The Lost Samples of the Golden Mile: New Data Sheds Light on the Depth and Temperature of Emplacement of this Giant Gold Deposit

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Historical ore specimens from the Golden Mile greenstone-hosted gold deposit, Kalgoorlie, WA, have been obtained from the Western Australian School of Mines museum. With mine coordinates and sample depths corresponding to open space within the Fimiston Super Pit, these samples provide information that is not otherwise available.

Ore textures in the museum samples, such as banded and brecciated veins and open space fill, are indicative of emplacement within a brittle deformation regime. Fragmented bands of pyrite from the Ivanhoe mine, which occur within a brecciated, banded quartz vein, are suggestive of a decompressive explosion breccia involving a volatile-rich ore fluid. This brecciation event clearly post-dates the pyrite bands, yet the pyrite contains elongate inclusion trails of gold, sulphides and tellurides parallel to the fragmentation axes, as well as gold-telluride boundary replacement. These observations contrast markedly with evidence of ductile shear-zone hosted mineralization at the Golden Mile, suggesting that a late stage of gold-telluride mineralization occurred at shallow levels, perhaps during uplift-related decompression.

Complex intergrowths of telluride minerals and gold observed in the museum specimens can help constrain the temperature of ore formation. Tellurides have been characterized using scanning electron microscopy-electron dispersive X-ray spectroscopy (SEM-EDS) at Curtin University, and include the more commonly observed coloradoite (HgTe) and calaverite ($AuTe_2$), as well as altaite (PbTe), tellurantimony (Sb_2Te_3), an unknown arsenic telluride ($AsTe_2$) and several Ag-Au tellurides (petzite, $AuAg_3Te_2$, sylvanite, $AuAgTe_4$, and stützite, $Ag_{5-x}Te_3$). Absolute maxima for ore formation can be established from the melting temperatures of telluride phases; that of calaverite and sylvanite are 464 ±3°C and 354 ± 5°C, respectively[1]. A lower bracket is provided by multi-telluride intergrowths in a sample from the Associated Gold mine containing the assemblage stützite-tellurium, which may be produced through the breakdown of empressite (AgTe) at 210°C[2]. As no empressite has been reported at the Golden Mile, the deposition temperature of these intergrowths must be above 210°C. Cabri's geothermometer for the Au-Ag-Te ternary has been applied to the calaverite and sylvanite in this sample, further narrowing the temperature range: sylvanite contains 10.5-12.9 wt % Ag, corresponding to 320°-230°C (T decreases with increasing Ag), and calaverite with 2.3-3.1 wt % Ag corresponds to 370°-320°C. A further constraint on temperature is provided from the assemblage sylvanite-stutzite-tellurium (calaverite absent), which has a maximum stability of 330°C[1].

Overall, observation of these samples indicates that, whereas earlier veining and mineralzation at the Golden Mile likely occurred under ductile conditions, later gold-telluride ore was deposited in a shallower, brittle regime. Temperature constraints provided by telluride minerals correspond to earlier estimates.