Genesis and Structural Architecture of the CSA Cu-Ag (P-Zn) Mine, Cobar, New South Wales

By

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Abstract

The CSA Cu-Ag-Pb-Zn deposit, one of the Cobar-style deposits, is located 11km NNW of Cobar in central New South Wales within an area known as the Cobar Mining Field. Historically mined for Pb-Zn, CSA currently recovers Cu-Ag and has a resource base (measured, indicated and inferred) of 11.4 mt at 6% Cu and 22 g/t Ag. While much work has been done on the Cobar-style deposits, there remains a variety of questions regarding the formation of each deposit and the mining field as a whole. Historically, structural studies of the CSA deposit have been restricted to the surface and upper levels of the mine (>9800m RL). Recent mining within the deposit has allowed for further structural analysis up to 1.3 km. A structural and mineralogical study of the CSA mine was undertaken to answer a variety of questions concerning the formation of the deposit, its key characteristics and features (structurally, mineralogically and geochemically) and how this information could be used to explore for similar styles of mineralization both on site and in the Cobar region.

Hosted in the Devonian CSA Siltstone, the deposit resides within the hanging-wall of the steep, west-dipping Cobar Fault. Major ore minerals include acanthite, chalcopyrite, cubanite, pyrrhotite, sphalerite, galena, pyrite, magnetite, and native bismuth. Gangue minerals include quartz, chlorite, calcite, stilpnomelane, plagioclase, biotite, muscovite and talc. The most common alteration styles are Fe-rich chlorite, Fe-Mg-rich chlorite and silicification.

Structural measurements and samples were collected from 45 drill holes across four major ore zones known as the Western, Eastern, QTS North and QTS South systems. Each system is composed of multiple lenses ranging in strike length (13-200 m), width (5-80 m), and vertical extent (200 m-1.2 km). Structural analysis highlighted the presence of two major cleavage groups, one corresponding to the regional cleavage (S_2) and another with varying orientations found locally deemed S_X to avoid timing implications. A subset of S_X was found to represent an early cleavage and was deemed S_1. The orientation of S_2 changes from 80°/090° at surface and the upper portions of the mine (>92000mRL) to 85°/264 (< 9000mRL) with depth and proximity to the Cobar Fault suggesting drag in the hanging-wall of the fault as it rotated in response to EW compression. Stereographic projections of S_2 and $S_2 \wedge S_0$ intersection lineations show that S_2 transects the regional folding produced early in the EW compression. The presence of a stretching lineation with down-dip orientation suggests the lineation was formed during dip-slip regime with very little transpression. Two cross-cutting fault systems, one sub-parallel with S_2 and the other sub-parallel with S_1 were identified and suggested the presence of orthorhombic fault arrays. Dilation occurred along the intersections of these faults allowing mineralizing ore fluids to be focused into pipe-like ore lenses.

A 3D model of the regional stress state was produced using the boundary elements method (Poly3D) in order to ascertain the affect the regional Plug Tank and Cobar Faults had on the formation and spatial location of the CSA deposit. The model showed that, when activated by EW compression, the geometries of these two faults produced a zone of minimum σ_3 directly beneath the deposit and caused dilation in the overlying orthorhombic fault arrays. Deep seated ore-forming fluids were driven along the Plug Tank Fault towards the eastern margin of the basin and up the Cobar Fault into this zone of dilation during compression. Ore-forming fluids were then focused along the intersections of the orthorhombic fault arrays producing the pipe-like ore lenses.

Geochemical analysis suggests that enrichments of Se, Cd, Fe, Mn, Sn, Tl, and Ge and depletions of Ba, K Na, and Rb occur within 100 m of ore lenses and can be used as vectors to ore. The most useful distal vector to ore was determined to be the depletion in Sr and Na occuring up to 500 m from mineralization. Fe-Mg-rich chlorite alteration is recognizable within 10 m of ore lenses.

Ore forming fluids are most likely sourced from the deepest part of the Cobar Basin during inversion. The amount of Cu and the presence of abnormally high fluorine within CSA suggest that

the source of the ore-forming fluids was most likely a basal unit in the rift package containing basalts and carbonates and/or rhyolites. Once the fluids sourced from the rift package travelled along the Plug Tank and Cobar faults into the orthorhombic fault arrays, they mixed with a cooler, locally sourced fluid already circulating through the faults causing precipitation of the Cu-Ag-Pb-Zn minerals.

Overall, this study concluded that the CSA deposit was formed via the interaction of far field stresses acting on regional faults to focus ore-forming fluids into the hanging-wall of the Cobar Fault. This study suggests that exploration done both on the mine site and within the region should include analysis of regional folding and faulting patterns as well as conventional geophysical and geochemical methods.

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