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Deformation and recrystallization microstructures in deformed ores from the CSA mine, N.S.W., Australia: Discussion

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MANY differing hypotheses have been offered in relation to the genesis of ore deposits in the Cobar region, N.S.W., Australia. They range from classical epigenetic interpretations (e.g. Rayner 1969, in relation to the CSA mine and the older mines southeast of Cobar), through syn-genetic (Sangster 1979, for the CSA mine) and remobilized syn-genetic models (e.g. Brooke 1975, Gilligan & Suppel 1978), to more complex proposals invoking remobilized massive subhalative mineralization and subordinate exhalative mineralization, overprinted by metahydrothermal mineralization (Marshall & Sangameshwar 1982, Marshall *et al.* 1983, mainly for CSA mine). More recently, Glen (1984, 1987), de Roo (1989, for Elura mine) and Hinman (1989, for the Peak deposit), proposed a metamorphic origin for their particular deposits and, by implication, for much of the exploited mineralization in the Cobar region; an interpretation now endorsed by Brill (1989).

Brill is to be congratulated on her detailed analysis of the microstructure of ores from the CSA mine. However, certain parts of this analysis of ore-mineral paragenesis and mesoscale vein relationships are questionable in my view, and detract from her conclusion that the ore zones at CSA mine have formed early in the deformation history. I do not, nevertheless, dispute her other conclusion that the work is inconsistent with models invoking deformation of a syn-genetic, *exhalative* ore body.

I should like to discuss five specific points from Brill's article.

(1) Her fig. 2 (after O'Connor 1980) is used to show that the orebodies are grossly transgressive to bedding and are *subparallel* to regional cleavage (S_1). Figure 2 in fact shows a constant-vergence small-angle relationship between the orebodies and S_1, a geometry that was originally recognized by Andrews (1913) at the New Occidental mine (but was modified by Glen 1987) and was interpreted by Marshall & Sangameshwar (1982) as a distortion of the angular relationship between feeder orebodies and bedding, progressively overprinted by S_1 (Fig. 1).

(2) The paragenetic sequence (Brill 1989, fig. 3) has a hydrothermal stage, during which all the main ore minerals at least partly precipitated, apparently predating the early metamorphic stage. How this supports a syn-tectonic origin for the mineralization (as advocated by Brill) is not clear, since she does not relate metamorphism and deformation events within the context of her paragenetic diagram. Nevertheless, her statements to the effect that foliation in the Cu–Zn ore is subparallel to S_1, and banding in Pb–Zn ore reflects an S_1-parallel preferred orientation, are consistent with deformation

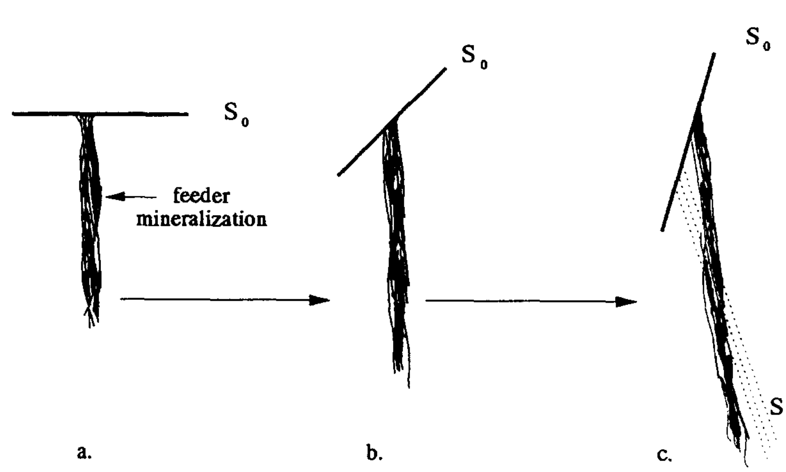

Fig. 1. Schematic diagrams; not to scale. (a) Relationship of bedding (S_0) to feeder mineralization before deformation. (b) & (c) Stages in the progressive modification of the angle between bedding and feeder mineralization during folding and cleavage (S_1) development.

being imposed on pre-existing ore. That is, the ore was pre-tectonic in terms of S_1.

(3) A similar difficulty exists in relation to the meso-scale chaotic texture which Brill likens to the "Durchbewegung texture" described by Vokes (1969) from many deformed Scandinavian ore deposits. Vokes applied the term to a chaotic clast-in-matrix texture that had developed in syn-genetic exhalative ores as a consequence of metamorphism and deformation. Although the term is not restricted to this set of circumstances (Marshall 1988, Marshall & Gilligan 1989) the texture can not, in itself, be construed as supporting a syn-tectonic genesis for the mineralization.

(4) Brill states that the relationships between vein orientation and cleavage suggest that mineralization commenced early in the deformational history and continued into a late-kinematic stage. Her fig. 4 is not entirely consistent with this; the relationships portrayed in parts A, B and even C of fig. 4 could involve pre-S_1 veins.

(5) Finally, although Brill shows that the sulphides exhibit dynamic recrystallization, this neither proves nor even supports a syn-tectonic genesis for the mineralization. For example, quartz exhibits dynamic recrystallization in a mylonite but this does not mean that the quartz was introduced during the mylonitization.

The purpose of these comments, through items (1)–(5), is not to discredit Brill's detailed microstructural work. Nor is it to disprove her conclusion that her work argues against a model involving deformation of a syn-genetic body of exhalative mineralization. It is, however, to show that at least some of the mineralization could be pre-tectonic (with respect to S_1/D_1), which suggests that more complex genetic models (e.g. of the type proposed by Marshall & Sangameshwar 1982, and Marshall *et al.* 1983) than a simple syn-tectonic genesis should be considered.

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