock cement. The mineralised rock often has ill-defined contacts and varies foot by foot in metal grade, thickness and width, forming lenses, streaks and irregular patches of mineralised ground. In detail the distribution and association of the minerals is complex but essentially follows a pattern which can be summarised thus:-

1. The mineralisation is predominantly copper-cobalt-manganese-barite. Only at Alderley Edge and Mottram Mine was lead present in economic quantities.

2. Barite and wad (manganese) have a wide geographic distribution around the Basin, while copper-cobalt-(lead) minerals are more restricted to areas proximal to faults.

3. The minerals occur through a vertical range of some 6,000 feet of Triassic rock

but are most abundant within the top of the Mottled Sandstone Formation and particularly in the overlying Keuper Sandstone Formation immediately below the regional 'seal' of the Waterstones. In addition Keuper Sandstone or Mottled Sandstone may be mineralised in faulted contact with Waterstones or Marl Formations.

[4]

4. The ore bodies form vertical or steeply inclined zones of mineralised sandstone immediately adjacent to certain faults, and disseminations within the sandstone host peripheral to a mineralised fault.

5. Not all faults in a similar geological situation are mineralised, and those that are may not be so along their entire length.

6. Rocks bearing copper or lead minerals are always leached of their iron oxide/ hydroxide red colouration. Barite and wad occur in both red or leached white rocks.

7. Ore grades are difficult to establish from 'one-off' assays, the disseminated nature of the ore being notoriously difficult to 'average'; grades being dependant upon the size of sample taken. Copper values of 0-25% are common; averages are in the range 1-5% copper.

8. The distribution of the minerals has led to conflicting theories for their origin. In their present distribution the minerals have formed initially by deposition from a solution impeded by a change in rock permeability. Only in very rare instances are the ore minerals found in a host rock other than conglomerate or sandstone. Initial deposition may have been caused by reaction with hydrocarbons, bearing sulphur, already present in the 'trap", or by solutions leaching metals from the muddy or fine grained sediments. Atmospheric alteration of the minerals has subsequently caused a redistribution of the metallic species within and beyond the original distribution pattern.

9. There is some evidence that early copper-iron sulphides were altered to copper sulphides and then to copper carbonates, silicates and sulphates. The implications of this, and more detail of the mineral paragenesis are beyond the scope of this monograph and will be found elsewhere.

The Mines

There are nine principal mining sites in the Cheshire-Shropshire Basin. All of them worked copper ores which were associated principally with cobalt at Eardiston and Clive; cobalt and silver at Bickerton and cobalt, lead and silver at Alderley Edge and Mottram St. Andrew. All sites had associated barite and wad. Little is known of the ores at Yorton, Pim Hill, Wixhill and Hawkstone, but they are likely to have been copper-cobalt in character. Vanadium was recorded at Pim Hill.

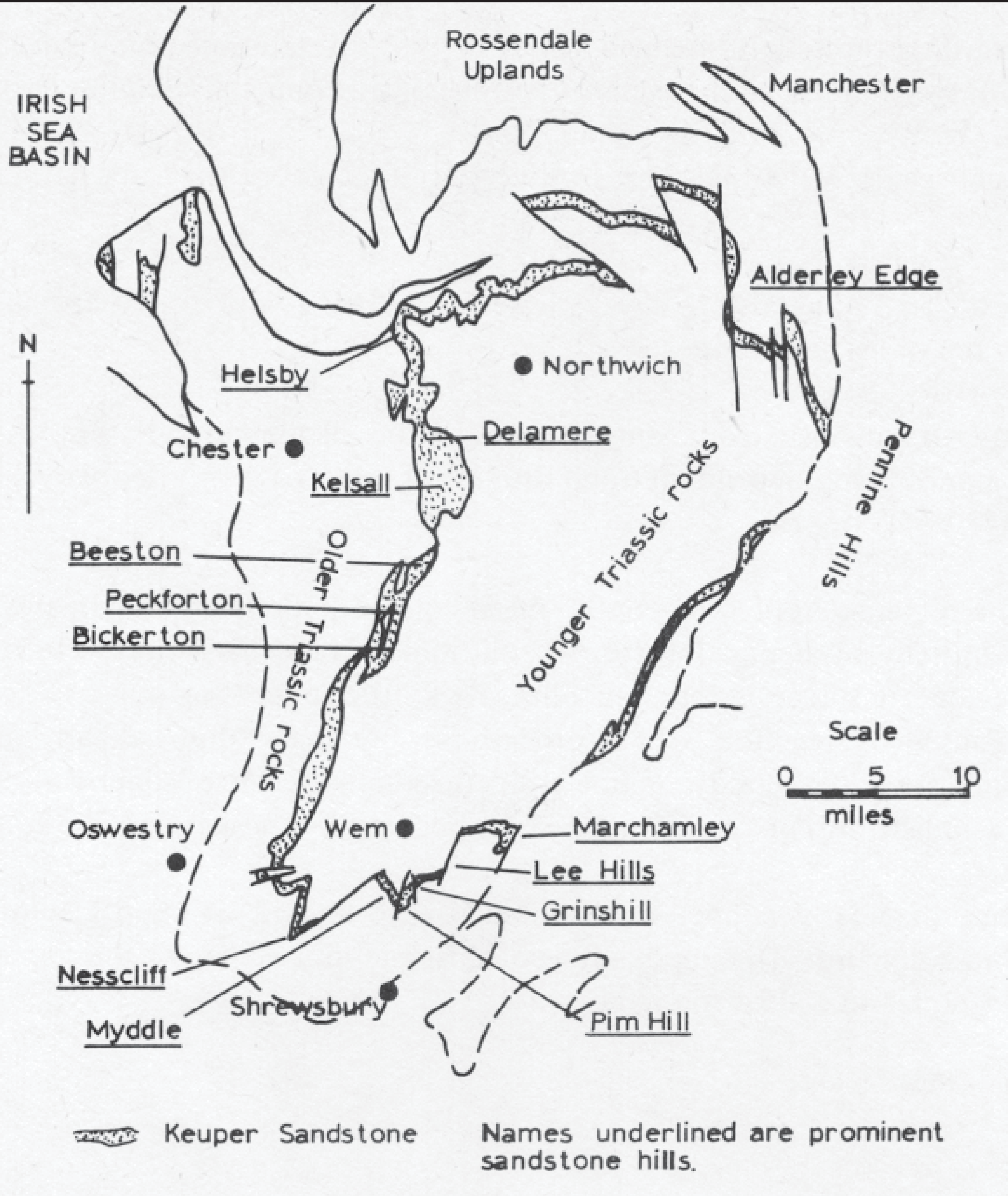
The regional setting of these mining sites is shown in Figure 2. At Alderley Edge and Mottram St. Andrew the ores were dispersed through faulted ground; at Eardiston, Bickerton, Clive, Pim Hill, Yorton and Wixhill the ores were mined from rocks adjacent to one principal fault, while at Hawkstone Park, the trial mines are in ground not adjacent to faults.

The date of first discovery of these mineral deposits is unknown, but they are likely to have attracted early attention by virtue of the brightly coloured copper compounds or the sterility of the ground around the mineral occurrence.

Mining by the Romans has been postulated for the Alderley Edge Mines (Roeder 1901)[3], (Roeder and Graves 1905)[4]; for the Mottram Mine (Roeder 1901)[3]; and for the Clive and Hawkstone Mines (Wood in Watkin 1879)[5]. Stone artifacts discovered at Alderley Edge and Mottram Mine have led to the conclusion that mining began prior to the Roman Occupation (Boyd-Dawkins 1875)[6].

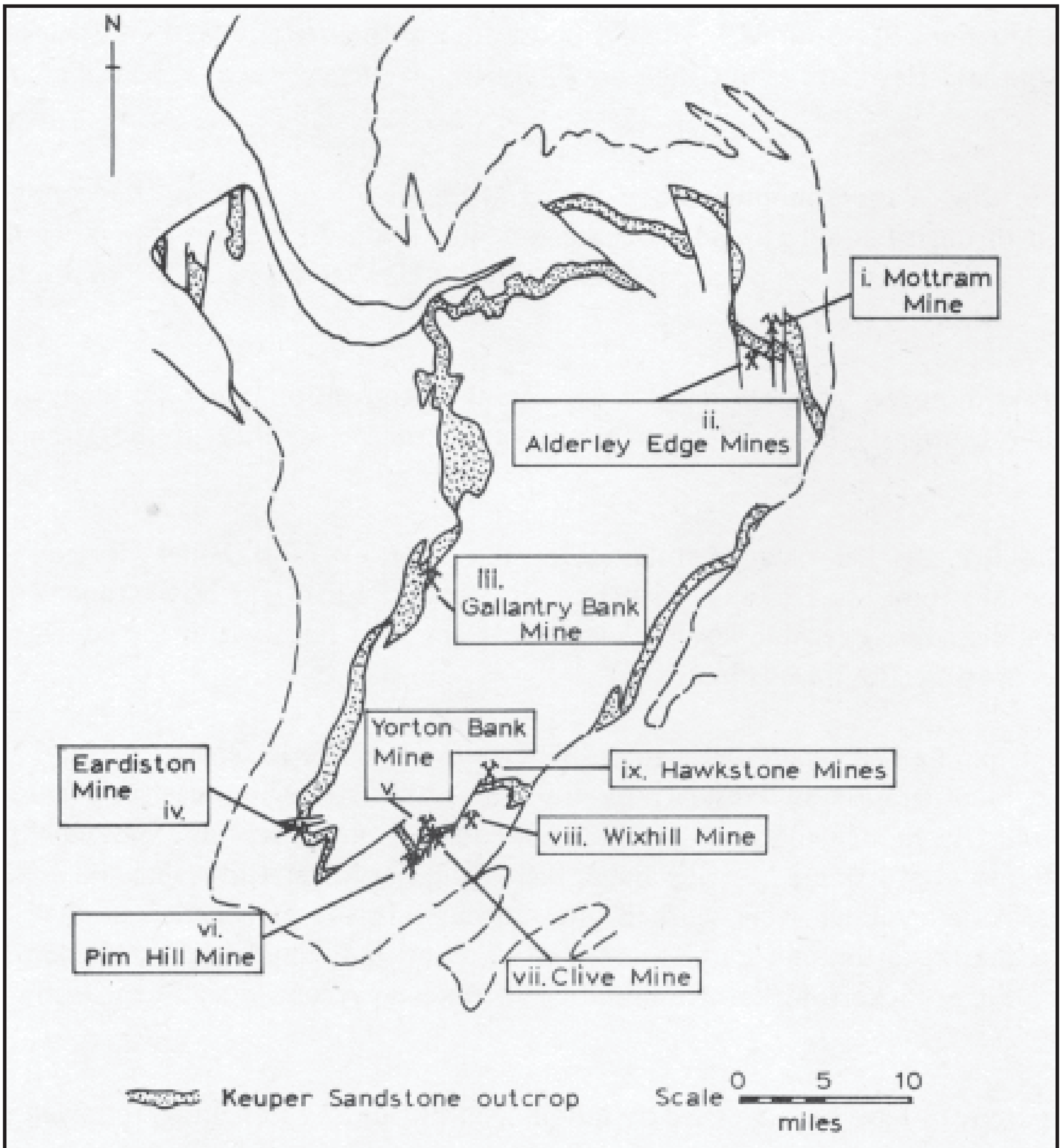
It is likely that mining had taken place at all the sites prior to the latter half of the 1700s, with the possible exception of Eardiston Mine (Carlon In Press)[2]. By the late 1700s the region was supporting a flourishing copper mining and smelting industry, though the most productive period of mining was undoubtedly the thirty years period 1850-1880 when the mines at Mottram, Alderley Edge, Bickerton, Eardiston, Clive, Pim Hill and Wixhill were worked. West and Wood Mines, Alderley Edge were worked intermittently in the early years of the 1900s and leases were sought or obtained for the Bickerton and Eardiston Mines. Various individuals and companies have shown a passing interest in the Alderley Edge, Bickerton, Eardiston and Clive Mines in recent years but it is most unlikely that any of them will be reopened.

All the mines seem to have been worked by initial open pitting and trenching, followed by shaft or adit access to underground mining where the ore was removed in the normal way by picking or later using drilled shot holes and gunpowder. The stopes produced were either linear or irregular, depending upon the form and nature of the orebody. In most of the mines timber props were used sparingly or not at all, the rocks standing without the need for artificial support.



THE CHESHIRE-SHROPSHIRE BASIN

FIG I



MINES IN THE CHESHIRE-SHROPSHIRE BASIN

FIG II

Only the Alderley Edge Mines appear to have been dry workings, although the Hawkstone trial mines were probably dry also. All the other mines were wet, some alarmingly so, and required the use of steam power to dewater them. Clive, Bickerton and Eardiston all had, at sometime or other, engine houses and steam engines, and some form of motive power may have been used at Yorton and Wixhill for pumping and hoisting.

The copper ores were initially treated on site or nearby by smelting, however by the early 1800s the ores were too low grade to be treated economically by direct smelting. In 1857 William Henderson, company chemist for the Alderley Edge Mining Company, patented a process for copper extraction from poor copper ores using an acid leaching technique (Henderson 1857)7. This method was later adopted at Bickerton, Eardiston and Clive.

The following review of the Cheshire-Shropshire Basin mines is based on archival, field and verbal researches and is intended to shed new light on these old mines. For each mining site the location is given with the National Grid Reference. The present (1980) surface features and remains are described and a brief outline of the mining history, geology and related features given. References for each locality are given, where these are generally available.

Commencing in the north-east corner of the basin, the mines are described in anticlockwise order around the region, as numbered in Figure 2.

i. MOTTRAM MINE

Location: The Mottram Mine is situated at Kirkleyditch village, Mottram St. Andrew, Cheshire, NGR SJ874784.

Geology: Lead, copper, cobalt ore was worked from a conglomerate, which appears to have been the equivalent bed to the Engine Vein Conglomerate (Keuper Sandstone Formation) on Alderley Edge nearby. The ore occurred as NW-SE trending mineralised zones within the host rock, pinching and swelling from 1-40 feet in width, to a bed height of 6-12 feet for a lateral distance of some 900 feet. Several zones were known; two were extensively worked. Ore graded 1-2% copper with 2.5-12.5% copper mineral content. Lead was present as galena, pyromorphite and cerussite; cobalt and nickel in asbolite; copper primarily as malachite and azurite.

Mining: Ore was worked in a surface quarry and underground. At least 3 shafts were sunk on the property, and an adit level driven from surface. No mine plan of the property is known to exist.

History: Stone artifacts found on the site have been attributed to pre-Roman miners. First recorded working was by the landowner, Lawrence Wright in 1807, when lead ore was raised and a smelter constructed. The main period of mining was between 1860-1867, work being undertaken by the Mottram Mining Company, the East Alderley Edge Mining Company and the Magnesium Metal Company in succession.

Output: Some 100-200 tons of copper metal; 50-60 tons of lead metal and over £1,000 worth of cobalt/nickel concentrate. Ore was treated by acid leaching and lime precipitation.

Surface: The only surface remains are the traces of the mine spoil heaps at SJ874783 and the now landscaped quarry in the garden of 'Copperfields' at SJ875783. The mine is flooded and inaccessible.

Notes: Vanadium minerals were recorded from the mine spoil by Sir H.E. Roscoe (Roscoe 1868)[8], (Roscoe 1876)[9]. A.W. Kingsbury (1956)[10], was of the opinion that this material had originally been brought from Pim Hill to Mottram for treatment. (See notes for Pim Hill Mine.)

References: Carlon (1979)[1], pages 114-120.
Dewey and Eastwood (1925)[11], page 17.
Mining Journal (1865)[12].

ii. THE ALDERLEY EDGE MINES

Location: On the crest and southern flank of Alderley Edge, Cheshire. Around NGR SJ858775.

Geology: Conglomerates and sandy beds within the Keuper Sandstone Formation and the upper part of the underlying Mottled Sandstone Formation are mineralised. Three horizons bear the main mineral impregnation; the Engine Vein Conglomerates, the Wood Mine Conglomerates and the West Mine Sandstones. The rocks are contained within a fault block, with the Alderley and Kirkleyditch Faults to west and east respectively. Several WNW-ESE trending faults cut the rocks and have mineralisation associated with them spatially. The rocks dip at angles of 10-200 to the south, dips increasing near the Alderley Fault in West Mine.

Some 42 mineral species are recorded or reported, though the list is unlikely to be complete as yet. The main orebodies were: Adjacent to the Stormy Point Fault (Stormy Point Mines); adjacent to the Engine Vein Fault (Engine Vein Mine) and its westwards extension (Wood Mine); the Middle and South Faults in Wood Mine; disserninations in sandstone (West Mine).

Ore grades in the years 1857-1865 averaged 1.5% copper, 8.6 ounces of silver/ton of ore.

Mining: The main workings are on the southern flank of Alderley Edge as West and Wood Mines. The older and smaller workings are situated near the crest of the Edge around Stormy Point and Engine Vein. Small trials