RUSHWORTH AND WHROO GOLDFIELDS, VICTORIA

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LOCATION

The Rushworth Goldfield is 135 km N of Melbourne and 38 km SW of Shepparton in central Victoria at 145º00'01"E, 36º30'06"S; Bendigo 1:250 000 map sheet (SJ55-01). Whroo is 7 km S of Rushworth (Figure 1).

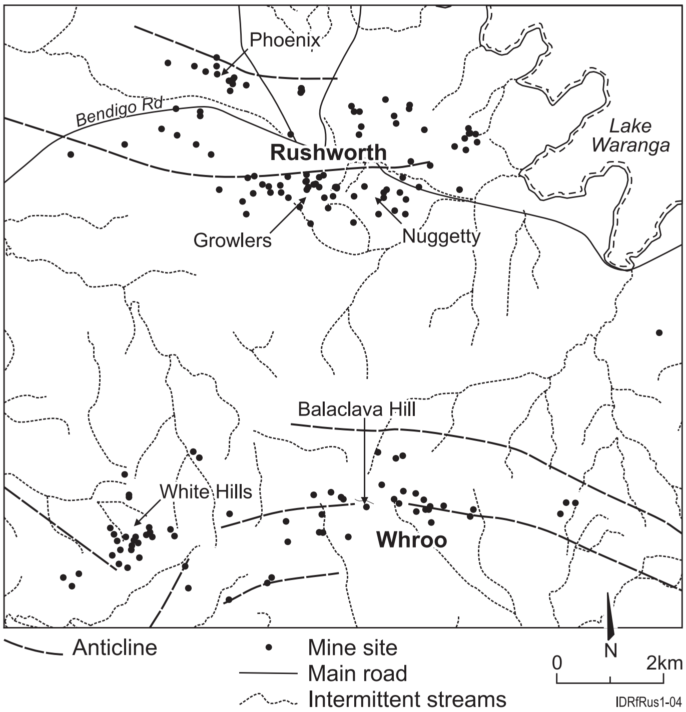

Figure 1. Map of Rushworth and Whroo Goldfields with simplified distribution of workings and structural trends.

DISCOVERY HISTORY

Placer gold was discovered in the area in the gold boom of the 1850s and the settlements of Rushworth and Whroo were quickly established. Mining Au-bearing quartz veins and reefs had developed by 1860, but activity fluctuated and had all but ceased by World War I. Dozens of individual shafts, generally 40-60 m deep, were sunk across the Rushworth Goldfield with a maximum depth of about 180 m (Bannear, 1993; Edwards *et al.*, 1997). Many workings developed into small open cuts up to 10 m wide, working multiple veins, *e.g.*, Nuggetty, Phoenix and Growlers (Figure 1). An estimated 97 000 oz of Au was produced from the Rushworth Goldfield (Garratt, 1985). At Whroo, many shallow workings are scattered throughout the forest; on Balaclava Hill, a deep shaft (122 m) and an open pit (80 x 40 m across and 30 m deep) were developed. Production at Whroo is estimated to be 40 000 oz of Au (Garratt, 1985)

PHYSICAL FEATURES AND ENVIRONMENT

Gently undulating rises to low hills (relief 110-210 m) dominate the landscape. Shallow stony clay soils are developed on the slopes and in gullies. The annual rainfall is about 300-400 mm, so that stream flow is intermittent. Mean temperature ranges are 14-29ºC in January and 6-13ºC in July. These goldfields lie within forest at the southern boundary of the Murray Basin. The open forest generally comprises red ironbark (*Eucalyptus tricarpa*), grey box (*E. microcarpa*) and yellow box (*E. mellidora*). The understorey includes several *Acacia* spp., *Grevillea* spp., bush pea, orchids, daisies and grasses. Patches of mallee eucalypts occur sporadically, forming dense areas of up to several tens of hectares. The forest canopy generally reaches 15-20 m in the ironbark portion with heights of about 5-8 m in the mallee.

GEOLOGICAL SETTING

Rushworth lies within the Melbourne Zone, a moderately faulted and folded Palaeozoic belt in the southern portion of the Lachlan Fold Belt of Victoria (Gray, 1988). Ordovician to Devonian greenschist metamorphosed marine to terrestrial sediments have been intruded, in places, by Late Devonian granitoids. Locally, Siluro-Devonian marine sediments include fine- to medium-grained sandstone, siltstone and mudstone. Rare conglomerate lenses occur to the S and some sandy beds contain abundant fossil mollusc casts. Weathering has subsequently removed all traces of carbonates at the surface. A small, deeply weathered diorite dyke of indeterminate age occurs to the W of the Whroo workings.

The local geology comprises a series of E-W striking fold hinges with open to tight limbs and steeply S-dipping axial planes. Large-scale folds are several hundred metres apart with evidence of multiple, complex fold hinges up to 10 m apart. Developed across this regime are a series of faults and shears indicating N-S compression.

Perched Tertiary gravels are scattered across the region. Some reach 5 m in thickness and comprise bleached pebble to cobble gravel in a mud to silt matrix. Some are ferruginized and most contain traces of alluvial Au.

REGOLITH

The goldfields lie on low hills, which form a watershed for local drainage to the E and W. Remnant perched gravels are evidence of wetter climates, but the present weathering and erosion products have resulted in shallow, nutrient-depleted soils with poor structure. Weathering continues to the water-table, at a minimum of 60 m.

Across most of the area, the upper portion of the regolith has been stripped to expose saprolite and weathered bedrock with an indurated laterite and mottled zone only preserved locally. In these places the laterite is generally less than 1 m thick with variable mottled zones from 1-10 m. Transported materials in gullies include clasts of weathered bedrock and ferruginous gravel. Many quartz veins have also developed thick ferruginous caps. Dark, red-brown ferruginous pisoliths are common in the stony clay soils.

MINERALIZATION

Primary mineralization with Au grades of up to 'many ounces to the ton' are reported in official documents of the late nineteenth century, with the highest being 3100 g/t (Garratt, 1985). Three principal sets of quartz veins (Figure 2) define the style of lode Au mineralization. The three Au-bearing vein sets associated with N-S compression are: -

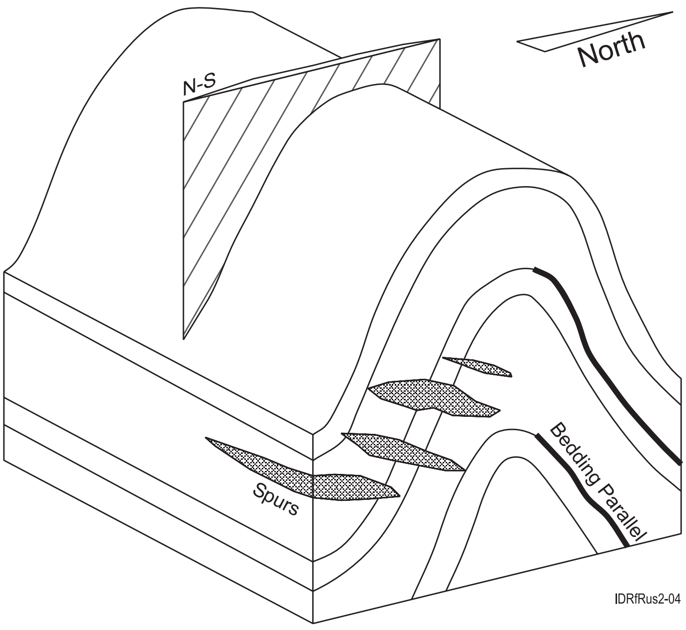

Figure 2. Simplified diagram of vein styles and their relationships at Rushworth.

- An E-W striking, bedding parallel vein, generally less than 150 mm thick, but persistent in strike and dip;
- N-S striking cross veins which dip steeply to the W and may be up to 0.5 m thick and;
- E-W striking spur veins up to 2 m thick, dipping gently (<15º) to the N; these are the most common and occur in packages of several veins that extend for tens of metres along strike and down dip.

A similar series of veins occurs at Whroo although, within the Balaclava workings, their relationship is uncertain and there are multiple generations and complex structures. Underground, at the 57 m Level, a stope was measured at 5 m across, 30 m long and 20 m high. An added variation at Whroo is Sb mineralization, although the grades and material won were uneconomic.

Limited information on the primary ore indicates that the Au is generally confined to quartz veins on the contact with the wall-rock. The very narrow mineralization probably explains why few mines worked below the weathered profile. Within the weathered profile, there is evidence of Au dispersion into the country rock and of some superficial enrichment of Au. Some drill results show a distinct increase in Au grades to 5-15 m below surface followed by a broad zone of very low to depleted Au to about 35 m and then a steady increase in Au until the watertable is reached at 60 m (Figure 3). Below 60 m, there is a sharp decrease in Au grades.

REGOLITH EXPRESSION

Fine-grained Au has dispersed down slope from all exposed auriferous quartz veins by physical and chemical processes. However, the upper part of the soil profile also has been contaminated by soil and mullock distributed by mining, dispersing Au still further, resulting in broad surface anomalies. Accordingly, geochemical survey methods used in the area by New Holland Mining NL have been:

i) Rock chipping of isolated ferruginous outcrops and exposed veins in old workings;

ii) Augering to the 'C' soil horizon or the top of saprolite on 50x200 and 25x100 m grids. Soil was sieved to <1.56 mm and analysed for Au, As and Sb (*e.g.*, Cherry, 1994; Turner, 1993; Turner and Cherry, 1996).

An orientation survey near Whroo revealed that Au concentrations in soil samples along grid lines were not repeatable. There was also poor correlation between analyses of split samples by different laboratories (Figure 4) (Cherry, 1998). It has not been determined whether this was due to a nugget effect or analytical error.

Regional and grid-based geochemical sampling highlighted an association between Au, As and Sb. Where As concentrations are high, and As>>Sb, Au abundances tend to be low (apart from a few spikes in Au). This indicates either nuggety Au or that Au was not always present. However, if As and Sb contents are similar, Au abundances are enhanced; alternatively, if Sb contents are enhanced then so too is Au. These associations suggest that there were two Au mineralizing events, one Sb poor and the other Sb rich.

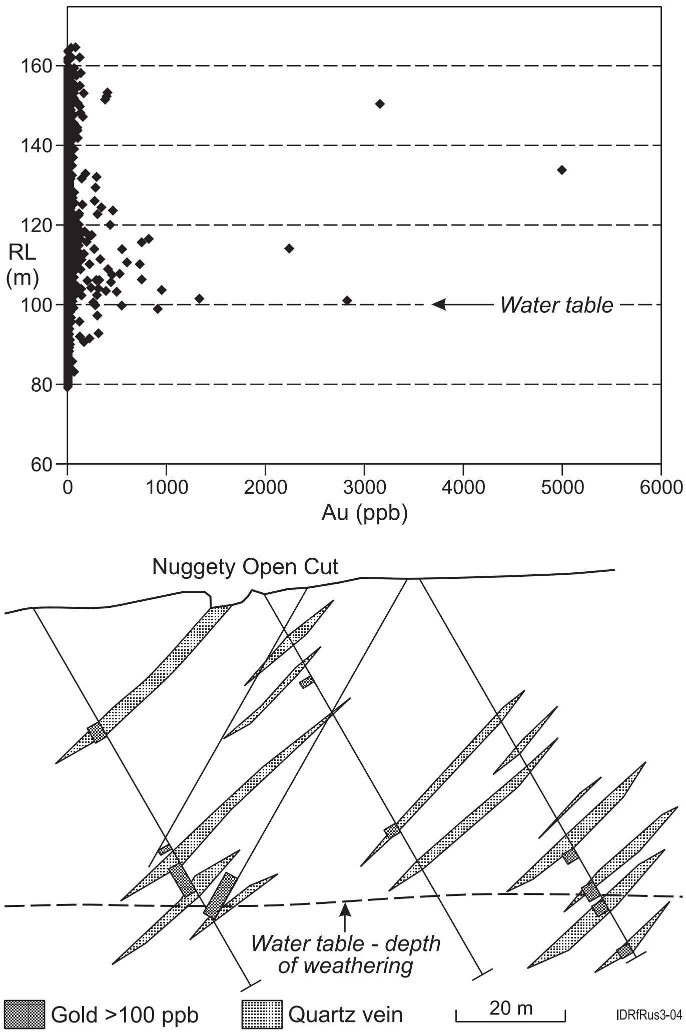

Figure 3. Gold data from a drilling program at Rushworth. Note the increase in Au above the water table (100 m RL) to about 150 m RL with a gap at 130-150 m. Scattered >2000 ppb data are nuggetty Au in quartz veins. N=1395.

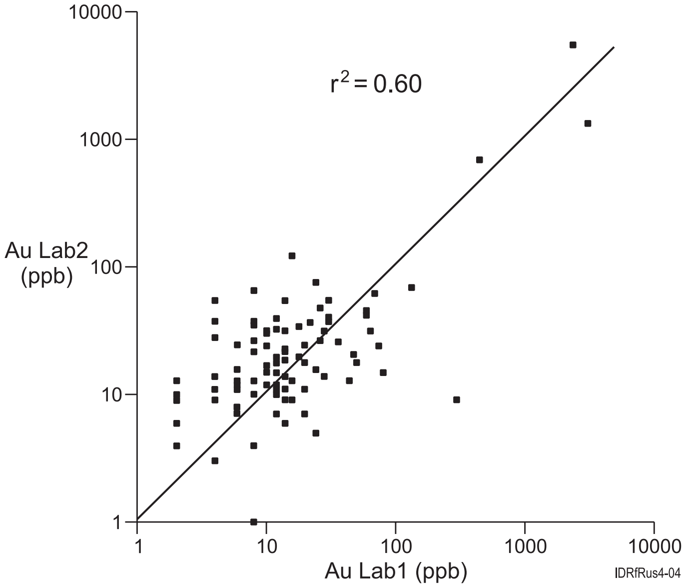

Figure 4. Inter-laboratory comparison of soil samples from near Whroo, plotted on a log scale.

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SAMPLE MEDIA - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Maximum anomaly (ppm)	Dispersion distance (m)
Primary mineralization -quartz-sericite	Au	PM203	0.02	<0.02	0.1	20	<<0.1
	As	G102	20	?		1400	
	Sb	G102	5	?		640	
Supergene mineralization	Au	PM203	0.02	<0.02	0.1	43.3	1-2
	As		20	<20	100	2700	
	Sb		5	<5	40	980	
Soil	Au	PM205	0.001	0.03	0.11	5.46	>100
	As		20	30	50	460	
	Sb		5	10	37	2450	
Regional average	Au	PM205	0.001	<0.02		43.5	
	As		20	<20		1965	
	Sb		5	<5		16800	

G102 Aqua regia digestion with AAS finish

PM203 and PM205 Aqua regia digestion of 50 g sample with graphite furnace AAS finish