BOUNTY GOLD DEPOSIT, FORRESTANIA GREENSTONE BELT, WESTERN AUSTRALIA

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LOCATION

The Bounty Gold Deposit is located approximately 115 km SSE of Southern Cross (Figure 1) at 32º05'56"S, 119º46'30"E; Hyden 1:250 000 map sheet (SI50-04).

DISCOVERY HISTORY

The deposit was discovered by Aztec Exploration Ltd in 1985 by re-sampling RAB drill cuttings, generated by an earlier Ni exploration program. Anomalous Au was found and subsequent auger and RAB drilling intersected 11 m at 5 g/t (Bryan Smith, Aztec Mining, pers. comm. 1989).

PHYSICAL FEATURES AND ENVIRONMENT

The major landforms of the area are undulating plains at 420 m ASL with about 50 m of relief. Bounty is on the E flank of a range of hills and locally straddles an E-striking ridge. Drainage is poorly developed, but generally trends N and S from the ridge into broad valleys before entering a salt lake system about 10 km to the SE. The annual rainfall is about 450 mm, mainly in winter; the potential annual evaporation is about 1200 mm. Mean temperature ranges are 15-32ºC in January and 5-16ºC in July. Two major soil types control the nature and density of the vegetation. Vegetation on lateritic soils is a closed shrubland of *Acacia*, *Casuarina* and *Hakea* spp., and a few mallee eucalypts up to 4 m. On calcareous clay soils, sclerophyll woodland is dominant, consisting of mixed *Eucalyptus* spp. (up to 5-10 m high, with multi-stemmed mallee in lower lying areas) with a few larger salmon gums (*E. salmonophloia*).

GEOLOGICAL SETTING

Bounty is in the Archaean Forrestania Greenstone Belt (Figure 1), a southerly extension of the Southern Cross Belt. The Forrestania Greenstone Belt (Chin *et al.*, 1984) is dominated by tholeiitic basalt and occupies wide zones to the E and W of a core of sediments (cherts, siltstones and sandstones). Ultramafic rocks, including komatiites, now altered to chlorite schists, and serpentinized dunites also occur. Some meta-gabbros are associated with the flanking mafic rocks, and several BIF units are associated with ultramafic rocks. A series of E-striking lower Proterozoic gabbroic dykes cut across the greenstones. The main Au deposit is in a narrow zone, known locally as the Bounty Zone, of BIF-related Fe-rich amphibolites and some associated siliceous and pelitic rocks. Dolerite and high-Mg basalt flank the deposit to the W and E respectively.

REGOLITH

The average depth of weathering at Bounty is approximately 40 m (Britt and Gray, 2001). Where complete, the profile has an upper ferruginous horizon (Fe-rich clays and lateritic residuum), underlain by mottled clays, bleached saprolite and unweathered rock (Lintern *et al.*, 1990). Much of the ferruginous horizon exposed in the Bounty and North Bounty pits (Figure 2A) is a 2 to 4 m thick indurated light brown to reddish brown clay, mottled with incipient pisolitic structures. Well-defined black Fe-rich nodules (<10 mm) are locally very abundant and form nodular duricrusts 1-2 m thick that extend laterally for tens of metres. Horizontal to subhorizontal, slightly convoluted structures (possibly once voids) are occupied by very pale grey sandy clay. The ferruginous horizon has been eroded from much of the area (Figure 2A), exposing saprolite; a mantle of colluvium-alluvium overlies saprolite on the lower slopes and valleys.

There are four soil types, the first two being dominant (Lintern *et al.*, 1990):

(i) an acidic, friable, yellow to reddish brown clayey sand, with abundant brown sub-angular to sub-rounded ferruginous gravel, developed on duricrust.

(ii) red to light brown, friable, clay loams with abundant soft carbonate at a shallow depth (generally less than 150 mm). Some profiles in this soil group merge, at depths of 1-2 m, to saprolite derived from mafic rocks. More commonly, although some large pockets of soft carbonate continue to about 1.5 m, massive, dark red-brown to dark brown, non-calcareous clays appear at 500-700 mm and form a continuous substrate below about 1 m. This clay substrate is very plastic, is neutral to mildly acidic and merges over a narrow zone to weathered rock at a depth of 5-6 m.

(iii) duplex soils, consisting of greyish-brown sandy clay, 0.1-0.15 m thick, overlying massive brown, calcareous clay.

(iv) reddish yellow-brown loose sands are restricted to thin bands of chert on upland areas. Quantities of chert fragments occur at the surface

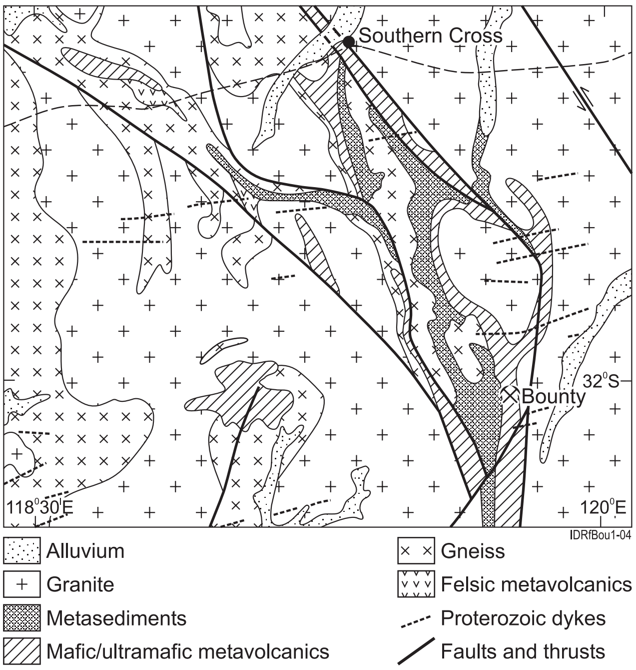

Figure 1. Locality and regional geology (after Myers and Hocking, 1998).

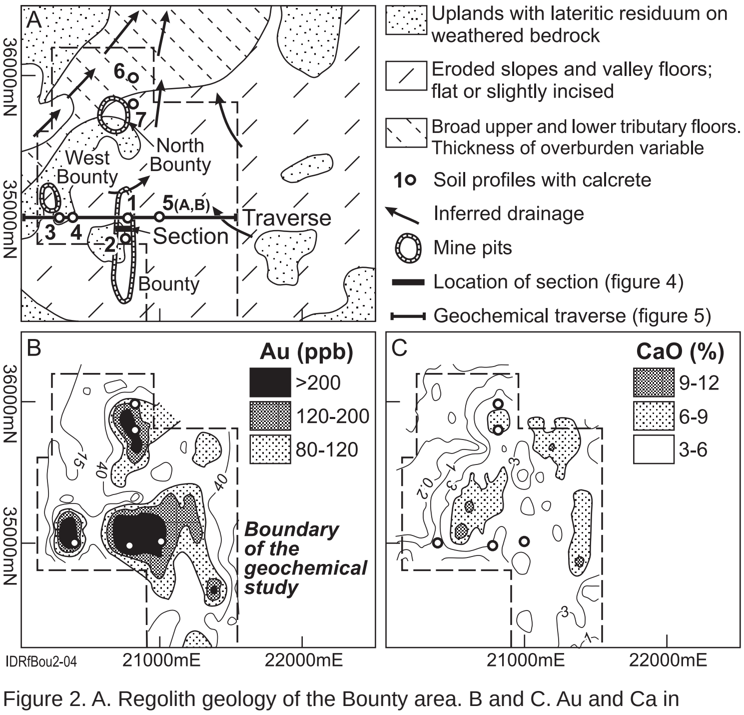

Figure 2. A. Regolith geology of the Bounty area. B and C. Au and Ca in the soil.

or at depths of up to 0.3 m, with partially weathered chert at about 0.5-0.75 m.

The areas dominated by lateritic gravelly sand-rich regolith are commonly separated from the calcareous and clay-rich regolith by breaks in slope. However, in places, these breaks are ill-defined or absent; for example where spurs, dominated by the lateritic regolith, extend from uplands to the adjacent valley floor. For example, outcropping lateritic residuum, exposed at the S end of the North Bounty pit, is situated on the lower end of a spur. To the N, friable calcareous light-brown clays form the surface unit. These merge at a depth of <1 m to plastic non-calcareous clay, in turn overlying laterite duricrust, which itself merges to coarsely mottled clay. This lateritic duricrust also changes laterally to a mottled clay and is the dominant substrate to the dark brown clays, although in places a light brown clay horizon, 0.3 m thick, lies between these materials. Near the NW corner of this pit, gravelly lenses (0.3 m thick and about 1 m long) occur at the interface between the dark brown plastic clay and the underlying mottled clay. This suggests that fluvial transport could have played a role in development of the upper parts of the regolith. Conversely, in other profiles (E wall of Bounty pit) plastic clay is continuous with the underlying weathered rocks (high-Mg basalt) implying it to be residual (Lintern *et al.,* 1990).

Some calcareous red earths have a gilgai micro-relief (a complex pattern of sinkholes and low mounds or puffs). These are best developed over a few hectares on the valley divide between the N and S drainages. The most common substrate to the calcareous clays are non-calcareous dark red-brown plastic clays, although there are some areas where very friable clays directly overlie weathered rock (Lintern *et al.,* 1990).

MINERALIZATION

The Bounty mineralization is in a steeply dipping semi-conformable shear system within near-vertical W-dipping metasediments (chert and BIF). The metasediments are sandwiched between metadolerite in the hanging wall and a komatiite to high-Mg basalt-ultramafic sequence in the footwall. This sequence extends several km N and S of Bounty. There is a strong association between the occurrence of Au and the presence of underlying chert and BIF. Gold mineralization occurs

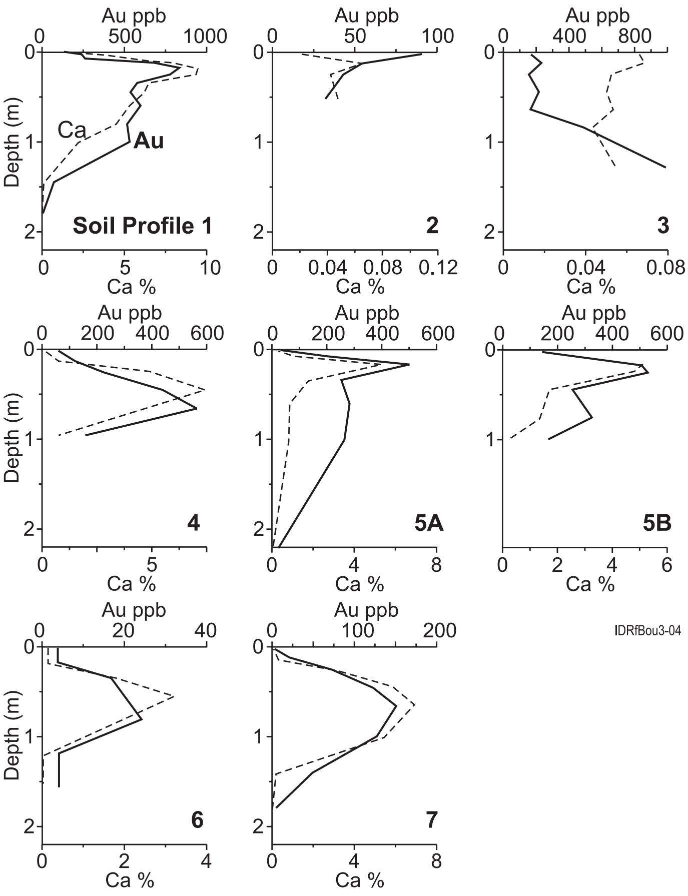

Figure 3. Gold and Ca in selected vertical soil profiles (see Figure 2A for their locations).

mainly in zones of quartz-sulphide-carbonate alteration and had an average grade of 5 g/t from 0-60 m, 8.9 g/t from 60-310 m and is continuous below this. Near the surface, mineralization is about 20 m wide, however, the soil anomaly (>80 ppb) extends down slope for over 750 m. The mine had a total underground and open cut resource of 1.4 Moz (Mining Australia, 2002). Mining commenced in 1988 and was completed in 2002.

REGOLITH EXPRESSION

Soil

In the area of the Bounty pit (Figures 2A, 2B), the highest Au concentration (1020 ppb) in augered (0-1 m) soil samples occurs in calcareous soil directly over the main Bounty Zone. Here, Au and Ca (carbonate) are closely correlated within the vertical soil profile (soil profile 1, Figure 3). The distribution of Au in the soil indicates a nearly continuous zone of enrichment with a linear N trend through the centre of the Bounty Zone. Prior to mining, the major soil anomaly was associated with the main Bounty Pit, with its size and shape suggesting considerable down-slope dispersion, particularly to the E (Figure 4). The remaining anomalies in the same area are associated with the North Bounty Pit and the West Bounty Pit (Figure 2). Where there are thin alluvial sands (<0.2 m) overlying the red clays (duplex soils), the carbonate and Au are located slightly deeper in the soil profile (Figure 3, profiles 6 and 7). There is excellent *vertical* agreement between Au and the alkaline earths concentrations, as demonstrated by individual soil profile data. However, there is no apparent *lateral* correlation along a traverse (Figure 5). Not all the carbonate horizons are equally rich in Ca and Au. The tenor of each soil anomaly does not directly reflect the strength of mineralization. For example, the soil anomaly at 21420mE 31000mN (400 m at >40 ppb Au, maximum 380 ppb) has weak mineralization (3 drill holes gave 5 m at <200 ppb Au), whereas a similar anomaly at 21420mE, 31800mN (500 m at >40 ppb Au, maximum 250 ppb) has moderate mineralization (2 drill holes with 30 m averaging 700 ppb Au). There is a weak correlation between higher Au and Fe in non-calcareous, gravelly lateritic soils near mineralization (Figure 3; profiles 2 and 3).

Vegetation

Gold in vegetation (leaves and small branches) and mull (decaying plant matter on the surface) weakly reflect abundances in soil or mineralization (Table 1). For 31 vegetation samples, the Au concentrations (dried sample) range from less than detection (<0.5 ppb, sample pit 7, medium soil Au anomaly, poorly mineralized or background area) to 11 ppb (sample pit 1, over mineralization). The Au content of the mull (7 samples, mean 29 ppb) varies from below detection (<1.0 ppb, sample pit 6 in background) to 71 ppb (sample pit 4, mineralized and over a strong soil anomaly of 570 ppb) and were considerably higher than concentrations found in the fresh vegetation (mean 2.5 ppb). All the major plant genera in the area, including *Eucalyptus, Melaleuca, Thryptomene (Myrtaceae)*, and *Daviesia (Fabaceae)*, contain some Au, but no particular genus stands out as a Au accumulator or indicator of mineralization (see Table 1).

Samples from various parts of a single small tree, *Eucalyptus flocktoniae* (merrit), growing in the vicinity of soil profile 1 (Table 2) had the highest Au concentrations in the leaves, although the greatest mass of Au was in the trunk. Concentrations do not greatly differ between the organs of this tree, which suggests that any parts may be suitable for sampling. However, one sub-sample of small branches was below detection. If tall trees are prevalent, as at Bounty, and are the preferred

TABLE 1
GOLD IN PPB (DRY WEIGHT) FROM VEGETATION FROM SEVEN SAMPLE LOCATIONS

Site	*Eucalyptus*	*Melaleuca*	*Daviesia*	*Acacia*	*Thryptomene*	*Hakea*	Mull	Equivalent soil
3	np	3.8	np	np	1.9	3.1	29	990
1	<1.2, 2.2	11	np	np	np	np	51	830
4	np	<1	np	np	<0.5	np	71	570
5	np	1.7	6.5, 2.2	np	np	np	23	530
7	1.3, 6, <0.5	1.5,1.6	4, 1.3	<0.5	np	np	2.3	152
2	<1, 3.4	2	np	np	6.1	2.6	21	55
6	<1, <1	<1, <1	<1, <1	np	np	np	<1	24

Np - Plant species either not present or not sampled. Two examples were taken from some sites.
Sample 1 is located closest to the Bounty Zone.

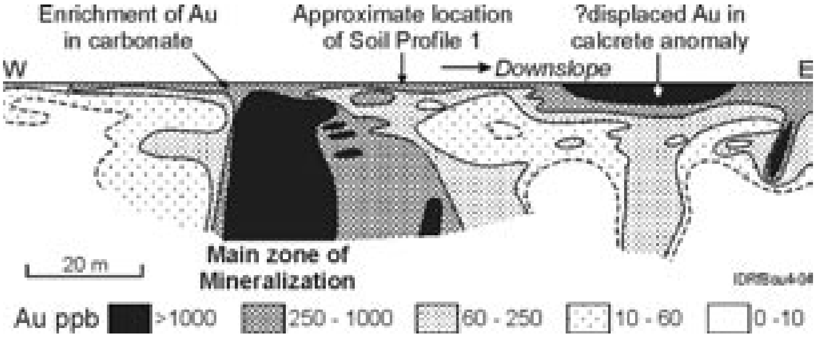

Figure 4. Gold in the top 20-30 m of the regolith section along 35000mN (after Smith, 1987).

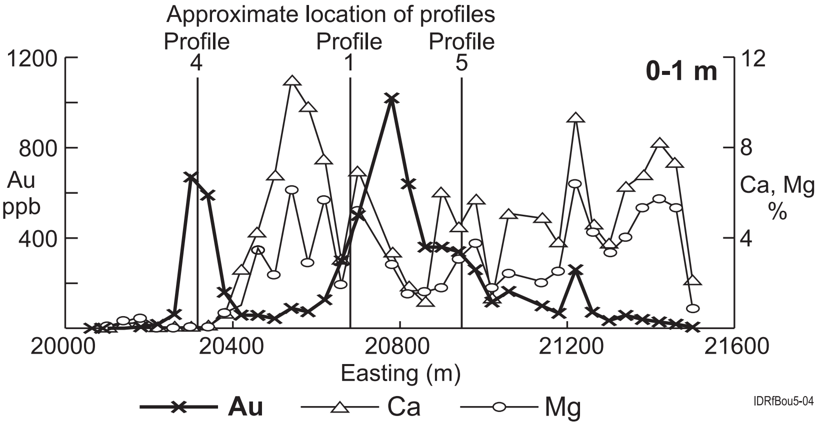

Figure 5. Gold, Ca and Mg in the 0-1 m soil from drill cuttings prior to pit excavation on section 35 000mN

sample medium, it may be practical to collect bark or wood rather than leaves.

Gold has been mobilized hydromorphically, because the alkaline earth metals and Au are closely correlated. Vegetation is implicated in Au dispersion but the magnitude of its role has still to be determined. Auger sampling is clearly successful in collecting the Au-rich carbonate horizon.

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TABLE 2
GOLD CONTENT, DRY WEIGHT AND TOTAL GOLD CONTENT OF ORGANS OF *EUCALYPTUS FLOCKTONIAE*

Sample Type	Au (ppb)	Dry weight (g)	Total Au (µg)
Leaves (1)	3.3	323	1.1
Leaves (2)	2.7	249	0.7
Branches (1) (<5 mm ∅)	1.8	190	0.3
Branches (2) (<5 mm ∅)	<0.5	108	<0.1
Branches (>5 mm ∅)	2.2	595	1.3
Bark	1.1	61	0.1
Trunk	2.0	4175	8.2
Near surface roots	1.6	864	1.4
TOTALS		6563	13.2