# LEFROY AND BEACONSFIELD GOLD MINES, TAMAR REGION, TASMANIA

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## LOCATION

The Lefroy Goldfield is located 15 km E of George Town on the E bank of the mouth of the Tamar River, at 41°06′54″S, 146°59′20″E. The Beaconsfield Mine is 11 km S of George Town at 41°12′06″S, 146°46′20″E, on the W bank. Respective maps are Bell Bay 4844 and Beaconsfield 4843, Tasmania 1: 25 000 series.

## DISCOVERY

Alluvial gold led to the discovery, in 1867, of reef gold at Specimen Hill, 1.5 km SE of Lefroy. Some 30 lines of reefs were discovered with production mainly restricted to the New Pinafore, Chum, Volunteer and Native Youth Reefs (Figure 1). Mining ceased in 1911. The 0.47 m wide outcrop of the isolated Tasmania Reef at Beaconsfield was discovered in 1877, again in the search for the source of alluvial gold. Mining ceased at Beaconsfield in 1914 but resumed in 1999.

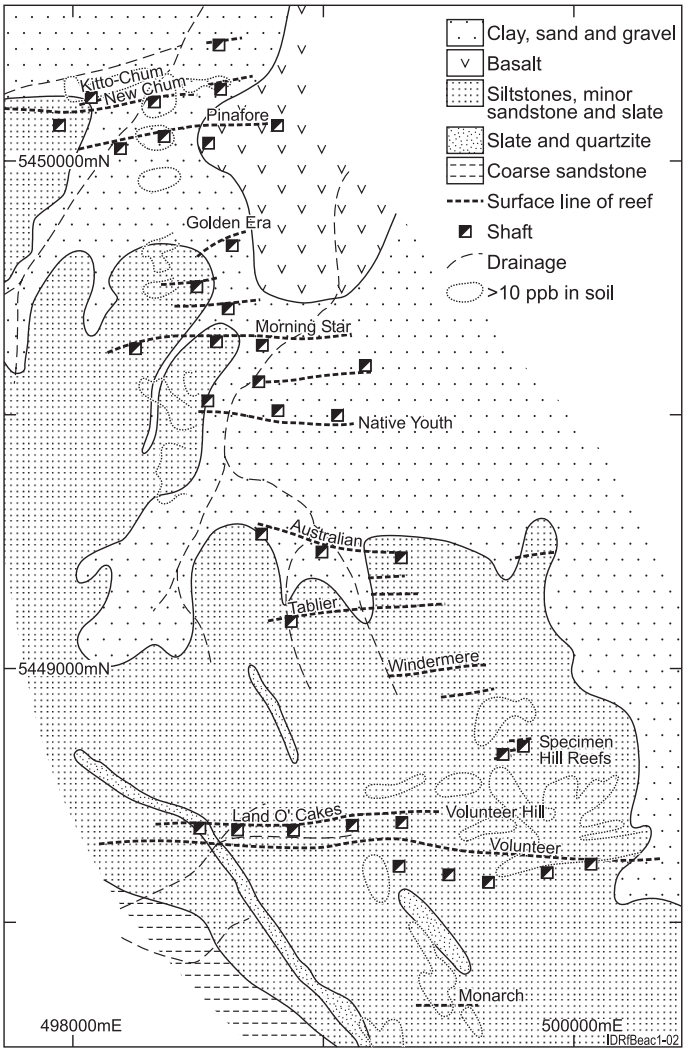


Figure 1. Lefroy goldfield. Location of reefs, simplified geology and Au anomalies in soil B horizon (Keele 1996, Purvis 1997).

Over the past 30 years, exploration in the Beaconsfield area has mainly used structural control and drilling. In contrast, in the Lefroy area, stream sediment and soil geochemical surveys were used in addition to those techniques. No new mineable reefs were found in either region. In retrospect, as the wall rocks are altered around the reefs, it would have been beneficial to i) analyse elements other than Au and As, ii) sample saprolite or soil C horizon instead of the soil B-horizon and iii) adopt a sample spacing sufficiently close to identify targets less than 10 m across.

## PHYSICAL FEATURES AND ENVIRONMENT

The Lefroy Hills form a topographically low, rounded basement rise and reach 200 m. Beaconsfield is located on the partially dissected West Tamar Plain, reaching 80 m on the exhumed structural ridge. The climate is temperate to Mediterranean, with an average annual rainfall of 950 mm. Thin secondary growth forest covers the areas that are not cleared for farming.

## GEOLOGICAL SETTING

The Tamar River follows a NNW lineament. Considerable thrusting occurred during the middle Tabberabberan Orogeny, when the entire region was metamorphosed to lower greenschist facies (Reed, 2001). The turbidites in the Lefroy area are among the oldest sediments of the 5-7 km folded and faulted Cambro-Ordovician to Devonian Mathinna Group. The Au deposits coincide with a W to E transition from sandstone to a shale-rich succession. In the Beaconsfield area, a series of NNW-striking, E-dipping, imbricate thrust slices incorporates 1 km of Cambrian to Devonian stratigraphy. The sediments change from shallow-water clastic sediments to deep-water limestones that are conformably overlain by turbidites equivalent to those at Lefroy. The Beaconsfield deposit is in the Cabbage Tree thrust slice, where Ordovician grits fine upwards to shales and limestones.

## REGOLITH

Yellow podzols 1-2 m deep occur in the Lefroy area; the soils in the Beaconsfield area are <0.6 m deep. Vegetation and soil originally obscured the quartz reefs in both areas. In the Lefroy area, several N-draining leads, up to 80 m deep, pass beneath Middle Eocene to Middle Pliocene basalts. A N-draining lead, running along the flank of Cabbage Tree Hill at Beaconsfield, is about 140 m deep; the sediments include locally-derived eluvial detritus.

## MINERALIZATION

The Lefroy auriferous quartz-carbonate-sulphide reefs are hosted by large, E striking, steeply dipping faults that cross-cut recumbent folds, especially on the location of superimposed, gentle, minor, open folds. Some of these structures, such as the Chum, Pinafore and Volunteer Reefs, are 1-2 km long, with crush zones 10-20 m wide and at least 400 m deep. Gold occurs in high-grade shoots (up to 30 g/t) within the reefs. The ore is concentrated in pipelike bodies at the intersection of the faults and a deformed earlier thrust, separating shale from micaceous sandstone. Mine dumps indicate that quartz-veined and altered sandstone, contain 0.5-2.0 g/t Au around some of the reefs. In several cases, the anticlinal fold axes have been exploited by late-stage quartz-vein stockworks. The Pinafore, Chum and Volunteer mines together produced up to 4.3 t Au.

The Tasmania Reef at Beaconsfield is a single, quartz-carbonate-sulphide dilational vein 400 m long with minor splays and bifurcations and is at least 1200 m deep. Overall, the NE-striking, SE-dipping reef averages 2.7 m in width, ranging from 8 to 0.5 m. From 1877 until its closure in 1914, the reef produced 26.6 t Au at a recovered grade of 24.5 g/t to a depth of 455 m below surface. The mine produced more than half of all the Au from NE Tasmania. The present combined proven and probable reserve is 1 143 000 t at 17.4 g/t.

Exploration at Lefroy has outlined alluvial gold reserves of 200 000 $m^3$ at an average grade of 0.5 g/t in long sinuous gullies averaging 30-40 m wide and 0.8 m thick under 1-2 m of overburden. The gullies lead N from the cluster of reefs (Murdoch, 1985).

## REGOLITH EXPRESSION

*Active stream sediment*

Keele (1996) carried out a BLEG (bulk leach cyanide extractable gold; detection limit 0.05 ppb) survey of 3 kg composite samples in an area of 210 $km^2$ surrounding Lefroy and in the Back Creek area immediately to the E. Of five strongly anomalous samples with >100 ppb Au and a further nine anomalous samples with 10-100 ppb Au, all but two correspond to known mineralization.

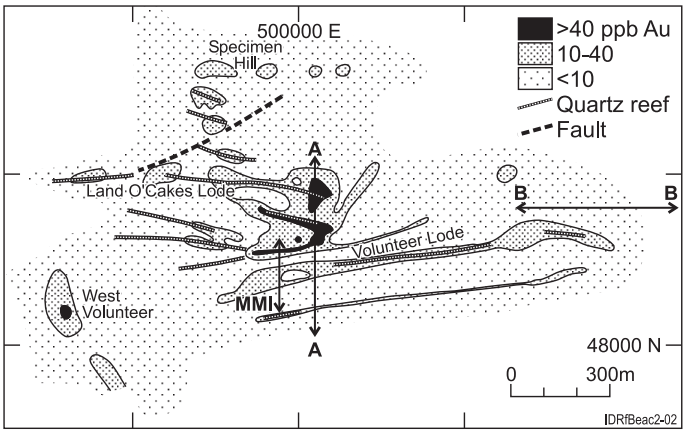


Figure 2. Soil B horizon soil Au anomaly over the Volunteer and Land O'Cakes Lodes, at Lefroy (Keele 1996). For cross section MMI see Figure 3. For cross section AA see Figure 4. For line BB results see text.

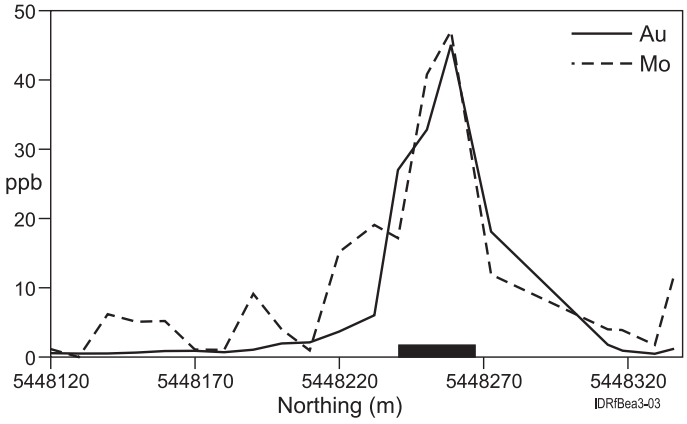


Figure 3. Match of Au and Mo in MMI analysis in soil C horizon across the Volunteer Reef, line 499900E, Lefroy. See Figure 2.

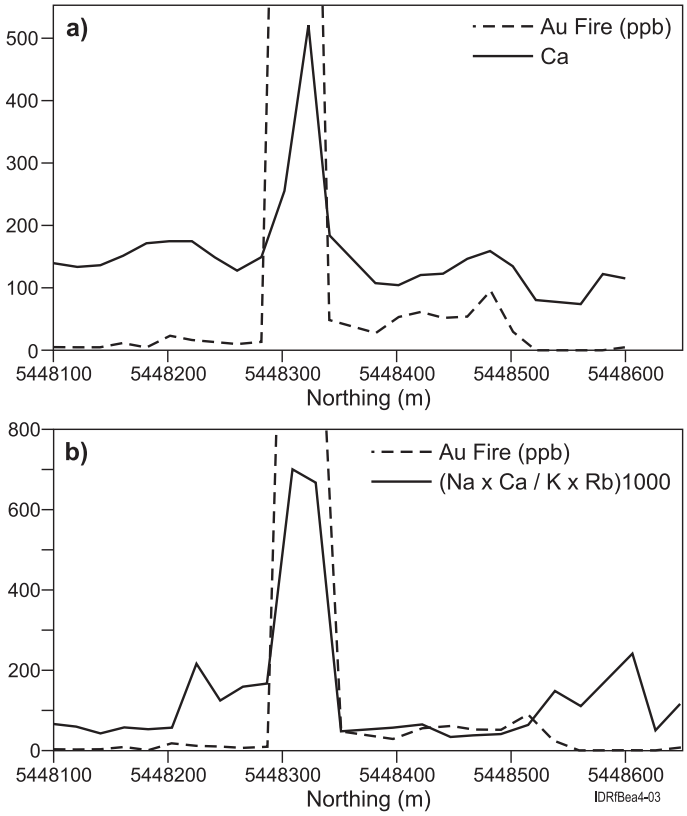


Figure 4. Match of Au by fire assay in the soil B horizon and Ca in the acid insoluble residue of the same sample, across the Volunteer Reef (section AA in Figure 2), line 500050E, Lefroy. Na and Ca enrichment and K and Rb depletion over the reefs can be used as reef indicators, enhanced as the index (Na x Ca / K x Rb)1000. The smaller peak at 5448500N indicates the Land O'Cakes Reef. See Figure 2.

*Soil*

Fifteen hundred B-horizon soil samples (from a depth of 200-300 mm) were collected at 20 m intervals (and at 10 m intervals at reef intersections) over the Lefroy area. These clayey soils with minor quartz were dried, pulverized and analyzed for Au (dl 5 ppb) by fire assay and As (dl 1 ppm) with an AAS finish. Those with >40 ppb Au and >50 ppm As were considered to be strongly anomalous. The results represent the major reefs well and, in particular, the major producing reefs at Volunteer, Land O'Cakes, Pinafore and Chum (Keele, 1996) (Figures 1 and 2). The 20 m spacing of the samples outside the areas of known reefs was, in retrospect, too wide in relation to the target sizes. There has been no systematic soil sampling in the Beaconsfield area.

*Channel and chip materials*

Sixty-five channel samples over 4 m and 31 chip samples over 2 m were taken from bedrock along road cuttings in the Land O'Cakes – Volunteer area and analyzed for Au and As. Overall, there is an excellent correlation between the channel and chip Au results and those from the soil. The bedrock Au abundances are two to three times greater than that in the overlying soil (Purvis 1997).

*Mobile elements in soils*

The Volunteer soil anomaly was followed up by Purvis (1997) by a Mobile Metals Ions analysis (weak cyanide leach, ICP-MS, dl 1 ppb and for Au 0.01 ppb). Twenty samples were taken at a depth of 0.7 m at 10 m intervals along line 499 900E across the western end of the reef. This gave a strong Au and Mo expression of the reef (Figure 3), a less strong positive As anomaly and a negative Ba anomaly over the reef.

*Acid insoluble residue of soils*

Forty six samples of the B-horizon soil at 20 m intervals were selected from line A-A 500 050E across the Volunteer Reef at Lefroy, line B-B 48 400N parallel to a barren section of the Volunteer Reef and line 499 550E across the non-productive Windermere Reef to the N (Figure 1). The samples were digested overnight in hot aqua regia, to remove carbonates and Fe-Mn oxides, and then washed thoroughly. The acid insoluble residue consists mainly of quartz with minor sericite. Thirty four elements were determined by simultaneous PIXE/PIGME spectroscopy (see Stott *et al.,* 1997). The results show a positive correlation between Au, As, Na, Ca and Cl. There is a strong positive correlation between elements comprising phyllosilicates (Al, F, Fe, Ga, K, Li, Mg, Rb, Sr and V), but these generally correlate negatively with Au.

The maxima in the cross sections over the Volunteer and Windermere Reefs (1245 ppm Na and 520 ppm Ca respectively) clearly show the position of the reef (background values one third of peak). At the Volunteer reef there is a distinct K, Rb and Al depletion over the reef. Both the EW section along the barren part of the Volunteer Reef and the NS section along the weakly mineralized Windermere Reef have much less Na and Ca than the section across the mineralized part of the Volunteer Reef, which has no K and Rb depletion. The product ratios Na x Ca/K x Rb or Na x Ca x Cl/K x Rb may be used as reef indicators.

*Wallrock alteration*

Widespread sericite-chlorite-pyrite alteration and quartz veining in the Lefroy area have been described by Purvis (1997). On a smaller scale, sericite destruction appears to have taken place around the reefs, as described above. In the Beaconsfield area, where the reefs contain more carbonate, ankerite spots occur up to 15 m from the Tasmania Reef. The EPR signals in small quartz veins indicate a 40 m wide halo below the Tasmania Reef in DDH 11 (Russell, 1995).

*Quartz*

A study of 327 core samples shows that the auriferous parts of the Beaconsfield and Lefroy reefs consist of microcrystalline quartz. This quartz has mean contents of 21 ppm As, 3 ppm Ge and 14 ppm Li, whereas barren parts of the reefs contain <2 ppm As, <1 ppm Ge and <3 pm Li. Statistical screening of quartz samples of Al, Ge, Li, Na, Rb, Ca and Cl contents is a useful indicator of gold mineralization in quartz (Russell, 1995; Russell and van Moort, 1999). Barren samples invariably have weak electron paramagnetic resonance (EPR) (Russell

and van Moort, 1997).


## ACKNOWLEDGEMENTS

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**SAMPLE MEDIA SUMMARY TABLE**

| Sample medium | Indicator element | Analytical method | Detection limits |
|---|---|---|---|
| Quartz | Au<br>As, Ge, Li | fire assay<br>PIXE/PIGME | 5 ppb<br>3, 1, 1 ppm |
| Stream sediments | Au | BLEG | 0.05 ppb |
| Soil, channel and chips | Au<br>As | fire assay<br>hydride AAS | 5 ppb<br>1 ppm |
| Soil, mobile metal ions | Au<br>Mo | MMI<br>MMI | 0.01 ppb<br>1 ppb |
| Acid insoluble residue of soils | Au<br>Na, Ca and K<br>Rb | fire assay<br>PIXE/PIGME<br>PIXE | 5 ppb<br>40 ppm<br>3 ppm |