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Stress Controls on Intrusion-Related Gold Lodes: Wonga Gold Mine, Stawell, Western Lachlan Fold Belt, Southeastern Australia

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Abstract

The Wonga gold lodes (~300,000 oz Au) in the Victorian gold fields of eastern Australia formed at a depth of less than 7 km within the seismogenic zone. The Wonga gold deposit is hosted by mudstone-dominant lithofacies that define the core of the regional synform. These are underlain by sandstone-dominant lithofacies that are interlayered with mafic schist. The lodes occur within the contact aureole of a late-stage granitic body that intrudes an earlier phase of the fractionated pluton. In contrast to the nearby 440 Ma Magdala orogenic gold lodes (~5 Moz Au), this smaller deposit formed at ca. 400 Ma and has been classified as intrusion related. The orogenic and intrusion-related gold deposits formed at different stages in the structural and magmatic evolution of the fold belt, and at different crustal levels. Compared to the Magdala lodes, the Wonga lodes have a close temporal and spatial relationship with the intrusive rocks, and a distinct structural style and mineralogy, including acicular arsenopyrite, stibnite, gold telluride alloys, bismuth, silver, and late-stage molybdenite.

The Wonga lodes formed between two distinct phases of regional faulting, and the kinematics of the mineralized structures cannot be correlated with any preserved, far-field regional paleostresses. Instead, they are inferred to reflect the local state of stress at the point that magmatic-related fluid overpressure occurred. Pervasive fluid overpressure drove deformation across a broad zone, producing massive, mineralized quartz-vein structures that included angular clasts of wall rock. A discrete overpressure event is suggested, rather than repeated crack-seal behavior. The lodes represent an early stage in the development of a fault zone characterized by a series of discontinuous, discrete shear failures. The geometry of the lodes is strongly dependent on structural position and rheology. Northeast-dipping, preexisting weaknesses, such as dike margins and variably developed crenulation cleavages, produced localized shear failure defined by dextral-reverse–slip structures (the hanging-wall structures); 30° to 60° SE-dipping extension veins and extensional shear veins (the link structures) diverge from these, creating en echelon lode geometries. There is a sudden change over the top of a regional plunge reversal defined by the dominant fold axes from shear failure (the hanging-wall structures) to extensional shear and then extensional failure (the links). This occurs along strike in the same structural corridor and within the same stratigraphic unit.

The explicit finite difference-code (FLAC) was used to model the local state of stress at the point where an influx of magmatic fluids raised the pore fluid pressure. The model predicts that a zone of slightly lower differential stress was associated with the plunge reversal and this variation in differential stress is interpreted to have caused the drastic change in lode style. The modeling highlights that only subtle differences in the elastic moduli of the rocks are required to produce the observed stress geometry.

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