Mississippi valley-type lead-zinc-fluorite and copper-dolomite associations in North-East Wales

The North-east Wales Mississippi Valley-type (MVT) Orefield is one of five major 'Pennine-type' orefields in Great Britain in which epigenetic Pb-Zn-Ba-F mineralization occurs within Lower and Middle Carboniferous carbonate-dominated sedimentary 'sequences. The four other orefields, described in chapters 3, 4 and 6 of this volume, comprise the Alston and the Askrigg blocks of the Northern Pennines, the Peak District, and the Mendip Orefield, the latter extending across the Bristol Channel into [text missing in the original]. All of these latter orefields have been far more intensively studied than the North-east Wales Orefield (Ixer and Vaughan, 1993), and in some cases well-defined patterns of mineral zonation have been demonstrated.

Mineralization in the North-east Wales Orefield comprises four principal types of deposit. Firstly, there are localized occurrences of Pb-Zn-Ba vein mineralization within the Lower Palaeozoic sedimentary rocks (see Pennant Mine GCR site report, this chapter). Secondly, along the margins of the Permo–Triassic sequences of the Vale of Clwyd occur a number of oxide-facies iron deposits, comprising fault zones impregnated with mainly earthy hematite, accompanied in places by earthy, black Co-Ni oxides (Bevins and Mason, 1999). Cobalt and nickel, as well as iron, were formerly mined from such deposits in the Prestatyn area (Burt *et al.,* 1992), while at the Great Orme, copper-rich black oxide deposits occurred. Thirdly, there is the major epigenetic fracture-hosted MVT Pb-Zn mineralization of the Halkyn and Minera blocks, represented by the Halkyn Mountain and the Pool Park and South Minera Mines GCR sites. To the west of this area, the Great Orme Copper Mines GCR site, hosted again by a carbonate-dominated Lower Carboniferous sequence, is the first example of the copper-dolomite class of mineral deposit to be recognized in Great Britain (Ixer and Davies, 1996).

In comparison to the other 'Pennine-type' orefields of Great Britain, the North-east Wales Orefield is geologically simple. A sandstone–shale turbidite succession of Silurian age, folded during Acadian deformation, crops out to the west of the Clwydian Range, and dips eastwards beneath a Carboniferous cover. The unconformity at the base of the Carboniferous succession is marked locally by a basal conglomerate which passes rapidly up into a shallow-water sequence of impure, bituminous to arenitic limestones with minor horizons of chert, shale and rare thin coals (Smith, 1921). Above this succession, and extensively quarried, lie the massive Loggerheads Limestone Formation (previously the 'Middle White Limestone') and the overlying Cefn Mawr limestone Formation (previously the 'Upper Grey Limestone') of Asbian to Brigantian age. This facies change indicates a palaeoenvironmental transition to clear, offshore waters in which coral reefs developed and an abundant benthic fauna flourished, dominated by crinoids and brachiopods. In the Halkyn Mountain area, the Cefn Mawr Limestone Formation is represented in its upper parts by a banded chert-dominated sequence.

In the upper part of the Dinantian succession, a transition to shallow-water, probably estuarine, conditions is marked by an increasing sandy component to the limestones. In the overlying Cefn-y-Fedw Sandstone Formation, of Namurian age, there is again a marked facies variation, while in the southern part of the orefield the formation consists of coarse sandstones. In the Halkyn Mountain area bedded cherts are a major component. The Cefn-y-Fedw Sandstone Formation is overlain by Westphalian coal-bearing strata, worked for coal in places around the periphery of the orefield and marking the final transition from estuarine to coastal swamp conditions and implying a long history of gradual uplift of the landscape. Relatively major uplift then occurred in post-Westphalian times, which was probably related to the Variscan Orogeny, although the area lies well to the north of the Variscan Front. The entire Carboniferous sequence was tilted eastwards, so that presently it dips beneath the Permian and Triassic sequences of the Cheshire Basin.

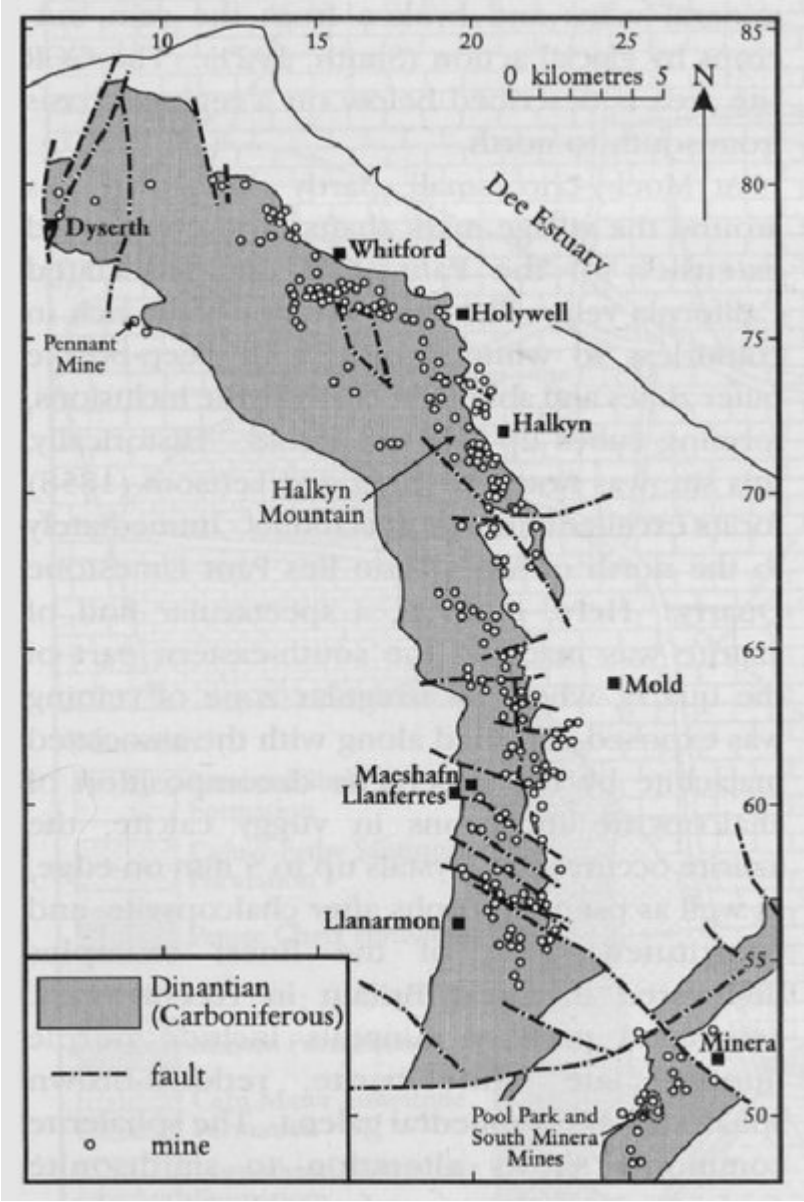
The epigenetic Pb-Zn mineralization, emplaced chiefly along N–S- and E–W-striking Variscan tensional dip-faults, is mainly developed within a > 750 m-thick succession between the Loggerheads Limestone Formation and the upper part of the Cefn-y-Fedw Sandstone Formation, although extensions into the overlying Coal Measures have been reported (Smith, 1921). The E–W-trending fractures are the most richly mineralized, while those running north–south tend to carry only calcite and rarely show any appreciable sulphide content. In addition to steeply dipping veins, the mineralization manifests itself as metasomatic replacement flats and pipes, and also as fillings to pre-existing palaeokarstic voids. The

distribution of the larger mineral deposits is controlled strongly by lithological variations in the host rock. Particularly intense mineralization tends to occur in thinly bedded limestone sequences overlain by shale bands; clearly the shales presented a barrier to brittle fracture propagation, acting as cap-rocks, ponding hydrothermal fluids which then migrated laterally along bedding planes of the underlying limestones to form 'flats'. In textural terms, the mineralization tends to be of a coarse (i.e. centimetre, not millimetre) crystal size, and exhibits features indicative of open fracture filling, such as crustiform banding.

In comparison to the other 'Pennine-type' orefields of Great Britain, the mineralogy of the North-east Wales Orefield is relatively simple. It is dominated by calcite, galena and sphalerite, with quartz becoming an important gangue mineral in the south, around Minera. Fluorite is present at a number of localities in the orefield's central and northern sectors, although rarely in large quantities, in contrast to the Pennine orefields where it has been mined in large tonnages; the same applies to barite, which at many localities (with the exception of the Pennant Mine GCR site) is little more than a trace mineral. Minor sulphides comprise chalcopyrite, pyrite, marcasite and enargite, while uraninite-bearing bituminous hydrocarbons are present at several sites.

GCR sites illustrating the character of the North-east Wales Orefield Mississippi Valley-type deposits (Figure 5.71) show contrasting mineral assemblages; the Halkyn Mountain GCR site, in which quartz is rare, contrasts with the quartz-rich mineralization of the Minera Block, in the southern part of the orefield, represented by the Pool Park and South Minera Mines GCR site. In addition to the primary mineralization, in the Halkyn Mountain GCR site area, supergene alteration has resulted in the formation of cerussite, pyromorphite, smithsonite, cinnabar, malachite, chrysocolla and azurite. Additionally, some of the finest known specimens of azurite from Wales have been discovered very recently at the Halkyn Mountain GCR site (Bevins and Mason, 1999). Finally, a possible extension of the orefield, at the Pennant Mine GCR site, shows the additional presence of barium mineralization.

References



(Figure 5.71) Map showing the distribution of old lead mines in the North-east Wales Orefield, showing the locations of the Halkyn Mountain, Pool Park and South Minera Mines, and Pennant Mine GCR sites. After Lewis (1976).