THE STAWELL Au DEPOSITS, WESTERN VICTORIA

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LOCATION

The Stawell Au Mines are centred on the NE outskirts of Stawell township at 37º03'S, 142º48'E on the Ballarat (SJ 54-8) 1:250 000 and Ararat (7243) 1:250 000 map sheets.

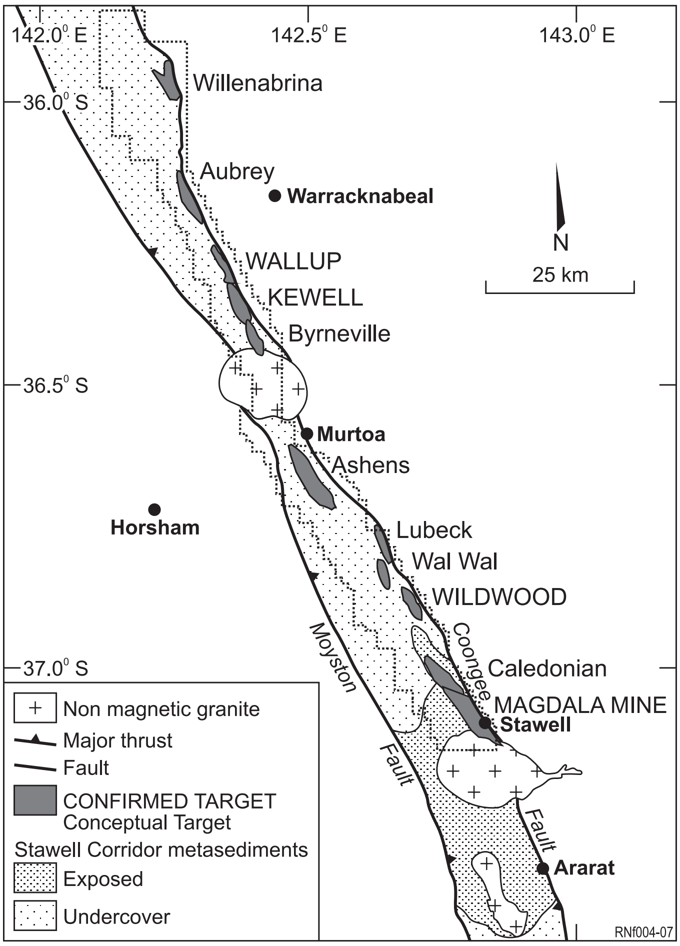

Figure 1. Stawell Zone; geology with targets under Murray Basin cover (modified from Leviathan Resources, 2004).

DISCOVERY HISTORY

Alluvial Au was discovered in the Stawell region in 1853 with >24 t Au won from various deep leads up until 1912. Gold in quartz reefs was found in 1855 and in the 1880s, within shear zones and in metamorphosed schists (as at the current Magdala and Wonga Mines, respectively). When production ceased in 1926, >59 t Au had been produced from hard-rock sources (Watchhorn, 1986). A joint venture between Western Mining Corporation Ltd and Central Norseman Gold Corporation commenced underground mining in the Magdala decline in 1981 and open pit mining of the Wonga ore-body in 1984. By 1990, the Stawell mine had produced 82 t of gold with 61 t from primary sources and 21 t from alluvial gold (Phillips and Hughes, 1996; Woodall, 1990). The mining areas currently strike over 3 km and reach more than 1000 m below surface, measured from the top of Big Hill and extending beneath parts of the Stawell Township (Figures1 and 2; Leviathan Resources, 2004). Regolith geochemistry has played a minor part in exploration in the district model, but understanding of element dispersion into the cover may assist its application.

PHYSICAL FEATURES AND ENVIRONMENT

The Stawell deposits occur in hilly terrain (>230 m ASL) with up to 40 m relief above the surrounding agricultural countryside. The average annual rainfall is 576 mm (Bureau of Meteorology, 2006). Residual box ironbark forest of moderate height, dominated by grey box (*Eucalyptus macrocarpa),* red ironbark (*E. tricarpa)* and yellow gum (*E. leucoxylon),* with a shrubby understorey of wattles (*Acacia* spp), occurs on the more rugged hills, whereas lower areas are covered by agricultural grazing lands interspersed with mixed *Eucalyptus* and minor *Acacia* woodlands. The climate of the Stawell area is temperate with warm to hot summers and cool to cold winters with several days having minima <0ºC each year. Mean minimum and maximum temperatures are 13-28ºC in February and 4º-12ºC in July (Bureau of Meteorology, 2006).

GEOLOGICAL SETTING

The Stawell Goldfield occurs within the Stawell Zone of the Lachlan Fold Belt in the strongly deformed early Palaeozoic St Arnaud Group turbidites, which contain fault-bounded Cambrian volcanic and volcanoclastic rocks (Miller *et* al., 2006; Schaubs *et al*., 2006). These rocks are intruded and contact metamorphosed by the large Devonian I-type Stawell Granite (Miller *et* al., 2001).

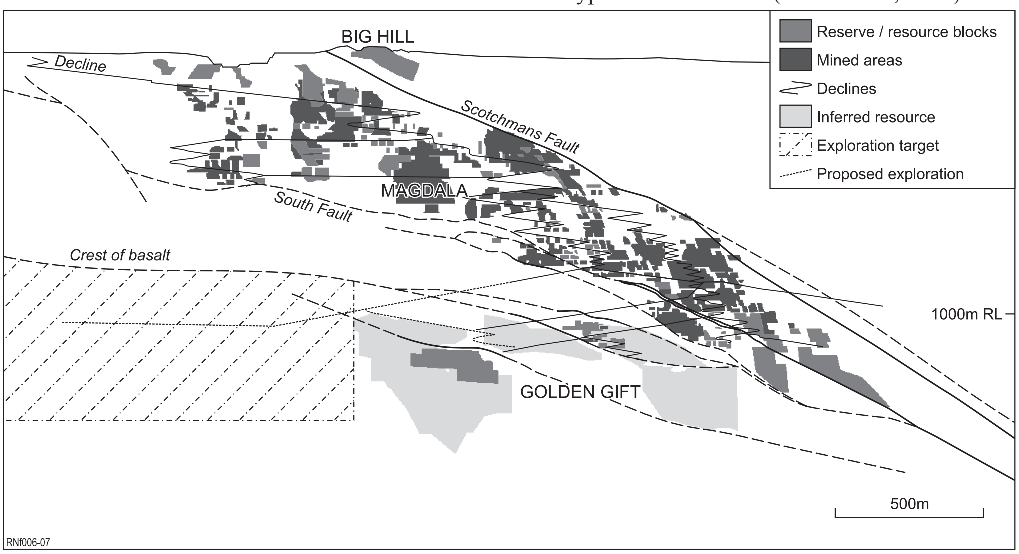

Figure 2. Longitudinal Projection of the Central lode systems: Big Hill, Magdala and Golden Gift Au mineralization at the Stawell Gold Mine (modified from Leviathan Resources, 2004).

REGOLITH

The Stawell regolith is described in detail by Williams and Radojkovic (2004), and is summarized below. Stawell is located on regolith cover of moderately weathered channel deposits, erosional rises and some weathered colluvial sediments on low hills. The lowest topographical areas are channel and overbank deposits that form alluvial landforms extending to the W and N. Relatively unweathered alluvial sediments in fans and terraces form a thin (<10 m) cover along present day drainages. The regolith is mottled and may be indurated with Fe oxides and/or clay. Resistant caprocks are commonly ferruginous or siliceous duricrust and overlie poorly consolidated conglomerate that is generally mottled or bleached. Transported colluvium is also common in the Stawell region. This is poorly sorted, with some quartz and feldspar in a clay-rich matrix. The soils associated with this regolith are generally deep and well structured, and have some minor Fe oxide mottling.

Big Hill, a low hill or rise of very highly weathered saprolite, has near-surface Au mineralization. The regolith, up to 80 m deep at the Wonga open pit, consists of very pale weathered schist and quartz veins, with extensive Fe oxide staining on the quartz veins. Manganese oxide staining is also evident in some places. Mineralogy is dominated by kaolinite and illite. The quartz veining protects the regolith from erosion, resulting in local topographic highs for the residual material, with shallow soil (<2 m). Other residual regolith materials around Stawell include highly weathered sandstone, mudstone and siltstone, with Fe oxide staining, mottling and induration.

MINERALIZATION

The Stawell Au deposits are comprised of the Hangingwall and Central lodes (Figure 2) and the Wonga lodes. The Hangingwall and Central lodes merge near the surface and are collectively termed the Central lode systems (Miller and Wilson, 2002). The Hangingwall lode is formed between the Mine schist and the volcanogenic rocks, whereas the Central lode is associated with a sequence of chlorite-sericite altered mudstones (previously termed 'volcanogenic' sedimentary rocks; Fredericksen and Gane, 1998) on the western margin of a basalt dome – the Magdala Antiform (Vandenberg *et al.,* 2000). This is a doubly-plunging unit of basalt, 1 km wide and over 3 km long, encased by sulphide- and Fe-enriched sedimentary rocks (Stawell Facies) that host the mineralization (Dugdale *et al.,* 2006) - generally referred to as the Magdala-style mineralization. The Central lode system comprises a number of distinct styles of mineralization, including laminated reefs, linking 'flat' lodes, stockworks, tension vein arrays, disseminated sulphides and massive sulphide lenses (Figure 2). Hydrothermal fluid flow along major reverse faults is thought responsible for the ore formation, which is mostly localized on the western flank of the Magdala Dome. Timing of mineralization is related to deformation events, with the major mineralization occurring *ca* 440 Ma and minor mineralization *ca* 425 Ma and 410 Ma (Miller *et al.,* 2006; Dugdale *et al.,* 2006).

The Wonga Lodes are unlaminated and generally massive with angular wall rock clasts and fine disseminated arsenopyrite in wall rock fragments (Miller *et al.,* 2002). The Wonga deposit is located within the psammo-pelitic Wonga Schist in the contact metamorphosed aureole of the Stawell Granite. The Wonga Lodes are related to late quartz-feldspar porphyry intrusions and have different structural orientation to the Magdala Lodes (Miller *et al.,* 2002).

REGOLITH EXPRESSION

Geochemical expression of the Au mineralization at Stawell is well defined in soils (partial and total analysis) and saprolite. Approximately 55 soil samples (0-10 cm, -250 mesh sieve fraction) were collected on traverse lines over the Big Hill area (Fig. 3) and in regional background areas (2-15 km from the mineralization). Nine soil profiles were also sampled (0-150 cm, -250 mesh sieved fraction) near Big Hill and in regional areas. A near-total hydrofluoric-nitric-perchloric acid digestion

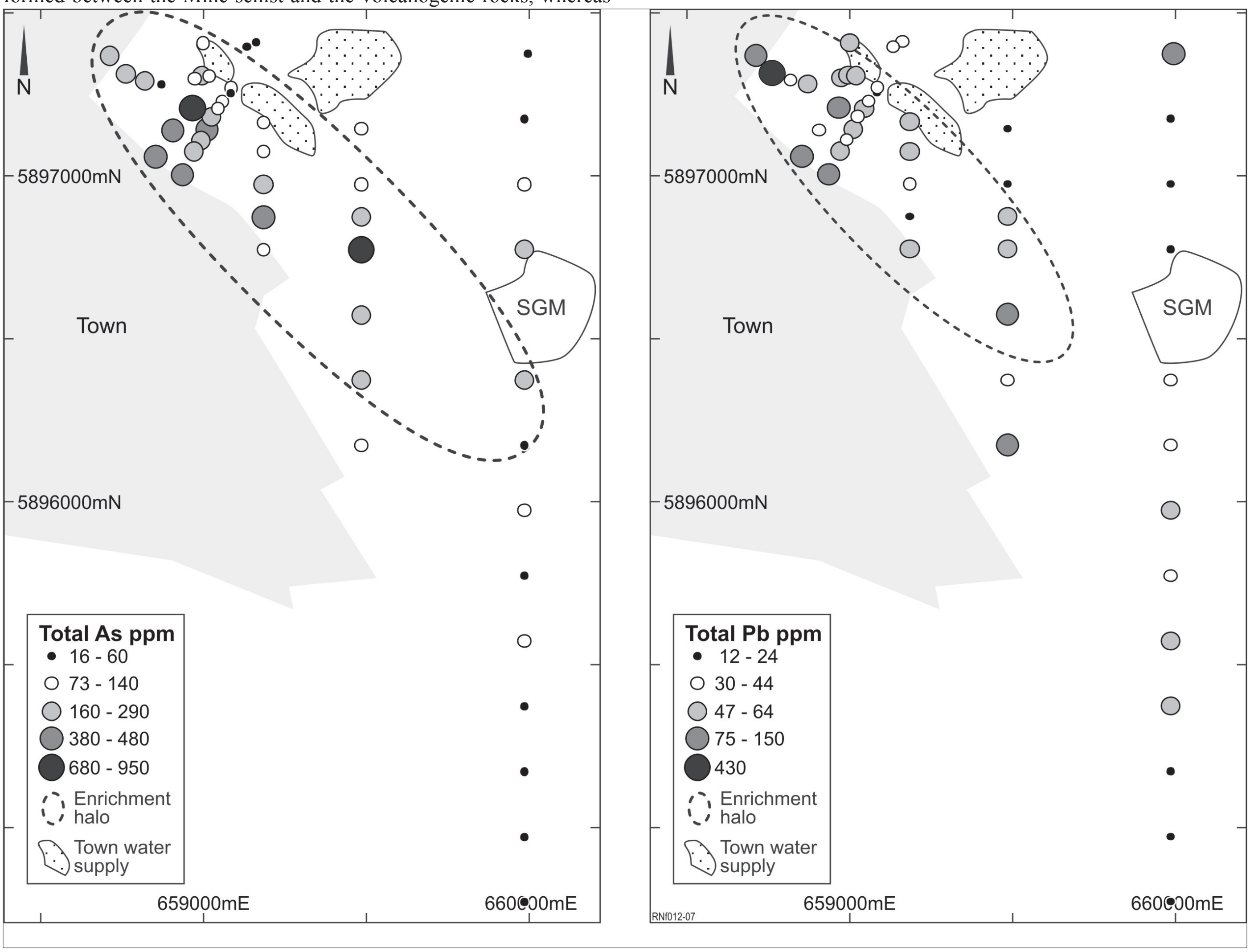

Figure 3. Geochemical distribution of total As and Pb in soils (0-10 cm) around the Stawell Gold Mine. SGM is the surface operational area of Stawell Gold Mine.

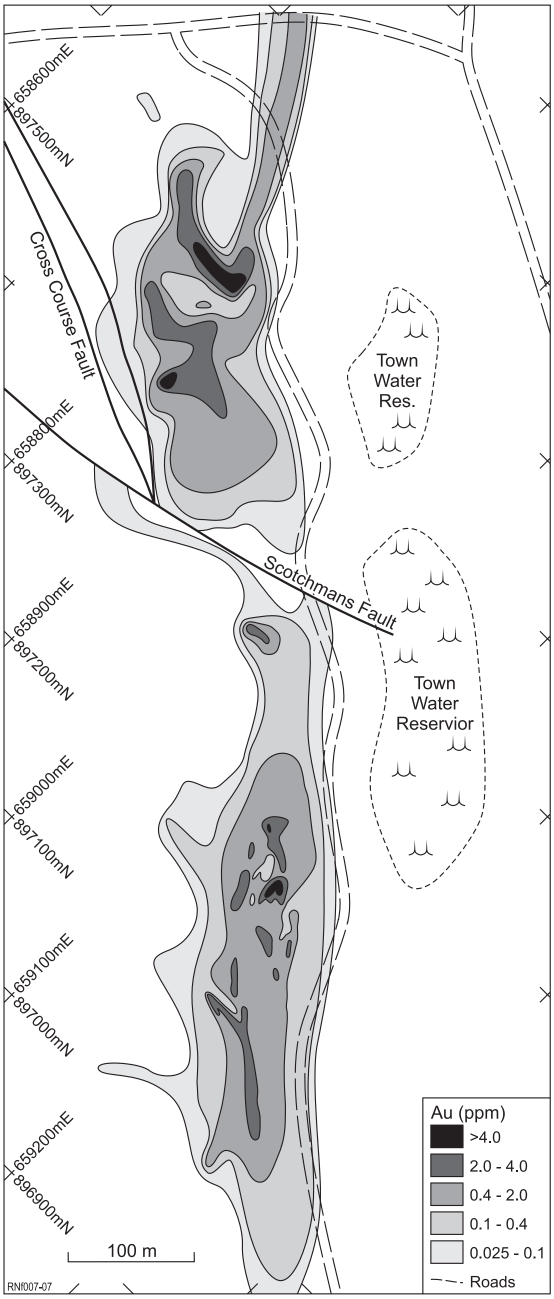

Figure 4. Generalized distribution of Au mineralization in the near surface environment based on regolith sampling near the Stawell Gold Mine.

and a weak HCl partial extraction (1 M HCl; Noble, 2007) of soil samples were analysed for a suite of 50 elements by ICPMS and ICPOES. Additional soil sampling was conducted by Stawell Gold Mine staff for Au analysis by fire assay. Saprolite was sampled and analysed from the Big Hill area, with full details in a report by the Geological Survey of Victoria (Williams and Radojkovic, 2004).

At Big Hill, soils (0-10 cm) have elevated maximum, mean and median concentrations of the indicator elements listed in the Summary Table. Total As, Cr and Pb show the greatest contrasts, with strong haloes associated with the near surface mineralization (Noble, 2007; Figure 3 and 4). Arsenic concentrations are significantly higher than representative background soil within 15 km of the mine. Total As in the regional soils ranged from 1-16 ppm with a mean of 9.4 ppm, significantly greater than the world average As content of uncontaminated soils estimated as 5 ppm (Voigt et al., 1996) or < 6 ppm (Francesconi and Kuehnelt, 2002; Gao et al. 1998; Lin and Puls; 2003; Mandal and Suzuki, 2002; Taylor and McLennan, 1995; Wedepohl, 1995). Soils of Big Hill contained significantly greater concentrations of As of 16 - 946 ppm with a mean of 175 ppm. The results indicate significant As enrichment in the area for both surface and subsurface soils. The high abundance of As in soil (0-10 cm) at Stawell is attributed to two factors: *natural*, due to the high background and geochemical halo associated with the major orebody, and *anthropogenic,* due to mining, *e.g.,* dust derived from grinding of the sulphidic rocks and urbanization. However, the former appears to be the more significant (Figure 3). Gold has a distinct footprint in the soil geochemistry over the northern section of Big Hill, but the dispersion is less than that of As (Figure 3 and 4).

Weak HCl partial extraction revealed similar patterns of dispersion for As and Pb, but did not show increased dispersion haloes, and is not as useful as the near-total four acid digestion.

Sequential extractions of soil profiles in the Stawell region indicate As is typically fractionated, in order of decreasing concentrations, into Total > Organic > Fe oxide > Exchangeable > Mn oxide > Carbonate > Bioavailable (Noble, 2007). Organically- bound As and total As were greatest in the clay-rich argillic/kandic horizons at 30-80 cm whereas exchangeable As, Mn oxide As, Fe oxide As and bioavailable As were greatest in the surface horizon (0-10 cm), which generally corresponded to the depth of highest Cation Exchange Capacity (Noble, 2007). There is some association between organic C content of the soil and As, relating to the increased exchange capacity associated with organic matter.

Saprolite is enriched in As, Fe, Pb, W, Cu, S and Pd in Au-rich zones (Williams and Radojkovic, 2004). Individual element enrichment is different, depending on saprolite parent material. Saprolite of mineralized schists has more As, Fe, Cu, S and Pd than unmineralised schist saprolite, whereas saprolite of the sedimentary rocks of the Stawell

SAMPLE MEDIA - SUMMARY TABLE

Sample medium	*Indicator elements*	*Analytical methods**	*Detection limits (ppm)*	*Background* *(ppm)*	*Maximum anomaly (ppm)*	*Dispersion (m)*
Primary mineralization	Au As (Fe, Zn, Na, Ba, Cl, Pb Te)	Fire Assay ICPMS (XRF, ICPMS ICPOES)	0.001 0.1	0.80 225	150 44000	
Saprolite (Mine schist)	Au As Pb W Cu S	Fire Assay ICPMS ICPMS ICPMS ICPOES ICPOES	0.001 0.5 0.5 0.1 2 50	0.19 290 28.5 2.69 54.8 267	28.1 4350 360 28.5 500 27400	
Saprolite (Volcanogenics)	Au As Pb W Cu S	Fire Assay ICPMS ICPMS ICPMS ICPOES ICPOES	0.001 0.5 0.5 0.1 2 50	0.05 47.9 15.5 2.15 42.7 174	10.9 4900 84.0 43.0 480 24200	
Soil - Total	Au As Cr Pb	Fire Assay ICPMS ICPOES ICPMS	0.001 0.1 0.1 0.1	0.005 9.4 77 15	>4 946 315 426	50 200 100 200
Soil -Partial analysis	As Pb	1M HCl & CPMS) 1M HCl &ICPMS	0.1 0.1	0.1 0.14	5.6 17	100 100

* ICPMS, ICPOES analysis after HF-HNO_3-$HClO_4$, acid digestion, except for partial analysis

** Background for Stawell saprolite based on the mean for unmineralized saprolite sampling from Williams and Radojkovic, 2004. Background for primary mineralization based on mean from drilling assay database from Leviathan Resources accessed in 2004.

Facies has more As, Fe, Pb, W and Ca than unmineralized saprolite of a similar parent material (Williams and Radojkovic, 2004).

Generally, the regolith signature of mineralization is strong, particularly in the areas of residual parent material. Exploration strategies in the area could use a broad range of geochemical methods and sample media with success.

DISPERSION MODEL

B**[1]

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