Journal of Structural Geology, Vol. 13, No. 1, pp. 119 to 120, 1991
Printed in Great Britain

0191-8141/91 $03.00+0.00

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

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(*Received* 4 *June* 1990; *accepted* 12 *June* 1990)

I APPRECIATE the comments that have been made to my paper by Marshall, and would like to reply to the points made (in order).

(1) Figure 2 in the original paper (Brill 1989) represents a gross-scale cross-section of the CSA orebody. In order to determine the age relationship between metamorphism, deformation and mineralization, however, one should also consider my fig. 4 which gives a detailed account of the relationship between regional cleavage and the different vein systems (cf. point 4 below).

(2) There is a mistake in my earlier fig. 3. The figure should be replaced with Fig. 1 of this discussion. I agree that most of the Pb–Zn mineralization is early in relation to the major deformation phase and is early S_1 (or may be even pre-S_1).

(3) "Durchbewegungs textures" are used in a descriptive sense. I do not attempt to use the term to suggest a syn-tectonic origin for the deposit. The textures are used in addition to the microstructures to illustrate an early timing of the mineralization in regard to the main deformation phase D_1. It should also be noted here, that "Durchbewegungs textures" are most commonly seen close to black chlorite shear zones which show cross-cutting relationships with S_1 and earlier Cu-mineralization, and are late tectonic.

(4) Not only the relationships between the veins, but also the fact that all these veins, including the tension veins and late shear veins, are mineralized should be taken into account. This indicates an extended period of the mineralization event from an early tectonic (or even some pre-S_1 as indicated in fig. 4) to a late tectonic stage.

(5) Dynamic recrystallization of the sulfides is not used in order to indicate that the sulfides were introduced during the main phase of deformation. Rather, it was used in addition to the other deformation textures shown by the sulfides to illustrate that the timing of the mineralization would have to be placed *early* in D_1.

I acknowledge that deformational and recrystallization textures by themselves are not sufficient to propose a syntectonic origin for the mineralization at the CSA mine. However, since publication of the paper, O, C, H and S isotopes and fluid inclusion data have been obtained from the mineralized zones (Brill 1988, Seccombe & Brill 1989, Brill *et al.* in preparation). The isotope data indicate a depletion within the ore zones and there are two possible explanations: (i) two fluids have interacted in the ore zone (meteoric and metamorphic water); or (ii) a pre-existing discordant vein system was modified and overprinted during the metamorphic event. Fluid inclusion data and chlorite compositional data indicate a possible resetting of early, low-temperature Pb–Zn veins, but not early, higher temperature Cu veins. They also indicate a lower temperature for the late shear

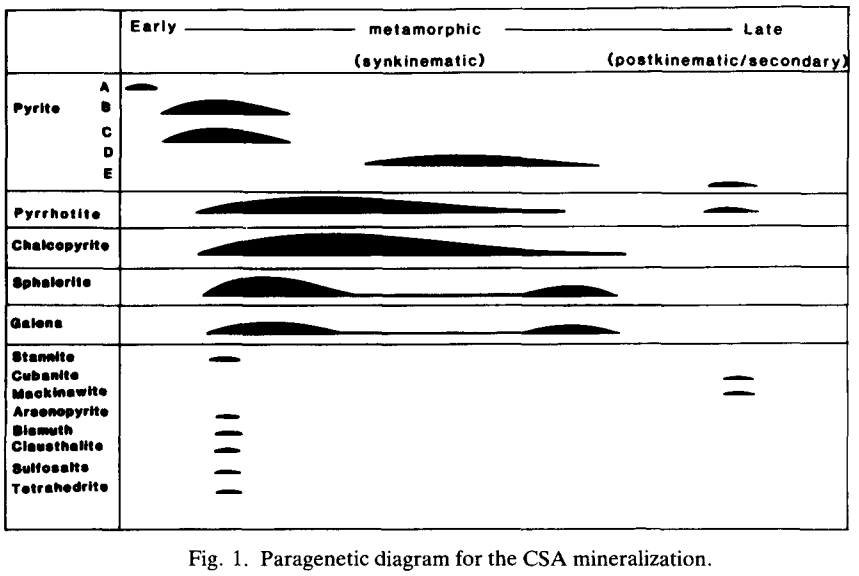

Fig. 1. Paragenetic diagram for the CSA mineralization.

zones that carry a late Pb–Zn phase. In his fig. 1, Marshall proposes a 'feeder' vein system for the CSA mine. The classical model of exhalative massive sulfide deposits (cf. Franklin *et al.* 1981, Ohmoto & Skinner 1983) implies a higher temperature, discordant Cu-rich feeder (or stringer) vein system and an overlying lower temperature, concordant Pb–Zn mineralization. This is not indicated in Marshall's figure. It is also not clear why a 45° rotation of S_0 in fig. 1(b) did not affect the orientation of the 'feeder' mineralization (unless the vein system formed simultaneously with the rotation event).

I agree with Marshall that a simple genetic model does not apply for the CSA mine. The possibility of a pre-existing vein system at the CSA mine cannot be disregarded, but this need not be an exhalative 'feeder mineralization'. Any pre-existing vein system that may have been present has subsequently been strongly remobilized and overprinted by metamorphism so that most of the mineralized zones in the manner in which they are present now, are the result of a prolonged phase of early to late tectonic fluid activity.

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