# Mwyndy Mine

[ST 056 819]

## Introduction

Iron ores have been extracted from the Dinantian limestones of South Wales since Roman times (Rankin and Criddle, 1985), with activity peaking during the 1500s and again in the 19th and 20th centuries, the last mine to close being Llanharry, in 1974. The ore averaged 48% Fe and total production is estimated to have been in the order of 9.5 million tons (Shepherd and Goldring, 1993). Ore production was strictly related to global demand and availability, as well as to the availability of smelting fuel, both in the form of wood charcoal and coal; hence the rather erratic working pattern through the ages (T.P. Young, pers. comm.).

There are now few obvious remains of this once extensive iron ore industry which formerly dominated the Iiantrisant district. However, at Mwyndy Mine (Figure 5.81) a considerable area of tips still remains. Although these are overgrown, small excavations readily reveal representative samples of the style of mineralization worked in these mines, namely oxide-facies iron (and less-frequent manganese) ores.

The ores consist of goethite, hematite, quartz and a range of late accessory phases. Originally, they were believed to be of supergene origin (Sibly and Lloyd, 1927). Williams (1958), however, challenged that theory, suggesting that the ores had been emplaced by ascending hydrothermal fluids during Miocene times, thus linking the mineralization to tectonic disturbances during the Alpine Orogeny. Conversely, Gayer and Criddle (1969) were able to demonstrate that the ore distribution was controlled in fact by Variscan fracture patterns, and that the mineralization was itself cut by faults of probable Alpine age.

Evidence, in the form of detrital hematite and fragmented quartz crystals, within strata of Rhaetian age from the Bridgend area, led Gayer and Criddle (1969) to conclude that the ores were most probably of late 'Keuper' (Triassic) age. Rankin and Criddle (1985) also concluded that the ores were pre-Jurassic in age, citing the Mendips as an analogy, where unmineralized Jurassic sedimentary rocks lie directly upon Dinantian limestones containing Fe-Mn oxide ores.

Fluid-inclusion studies, carried out by Rankin and Criddle (1985) on calcite and quartz samples from Llanharry Mine, yielded homogenization temperatures and salinity data indicating that the mineralization was deposited from alkaline fluids of relatively low temperatures (300–98° C) and bimodal salinity (2–10 wt% and 10–24 wt% equivalent NaCl). They suggested that the mineralization was emplaced in late Triassic times, involving groundwaters that leached Fe (and Mn) as they passed downwards through the Triassic strata. Such groundwaters, derived from the extremely saline sabhka environments that existed in this part of South Wales during late Triassic times, would have also been capable of dolomitizing the limestones which they passed through, a feature widespread in the vicinity of these iron deposits. Rankin and Criddle (1985) suggested that these descendant, iron-rich fluids had probably interacted with hotter fluids rising up the Variscan fracture systems within the Dinantian strata, to create a fluctuating hydrothermal system which deposited the iron mineralization in a rhythmic manner, leading to banded mineral deposits.

Rankin and Criddle (1985) observed also that the fluid-indusion data from Llanharry Mine were not incompatible with results which would be expected for MVT Pb-Zn mineralization, and they noted that there were showings of such mineralization in the Llantrisant area. The lack of significant Pb-Zn mineralization in the vicinity of the Mwyndy iron deposits was interpreted, albeit speculatively, as being due to the low brine fluid temperatures (< 100° C), MVT fluids typically being between 80°–200° C.

Shepherd and Goldring (1993) suggested that an alternative interpretation of similar fluid-inclusion data from both the west Cumbria and South Wales iron ore deposits was for initial, low-temperature fluid descendant iron mineralization, followed by higher-temperature mineralization along pathways through the iron ore. This is in accordance with newly described evidence seen at both the Mwyndy Mine and the Ogmore Coast GCR sites (Bevins and Mason, 2000) which indicates that the cavity-fill quartz, calcite and barite mineralization of the South Wales iron mines could have been deposited by rising MVT fluids percolating through pre-existing iron oxide deposits.

## Description

All of the South Wales goethite-hematite ore deposits occur to the south of the South Wales Coalfield and are hosted by carbonate sequences of Dinantian age, overlain to the north by Namurian shales, in the 'south crop' of the coalfield. The limestones were tilted to the north or NNW by Variscan deformation and subsequently eroded in an arid climate during Permo-Triassic times. Progressive subsidence in late Triassic times, prior to the Rhaetic marine transgression, led to the gradual burial of much of this eroded Carboniferous surface by mudstones of the Mercia Mudstone Group. In topographically high areas, flash floods led to the deposition of breccias and clast-supported conglomerates (previously called the 'Dolomitic Conglomerate'), consisting chiefly of subangular fragments of Carboniferous-age limestone, filling hollows in the erosion surface.

The iron ore deposits at Mwyndy, and elsewhere in the immediate vicinity, usually occur within 150 m of the eroded surface of the tilted Carboniferous strata. Typically, limestones are pervasively dolomitized and hematized in wide zones around the orebodies. Hematization and dolomitization of Dinantian limestones is in fact common throughout its outcrop to the south of the coalfield and is much more widespread than are the actual orebodies, giving the soils in the vicinity of the orebodies a characteristic deep-red colour. The overlying Triassic conglomerates are also hematitic, but to a lesser extent, and the conglomerates appear to have formed a cap to the high-grade iron mineralization, as at Llanharry, described by Rankin and Criddle (1985).

At the iron mines of the south crop area, including Mwyndy, good exposures of the mineralization are lacking, due to most of the open workings having been backfilled. Those that remain reveal little information regarding the structural character of the mineral deposits, except that they formed irregular, but broadly linear, massive fracture-fills and replacements (possibly palaeokarstic in part) of the limestones along WSW–ESE-trending lineaments.

Hand specimens of iron ores from the tips at Mwyndy Mine show the ore to consist typically either of earthy to massive, often banded goethite or hematite. Goethite-dominated ore, which is certainly the commonest material seen on the tips at present, comprises massive to banded goethite, the latter variety containing intergrown quartz along some bands. Vugs in this ore are lined with goethite stalactites and quartz, calcite and barite. Crystalline goethite may coat, and form inclusions in, the quartz and calcite, imparting a smoky colour to them.

Massive, siliceous hematite ore was known traditionally by the miners as 'blue-ore', due to its steel-grey colour. Cavities within the 'blue-ore' hematite contain both crystalline quartz and specular hematite, which, by analogy with the goethite ore, occur in several superimposed generations. Calcite and barite are again associated phases.

Pyrite is not uncommon on the tips at Mwyndy Mine, where nodular aggregates of modified pyrite cubes up to 15 mm in diameter occur as fist-sized lumps in the tips nearest the Barn public house. These pyrite aggregates, overgrown by traces of barite, have been pseudomorphed by mid-brown goethite, although locally fresh pyrite remains in the inner parts of the nodules. Such pseudomorphs are widespread throughout this part of South Wales but the replacement is usually total. Chalcopyrite was reported from this site by North (1916), but its paragenetic position is unclear; in polished section the pyrite is free of other inclusion-forming sulphides.

Calcite is an abundant mineral in these iron ore deposits and formerly occurred as well-developed nailhead and scalenohedral crystals (Rankin and Criddle, 1985; Bevins, 1994). It is common at Mwyndy Mine as cavity-fills, and particularly as veins cutting hematized limestone. Barite occurs as well-formed, euhedral, tabular crystals, and some fine specimens were preserved when the mine was working, including an exceptional, doubly terminated 50 mm, yellow-brown barite crystal (Figure 5.82) in the National Museum of Wales collection (Bevins, 1994). Barite is clearly a late-stage mineral; in addition to occurring on pyrite pseudomorphs and in cavities in hematite and goethite, it is present within massive iron ore, as thin, crosscutting veinlets. Barytocalcite, again a late-stage mineral, is present as rare, yellowish, bladed crystals up to a few millimetres in length.

The iron ores of South Wales thus have a straightforward paragenetic sequence in general terms, comprising initial goethite-hematite-quartz-pyrite deposition, followed by cavity infilling and cross-veining by euhedral quartz, calcite, barite and barytocalcite, the quartz and calcite being overgrown by goethite and specular hematite in places.

## Interpretation

This oxide-facies class of iron and manganese ore deposit is unusual in global terms (Shepherd and Goldring, 1993), being represented in Great Britain by significant orefields in west Cumbria, the Forest of Dean and the South Wales–Mendip area. In each case the ores occur in near-surface Dinantian limestone sequences overstepped by red-bed-type sedimentary rocks of Permo–Triassic age; the host limestones are hematized and dolomitized and the ores tend to occur along pre-existing Variscan fracture systems. The genesis of the deposits has been successively re-interpreted, but a central theme is that the iron must have been supplied from the overlying red-beds by downward migration of hypersaline brines.

Paragenetic studies of the mineralization all point to early, colloform-banded iron oxides and silica being overprinted by crystalline quartz, iron oxides, calcite and finally barite. It has recently been suggested (J.S. Mason, unpublished interpretation) that the late-stage, cavity-filling minerals may have been formed during a transition from descending, iron-rich groundwaters in late Triassic times to ascending, MVT fluids in early Jurassic times. That such fluids were active then is readily demonstrated at, for example, the Ogmore Coast GCR site, where intense Pb-Ba mineralization cuts and impregnates sedimentary rocks belonging to the Lower Lias, of Hettangian age (Fletcher, 1988).

This hypothesis is in accordance with the alternative interpretation of the West Cumbria Orefield proposed by Shepherd and Goldring (1993), and is further supported by relationships at the Ogmore Coast GCR site, where calcite-barite-galena veins cut and brecciate hematized limestone. This would suggest that, since the hematization is believed to be cogenetic with ore formation, that the MVT Pb-Ba mineralization post-dated the oxide-facies iron mineralization.

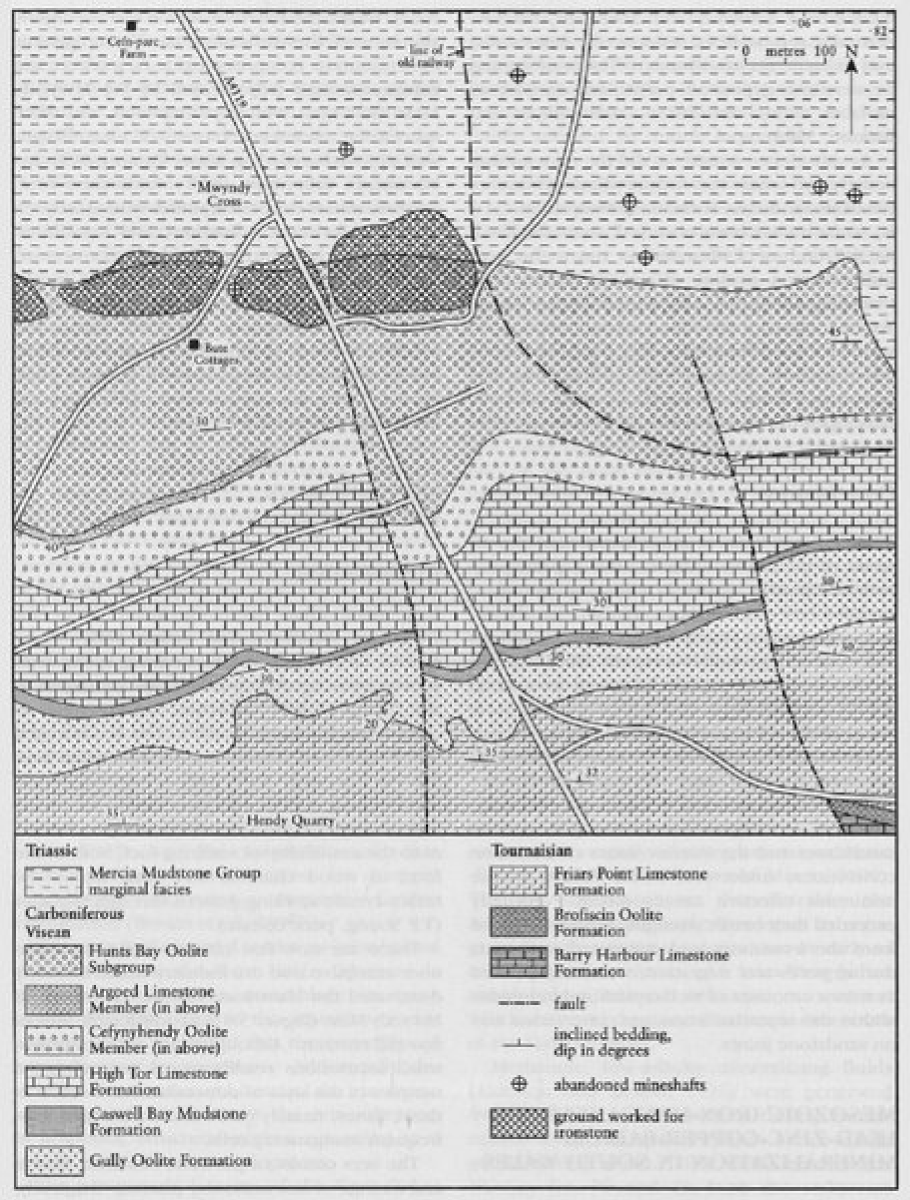
Mason's new interpretation, reported by Bevins and Mason (2000), may be summarized thus: warm, hypersaline, alkaline, Mg-rich brines percolated through the Keuper marls during late Triassic times to access Variscan fracture-controlled pathways (and perhaps palaeokarstic fissures) in the Dinantian limestones, after passing first through the relatively permeable conglomerates, breccias and sandstones of the Mercia Mudstone Group. They leached metals, in particular Fe and Mn, and their subsequent reaction with the Dinantian limestones resulted in dolomitization and hematization. Due either to metasomatic reactions with the Dinantian limestones, or the mixing of ascendant and descendant fluids, layers of iron and manganese oxides, with quartz, were deposited in the upper part of the limestone sequence and, locally, in the Mercia Mudstone Group. Conditions at times permitted the iron to precipitate as pyrite. During Rhaetian times, as crustal subsidence increased, basin development in the Bristol Channel began to generate deep-seated, hot, MVT fluids which, in their circulation, found their way back up the same fracture systems. These deposited calcite, quartz, and finally barite, percolating through the vuggy iron ores to fill cavities, or in some cases lining new fractures, which cut the hematized limestones and iron ores. Initially, mixing of fluids from above and below continued, with the deposition of the oxide facies (i.e. goethite and specular hematite) within developing quartz and calcite. However, this was relatively minor compared to the bulk of the iron ore which had already been emplaced by this time, and may have been due to iron-oxide recrystallization. Evidence from the Ogmore Coast GCR site suggests that this phase of mineralization was followed by more typical MVT calcite-barite-galena-sphalerite-dominated mineralization.

Fluid-inclusion data for the West Cumbria and South Wales iron deposits, taken from quartz, calcite and fluorite in the West Cumbria Orefield (Shepherd and Goldring, 1993), and quartz and calcite from South Wales (Rankin and Criddle, 1985) are remarkably similar. Both data-sets show that these minerals were deposited from highly saline (up to 24 wt% NaCl equivalent) calcium- and magnesium-rich alkaline brines at temperatures of 84°–121° C (West Gumbria) and up to 98° C (South Wales). These temperatures are rather high for simple descendant brines originating in a sabhka environment, as recognized by both sets of authors. However, if these minerals had been deposited in cavities in pre-existing hematite-goethite by rising fluids, then the fluid-inclusion data would merely refer to the fluids which deposited the late cavity-fill minerals and not the banded hematite and goethite, which could then have been deposited at a much lower temperature, a possibility recognized by Shepherd and Goldring (1993).

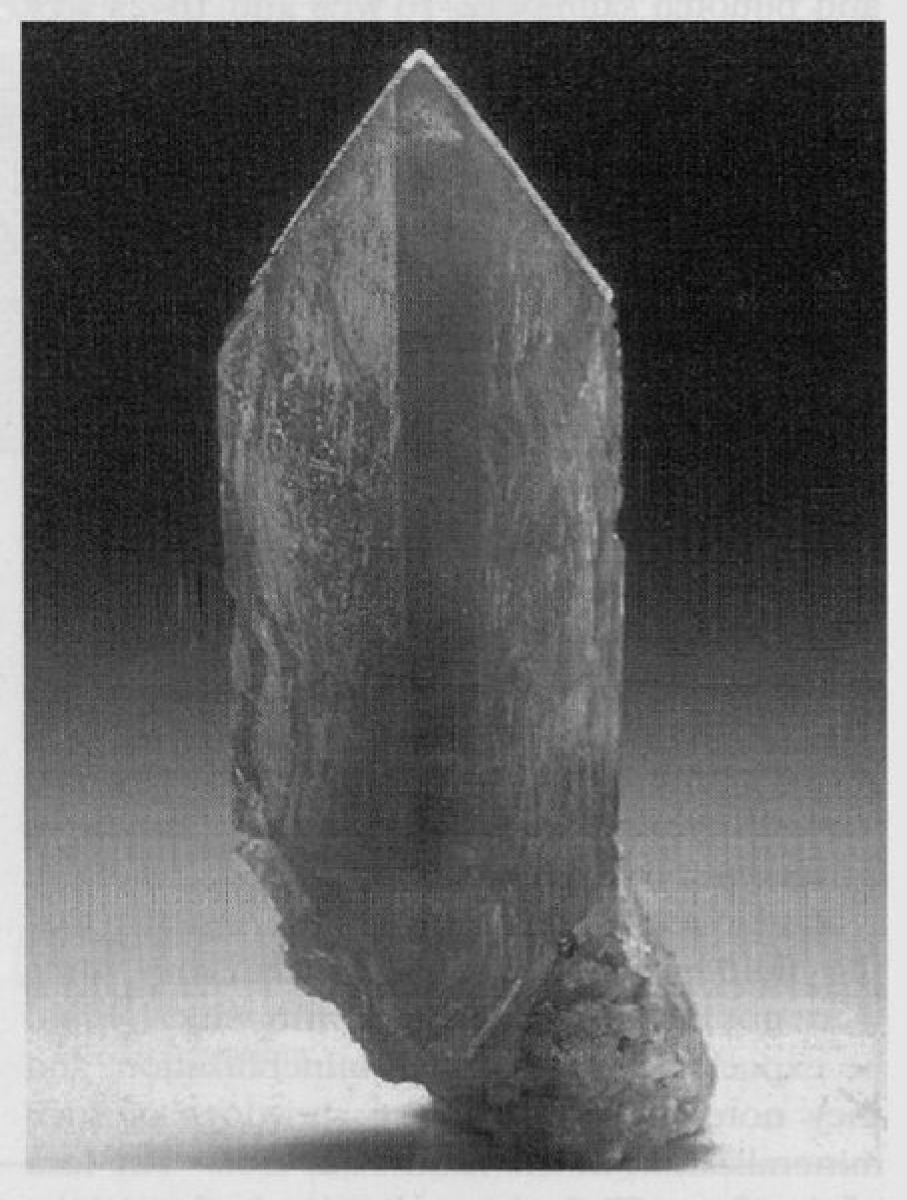
## Conclusions

The iron oxide mineralization at Mwyndy Mine is controlled by the juxtaposition of Dinantian limestones, with attendant Variscan fractures and Triassic red-beds. The iron was probably sourced by sabhka brines leaching Mercia Mudstone Group rocks and then entering the Variscan fractures via the more permeable conglomerate, breccias and sandstones. Later, cavity-fill minerals, upon which the fluid-inclusion data are based, were deposited from hot, hypersaline brines of MVT affinity, as the style of mineralization transferred from oxide-facies Fe (and Mn) to MVT Pb-Zn-Ba.

[References](#)




*(Figure 5.81) Map of the Mwyndy Mine GCR site. Based on British Geological Survey 1:50 000 sheets 261 and 262, Bridgend (1989b), and Institute of Geological Sciences 1:10 000 Sheet ST08SE (1984).*



(Figure 5.82) Photograph of barite from the Mwyndy Mine GCR site. (Photo: M.P. Cooper, © National Museum of Wales.)