GOLDEN DELICIOUS GOLD DEPOSIT, WESTERN AUSTRALIA

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LOCATION

The Golden Delicious deposit is approximately 50 km S of Laverton at 29°1'S, 122°27'E; Edjudina 1:250 000 map sheet (SH51-06).

DISCOVERY HISTORY

Billiton Australia Ltd, the predecessor to Acacia Resources Ltd, began ground aquisition in the Golden Delicious and Cleo (*this volume*) areas in 1987. The Golden Delicious deposit was quickly defined by RAB drilling (Newton *et al.,* 1998). It has a total resource of 6.1 Mt at 1.3 g/t Au (0.6 g/t cut-off), including a high grade northern zone of 2.4 Mt at 1.8 g/t Au (1 g/t cut-off) (Acacia Resources Ltd., 1995). The Granny Smith tenements are now owned by Placer Dome.

PHYSICAL ENVIRONMENT

The Golden Delicious deposit lies beneath a broad colluvial plain, approximately 5 km E of the margin of Lake Carey and 5 km NE of the nearest exposed Archaean rocks. The present surface slopes very gently NW (maximum of 4 m of elevation difference over 1 km across the study area). The basement palaeosurface beneath the plain also slopes NW but the gradient is steeper (maximum of 20 m across the study area) and is more variable.

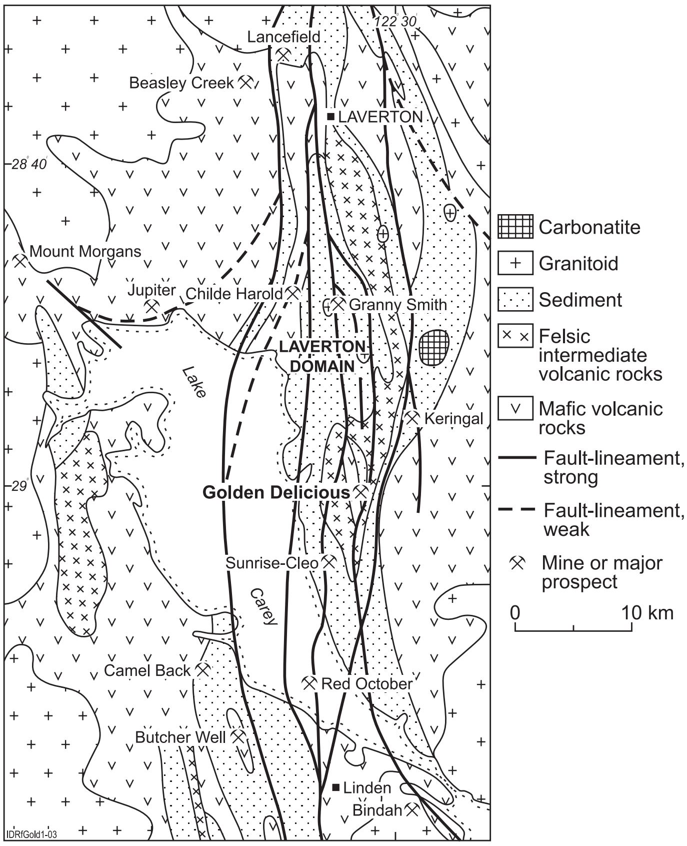

Figure 1. Regional geology and setting of the Golden Delicious Au deposit after Newton et al., (1998).

The climate is semi-arid, with a variable annual rainfall (200-250 mm). Average minimum and maximum temperatures for July are 5-15ºC and 21-37ºC for January. Vegetation around the deposit comprises sparse to dense *Acacia* spp. woodland, with an understory of *Acacia, Eremophila* and *Cassia* spp. shrubs (Hall *et al.*, 1994).

GEOLOGICAL SETTING

The Golden Delicious deposit is in the Archaean Norseman-Wiluna greenstone belt of the Yilgarn Craton, in the southern part of the Laverton Domain (Figure 1). This zone has major N and NNW trending shear zones and faults. The region consists of folded, faulted and metamorphosed greenstones surrounded by granite. The major lithologies include ultramafic and mafic metavolcanics, felsic metavolcanics and volcaniclastics, banded iron formation, layered gabbroic sills and intrusive sheets of granite (Keserue-Ponte, 1995). The granitoids can be divided into two suites: (i) a comagmatic monzonite-syenite suite, consisting of dominant medium-grained monzonite and minor medium to coarse-grained syenite with gradational contacts and extensive propylitic alteration and (ii) a fine- to medium-grained granite. Most contacts between these granitoids are strongly sheared and relationships are not well understood. However, work by Acacia Resources Ltd (1995) indicates that these granitoid suites lie on different fractionation trends and are probably separate intrusive events.

REGOLITH

Both mineralized and country rocks are weathered to 70-80 m, and covered by up to 20 m of colluvium-alluvium derived from the regolith of mafic rocks several km to the ESE. The entire regolith is saturated with saline, weakly alkaline groundwater below approximately 10 m. The major regolith units (Bristow *et al.,* 1996) are: -

(1) Residual Archaean materials, weathered to 70-80 m, consist of clay-saprolite, saprolite and saprock, with some truncated or incipient mottled zones. The clay-saprolite has large (up to 200 mm diameter) hematite-rich mottles. However, little coherent primary lithic fabric is preserved in either mottles or clays except towards the base of the unit. The mottling appears unrelated to many geochemical trends in the residuum, and may be a late overprinting on an already truncated, deep regolith.

(2) Cainozoic alluvial, colluvial and/or aeolian sediments dominate the surface and vary from less than one metre to many tens of metres in thickness. On section 6790200mN, depicted in Figures 2 to 4, there are from the top downwards: (i) Calcareous, hardpanized, silty clays (4 m thick) that are dominantly fine (<1% gravel) and strongly indurated with silica, carbonate, Fe oxides and dendritic Mn oxides. Carbonate also occurs as thin (up to 5 mm), laminar, sub-horizontal coatings along partings and fractures. (ii) Silty clays (4-6 m thick) with a few irregular carbonate mottles, up to 40 mm in diameter, are dominantly fine-grained, although gravels are more common than above. (iii) Silty clays with abundant Fe-rich gravel (5-8 m thick, dominantly broken and abraded Fe-rich maghemite-bearing pisoliths, nodules and ferruginous lithorelics with minor quartz and unweathered rock fragments. The upper few metres in the NE contain minor concretionary goethite and the lower metre is cemented by pale pink carbonate. (iv) A thin basal layer of reworked fragments of hematitic mottles, similar to the underlying mottled zone.

MINERALIZATION

Gold mineralization (Figure 2) is hosted by a suite of granitoids (Grove, 1996), within narrow shears that intrude sheared intermediate to mafic metavolcanic and volcaniclastic rocks (Figure 1), including intermediate trachy-andesitic to mafic metavolcanics, minor interbedded volcaniclastic rocks and banded iron formation. Elements associated with Au mineralization are W, Sb, K and REE, although none displays a very close correlation with Au (Bristow *et al.*, 1996).

REGOLITH EXPRESSION

Weathered basement rocks

Extensive drilling indicates that Au concentrations in the mineralized zone decrease sharply above 25-30 m depth (Figure 2), which approximates to the base of the mottling within the mineralization. This may reflect primary Au distribution rather than depletion by weathering (see below). Dispersion of Au (40-80 ppb) in the top few metres of the weathered basement, 300 m wide, is centred above the mineralization, due to residual accumulation or chemical concentration, providing the

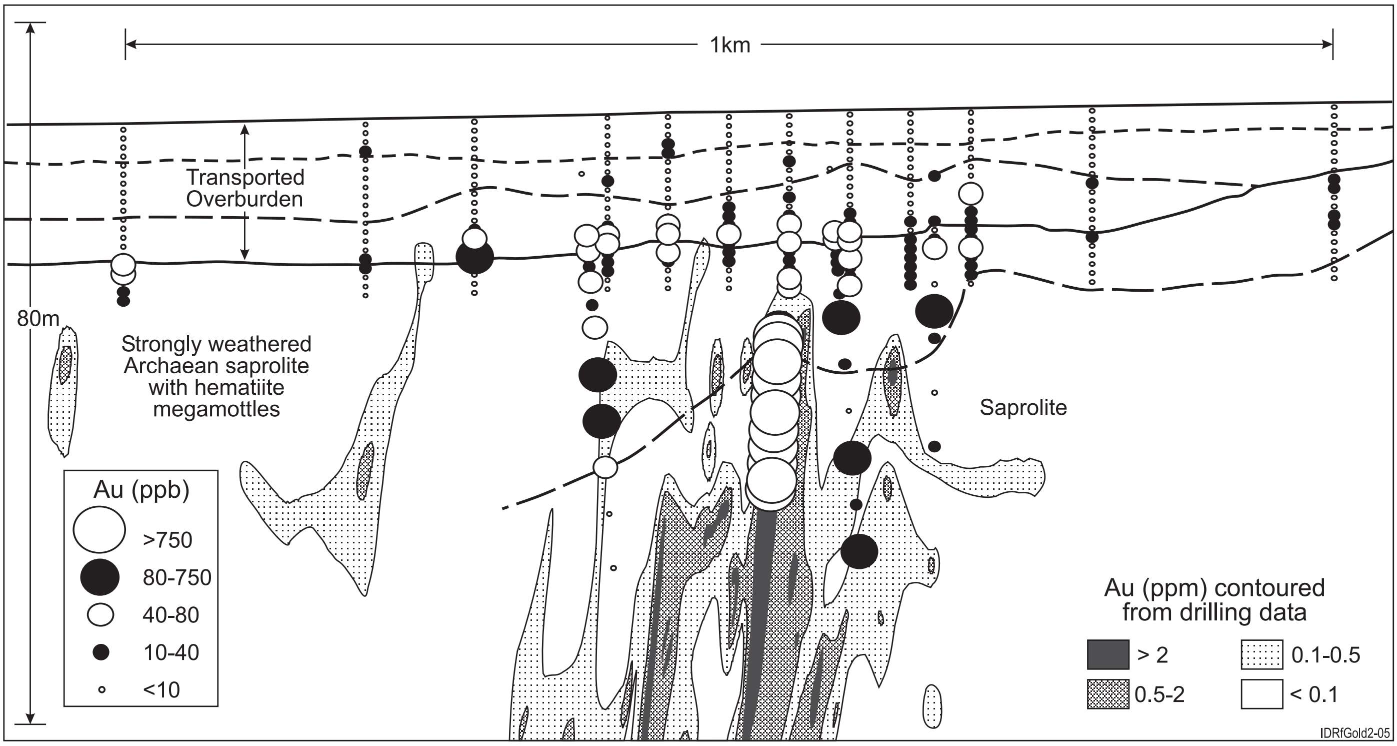

Figure 2. Gold distribution in the residual profile and overburden.

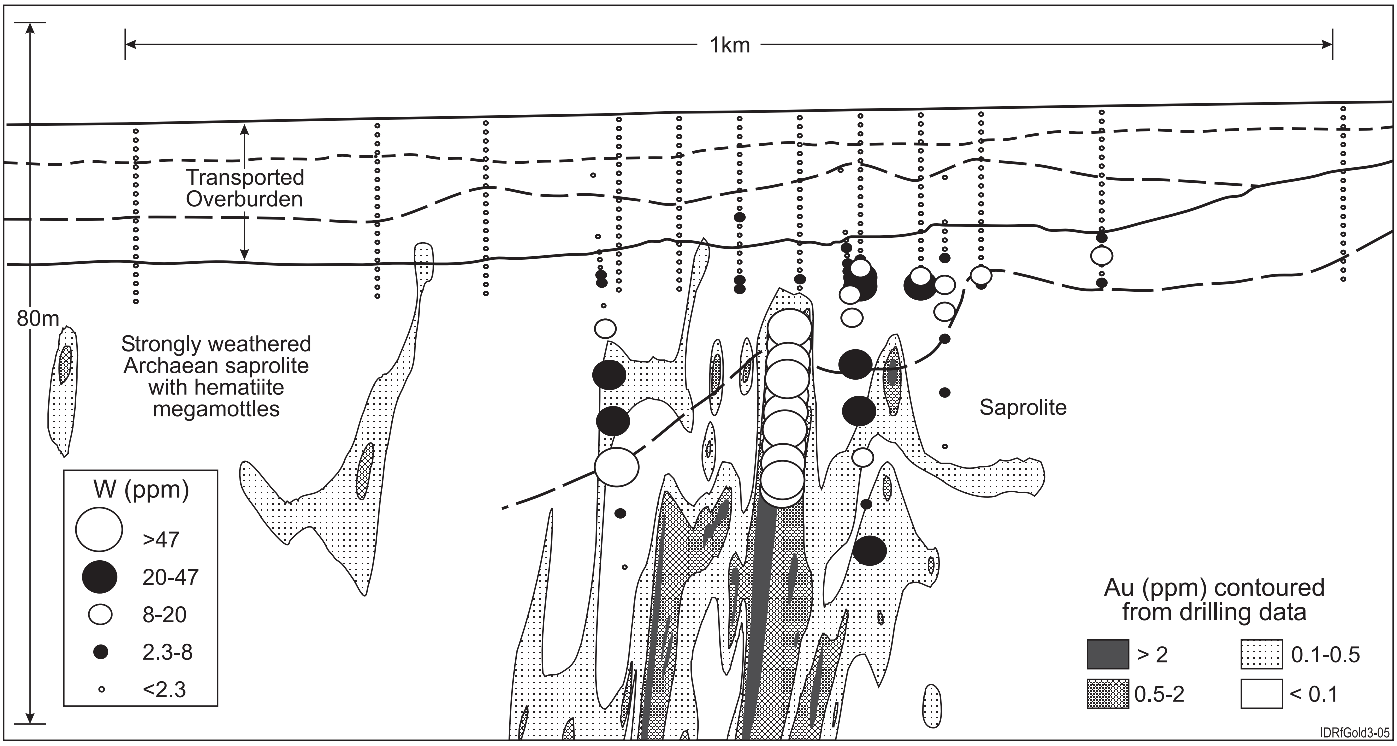

Figure 3. Tungsten distribution in the residual profile and overburden superimposed on Au distribution map.

best medium in the residual regolith.

The W distribution in the saprolite (Figure 3) is similar to that of Au. Tungsten concentrations in the mottled zone, just below the unconformity are significantly less than in the underlying saprolite. Tungsten depletion by dissolution would not be expected due to the relatively high stability of W minerals, further supported by W solubility experiments on this saprolite and mottled zone. Accordingly, it is concluded that the distribution of W reflects its original distribution in the primary mineralization prior to weathering. There is no evidence for lateral dispersion of W from mineralization.

The Sb abundance of primary mineralization is low (maximum 8 ppm) but relatively enriched in the residual regolith, particularly the weathered mineralization, shown by a broad anomaly in Fe-normalized data, and a correlation between Sb/Fe and Au. Arsenic concentrations in mineralization are also low (<7 ppm) and there is no evidence for dispersion from the mineralization; there is only a very slight increase in the As/Fe ratio in the mottled zone (Bristow *et al.,* 1996). The Sb/Fe ratio gives a broader anomaly in the weathered basement than Au; this may be primary, but the small solubility of Sb suggests some secondary dispersion.

Transported overburden

The transported overburden was sampled by 12 RAB holes specifically drilled to avoid cross-hole contamination. There is a widespread Au anomaly in the basal ferruginous gravels (Bristow *et al.,* 1996) reaching 12-107 ppb, distributed 500 m across the mineralization (Figure 2) and offset slightly down slope. The Au can be dissolved without pulverizing the samples and up to 80% of it is iodide-soluble (Gray and Lintern, 1998). This indicates that little of the Au is occluded. The close spatial relationship to mineralization and the Au anomaly in ground water (see below) suggests aqueous dispersion from mineralization. Sampling the few metres of basal gravel provides the optimum target enhancement at

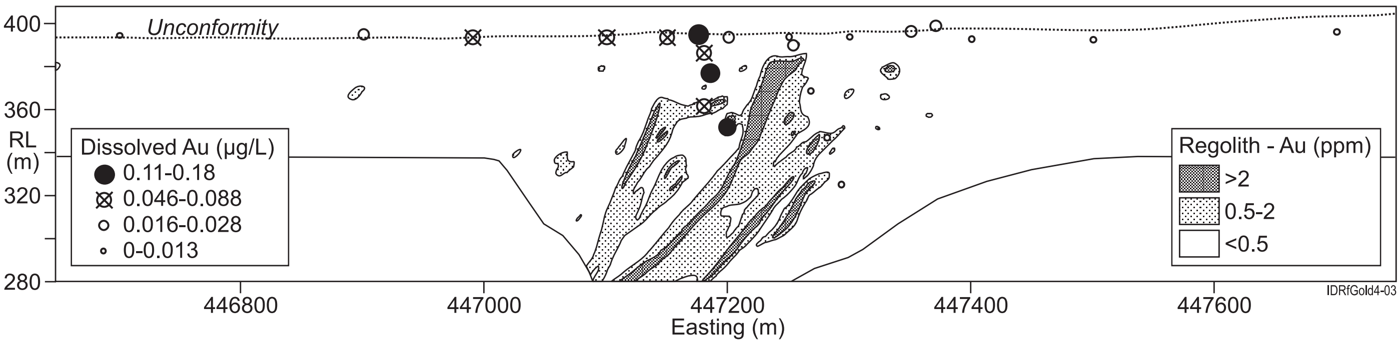

Figure 4. Distribution of Au dissolved in groundwater at Golden Delicious on profile 6790200N (dots), superimposed on Au distribution in the regolith.

this site, enlarging the target by up to 400 m. Shallower sediments are much poorer in Au (5-12 ppb or less), probably approaching background for a Au-bearing province.

There is no detectable W (detection limit 2 ppm) in the transported overburden (Figure 3). Both As and Sb are closely related to Fe in the transported overburden and consequently are broadly anomalous in the basal ferruginous gravels (Sb max 4.5 ppm; As max 41 ppm; Bristow *et al.,* 1996). However, if Sb and As are normalized to Fe, any spatial association with mineralization in the transported overburden is lost.

In contrast with sites S of the Menzies line (e.g., Panglo Gold Deposit, *this volume*; and Bounty Gold Deposit, *this volume*), there is no association of Au with carbonate at the detection limits of INAA (5 ppb). The carbonates at Golden Delicious form laminar sub-horizontal veins, coatings and mottles and are probably groundwater calcretes rather than pedogenic carbonate.

Hydrogeochemistry

Golden Delicious is in the central groundwater region of the Yilgarn Craton (Gray, 2001). Groundwaters at Golden Delicious are neutral (pH 6.5-7.3) and have a similar Eh range to neutral waters from other sites in the central region. Because it is close to Lake Carey, groundwaters are more saline (up to 16% TDS) than elsewhere. Gold in groundwater is anomalous, (0.046-0.18 µg/L), with the anomaly slightly offset to the W (Figure 4), for 200 m across strike of mineralization. These concentrations are typical of the region, with Au probably dissolved as a halide.

Arsenic, Mo, Ag, Sb, W, Tl and Bi have moderate to high concentrations in groundwater at Golden Delicious, again typical of neutral waters in direct contact with weathering sulphides. These results suggest that groundwater may be a valuable regional exploration medium, with sampling intervals of 1 km or more if analysed for Au and a range of pathfinder elements.

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SAMPLE MEDIA - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)	Dispersion distance (m)
Shallow sediments	Au	NAA	0.005	-	-	-	Nil
	W	NAA	2	Below det.	-	-	-
Basal ferruginous gravels	Au	NAA	0.005	0.010	0.040	0.105	200
	W	NAA	2	Below det.	-	-	-
	As	NAA	1	7	10	41	50
	Sb	NAA	0.2	-	-	-	nil
Ferruginous upper mottled zone	Au	NAA	0.005	0.010	0.012	0.080	150
	W	NAA	2	Below det.	-	-	-
	As	NAA	1	5	8	28	80
	Sb	NAA	0.2	1	1.2	8	150
Groundwater	Au	NAA (carbon concentrate)	0.005 ppb	0.010 ppb	0.015 ppb	0.18 ppb	100
	Bi	ICP-MS	0.001	0.003	0.005	0.022	50
	As	ICP-AES	0.02	0.10	0.14	0.33	> 250

