Mineralogy, Petrography and Gold Distribution at the Twin Hills, Epithermal Deposit North-Central Queensland, Australia

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CONTENTS

ABSTRACT

The Twin Hills epithermal system is located 250 km south of Charters Towers, Central North Queensland within the Drummond Basin. Mineralisation is hosted within a half graben, filled with hydrothermal vent breccia containing lithological clasts from multiple sources, which have undergone silicification and pyritisation. The deposit features characteristic sub-low temperature, low-sulphidation mineralisation, classified as adularia-sericite type. Chalcedony quartz and later comb quartz/fluorite veins host the precious metal mineralisation. Textures within the quartz suggest that boiling was the main mechanism for the co-precipitation of gold with pyrite. The latter is a key mineral in tracing precious metal distribution in the deposit.

Scanning electron microscope (SEM), electron microprobe analysis (EPMA) and laser ablation-inductively coupled mass spectrometry (LA-ICPMS) have been used to identify three main morphological-geochemical groups of pyrite at Twin Hills. Each can be linked to one of three distinct genetic stages: (1) early, largely biogenic pyrite formed in an euxinic sinter environment overlying the main ore system, and which carries high amounts of Au, Ag, As, Sb, Mo and Tl; (2) main-stage pyrite, characterised by milling, resorbtion and overgrowth in which two sub-stages-each representing distinct fluid pulses are recognised [(a) enrichment in Au-(As) and (b) enrichment in Ag-(Se)]; and (3) late-stage pyrite containing low contents of most trace elements formed in a phreatic phase after collapse of the sub-basin and which involved fluid mixing.

Twin Hills pyrite hosts significant amounts of refractory 'invisible' gold, both as lattice-bound gold and as gold nanoparticles. Concentrations of several tens of ppm Au were measured in early- and main-stage pyrite. Electrum is, however, the main gold mineral in the deposit; it may, however, be Ag-rich and thus slow-leaching. High-grade *'ginguro'* mineralisation at Twin Hills is characterised by abundant naumannite (Ag_2Se), which may contribute, alongside electrum and invisible silver in pyrite, to the overall silver balance.

The presence of enhanced concentrations of Sb, As, Tl and Mo in the pyrite formed in a euxinic sinter environments suggests that these may be viable pathfinder elements in future exploration for other possible hydrothermal outflow zones in areas of shallow cover.