Tungsten/Wolfram

The presence of tungsten / wolfram in tin ores in the south-west of England (Cornwall and West Devon) was, like arsenic, a major contaminant which, if it was not removed prior to smelting, seriously degraded the value of the metal. Its German name ‘wolfram’ is even derived from reference to its unwanted status - wolf’s spit or froth (Young pers comm.1). It was not until the second half of the 19th century that the value of the metal as a hardening alloy in steel was realised and at that period methods of effectively separating tungsten ores from the tin were being developed. The processing of tungsten ores was never-the-less a complex procedure and the British metal industries showed little interest in it, preferring to send the concentrates to Germany for processing and re-importing the metal for use in the steel industry. With the advent of the First World War this reliance on German processing was curtailed, British industry had to quickly develop its own facilities and tungsten ores were in considerable demand for armament production. The rise and fall of production in Cornwall, West Devon and Cumberland (the only other source of tungsten ores in Britain) was governed thereafter by periods of conflict.

Geological background

The principal economic ores of tungsten or wolfram (the two names are interchangeable for the metal although the latter is frequently used to refer to the ores) are wolframite (\([\text{Fe, Mn}] \text{WO}_4\)), a mixture of the tungstates of iron and manganese, and scheelite (\(\text{CaWO}_4\)), calcium tungstate. They are found in the south-west of England in association with tin as stockworks in greisen mineralisation linked to the Cornubian granite emplacement (Scrivener & Shepherd 1998, 149-50; Beer & Scrivener 1982, 134-35). In the north-west, on the southern slopes of Carrock Fell in what is now Cumbria, the mineralisation is associated with a granite-greisen outcrop of the Skiddaw Granite Cupola (Moore 1977, 7-8).

Historical background

Although a number of mines in Cornwall, including East Pool, South Crofty, Carn Brea, Tincroft and Clitters United, along with Bedford United in Devon (Brooks 2001, 107-30), produced tungsten concentrates as a by-product of tin production (some 4857 tons from Cornwall up to 1913 - Burt et al 1987, xxxii), only a few mines in the south-west of England have been developed primarily as tungsten producers; Cligga Head, Castle-an-Dinas, in Cornwall, and Hemerdon, in west Devon. The latter, although sitting on one of the largest tungsten deposits in Europe, has a recorded production of only 31 tons since being opened up late in the First World War (Dines 1969, 688-89). Despite having significant investment in milling facilities in the 1940s and again in the 1970s it has been kept on ‘care and maintenance’ for the majority of its life. There is, however, active development currently underway on the site. Cligga Head was re-opened in 1938, having been worked in a

1 Tim Young, Wolf’s spit: new evidence for an old term, presentation to the Historical Metallurgy Society meeting on Research in Progress, Newcastle University 6 November 2012.
small way prior to that date, and worked until 1945 in response to the high demand created by the Second World War, producing 300 tons of tungsten concentrates (Dines 1969, 457-59).

Castle-an-Dinas was by far the most important tungsten mine in Britain, with a total production of over 2483 tons of concentrates over its 40 year life (Brooks 2001, 137). Tony Brooks (2001) provides a comprehensive account of the mine which was opened up in 1917 in response to war time demand. Apart from a brief period on care and maintenance in the 1920s the mine operated until the decline in the price of tungsten price after the end of the Korean War, with its most productive period in the late 1930s.

Carrock Mine, the only tungsten producer outside of Devon and Cornwall, was probably the first to be worked primarily for tungsten. It was tried initially as a lead / copper prospect in the 1850s and 1870s but soon failed and then re-opened for tungsten in 1902, being taken over by the German run Cumbrian Mining Company in 1906. In 1913 British interests took over and the mine was worked for the duration of the First World War, after which it was closed and only re-opened in 1942 as renewed conflict increased demand for the metal. Despite government sponsored exploratory work, the mine did not go into production and was abandoned the following year. Further exploratory work was carried out in the early 1970s and a new mill erected, but the closed more or less immediately. Renewed interest in the late 1970s led to further exploratory work and the mill was reactivated but only operated for a short period before it was closed in 1981 and dismantled in 1985 (Moore 1977; Cooper & Stanley 1990, 43-47).

**Technology**

The separation of tungsten ores from the tin ore cassiterite was difficult, the similarity in their specific gravities (wolframite 7.1 - 7.5, and cassiterite 6.8 - 7.1) limited the effectiveness of gravity separation although controlled crushing using stamps could result in the more friable wolfram ores being removed as slimes, along with a portion of the tin. Tin ore associated with tungsten ores was therefore avoided if at all possible (Brooks 2001, 5).

In 1844 the Oxland process was introduced as an effective method of removing unwanted tungsten from tin concentrates - the soda process. The concentrates were first roasted with sodium carbonate as a result of which sodium tungstate was produced and, as that is soluble in water, the tungsten could be removed by leaching. This process was replaced at the turn of the century by magnetic separation which first separated out any iron oxides from the concentrate using low power magnets and then removed tungsten minerals with high power magnets, leaving a clean tin concentrate. The tungsten ores thus separated were pickled in acid to remove any remaining iron, dried then passed through another magnetic separator to produce a clean tungsten concentrate (Brooks 2001, 5-6). The mill at Castle-an-Dinas used a combination of crushing, gravity separation and magnetic separation, and is described in detail, illustrated with a flow sheet, in Brooks 2001 (38-44).

The mill erected at Carrock Mine in the 1970s and the trial plant at Hemerdon in the 1980s were probably the most advanced ore preparation plants erected in Britain which did not rely on flotation.
The infrastructure of tungsten / wolfram mining

Prior to the first decade of the 20th century the production of tungsten concentrates came as a bi-product of tin production and was, thereafter, a relatively small scale specialist operation only viable during periods of conflict. It placed no new demands on transport systems or settlement patterns.

Archaeology of tungsten / wolfram mining

Until recently, there have been no archaeological investigations embracing the physical evidence for tungsten mining. The Castle-an-Dinas mine site was included in the Archaeological Survey Report (Bishop 2011) but only where it impacted on the Iron Age hill fort and the mine itself was not surveyed.

Two factors in recent years have focused attention on the archaeology of tungsten mining in Devon and in Cumbria. In the first instance, the renewed interest in exploiting the deposits at Hemerdon has initiated an assessment of the surviving features, including the mill buildings, but the results of that work have yet to be published. At the Carrock Mine, concerns over the environmental impact of mine water discharges have resulted in remedial work, including stabilisation of one of the mine entrances and on-going management of the scheduled ancient monument by the Cumbria Amenities Trust Mining History Society, supported by an archaeological survey carried out by Archaeo-Environment Ltd (2012). In its turn, that has highlighted the condition of the early 20th century mill buildings which are to be surveyed prior to conservation work (John Hodgson, LDNPA archaeologist, pers comm.2).

Acknowledgements

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Bibliography


2 Based on discussion at the Lake District Mines Forum meeting, Kendal, 31 January 2013.


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