Granite Related Indium Mineralisation in Southwest England

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1 Introduction

Southwest England (fig. 1) constitutes one of the most significant historical mining regions in Europe with an extractive industry spanning several thousands of years. The historic production was dominated by tin and copper, but at the peak of mining, a much wider range of metals and metalloids were being recovered (notably Ag, As, Pb, Sb, and Zn).

2 Results

The geology of southwest England is dominated by the voluminous granite batholiths that intruded during the Variscan orogeny. Significant indium is found in sulphide-bearing skarns from the northern margin of Dartmoor (the Red-a-Ven mine), the greisen vein systems at Redmoor and Cligga Head, and more than 20 main stage mineral vein systems across the region. The richest occurrences have been identified at Botallack (St Just district); Dolcoath, Wheal Concord and Nangiles (Camborne-Redruth-St Day district), Wheal Charlotte (St Agnes) and Perran St George (Perranporth).

Total indium concentrations are very variable within and between the individual deposits (fig. 2). Whole-rock concentrations reach 420 ppm (800 ppm in 100% sulphide + oxide). The indium is distributed between sphalerite (<1.2 wt%), chalcopyrite (<2200 ppm), stannite (<6700 ppm) and cassiterite (<1800 ppm). Indium rich vein systems also carry rare, minute grains of roquesite (CuInS₂) which are commonly associated with bornite and chalcocite. While the mineralogical distribution of indium

Fig. 1. Geological map of SW England showing the principal areas affected by granite-related mineralisation.

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is variable, there is commonly a broad correlation between the concentrations within coexisting host minerals.

3 Potential for Extraction

Although indium concentrations are highest in sphalerite and stannite, chalcopyrite is the dominant mineral host throughout the area. This raises important questions to the potential for extraction. Most economic operations elsewhere recover indium from sphalerite during smelting by acid leaching and precipitation (Hoffmann, 1991; Alfantazi & Moskalyk, 2003). Although we have failed to find a commercial process for indium recovery from copper concentrates, Ke et al. (1984) reported a method to recover indium along with other metals from copper smelter flue dust, which could form a basis for the development of a commercially viable method of extraction.

4 Methods of Formation

Our investigations suggest that there are three particular environments that have lead to the deposition of indium: 1) The sulphide skarn environment, where indium is variably associated with sphalerite and chalcopyrite; 2) a high temperature granite-related vein assemblage where chalcopyrite is the dominant host along with minor Cu-rich sphalerite; and 3) a low temperature granite-related vein assemblage, where indium occurs exclusively in sphalerite. We interpret roquesite to have formed during alteration of indium bearing chalcopyrite to bornite during supergene oxidation and/or weathering.

5 Conclusions

While indium may never become a main commodity for targeted exploration and extraction, the metal has significant potential to add value to the extraction of tungsten, tin, copper and zinc in the region. Although the metal is considered as a potential by-product by Western United Mines, much more detailed investigations are required to fully understand the timing and nature of indium mineralisation within individual mineral vein systems.

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References
