Geology of the Tropicana Gold Project, Western Australia

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Abstract. The Tropicana-Havana gold deposit is hosted by Archaean rocks that lie along the eastern margin of the Yilgarn Craton, Western Australia. The Mineral Resource for the project is 75.3 million tonnes grading 2.07 g/t for 5.01 Moz of gold. Gold mineralisation postdates peak granulite-facies metamorphism and formed from variably oxidised, higher temperature (>350˚C), silica-undersaturated fluids. Fluid flow in more competent domains was largely controlled by fracture and grain boundary permeability, and was accompanied by selective sulfide and secondary biotite replacement of metamorphic biotite and amphibole. Partitioning of strain into strongly biotite-sericite-pyrite-altered shear planes, dissolution fractures, and around lithons with jigsaw-fit breccia textures, is evident in domains with higher gold grades. Discrete, laterally continuous high-strain sericite-biotite-chlorite±graphite shear zones that bound ore zones are weakly anomalous in gold. Sulfides within the ore zones are dominated by fine pyrite (2-8%, <0.2mm) with minor chalcopyrite, electrum and telluride minerals. Free gold occurs as fine-grained (10-30 µm) inclusions in pyrite and along biotite-sericite fractures in silicate minerals.

Keywords. Gold, Archaean, architecture, structure

1 Introduction

The Tropicana Gold Project, located 330 kilometres east north-east of Kalgoorlie, is part of the Tropicana Joint Venture, which is 70% owned by AngloGold Ashanti Australia (the manager) and 30% by Independence Group NL (Figure 1). The mineral deposit is hosted in tectonically reworked Archaean rocks that form the eastern margin of the Yilgarn Craton, Western Australia. Tropicana is the first deposit discovered in this remote portion of the Great Victoria Desert and is widely regarded as defining a new greenfields gold province (Kendall et al 2007; Doyle et al 2007).

Classification	Tonnes (Mt)	Grade (g/t)	Contained gold (Moz)
Measured	19.9	2.38	1.53
Indicated	31.0	2.06	2.05
Inferred	24.3	1.83	1.43
Total	75.3	2.07	5.01

Table 1. Current Tropicana Mineral Resources identified within a US$1000/Oz pit shell.

The Mineral Resource for the project is currently 75.3 million tonnes grading 2.07 grams/tonne for 5.01 million ounces of gold (Table 1; Kent et al 2008). This represents an increase of approximately 1 million ounces from the first Mineral Resource estimate released for the project in December 2007.

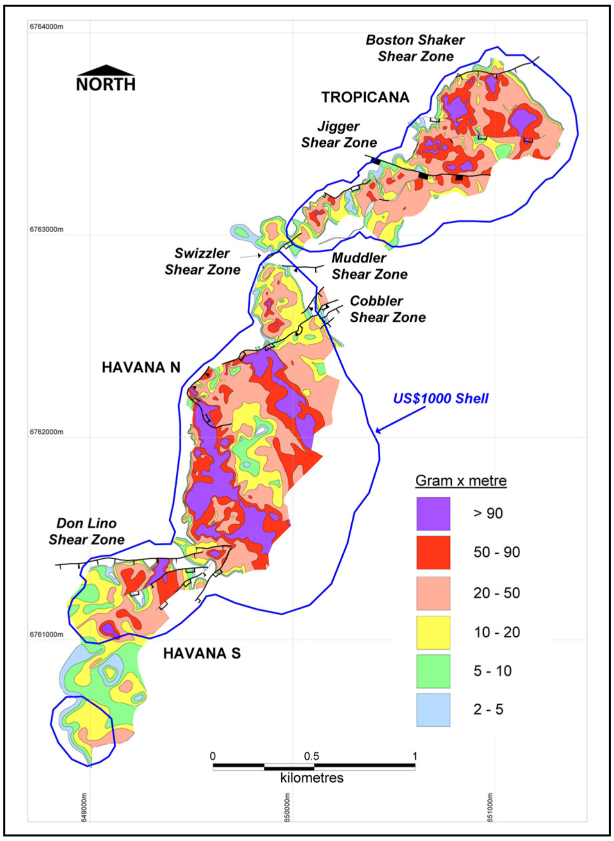

Figure 1. Gram x metre plot and principal shear zones

2 Geological setting

The Tropicana Gold Project lies to the west of a major tectonic suture between the Yilgarn Craton and the Proterozoic Albany-Fraser Province that stretches over 550km. The regional geology is dominated by granitoid rocks, felsic to mafic paragneiss and orthogneiss, and felsic to ultramafic intrusive and volcano-sedimentary rocks that were emplaced in deep, quiet water (submarine) environments.

Granulite and amphibolite-facies gneissic metamorphic rocks hosting the Tropicana and Havana gold deposits are interpreted from geological mapping and detailed proprietary aeromagnetic data to be bound by large scale shear and fault zones. Neither the immediate metamorphic host rocks nor mineralised zones are exposed at surface due to the presence of widespread Recent to Permian aged cover sequences (0.5–15 m thick). Recent aeolian sands locally manifest as stabilised dunes up to ~12 m high and overlie an incised sequence of siltstone, sandstone and pebbly conglomerate units interpreted as Permian in age. Both the basement and cover sequences have been overprinted by a Tertiary lateritic weathering profile to depths of ~40–50 metres. Geochemical data from auger sampling and RAB/aircore drilling highlights the strongly depleted character of gold in the saprolitic zone of the weathering profile. The observation is consistent with the low tenor of geochemical anomalism in public domain soil data (peak 31ppb) and AngloGold Ashanti auger results (Kendall et al 2007; Doyle et al 2007).

2 Deposit architecture

Together, the Tropicana and Havana deposits define a NE trending mineralised corridor ~1.2 km wide and ~5 km long that has been tested to vertical depth of 400m (Figure 1). Mineral Resources remain open down-dip for both the Tropicana and Havana deposits, and to the south of the Havana deposit.

Tropicana deposit comprises one main ore zone (2-50m thick) and subordinate thin (3-5m), discontinuous mineralised lenses that typically return intercepts <0.5 g/t gold and are hosted within the garnet gneiss-dominated hanging wall package. The Havana zone comprises a lower, laterally continuous higher-grade lode (2-50m thick) that is overlain, in central and southern parts of the proposed pit, by stacked, typically lower-grade and thinner (5-25m) ore zones dominantly hosted in quartzo-feldspathic gneiss (Figure 2).

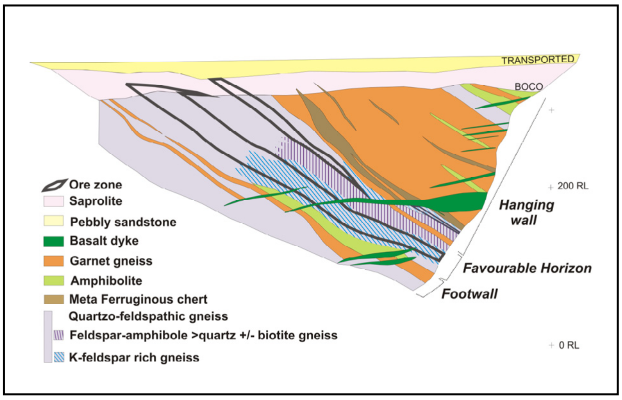

Figure 2. Havana cross-section 141550N (local grid)

Models of the mineralised envelope (≥0.3 g/t) define a wavy, asymmetric foliation that is broadly sub-parallel to dominantly E to SE dipping gneissic banding and local stratigraphic divisions. The foliation is deflected approaching discrete high-strain sericite-biotite-chlorite±graphite shears that are anomalous in gold.

Three distinct structural domains can be identified: Tropicana, Havana North and Havana South. The northern margin of the Tropicana domain is defined by the east-northeast-striking and southerly-dipping Boston Shaker Shear Zone. Mineralisation in part terminates against the shear, but mostly against a downward flexure in the hanging wall garnet gneiss package that may mark an early fold closure. The Tropicana and Havana domains are separated by NE- to E-striking, variably-dipping structural discontinuities defined by the Muddler, Swizzler and Cobbler Shears (Figure 1). At Havana, the boundary between the northern and southern structural domains is coincident with an E-W-striking steep fault (Don Lino Shear). The Don Lino Shear comprises multiple overstepping segments that although localised along the domain boundary are laterally discontinuous and interpreted to be coincident with an earlier fold closure with a SE plunging axis. To the south of the fault and interpreted closure, ore zones appear less continuous and, with some exceptions, are generally lower grade.

3 Higher-grade lenses

In detail, single lodes comprise multiple stacked higher-grade (≥3g/t) lenses within a lower grade (≥0.3 g/t) envelope. Single high-grade lenses and their medium grade halos locally converge to form thicker, composite mineralised zones. High-grade lenses in the Havana domain dip towards between S and E, and intersect in lines plunging to the SSE. This contrasts with the E- to SE-dipping high-grade lodes in Tropicana domain, which intersect about a generally E-plunging line. Higher-grade lodes in the Havana South domain are laterally discontinuous and many are displaced on shears making interpretation of the RC drill holes difficult.

In sections parallel to the plunge direction, higher-grade (≥3g/t) lodes are enveloped by lower grade shells and are oriented at a slightly steeper angle than the modelled ≥0.3g/t envelope (Figure 3). In sections orthogonal to the plunge direction, ≥ 3g/t lodes comprise steeper-bounding domains and flatter linking segments, the intersection of which defines the principal lineation (Figure 4). The resultant geometry is interpreted as a linked shear system that in drill core manifests as discontinuous biotite-pyrite shears which are developed on a mm to cm scale and characterised by asymmetric SC or SC' fabrics and sigma porphyroclasts.

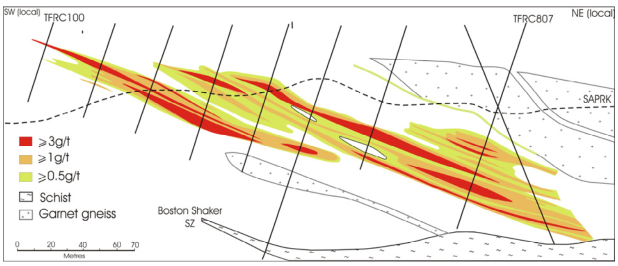

Figure 3. Tropicana long-section parallel to plunge direction. Looking N

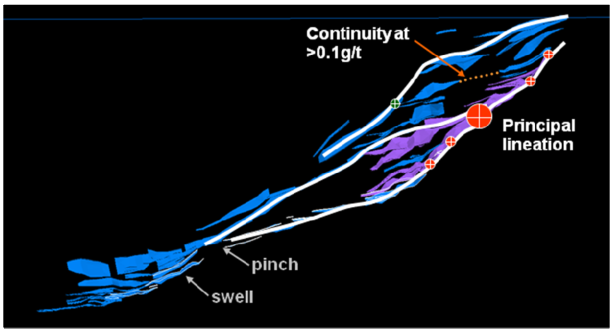

Figure 4. Havana section orthogonal to plunge direction. Looking SE through 3D Vulcan model.

4 Mineralisation style

Mineralisation was strongly influenced by the character of precursor metamorphic facies at scales ranging from single grains and crystal-clusters (millimetre to centimetre scale) to preferential concentration of gold in rheologically and/or chemically favourable K-feldspar-rich facies of the quartzo-feldspathic gneiss association (deposit scale).

At a fine scale, biotite-pyrite selectively replaced former mafic-dominated gneissic bands, and sericite-calcite selectively altered plagioclase feldspar-rich bands. In leucocratic domains and bands, pyrite and secondary biotite occur as gain-boundary controlled disseminations replacing primary metamorphic biotite and former amphibole. These textures are most common in domains with lower gold grades. In domains with higher gold grades, styolititic dissolution fabrics, crackle-breccia textures, and shears, fractures and veins with biotite-pyrite±sericite fills are more abundant. Sigmoidal-shaped lithons (1 to ≥15cm long) with crackle-breccia textures are separated by more thoroughly biotite-sericite±pyrite-altered gneiss and schist. Gradations from jigsaw-fit breccia textures into strongly shear-rotated fabrics, suggest a role for strain partitioning during alteration and mineralisation.

At the deposit scale, sectional interpretation combined with statistical evaluations suggest that for any given grade threshold K-feldspar-rich gneiss and pegmatite facies contain a higher proportion of gold than other facies within the quartzo-feldspathic gneiss association (Figure 2). Some schist, cataclasite and chert facies are near completely replaced by pyrite and/or pyrrhotite, but in drilling to date have not returned economic gold concentrations, and grades within single intercepts are typically ≤ 1 g/t.

Sulfides within the ore zones are dominated by pyrite (2-8%, <0.2mm) with accessory pyrrhotite, chalcopyrite, electrum and telluride minerals, and trace minerals including, but not limited to, sphalerite, galena and bornite. Free gold occurs as fine-grained (typically 10-30 µm) inclusions within pyrite and less commonly along biotite-sericite fractures cutting silicate minerals. Visible gold has not been observed in drill core or chips. The pyritic ores are enveloped by a disseminated pyrrhotite±pyrite halo that is locally more strongly developed in the hanging wall. Within the mineralised zone relic pyrrhotite inclusions in pyrite suggest increasing but variable oxidation states.

Mineralised zones are enclosed within a sub-concordant alteration envelope. The alteration envelope exhibits a mineralogical zonation with central biotite≥sericite>>calcite±siderite zones, passing outward through sericite>biotite>chlorite±calcite, into sericite-chlorite±biotite±calcite at the margins. Outside the hydrothermal alteration envelope, prograde metamorphic minerals have altered to various assemblages of chlorite, sericite, calcite, epidote and hematite. Combined, the alteration assemblages, occurrence of chalcopyrite, and trace element concentrations in pyrite suggest fluid temperatures exceeding 350˚C.

3 Discussion

Gold mineralisation is temporally related to shear planes that post-date the main gneissic fabric developed during, peak (granulite facies) metamorphism. Variation in the orientation of bounding and internal shears is attributed to the influence of lithological layering and pre-existing polyphase folding on the shears during mineralisation.

Permeability created during brittle fragmentation was accompanied by synchronous partitioning of strain into pervasively biotite-sericite-pyrite-altered dissolution and shear planes that envelop more competent lithons. Sulfide and gold mineralisation formed from higher temperature (>350˚C) silica-undersaturated fluids that were buffered by the wall rock at variable oxidation states.

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