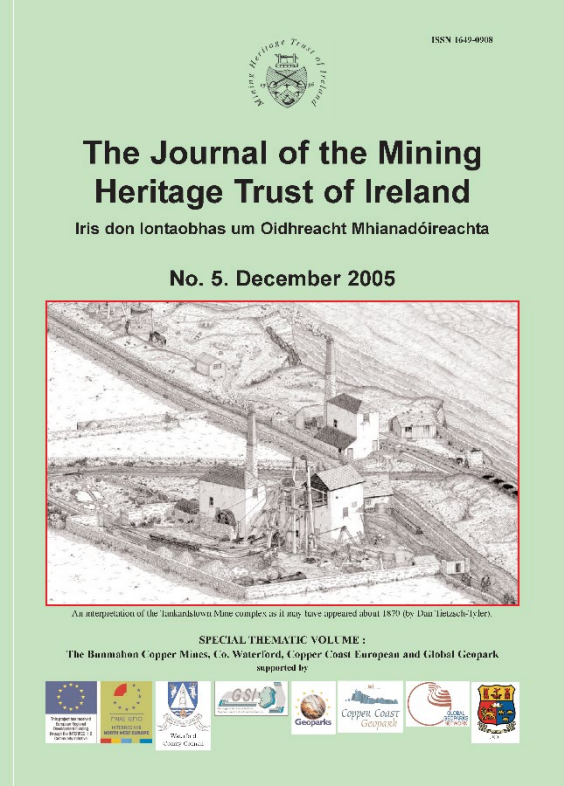

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THE MINERALOGY OF THE BUNMAHON COPPER MINES, CO. WATERFORD

By Stephen Moreton

Abstract: Twenty eight minerals are known to occur in the copper mines of the Bunmahon district. Some of these have formed as colourful coatings on the walls of the mines after their abandonment and include several normally uncommon species, namely: atacamite, botallackite, brochantite, clinoatacamite, connellite and langite. In the early days of mining fine specimens of cuprite and native copper were found, but these are elusive nowadays. *Journal of the Mining Heritage Trust of Ireland*, **5**, 2005, 11-14.

INTRODUCTION

The copper mines of the Bunmahon area have never achieved prominence as a source of fine mineral specimens. This may be due to a combination of factors. There is only a modest development of oxidised zones in the deposits, and the primary veinstuff tends to be compact with few open vugs to allow crystallisation of the constituent minerals. Perhaps the main reason is the absence of collecting activity during the period the mines were being worked. Scattered reports and a handful of old museum specimens from the nineteenth century indicate that good mineral samples were present, it just seems that few have survived to the present day.

In recent years the mines have been visited by collectors and amateur mineralogists. Consequently many minerals not recorded by their Victorian counterparts have come to light. These are dominated by post-mining formations on the walls of the old workings, and on tip material. As these have formed in the decades subsequent to mining it is unsurprising they are absent from the 19th century accounts. Conversely, it has not been possible to repeat some of the 19th century discoveries as they have been obliterated by later mining, or the ravages of time.

This article summarises the mineralogy of the district, drawing on historical reports, and on modern published work, supplemented with the author's own, unpublished observations from intermittent visits to the area over a period in excess of 20 years. As exploration has concentrated on the easily accessible coastal sites, leaving many of the inland ones on private land unexamined, this article cannot be viewed as a complete and comprehensive survey of the district's minerals. Rather it is a summary of the present state of knowledge.

MINERALOGY

There follows an alphabetical listing of the minerals currently known from the mines. Minerals, such as anatase, epidote and rock-forming minerals, which are incidental and unrelated to the copper mineralisation, are not described. Identifications of recent finds have been by electron probe analysis, X-ray fluorescence (XRF), X-ray diffraction (XRD) and infra-red spectroscopy (IR) wherever appropriate.

Ankerite, $Ca(Fe,Mg,Mn)(CO_3)_2$
The notes of the late Dr George Ryback mention a XRF identification of ankerite from "Knockmahon mine".

Atacamite, $Cu_2Cl(OH)_3$
Ireland's first reported occurrence of atacamite was as powdery green coatings on the east side of the partially rubbish-filled pit next to the Tankardstown engine house (Moreton, 1991). It has since been found on the coast at Cuan (Stage) Cove with botallackite and clinoatacamite (see below).

Barite, $BaSO_4$
Barite was reported by Holdsworth (1834), and also by Wheatley (1971), but few details were given.

Bornite, Cu_5FeS_4
Recorded by Smyth et al (1864), no details.

Botallackite, $Cu_2Cl(OH)_3$
Botallackite was reported by Braithwaite & Wilson (2001) from a natural vein outcrop on the coast at grid ref. X 444 986. Here it forms crystals up to 2 mm long accompanying cuprite, malachite and traces of connellite and native copper. They also report an occurrence with atacamite and clinoatacamite nearby at Cuan (Stage) lode.

Brochantite, $Cu_4SO_4(OH)_6$
Microcrystalline, emerald green crusts with langite, from the walls of Tankardstown mine, have been identified by XRD and microchemical tests as brochantite. Traces have also been found in a tip near Bunmahon accompanying lavendulan (below).

Calcite, $CaCO_3$
Holdsworth (1834) mentioned finding a rose-coloured variety of calcite in one mine, but neglected to say which. According to Wheatley (1971) it is more prevalent in the outer parts of the mineralised zone. Both authors associate it with minor Pb/Zn mineralisation.

Chalcanthite, $CuSO_4.5H_2O$
Light blue, water-soluble efflorescences of chalcanthite, accompanying atacamite, were noted by Moreton (1991) on the east side of the rubbish-filled pit near the Tankardstown engine house where an overhang protected them from the rain.

Chalcocite, Cu_2S
Grey copper sulphide ores are widespread in small amounts, and referred to by Holdsworth (1834). Chalcocite is a likely mineral although careful tests would be needed to distinguish it from related minerals such as djurleite and digenite.

Chalcopyrite, $CuFeS_2$

Chalcopyrite was the principal ore sought and is probably unbiquitous. It occurs massive or disseminated; crystals have not yet been found by the author. Particularly rich lumps may be found in a small tip in the valley floor at Kilduane.

Chrysocolla, $(Cu,Al)_2H_2Si_2O_5(OH)_4.nH_2O$

There is a specimen of chrysocolla in the Russell collection at the Natural History Museum (London) from "Knockmahon mine" (George Ryback, personal communication).

Clinoatacamite, $Cu_2Cl(OH)_3$

Clinoatacamite was found as a mixture with atacamite and botallackite by the late Dr. George Ryback as green crusts on the roof of an adit in the sea-cliff in Cuan (Stage) Cove (Braithwaite & Wilson, 2001). Identification was by XRD. So far this is the only known Irish occurrence of this very rare mineral.

Cobalt arsenide, CoAsS

Tiny (up to ca. 60 microns) euhedral grains of a cobalt arsenide mineral occur in erythrite-stained material in waste behind the rubbish filled pit near the Tankardstown engine house. An average of 9 electron-probe analyses gave 26.36 % Co, 5.26 % Ni, 2.28 % Fe, 0.44 % Sb, 42.61 % As and 20.89 % S. The ranges for Ni and Fe were 3.36 - 10.00 and 1.10 - 4.43 % respectively. It replaces and grows around earlier pyrite, and is also present as inclusions in chalcopyrite. This composition fits cobaltite, but it could conceivably be low iron glaucodot or alloclasite, which have the same formula. Alloclasite can be eliminated as it is pleochroic and the material here is not. XRD would be needed to distinguish the other two.

Connellite, $Cu_{19}Cl_4SO_4(OH)_{32}.3H_2O$

Connellite was first reported by Moreton (1991) as an intimate mixture with langite at the mouth of a level on Bonhiva lode, in the sea cliff almost opposite the Cassaunnagreana rock, at grid ref. X 446 986. Since then a rich occurrence has been found in a small level in Trawnamoe cove. Here it forms intense cobalt blue stains and coatings on one wall of a small stope, and amongst debris on the floor below. Identification was by XRD and IR. Traces have also been found at the botallackite occurrence of Braithwaite & Wilson (2001) and in a tip near Bunmahon with lavendulan (Ryback & Moreton, 1991).

Copper, Cu

Native copper as crystalline and dendritic masses was recorded from Kilduane mine by Smyth et al (1864). None was found by the author on a visit in 2002. Little remains of the 19th century workings here. Those that are easily found date to the early 20th century (Des Cowman, personal communication). The Russell Collection in the Natural History Museum (London) includes copper from "Knockmahon mine". Two excellent specimens in the National Museum of Ireland, labelled simply "Waterford", are doubtless from the Bunmahon district. G1359 is a magnificent arborescent sheet, ca. 12 x 7 cm, with some octahedral faces. G1284 is composed of delicate branching masses. Traces of copper with cuprite were reported by Braithwaite & Wilson (2001) in a vein outcrop on the coast.

Cuprite, Cu_2O

Crystals of cuprite on native copper were recorded from Kilduane mine by Smyth et al (1864) and some of Smyth's specimens with native copper, collected in 1847, are preserved in the Russell Collection in the Natural History Museum (London). It has not, to the author's knowledge, been found at Kilduane in recent times. The Russell Collection also includes cuprite from "Knockmahon mine". Veinlets of massive cuprite, with traces of copper and minor botallackite have been reported in a vein outcrop in a small cove at grid ref. X 444 986 (Braithwaite & Wilson, 2001).

Figure 1. Native copper from the Tankardstown area. National Museum of Ireland, Natural History specimen G1359. Two cent coin for scale. Photo: Matthew Parkes

Dolomite, $CaMg(CO_3)_2$

Dolomite was mentioned by Wheatley (1971) as an accompaniment of minor Pb/Zn veins.

Erythrite, $Co_3(AsO_4)_2.8H_2O$

"Blue and red earthy arseniate, and earthy black oxide of cobalt" were reported by Holdsworth (1834) but no details were given. Greg and Lettsom (1858) record erythrite with malachite, in what must have been an attractive colour combination, from "Bonmahon Head". The 6" geological map (Waterford, sheet 24) also records traces of cobalt from here. In recent times it has been found as pink stains, of post-mining origin, in dump material on the cliff top at Trawnamoe, and rarely at Trawnastrella nearby. Similar material also occurs in waste behind the rubbish-filled pit near the Tankardstown engine house. This latter material contains minute, disseminated grains of a cobalt arsenide mineral (see above).

Galena, PbS

Massive, disseminated, and argentiferous galena has long been known from the district, but is scarce and concentrated towards the periphery of the mineralised area (Wheatley, 1971).

Gypsum, $CaSO_4.2H_2O$

Holdsworth (1834) found "small, but highly splendent crystals of sulphate of lime" without saying at which mine. As gypsum is an extremely common, and rapidly-formed, post-mining

encrustation it is probably present in many of the workings, although its often crumbly, and dirty, appearance may explain why there appear not to be any modern reports of it.

Langite, $Cu_4SO_4(OH)_6.2H_2O$

The first report of langite from the district was a minor occurrence with connellite in a level on Bonhiva lode (Moreton, 1991) although it had previously been found in traces with lavendulan in a tip near Bunmahon (Ryback & Moreton, 1991). Rich crusts of microcrystalline, blue-green langite (XRD confirmed) have since been recovered from the walls of levels in the cliffs below Tankardstown mine. By Irish standards these are second only to the famous examples from the walls of Mountain mine, Allihies, Co. Cork, where are of international importance. The friable nature of their matrix detracts somewhat, together with their association with a copper-rich silica gel material that dehydrates and crumbles soon after removal to a dry environment.

Lavendulan, $NaCaCu_5(AsO_4)_4Cl.5H_2O$

Pale-turquoise fibrous spherules, 0.07 mm across, of lavendulan were found with erythrite and traces of connellite, langite and brochanite,on a grey shaley matrix, in a tip at grid ref. X 425 985 near Bunmahon by the late Dr George Ryback (Ryback & Moreton, 1991). This tip has recently been cleared away.

Malachite, $Cu_2CO_3(OH)_2$

Malachite can be found as spherules up to 5 mm across in quartz in waste derived from North Tankardstown mine. It was also reported by Greg & Lettsom (1858) from "Bonmahon Head". As a post-mining formation, rich crusts occur in the furthest reaches of the level on Bonhiva lode (Moreton, 1991) and it is a constituent of the otherwise amorphous, wet, blue and green gels the coat the walls of Tankardstown mine (XRD and IR confirmed). These are illustrated on the cover of MHTI Journal 2, December 2002.

Pyrite, FeS_2

Disseminated cubes up to 1 mm are widespread according to Wheatley (1971).

Quartz, SiO_2

Massive milky quartz is the principal gangue mineral in all the veins. Rarely, little (usually < 2 cm) milky prisms can be found in small cavities.

Sphalerite, ZnS

Sphalerite was reported by Wheatley (1971) as pale russet grains up to 1 mm across, and was also mentioned by Holdsworth (1834).

Tenorite, CuO

Holdsworth (1834) mentioned "black oxide of copper" (tenorite) but gave no details.

Tetrahedrite, $(Cu,Ag,Fe)_{12}Sb_4S_{13}$

25 micron grains, of near Sb end-member tetrahedrite, with about 1.6 % Ag were reported by Wheatley (1971). In the course of this study, two < 20 micron grains of a zinc-rich argentian tetrahedrite were observed at the margins of a chalcopyrite grain in the cobalt arsenide sample analysed above. Both grains gave similar electron probe analyses. Averaged these were 18.78 % Ag, 5.10 % Zn, 2.06 % Fe, 24.24 % Cu, 26.00 % Sb, 1.66 % As and 22.44 % S.

DISCUSSION

To date twenty eight minerals are known from the mines of the district. Some of these (atacamite, chalcanthite, clinoatacamite, connellite, langite, and probably the lavendulan) owe their existence entirely to post-mining oxidation processes. The erythrite found in modern times is also post-mining but that found in the 19th century most likely represents natural supergene material. The botallackite is from a natural outcrop and so it too can be considered an entirely natural occurrence. The presence of four chloride minerals (atacamite, botallackite, clinoatacamite and connellite) is, doubtless, attributable to the proximity of the sea.

The cobalt arsenide from Tankardstown is of interest as the presence of erythrite has been known for a long time, without any record of a primary cobalt ore as its source. It is hoped future work will confirm its identity more precisely.

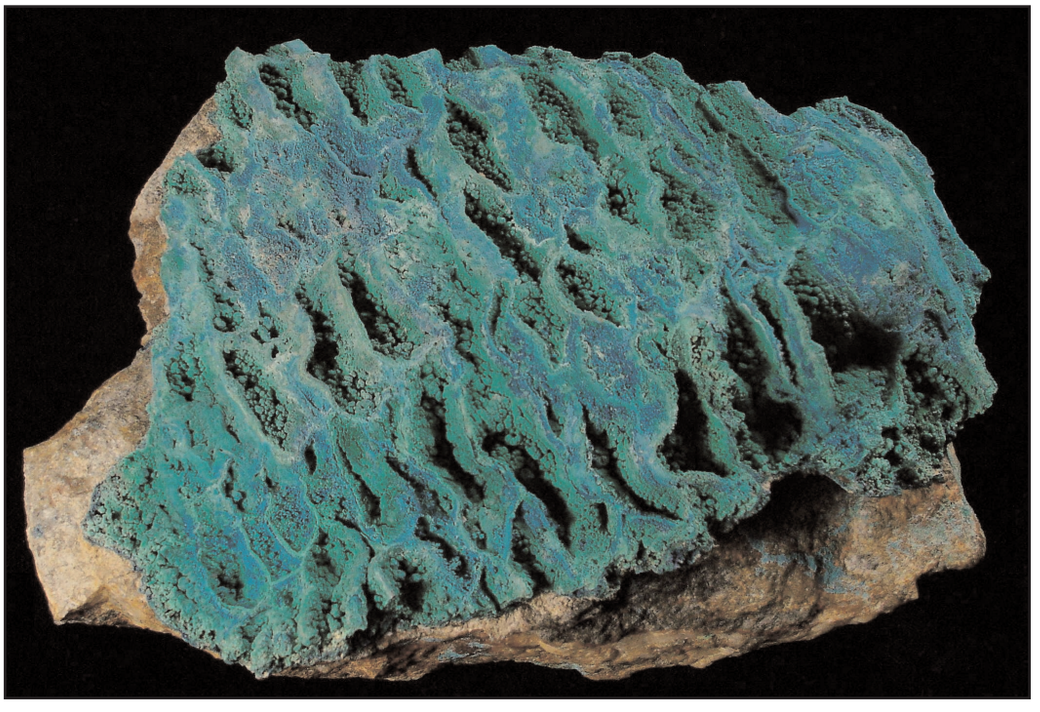

Figure 2. Rippled malachite with blue langite, from the walls of Tankardstown mine. Field of view 11 x 7 cm. Photo: Stephen Moreton.

In addition to the minerals listed above, some mention should be made of the colourful deposits that richly adorn the walls of Tankardstown mine. As these are largely amorphous complex mixtures they are not a defined mineral. Chemical analysis shows them to be a mixture of silica gel and copper salts. Removal to a dry environment results in their rapid dehydration and disintegration making them of little interest to collectors. Analysis of these is continuing and, it is hoped, will be published in due course.

Also present in Tankardstown mine are soft, wet stalactites of a black substance (at a point marked "Black mineral on walls" on the plan of Critchley (2002)). This has a very high water content (84 % loss at 105 ^{o}C) and is completely amorphous to XRD. A wet chemical test by the author gave a very strong reaction for manganese.

It seems likely, from the few 19th century reports of fine erythrite, malachite, copper and cuprite that good specimens were found in the heyday of mining. Unfortunately for Irish mineralogy, Ireland has never had the vigorous tradition of collecting that characterised the famous British mining districts such as Cornwall, the Caldbeck Fells and Leadhills. Whilst "old-time" specimens from these areas abound, very few survive from contemporary Irish mining districts. Without collectors and dealers offering incentives to the miners to save specimens, whatever they found is likely to have been treated as ore for the smelter, rather than as a piece of their natural heritage.

That about a third of the minerals listed above owe their discovery to modern collectors is a testament to the importance of allowing amateur mineralogists access to carry out their activities. As there remain sites, particularly inland, that have not been properly examined, there is plenty of scope for further discoveries.

ACKNOWLEDGEMENTS

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