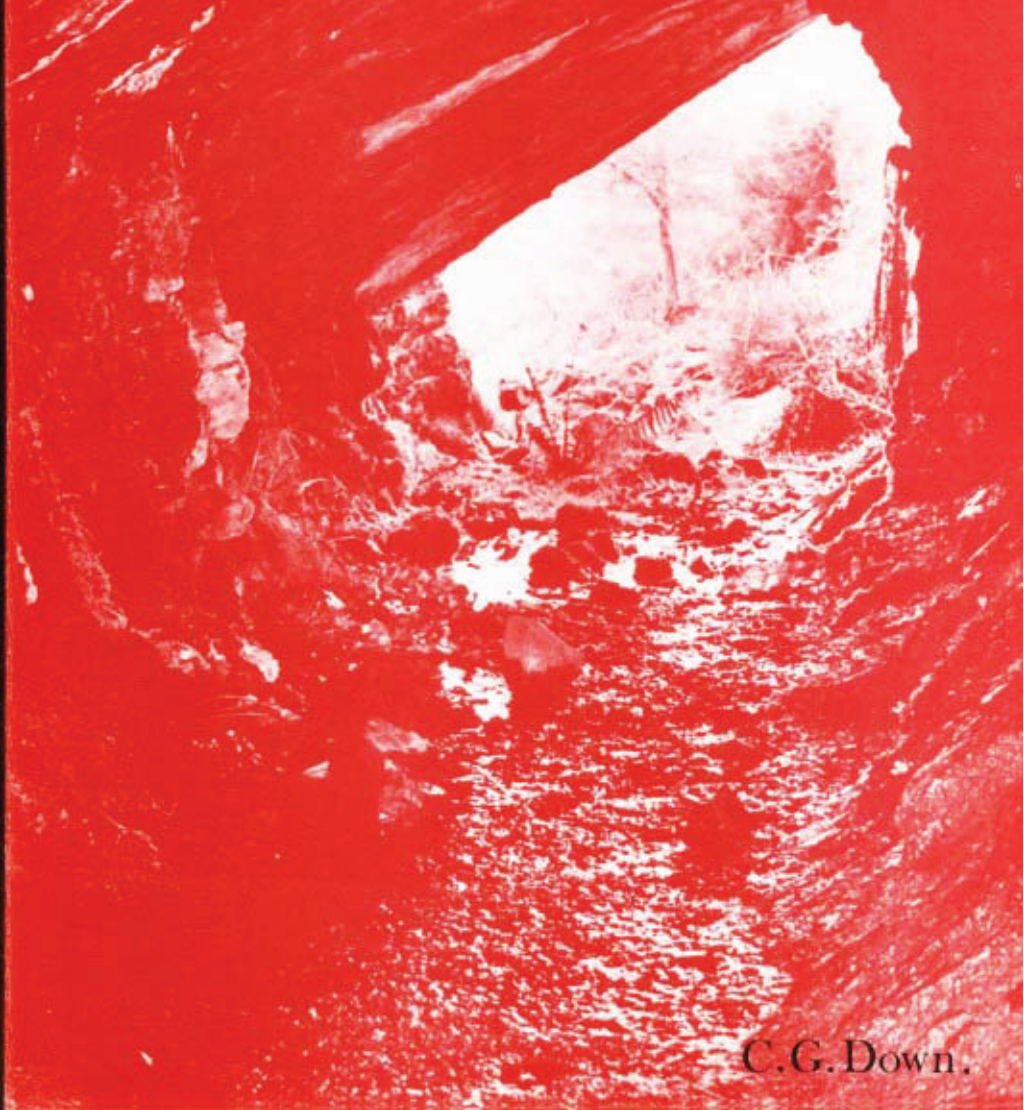
British Mining No.14.

THE MANGANESE MINES OF NORTH WALES



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THE MANGANESE MINES OF NORTH WALES

C.G. DOWN. B.Sc., Ph.D.

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1980

Readers wanting further information on manganese mining should visit Dave Linton's website http://www.hendrecoed.org.uk/Merioneth-Manganese/ which includes work done since Chris Downs' book was published in 1980.

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PLATES

1. **INTRODUCTION**

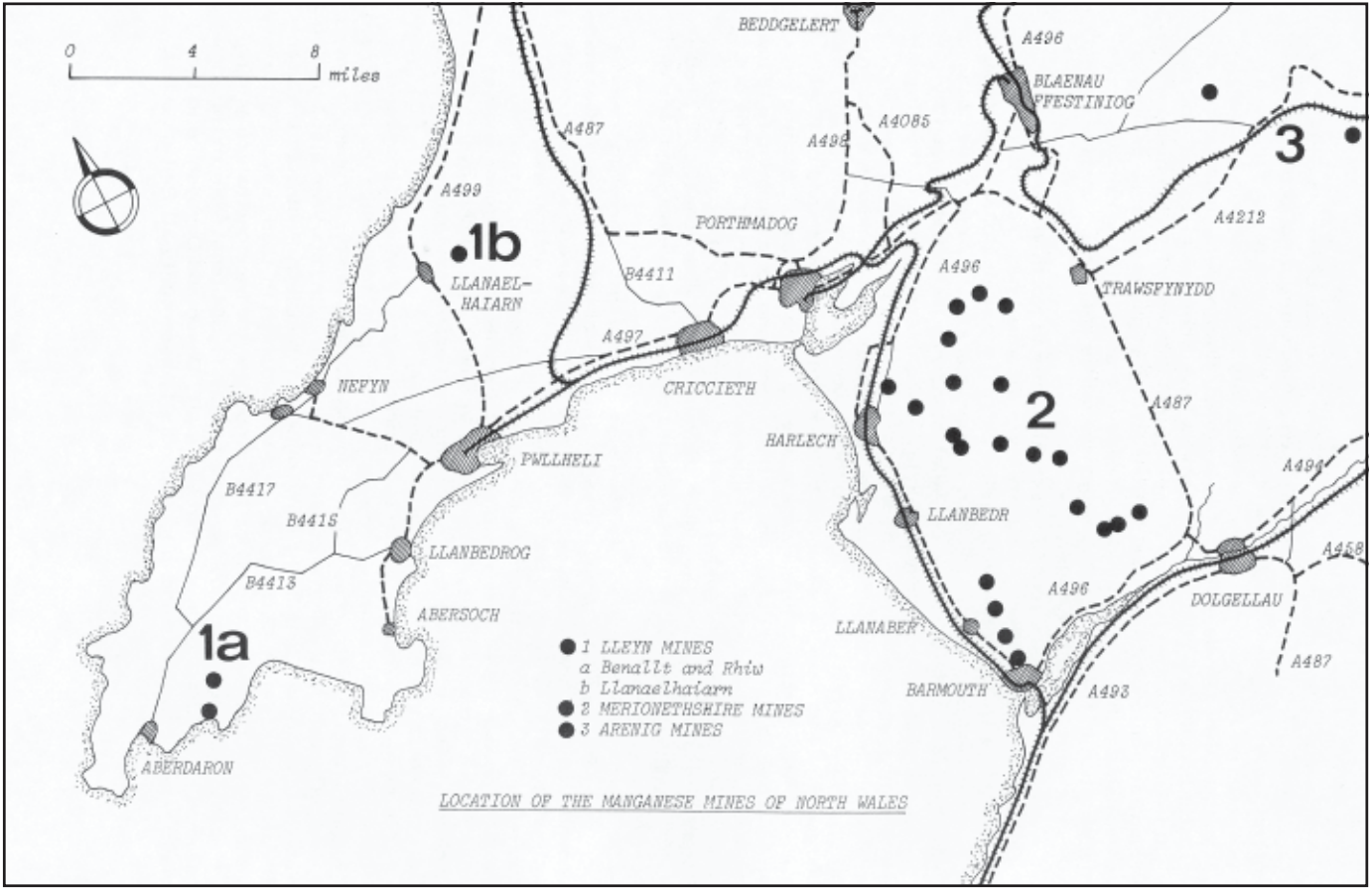
North Wales is well-known as a former producer of many metals. Lead, zinc, copper, iron and gold have all been mined with, if not profit, at least enterprise and persistence. The number of significant mines for these metals is, however, very small: perhaps only Parys mountain (copper), Clogau and Gwynfynydd (gold), and Van (lead/zinc) rank as important producers, although many other smaller mines have immense historical and technical interest attached to them. The typical features of Welsh metal mining, indeed, are an unprofitable and lengthy struggle against adverse geology on some inaccessible mountainside. These characteristics were never more marked than in the case of the manganese mines of Caernarvonshire and Merionethshire (now Gwynedd).

Manganese ores are found in several places in North Wales, but in only three have they ever been of economic significance: near Aberdaron on the Lleyn Peninsula in Caernarvon; in the central mountains of Merioneth east of Harlech and Barmouth; and still further east, in the Arenig area between Trawsfynydd and Bala. Even by Welsh standards the industry was tiny but the fragmentary documentary evidence and the interpretation of the almost vanished traces on site make the study of the mines peculiarly rewarding.

So far as can be determined, manganese was first worked in Wales in about 1835 and until closure in 1840 these outcrops of a very thin manganese bed (under 24 inches) were worked to the north of Barmouth and on Foel Wen in Cwm Nantcol. These workings were mere surface scratching, exploiting the altered (oxidised) ore at the outcrop and not attempting to follow the bed beneath the glacial debris which so frequently buried it. The ore was sent to Glasgow for making bleaching powder; only the oxidised portions seemed of value and very soon the mines were abandoned. No production figures exist, but it is a safe guess that only a few thousand tons of ore were removed.

It seems to have been in late 1884 - early 1885 that interest in the ores revived, with the exception of a meagre 138 tons of ore produced in Caernarvonshire and the Arenigs between 1867 and 1872. There is a close correlation between this date and the discovery in 1883 of practical methods of capitalising on the fact that manganese, when added to steel, imparted valuable properties of wear resistance and hardness. So important was this discovery that the use of manganese in metallurgy quickly overtook the variety of esoteric uses hitherto existing and became (and has remained) by far the largest single market for the metal.

The revival in Wales was due to the proprietors of Mostyn Ironworks, Flintshire, who formed the Dyffryn Mining Company to develop the Merioneth deposits and supply the ores to the ironworks. In 1885 the company developed its first mines, which produced ore in 1886. In this year also, mining was initiated at the Benallt and Rhiw mines on the Lleyn Peninsula in Caernarvon. No less than 12 mines opened in Merioneth in 1886, almost all owned either by the Dyffryn company or its competitor the Merionethshire Mining Company, and their combined production was 11,384 tons. From this time onwards English manganese (from Cornwall, Devon and Derbyshire in the main) was eclipsed; as shown in Appendix 1, essentially all British output came from Wales from this year.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LLANBEDROG
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ABERDARON
LLANBEDR
A496
LLANABER
BARMOUTH
A493
DOLGELLAU
A487
1 LLEYN MINES
a Benallt and Rhiw
b Llanaelhaiarn
2 MERIONETHSHIRE MINES
3 ARENIG MINES
LOCATION OF THE MANGANESE MINES OF NORTH WALES

In 1887 the number of Welsh mines increased to 16, and to 21 in 1891, but after 1892 the first boom was over. There is little doubt that this collapse was due to the extremely poor quality of the Welsh ores, plus their inaccessibility; overseas sources of far richer and cheaper ores were now being developed and were thereafter to sustain the British iron and steel industry. Only in exceptional circumstances was it ever to be possible for Welsh ores to be produced profitably.

The employment provided by mining at this time was never very great, the peak year was in 1887 when 307 men were at work, mostly underground. After 1891 the number dropped below 100, and was only 11 men by 1895. The largest mine was Hafodty with 30 - 50 men during the peak years. From 1892 to 1903, the Lleyn mines were either closed or producing but a few hundred tons, while the Merioneth mines struggled on; the nadir was 1898 when but 231 tons was produced, from the three remaining Merioneth mines. Then came a remarkable revival.

In 1903 a company was registered to work the Lleyn mines and in 1906, after considerable capital expenditure, 21,990 tons were sold. From 1903 onwards it was these mines which produced the bulk of Welsh output. The reasons for this increase are hard to pin down: certainly trading conditions were eased by the Russian - Japanese war at this time, which reduced our imports of Russian manganese, but this cause produced no increase whatever in Merioneth mining activity. Therefore, the prime cause is more likely to be simply that, for the first time, provision of adequate capital enabled a Welsh manganese mine to be worked in a proper and effective way; plus, it is suspected, the coincident discovery of a large and accessible orebody.

After 1908 output declined again, probably because ore bodies accessible by opencast working at Benallt and Rhiw had been exhausted, and did not pick up until World War I, when interruption of imports again encouraged the Welsh industry. Production peaked at 17,456 tons in 1918, was held at 12000 tons until 1920, and then crashed to a mere 500 tons in 1921. Production continued at this low ebb unti1 1928 when, after mining just 205 tons in Merioneth and 30 tons in Lleyn, Welsh manganese mining ceased.

That might have been the end of the history had it not been for World War 11 when the Ministry of Supply revived Benallt mine and produced 62,000 tons up to the final closure in 19450 There is no reason to anticipate any revival of manganese mining in Wales, although it should be added that in 1957 a mining company did take extensive leases of the ores in Merioneth, where vast reserves of low-grade ores still exist. In Caernarvon the existing mining areas are substantially exhausted although the possibility of new reserves remains. Three other Welsh manganese mines should be mentioned here for the sake of completeness. In 1867 Griffith Jones' mine at Cwm Mach, Bangor, produced a bare 5 tons of manganese ore, having produced nothing before or since.

About 2 miles south-west of Abergele, Denbighshire, was Nant Uchaf haematite mine where manganese (and lead) ores were found in association with the iron. Between 1880 and 1883 the mine produced just 569 tons of manganese ore, the company (Abergele Haematite Co. Ltd.) going into liquidation in 1884. The third mine was Drws-y-nant, located in the valley of the Afon Wnion between Dolgellau and Bala; officially a gold mine (although ignored by the standard works on gold) Drws-y-nant was listed as a

manganese mine between 1869 and 1877, but it produced no ore. Manganese mines are also on record in Cardiganshire but no ore seems to have been produced by them.

Finally it should be added that prior to the Welsh resurgence in 1886, England was the main source Of home-mined manganese ores, production of which trickled on until 1907 with an isolated parcel produced in 1927. The main sources were Cornwall and Devon (Chillaton and Hogstor mines being among the most important) but a few tons are recorded for the Isle of Man, Somerset and Derbyshire.

2. **MANGANESE: Uses and trade**.
The earliest use of Welsh manganese ores, in the oxide form, was in the manufacture of bleaching powder in the chemical works around Glasgow. This process simply involved boiling hydrochloric acid with the manganese, whence chlorine was liberated and collected to make the bleach.

This use was insignificant compared with the demand from the iron and steel industry for manganese ores. In this sector, manganese is a vital mineral of great strategic importance (in World War I, lack of manganese was a major problem facing the German steel makers) and at least 90% of world ore production is taken by the iron and steel manufacturers. In the 1940s an average 14 lb. of manganese was needed to make every ton of steel. The uses can be divided into three types:-

(a) as an alloy, in ferro-manganese, silico-manganese, and spiegeleisen. Ferro-manganese contains some 80% manganese, silico-manganese has 10% silica and 20% manganese, while spiegeleisen contains 15 - 25% manganese. In the 1880s Welsh ore was calcined at the ironworks before being added to the blast furnace together with richer manganese ores. The result was an alloy mid-way between ferromanganese and spiegeleisen, about 45% manganese, which was exported to the U.S.A;

(b) as a direct addition to the furnace charge of blast furnaces making basic iron; in this case the ore acts as a deoxidiser and desulphuriser;

(c) in the manufacture of manganese steel (such as Hadfield's "Era" steel, which contains about 12 - 13% of manganese). These steels have good resistance to wear and are of great value for such uses as railway crossings. Even conventional steel rails require an appreciable manganese content: in 1938 more than 200,000 tons of steel rails were used in Britain. Formerly these contained 0.8 - 0.9% manganese (equivalent to 1,600 – 1,800 tons of metallic manganese or about 2,500 tons of ore) but during the inter-war period this percentage was increased to 1.2% to give greater wear resistance.

Welsh ores were too low grade, and too impure, to enable them to be employed for ferro-manganese (although when "rediscovered" in the 1880s the ores were said to have been sent to Flintshire and Lancashire for this purpose) and hence their main value was in spiegeleisen, or as a direct addition to the blast furnace. In the 19405 around 100,000 tons/annum of ore were imported for the latter purpose and Welsh ores were technically suitable as substitutes; had the wartime supply position became sufficiently desperate this could indeed have been attempted.

Apart from metallurgy, manganese ores find minor but important use in various other processes. Their oxidising properties render them useful in glass manufacture, batteries, as a drier for varnishes and paints, and disinfectants, while manganese also gives colour to glass, pottery, tiles, ceramics, paints and in calico printing. The St. Helens glass industry was an important outlet for Welsh ores. Finally, manganese is used as a flux in smelting silver and lead ores.

The British and World trades in manganese have been influenced primarily by the development of new markets in steel-making, but temporarily also by wartime demands. Production of low grade ores in Wales has been

largely influenced by the discovery of richer overseas sources and by interruption of overseas supplies due to wars.

Prior to the large-scale requirements for manganese in the iron and steel industries, world output was in the 100,000 - 150,000 tons/annum range, with British production (almost entirely from mines in England) in the order of 1,000 - 8,000 tons/annum. In the mid-1880s when manganese steels became commercially viable, world output began to increase, from 150,000 tons in 1888 to 250,000 tons five years later. British output also increased dramatically, to 12,000 tons, at this period, and almost all produced from Merioneth mines. This was negligible however when compared with British imports. In the 1850s the manganese mines of Devon and Cornwall were largely killed by the discovery of ores in Germany, and after the 1880s the same picture was found. Imports, under 30,000 tons/annum prior to 1884, had increased to 140,000 tons in 1890 and ten years later were more than 250,000 tons. The twin problems facing British mines were summed up by Hunt in 1863:

“Large importations of Manganese from Spain, of a high quality, and sold at a low price have stopped all the Devonshire and Cornish Manganese Mines.”

These were equally difficult problems for the later Welsh mines, although Russia, Brazil, India, Chile and Turkey were the main sources of competition. In 1937, when world production of manganese ores was 6 million tons, Russia, India, South Africa and the Gold Coast between them produced 83% of that figure, and the combination of quality and price has always prevented Welsh ores from being of significance. Let us examine these two factors in turn. As the following table shows, Welsh ores were among the lowest grade worked:

Ore	Manganese %	Iron %	Silica %	Phosphorus %
Wales	30	2	24	0.02
India	49-52	10	3	0.13
Spain	50	2	10	0.10
Russia	52-56	2	8	0.18
New Zealand	53	2	8	0.07

In fact, the grade of Welsh ore was very variable, but almost never exceeded 35% and frequently was around 25% manganese. It had particularly high levels of impurities such as silica, a disadvantage when specifications (e.g. Ministry of Munitions) required less than 10% silica and at least 45% manganese.

Generally, ores had to contain at least 40% manganese before they were acceptable in world trade although, for strategic purposes the U.S.A. adopted a 35% cut-off grade. Thus it was only in internal trade that Welsh ore was marketable.

Prices of manganese ores were set on a per unit basis. Before World War I a typical price for imported ores (c.i.f. British ports) was 4 - 5p/unit, a unit being 1% of manganese. Thus, a 50% manganese ore with a price of 5p/unit sold for £2 .50/ton. In 1920 the price was up to 20p/unit, thereafter steadying at around 10p. The unit price was also on a sliding scale, depending on the richness of the ore. For impurities, deductions would be made, particularly if silica exceeded 8 - 10%. Ores exceeding 12% silica could be rejected at the buyer's option. Here again it can be seen how the disadvantages of impurities in Welsh ores hindered their exploitation.

If we look at the range of prices per ton then the practical aspects of these quality deficiencies emerge:

	Welsh Ores	Imported Ores
1881-1900	£0.50 - 2.50	£2 - 4
1901-1919	£0.50 - 2.00	£2 - 10
1920-1928	£1.40 - 3.00	£5 - 7

The overall result is that only with difficulty could Welsh ores be profitably worked, and they could not be sold in direct competition with imported ores except in very special circumstances.

Another important factor in the history of Welsh manganese is the influence of wartime conditions. Imports of ore rose up to about 1910, then steadying for a few years before declining until 1926; in other words broadly following the overall activity of the iron and steel industry. Welsh production on the other hand struggled along (at under 2,000 tons/annum in most cases) with three exceptions, 1886 - 1891, 1904 - 1908, and 1917 - 1920, in which periods production topped 12,000 tons/annum. The earliest of these periods of activity seems to have been due mainly to the development of several mines by Mostyn Ironworks, mines which closed when found uneconomic. The other periods were caused respectively by the Russian - Japanese war (which prevented us from importing our normal quota from Russia) and World War I.

The impact of war on the industry was first recorded in 1874 when the price of spiegel dropped by half to about £7/ton due to the ending of the France-Prussian war. The most dramatic example came from World War I; the Welsh output increased from 8,437 tons in 1914 to 17,456 in 1918 but this was dwarfed by the burgeoning U.S.A. production which, from a meagre 2,635 tons in 1914 increased to 122,275 tons in 1917 and to 1½ million tons in 1918. Due to the loss of Russian supplies Brazilian output increased from 180,680 tons to 524,434 tons over 1914 - 1917, although almost none of this came to Britain. Our manganese came almost wholly from India during that war, although there were severe problems with shipping. One writer, commenting on the strategic significance of manganese, saw a portent in the fact that German output increased from 92,000 tons in 1912 to 330,000 tons in 1913 - but ignored the fact that British imports showed a similar trend.

There is no denying the temporary benefits that wartime conditions brought to the Welsh manganese industry, but equally these production increases were still insignificant compared with national needs. So too were the results of the reopening of the Caernarvonshire mines in 1940 (after closure since 1928) by the Ministry of Supply. Worked strictly to supply local furnaces, production totalled just over 60,000 tons up to the end of 1945 when manganese mining in Wales ceased, probably for ever.

3. **GEOLOGY**

The North Wales manganese ores fall into three distinct types which can be considered in turn.

In the Lleyn Peninsula at Nant and Benallt mines the ore (which is of Ordovician age) forms irregularly shaped, discrete bodies or lenticles located in a mudstone host rock. These orebodies range in size from as little as 10-20 tons to as much as 30,000 tons. They dip steeply to the east at 45˚- 60˚ and are extremely complex and faulted; it has been said that Benallt had the most complicated geology of any metalliferous mine in Britain. At Benallt several orebodies were worked, typically about 8ft. thick at maximum; at Nant only one orebody was worked, which comprised a rather more regular structure some 16 - 20 ft. thick.

A very different picture is provided by the Merioneth ores which form part of the 1,000 ft.-thick sequence of Manganese Shales in the Harlech Beds of the Cambrian system. Close to the bottom of these shales occurs the ore, a sedimentary bedded deposit some 10 - 18 inches thick; above lies 5 - 6 ft. of so-called bluestone (the miner's term for the rock) which is very weakly manganiferous, while underneath the ore is a 2 inch bed often rich in crystals of iron pyrites. The ore outcrops extensively from Barmouth north to Harlech, and eastwards to Cwm Mynach, as well as around Llyn Bychan and Nantcol. The precise thickness of the workable ore varies greatly and there are occasional reports of 48 inches but 12 inches was more typical. Of itself this thinness was no great disadvantage (Russian ores were only 12 inches thick) but problems arose because of the low grade of the ore and the hardness of the bluestone overlying it.

The number of beds of ore was for many years in dispute; in 1893 two beds were recognised, 850 ft. apart, but careful study seems to have confirmed the presence of but one bed. It must however be added that a section published in 1886 showed two beds 4ft. 6 in. apart, while some of the existing workings are very difficult to explain unless severe faults or folds are postulated (for which there seems no evidence) or unless there are, at least locally, two beds in fairly close vertical proximity.

The third type of orebody is found in the Arenig mines, where the ore forms an infilling in faults and fissures in the rocks. As such, the occurrences approximate to the true veins found with other types of metal ores. The veins could be up to 6 ft. wide, dipping very steeply, but very limited in extent. The Arenig ores were also very much richer (up to 54% manganese) than the 25 - 35 % of the other types.

It is a somewhat curious fact that during the period of exploitation, the mineralogical nature of the ore was unknown-and, in fact, is still in some doubt. Originally it was thought that the ores were largely the carbonate of manganese (the mineral rhodochrosite or dialogite) with, at the outcrop, the black oxide of manganese, pyrolusite. Only quite recently was it discovered that, in fact, the ores seem largely to comprise spessartite – a manganese silicate, plus some oxide. It may however be possible that the ore at Nant contains significant carbonate. At Benallt during the 1940 - '45 reworking, several brand new mineral specimens were found, including benalsite (after the name of the mine), cymrite (to commemorate the Welsh site), grovesite (after the geologist A.W. Groves who studied the site in detail) and pennanite.

4. **MINING, PROCESSING AND TRANSPORT;**

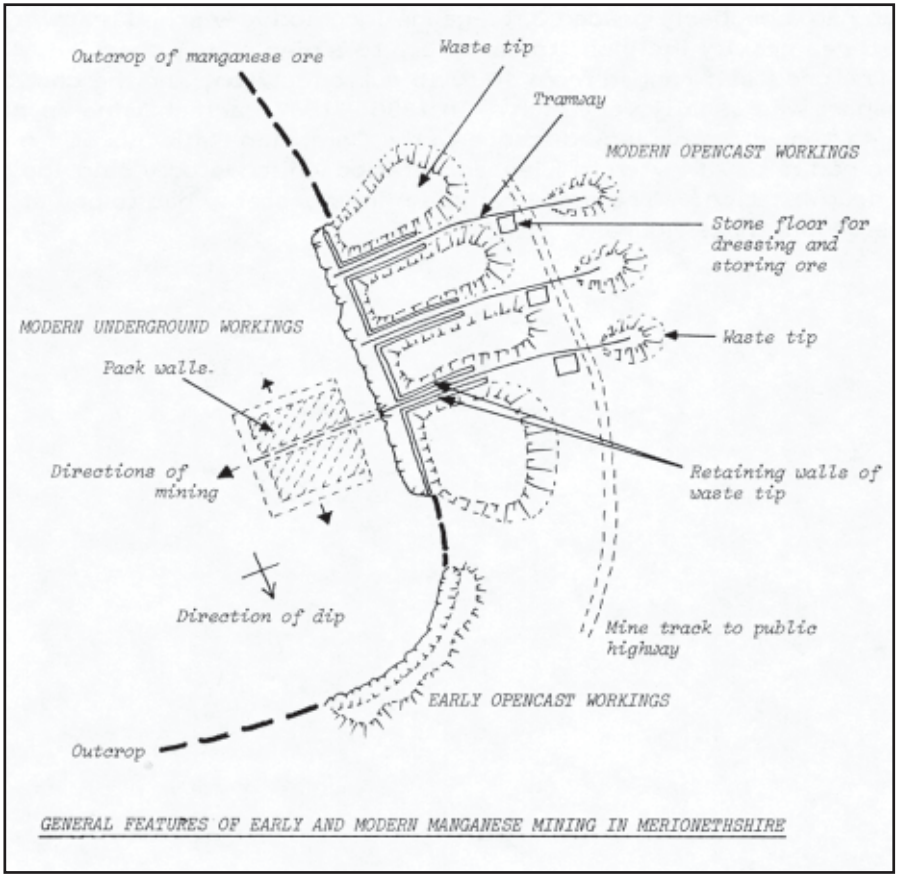
The mining methods used in Merioneth and Caernarvon were very different, due of course to the different geological situations of the ores. In Merioneth the earliest workings were for the oxidised outcrop of the bed of ore which was only 12 - 18 inches thick in general. Since the oxidation did not penetrate far into the bed, workings were more or less exclusively opencast and very extensive, perhaps half a mile or more along an outcrop at anyone mine. When in the 1880s the unoxidised ore began to be worked, access was gained by adits driven in from the opencast cliff faces, along the bed, running more or less horizontally. The general system is shown in the diagram.

Contemporary details are sadly lacking. Plans of Harlech mine in 1886 - 1887 seem to show that the ore was worked up-dip in blocks, as well as by single stalls about 8 yards wide, with pillars of similar dimensions. Adits were driven in the bluestone overlying the ore, so that a 6 ft. high adit would be 5 ft. in waste and 1 ft. in ore. Halse, at this time, commented that the workings were kept as low as possible, and occasionally wooden props were set. These were rare, however, and the main roof support was by carefully built packs, constructed of waste bluestone. Many of the mines still exhibit these packs in perfect condition and there are essentially no traces of roof collapse except at the entrances to adits. In working, the ground was set by the yard, at around £1.75 although very variable. The working method seems to have been that technically known as “resuing” in which the waste is removed for, say, 3 ft. ahead, after which the exposed ore is lifted up. Much of the work seems to have been by crowbar and there are only rare traces of drills and explosives having been used; in a more recent mine such as Rhinog, compressed air drills were installed. Overall the technology was of the simplest. A typical Merioneth mine would have used hand drilling and hand breaking of ore. The only surface facilities would have been an office and a blacksmith’s shop for sharpening tools.

Where the ore dipped steeply, as at Hafodty or the Arenig mines, conventional vein mining methods were used, with the ore being regularly stoped from levels - and shafts on the Arenigs. Stoping was also used at the Nant and Benallt mines with the aid of compressed air tools. Access to these Caernarvonshire mines was by inclines and shafts. None of the mines seems to have developed far enough for water to be a problem, although Nant started a drainage adit.

During World War II the Merioneth mines were inspected and preliminary plans made to reopen them. It was thought that two longwall faces, each 500 ft. long, could each get 150 tons/day or 50,000 tons/annum, so that two faces could supply all Britain’s needs for low-grade ore. The working costs exclusive of capital expenditure, would be about £1.50/ton.

On-site processing was negligible. In the 1890s the only preparation was hand picking of any obvious waste” and sifting out the fine (minus ½ inch) fraction. In 1919, ore was broken into 2 inch lumps for sale to the St. Helen’s glassworks. In the 1940s” the Caernarvon ore was passed through a jaw crusher and reduced to minus 4 in, before being despatched by road and rail.



GENERAL FEATURES OF EARLY AND MODERN MANGANESE MINING IN MERIONETHSHIRE

Transport was a major problem in view of the remote location of many of the mines. With very long outcrops being worked it was first necessary to gather the ore at some central point, and this was usually done by tramway, often of 24 inch gauge 'Jubilee' type. Hafodty used several self-acting inclines for this task. From here, it was usually necessary to lay a tramway to the shipping point; this resulted in some very long and very crude railways which, with the aid of inclines, wandered across the mountains until reaching a serviceable track for transhipment to road carts. At this point a stone transhipment dock would be built. There were occasional exceptions to this: some mines employed aerial ropeways rather than surface tramways although these must have been expensive, despite the claim by the Hafodty manager that he could build one for a mere £130/mile. Other exceptions were the Benallt and Nant mines, which had a properly graded 3 ft.-gauge locomotive-worked tramway, with three gravity inclines, to carry ore to a pier on the coast.

The ore itself ranged from 10 to 15 cubic feet/ton, and the cost of transport was usually very high. In 1886 - 1887 Harlech Mine spent only 4p/ton with a haulage distance to the Cambrian Railways of 1 mile. Artro had to pay 14p/ton to Llanbedr Station while Hafodty paid 15p to Barmouth Station. The more remote mines probably had to pay at lease double these figures.

Appendix 1. Output of manganese ores (tons. in Caernarvonshire, Merionethshire and Britain

Year	Caernarvon	Merioneth	G.B.	Year	Caernarvon	Merioneth	G.B.
1858	-	-	1400	1899	0	328	415
1859	-	-	1231	1900	318	1004	1362
1860	-	-	932	1901	521	1125	1646
1861	-	-	925	1902	531	627	1278
1864	-	-	500	1903	385	370	818
1867	5	33	808	1904	8247	282	8756
1868	-	50	1700	1905	14290	66	14474
1869	-	-	1558	1906	21990	748	22762
1870	-	-	4838	1907	15226	838	16098
1871	-	-	5548	1908	5937	115	6308
1872	50	-	7773	1909	2618	80	2768
1873	-	-	8671	1910	5343	124	5467
1874	-	-	5778	1911	4809	178	4987
1875	-	-	3275	1912	3934	236	4170
1876	-	-	2797	1913	5291	102	5393
1877	-	-	3039	1914	3437		3437
1878	-	-	1734	1915	4640		4640
1879	-	-	1052	1916	5140		5140
1880	-	-	2839	1917	9942		9942
1881	-	-	2884	1918	17456		17456
1882	-	-	1548	1919	12078		12078
1883	-	-	1287	1920	12875		12875
1884	-	-	909	1921	0	514	514
1885	-	-	1688	1922	0	250	250
1886	99	11285	12763	1923	358	663	2021
1887	208	12391	13777	1924	1296	1161	2457
1888	55	4006	4342	1925	446	383	829
1889	147	8671	8852	1926	0	128	128
1890	53	12018	12444	1927	971	60	1509
1891	235	8990	9476	1928	30	205	235
1892	0	5119	6078	1940	863	0	863
1893	0	635	1336	1941	1186	0	1186
1894	59	1683	1809	1942	10432	0	10432
1895	100	682	1273	1943	20333	0	20333
1896	246	813	1080	1944	17607	0	17607
1897	0	499	599	1945	11299	0	11299
1898	0	196	231				

Appendix 2

Production, manpower and ownership details of each mine are given here, where known. Manpower is given in both underground and surface employee categories: thus 5 + 3 denotes 5 men underground and 3 on surface. Production figures are in tons. Dates shown for owners may span longer periods than the output figures, because official statistics listed mine operators even when no ore was produced. Six figure grid references (grid letters SH) are also included, where the mine has been located.

ARTRO (approximately 604282)

Year	Output	Manpower
1886	2444	24 + 9
1887	nil	13 + 4

Dyffryn Mining Co. 1886-7

BARMOUTH (613167)

Year	Output	Manpower	Year	Output	Manpower
1886	21	-	1889	545	0 + 3
1887	500	-	1890	70	0 + 2
1888	49	2 + 1	1891	80	0 + 2
			Total	1265	

John Abraham 1886-92

BENALLT (223283)

Year	Output	Manpower	Year	Output	
1886	60	1 + 1	1904	600	
1887	158	2 + 0	1905	4828	
1888	55	2 + 1	1906	17300 *	
1889	47	2 + 0	1907	5014	
1890	53	-	1908	2946	
1891	35	2 + 0	1909	1901	
1892	nil	2 + 0	1910	5028	
1893	nil	nil	1911	4809 *	
1894	59	2 + 0	1912	3934 *	
			1913	5291 *	
			1940	863	
			1941	1186	
			1942	10432	
			1943	20333	
			1944	17607	
			1945	11299	
			Total	(to 1913)	52,118
				(to 1945)	113,838

* Includes output of NANT mine.
Possibly also some production 1923-28, included under NANT mine.

Benalt Manganese Co./Isaac Roberts & Owen Williams	1886
Isaac Roberts & Owen Williams	1887-95
North Wales Iron & Manganese Co. Ltd.	1904-1925

BRONWEN or **LLAN-LLEIDR MINE**

Year	Output	Manpower
1890	800	4 + 15
1889	100	5 + 2
1890	372	4 + 0
1891	40	2 + 0
Total	512	

Hugh Jones	1889 - 91

BWLCH Y RHIWGYR -see **EGRYN CAE MAB SEIFION** (689215)

CAPEL ENGEDI (c 590310)
CEFN TREVOR BACH(? 627365)
CEFN-Y-CLAWDD (665346)

CEL-FAWR (614170)

Year	Output	Manpower
1890	800	4 + 15
1891	652	6 + 2
1892	302	4 + 4
Total	954	

Dyffryn Mining Co. Ltd.	1891 - 4

CELL-FECHAN MINE (c 613166)

Year	Output	Year	Output
1886	2553	1905	16
1899	28	1904	90
1900	277	1905	50
1901	150	1906	100
1902	80	1907	41
1903	120	1908	40
		Total	876

Edith M. Abraham	1899
Thos. Abraham	1900-03
Mrs. Laura Williams	1904-08

CILCYCHWYN (630266)

Year	Output	Manpower
1890	800	4 + 15
1891	560	10 + 5
Total	1360	

Leonard Carter	1890
J.H. Hogge	1891-93

COED (or **LLANBEDR**) & **LLETTY WALTER** (605280)

Year	Output	Manpower
1890	nil	1 + 2
1872	955*	-
1873	179*	-
1875	29*	-
1886	1015	27 + 6
1887	1170	25 + 3
1888	356	4 + 1
1889	388	8 + 2
1890**	57	10 + 0
1891	437	9 + 10
1901	239	-
1902	144	-
1903	24	-
Total	3830	

* pyrites

** listed as COED from this date

Hope Jones & Co.	1869-71
Edward Jones	1872-78
Merionethshire Mining Co.	1886-87
Dyffryn Mining Co./D. Richards & Co.	1888-89
Llanbedr Mining Co. Ltd.	1890-91
William Lewis	1901-03

CRAFNANT (621291)

Year	Output	Manpower
1890	nil	1 + 2
1886	19	7 + 2
1887	8	4 + 0
Total	27	

Merionethshire Mining Co. 1886-87.

CWM BYCHAN
CWM MAWR No.1 or **NANT STEICYN** (634322)

Year	Tons	Manpower	Year	Tons
1887	nil	6 + 2	1900	12
1888	1889	10 + 3	1901	300
1889	2803	22 + 3	1902	96
1890	982	2 + 0	1903	24
1891	nil	0 + 4	1904	31
1892	nil	0 + 2		
1893	nil	0 + 1		
1894	nil	0 + 1	1907	440
1895	200	0 + 1	1908	29
1896	373	5 + 0		
1897	130	-	Total	7354
1898	40	-		
1899	5	-		

Dyffryn Mining Co. Ltd.	1887-1890
William Ryder	1891-1694
William Lewis	1895-1904
Edward W. Turner	1907-1908

CWM MAWR No.2 (632315)

Year	Output	Manpower
1890	nil	1 + 2
1891	107	6 + 1
1892	nil	2 + 0

Samuel Griffith 1890-1896

CWM MYNACH (681214)

Year	Output	Manpower
1886	779	36 + 9
1887	148	6 + 4
1890	155	0 + 4
1891	30	0 + 2
1906	501	
Total	1613	

Merionethshire Mining Co.	1886-7
D. Richards	1889-91
West Manganese Co. Ltd.	1906

CWM YR AFON (or **DROSGOL**) & **FOEL DDU** (640 292)

Year	Output	Manpower
1889*	2	0 + 2
1890	66	0 + 3
1891	404	0 + 6
Total	472	

* listed as FOEL DDU

Welsh Manganese Co. Ltd.	1889-91
Australasian Alkaline Reduction & Smelting Syndicate Ltd.	1891.

DIPHWYS NEW (667225)
DIPHWYS OLD (669238)

Year	Output	Manpower
1886	nil	5 + 17
1887	nil	13 + 10

Dyffryn Mining Co. 1886-87

DOLYBEBIN (604278)
DROSGOL see **CWM YR AFON**
DYFFRYN see **HAFOTTY**

EGRYN or **BWLCH-Y-RHIWGYR** (619200)

FFRIDD LLWYN GURFAL
FFRIDD TYDDYN-DU (? 637328)

Year	Output	Year	Output
1886	2553	1905	16
1896	20	1901	210
		1902	232
		1903	99
1898	71		
1899	148	1907	176
1900	600		
		Total	1555

Ellis Pritchard	1896-1903
Edward W. Turner	1907

FOEL DDU - see **CWM YR AFON FOEL WEN** (631270)

Year	Output	Manpower
1889	10	0 + 2
1890	34	0 + 15
1891	575	4 + 6
1892	25	0 + 2
Total	644	

Foel Wen Manganese Co./H.L. Haigh

GRAIG UCHAF (645266)

Year	Output	Manpower
1886	40	0 + 5
1887	731	0 + 4
1889	700	0 + 30
1890	3087	14 + 21
1891	2331	8 + 10
1892	898	5 + 16
Total	7167	

Merionethshire Mining Co.	1866-87
Dyffryn Mining Co. Ltd.	1889-94

HAFOD-Y-LLYN see **PENARTH**
HAFOTTY or **DYFFRYN** (618190)

Year	Output	Manpower	Year	Output	Manpower
			1890	3946	22 + 12
1886	1378	35 + 4	1891	1571	12 + 6
1887	nil	37 + 15	1892	1663	4 + 4
1888	1407	14 + 4	1893	Nil	0 + 2
1889	2080	22 + 20	1894	159	0 + 2
			Total	12,204	

Dyffryn Mining Co. (Ltd. after 1888)	1886-94 MAFOTTY
Samuel Pope & H. J. Wright	1896

HARLECH LLETTY see **LLETTY WALTER** and **COED HARLECH** (595322)

Year	Output	Manpower
1886	2871	28 + 7
1887	nil	6 + 2
1889	675	11 + 0
Total	3546	

Dyffryn Mining Co.	1885-87
Welsh Manganese Co. Ltd.	1889

HENDRE No.1 (614254)

Year	Output	Manpower	Year	Output
1889	277	0 + 7	1899	147
1890	823	12 + 2	1900	115
1891	658	8 + 5	1901	226
1892	147	6 + 2	1902	75
1898	85		1903	115
1904				161
Total				2829

Harlech Mining Co. Ltd.	1889-91
J.W. Macqueen	1892-94
F.B. Haigh and William Simon	1898
F.B. Haigh	1899-1901
William Simon	1902-04

HENDRECERRIG (? 644377)

LLANAELHAIARN (407461)

Year	Output
1872	50

John Cowper	1872-76

LLAN BEDR see **COED**
LLAN-LLEIDR see **BRONWEN**
LLECHWEDD GOLEU or **LLECHWEDD DU**

Year	Output	Manpower
1888	143	2 + 2
1890	132	5 + 0
Total	275	

D. Richards & Co./E. Pritchard	1888
Welsh Manganese Co. Ltd	1890
Australasian Alkaline Reduction & Smelting Syndicate Ltd.	1891

LLETTY WALTER see **COED**

LLYN DU BACH (? 657341)

Year	Output	Manpower
1890	542	0 + 1
1891	558	0 + 8
1892	nil*	0 + 10
1893	198	0 + 2
1894	201	0 + 3
1895	374	0 + 4
1896	48	0 + 1
1897	58	
Total	1974	

* Listed also as 1145 tons, probably in error for Llyn Dywarchen.

Welsh Manganese Co. Ltd.	1890-92
Alfred Ferguson	1893-95
Ellis Pritchard	1894-97

LLYN DYWARCHEN (654346)

Year	Output	Manpower
1892	1145	0 + 2
1893	314	0 + 4
1894	259	0 + 4
1895	108	0 + 2
1896	192	0 + 2
1897	150	-
Total	2168	

Welsh Manganese Co. Ltd/Ellis Pritchard	1892
Ellis Pritchard	1893-97

LLYN EIDDEW or **LLYN EIDDEW-MAWR** (645340)

Year	Output	Manpower
1889	1023	0 + 12
1890	769	2 + 10
1891	224	0 + 5
Total	2016	

Welsh Manganese Co. Ltd.	1889-91

MANGANESE ROYAL see MYNYDO NODOL

MOELFRE (629255)

Year	Output	Manpower	Year	Output
1886	2553	21 + 3	1905	16
1887	368	14 + 3	1906	145
1888	112	0 + 2	1907	182
1889	68	7 + 0	1908	46
1890	183	0 + 6	1909	80
1891	185	6 + 1	1910	124
1892	nil	3 + 2	1911	178
1896	180	-	1912	236
1897	161	-	1913	102
			Total	4919

1885-87	Dyffryn Mining Co.
1887-88	Harlech Mining Co. (Ltd)
1889-92	H.C. Bunkell
1896-97	Ellis Pritchard
1905-13	William Simon

MOEL MOCHOWGRYN or **MOEL LLECHOWGRYN** (? 800406)

Year	Output	Manpower
1887	15	3 + 0
1888	nil	2 + 2
1889	nil	2 + 0
1890	nil	0 + 2
1891	nil	2 + 2
1894	nil	0 + 2

Daniel Smeadly	1887-91
Allsop, Jones & Evans	1894

MYNYDD LLAN BEDR

Year	Output	Manpower
1886	123	11 + 5
1887	58	3 + 1
1888	50	0 + 1
Total	231	

Merionethshire Mining Co.	1886-87
Richards & Pritchard/Mrs. Haigh	1888

MYNYDD NODOL or **MANGANESE ROYAL** (860393)

Year	Output	Manpower
1867	33	-
1868	50	-
1885	-	12 + 0
1886	29	12 + 23
1906	2	-
Total	114	

Great Northern Manganese Co. Ltd.	1867-71
C. Herbert Stokes	1877-80
H. Hands	1885-86
G.A. Claughton	1906

NANT (210266)

Year	Output	Year	Output
1902	80	1923	358
1904	300	1924	1296
1906	17300*	1925	446
1907	7814	1926	Nil
1908	2991	1927	971
1911	4809*	1928	30
1912	3934*		
1913	5291*	Total	54,926
1918	9306		

* includes output of BENALLT mine

Fred Hall	1902
North Wales Iron & Manganese Co. Ltd.	1904-1925

NANT STEICYN see **CWM MAWR No.1**.

PENARTH or **HAFOD-Y-LLYN** (599291)

PEN ISA'R CWM (? 619265)

Year	Output	Manpower
1886	13	0 + 6

Merionethshire Mining Co. 1886

PISTYLL GWYN

RHINOG (654267)

Year	Output	Manpower
1891	578	0 + 25
1892	889	5 + 15
1893	128	0 + 2
1894	1064	0 + 2
Total	2659	

Dyffryn Mining Co. Ltd.	1891-94
H.J. Wright	1895

RHIW or **SUGAR LOAF** (221281)

Year	Output	Manpower	Year	Output
1886	39	2 + 1	1900	317
1887	50	3 + 2	1901	521
1888	nil	4 + 1	1902	451
1889	100	4 + 2	1903	385
1890	nil	5 + 0	1904	7347
1891	200	3 + 1	1905	9462
1892	nil	3 + 1	1906	2894
1893	nil	4 + 1	1907	1083
1894	nil	3 + 0	1909	717
1895	100	2 + 2	1910	315
1896	246	3 + 1		
			Total	24,228

Laura Jones & James Fagan	1886
James Fagan/G.J. Snelus	1887
G.J. Snelus	1888-96
Evan J. Evans	1900-02
British Manganese Co. Ltd.	1903-10

SUGAR LOAF see **RHIW**

TY CANOL
TYDDYN MEIRION
TYNLLAN see UNION
TY'N Y FRON
TYNLLWYN see **UNION**

UNION or **TYNLLWYN (TYNLLAN)**

Year	Output	Manpower
1893	nil	8 + 3

H.J. Wright	1893
Tynllan Manganese Co.	1894

VOTTY (676213)

Y GARN (? 700230)