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Controls on Ore Shoot Locations and Geometries at the Stawell Gold Mine, Southeastern Australia: Contributions of the Volcanosedimentary, Alteration, and Structural Architecture

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Abstract

The ability to effectively target ore shoots requires a clear understanding of the numerous parameters that control their formation. However, identification of the nature and timing of these parameters is difficult, particularly in polydeformed deposits with complex stratigraphic and hydrothermal histories. For example, ore shoots at Stawell gold mine's Magdala gold deposits in southeastern Australia are hosted by rocks that experienced at least three ductile and two brittle deformation events in the 70 m.y. prior to the principal mineralization event, and have a close spatial relationship to strongly chlorite ± stilpnomelane–altered sedimentary units near the apex of numerous >5-m-thick reentrant basalt lobes. Whereas the ore shoots at Stawell are located only on the southwestern flank of the 1-km-thick Magdala basalt, about 15 km along strike at the Wildwood prospect the ore shoots are predominantly restricted to the northeastern flank of the basalt. Here, the important issue of controls on ore shoot formation and distribution at Stawell is addressed by presenting the results of a multidisciplinary review of the characteristics and architecture of the volcanic and sedimentary facies, the spatial distribution of alteration assemblages, and the variations in intensity and vergence relationships of the cleavages associated with ductile deformation. This investigation, undertaken at both a regional and shoot scale, shows that the structures hosting the ore shoots at Magdala formed during preferential and localized reactivation of preexisting faults following rotation of the stress field. Preexisting structures, such as Central Lode fault, host many of the ore shoots and were initially generated during east-northeast–west-southwest compression at ca. 510 to 488 Ma. The geometries of these faults were also influenced by the irregular paleotopography of the basalt lobes, which represent flows of pillow and massive basalt separated by interflow sedimentary units. Coincident with this deformation, locally intense chlorite ± stilpnomelane alteration indurated the mud-rich units between the basalt flow-lobes and the Central Lode-type structures. Those thick, mud-rich sedimentary units are present on the southwestern flank of the basalt at Stawell, but predominantly near the top and on the northeastern flank at Wildwood. The switch to east-west compression at ca. 440 Ma caused localized failure and focusing of mineralized fluids in the indurated sedimentary rocks near the apex of the northwest-plunging portions of the basalt lobes. A second, subordinate mineralizing event at ca. 425 to 420 Ma utilized the same architecture under a different stress regime. During both mineralizing events, the high-grade ore shoots formed in zones of high fluid flow defined by the complex preexisting architecture.

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