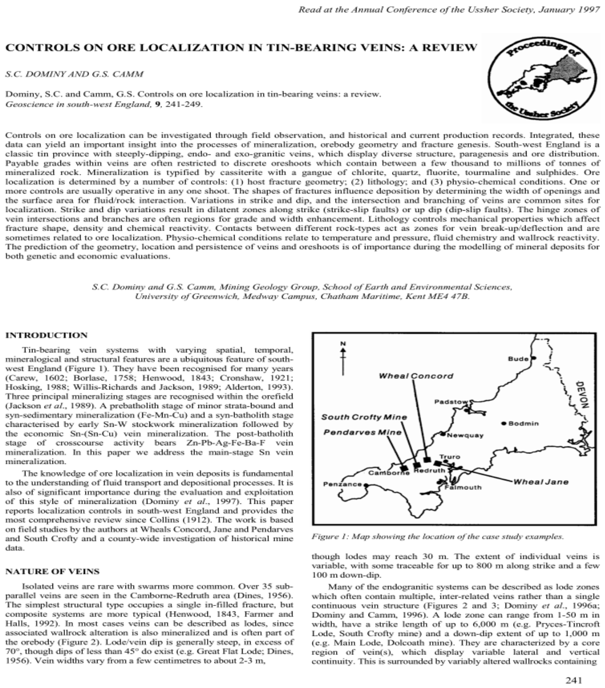
Structural controls on ore genesis (Reviews in Economic Geology, Volume 14)



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CONTROLS ON ORE LOCALIZATION IN TIN-BEARING VEINS: A REVIEW

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Controls on ore localization can be investigated through field observation, and historical and current production records. Integrated, these data can yield an important insight into the processes of mineralization, orebody geometry and fracture genesis. South-west England is a classic tin province with steeply-dipping, endo- and exo-granitic veins, which display diverse structure, paragenesis and ore distribution. Payable grades within veins are often restricted to discrete oreshoots which contain between a few thousand to millions of tonnes of mineralized rock. Mineralization is typified by cassiterite with a gangue of chlorite, quartz, fluorite, tourmaline and sulphides. Ore localization is determined by a number of controls: (1) host fracture geometry; (2) lithology; and (3) physio-chemical conditions. One or more controls are usually operative in any one shoot. The shapes of fractures influence deposition by determining the width of openings and the surface area for fluid/rock interaction. Variations in strike and dip, and the intersection and branching of veins are common sites for localization. Strike and dip variations result in dilatent zones along strike (strike-slip faults) or up dip (dip-slip faults). The hinge zones of vein intersections and branches are often regions for grade and width enhancement. Lithology controls mechanical properties which affect fracture shape, density and chemical reactivity. Contacts between different rock-types act as zones for vein break-up/deflection and are sometimes related to ore localization. Physio-chemical conditions relate to temperature and pressure, fluid chemistry and wallrock reactivity. The prediction of the geometry, location and persistence of veins and oreshoots is of importance during the modelling of mineral deposits for both genetic and economic evaluations.

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INTRODUCTION

Tin-bearing vein systems with varying spatial, temporal, mineralogical and structural features are a ubiquitous feature of south-west England (Figure 1). They have been recognised for many years (Carew, 1602; Borlase, 1758; Henwood, 1843; Cronshaw, 1921; Hosking, 1988; Willis-Richards and Jackson, 1989; Alderton, 1993). Three principal mineralizing stages are recognised within the orefield (Jackson *et al.*, 1989). A prebatholith stage of minor strata-bound and syn-sedimentary mineralization (Fe-Mn-Cu) and a syn-batholith stage characterised by early Sn-W stockwork mineralization followed by the economic Sn-(Sn-Cu) vein mineralization. The post-batholith stage of crosscourse activity bears Zn-Pb-Ag-Fe-Ba-F vein mineralization. In this paper we address the main-stage Sn vein mineralization.

The knowledge of ore localization in vein deposits is fundamental to the understanding of fluid transport and depositional processes. It is also of significant importance during the evaluation and exploitation of this style of mineralization (Dominy *et al.*, 1997). This paper reports localization controls in south-west England and provides the most comprehensive review since Collins (1912). The work is based on field studies by the authors at Wheals Concord, Jane and Pendarves and South Crofty and a county-wide investigation of historical mine data.

NATURE OF VEINS

Isolated veins are rare with swarms more common. Over 35 sub-parallel veins are seen in the Camborne-Redruth area (Dines, 1956). The simplest structural type occupies a single in-filled fracture, but composite systems are more typical (Henwood, 1843, Farmer and Halls, 1992). In most cases veins can be described as lodes, since associated wallrock alteration is also mineralized and is often part of the orebody (Figure 2). Lode/vein dip is generally steep, in excess of 70°, though dips of less than 45° do exist (e.g. Great Flat Lode; Dines, 1956). Vein widths vary from a few centimetres to about 2-3 m, though lodes may reach 30 m. The extent of individual veins is variable, with some traceable for up to 800 m along strike and a few 100 m down-dip.

Figure 1: Map showing the location of the case study examples.

Many of the endogranitic systems can be described as lode zones which often contain multiple, inter-related veins rather than a single continuous vein structure (Figures 2 and 3; Dominy *et al.*, 1996a; Dominy and Camm, 1996). A lode zone can range from 1-50 m in width, have a strike length of up to 6,000 m (e.g. Pryces-Tincroft Lode, South Crofty mine) and a down-dip extent of up to 1,000 m (e.g. Main Lode, Dolcoath mine). They are characterized by a core region of vein(s), which display variable lateral and vertical continuity. This is surrounded by variably altered wallrocks containing

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