BRONZEWING GOLD DEPOSIT, WESTERN AUSTRALIA

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LOCATION

The Bronzewing deposits (Laterite, Central and Discovery pits) are about 500 km N of Kalgoorlie and 80 km NE of Leinster, at 27°23′S, 120°59′E; Sir Samuel 1:250 000 map sheet (SG51-13).

DISCOVERY HISTORY

Bronzewing is a recent discovery in an area of thick transported cover and deep weathering, distant from historical producers. The gold deposit was targeted by Great Central Mines using a conceptual geological approach followed by reconnaissance bedrock drilling and sampling of buried lateritic residuum and ferruginous saprolite. Studies around Mt McClure in the early 1990s (Anand *et al.,* 1993) recognized lateritic residuum and the potential for this to be buried farther E in the depositional regime that is now Bronzewing. Deep drilling in 1992 outlined the Discovery, Central and Laterite mineralized zones (Eshuys *et al.,* 1995; Wright *et al.,* 1999).

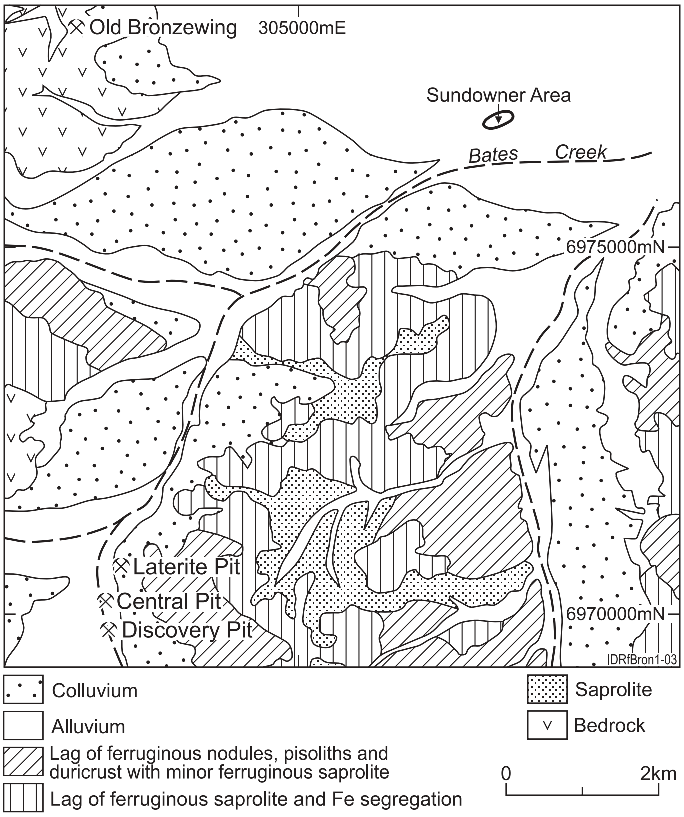

Figure 1. Simplified regolith-landform map of the Bronzewing area (after Anand et al., 2001).

PHYSICAL FEATURES AND ENVIRONMENT

Bronzewing is in an area of subdued relief where drainages and associated sediments comprise about 50% of the landscape (Figure 1). The deposits are beneath a colluvial-alluvial plain, with low hills, including backslopes of breakaways, of ferruginous duricrust, saprolite and ferruginous saprolite and, in places, bedrock, to the NE and NW. Bates Creek flows northwards in a series of braided channels, adjacent to the Bronzewing pits, with a gradient of <1:1000. Flanking the channels are extensive sheetwash areas covered with polymictic lag of ferruginous pisoliths and lithic and quartz fragments. The climate is semi-arid and has an irregular annual rainfall averaging 200 mm. Vegetation is mainly *Acacia* spp., with *Eucalyptus* spp. and *Santalum* spp. in creeks.

GEOLOGICAL SETTING

Bronzewing lies within the Yandal greenstone belt of the Yilgarn Craton. The geology is dominated by massive tholeiitic pillow basalts and dolerite, with ultramafic and gabbroic bodies to the W and NW. A N-striking diorite body intrudes the sequence to the SE of the Discovery Pit (Phillips *et al*., 1998). Metamorphism has been to upper greenschist facies.

REGOLITH

Close to the deposits, the modern alluvium conceals steep-sided channels over 50 m deep that, in places, are oblique to the present drainage (Bates Creek). The palaeochannel on the W edge of Discovery pit ran from SE to NW of the mine area. In the low-lying area to the SW of the orebody, ferruginous saprolite is overlain by 20-50 m of mottled Tertiary clay and silt, and an uppermost Quaternary colluvial-alluvial unit, 10-15 m thick, the top 5-6 m of which has been silicified to red-brown hardpan. Central Pit is on the edge of the palaeochannel and has approximately 20 m less transported material than at Discovery Pit. The unconformity occurs within and above a zone of lateritic nodules and pisoliths, visible around most of the circumference of the pit.

The weathering front on basalt is at about 100 m, and the residual profile consists of saprock, saprolite, ferruginous saprolite, mottled saprolite, collapsed mottled saprolite and lateritic residuum. The saprock contains relict chlorite, feldspars, quartz, calcite, mica and pyrite. The saprolite is generally 50-70 m thick and is composed of kaolinite, smectite and quartz; smectite is more abundant at depth. Ferruginous saprolite, yellow-brown to red-brown in colour, is dominantly kaolinitic and variably impregnated by goethite. Mottled saprolite consists of red, hematitic, tabular fragments (10-70 mm) formed by pseudomorphic replacement of structurally-aligned minerals in the bedrock by hematite. These fragments preserve the primary fabric and structure evident in the underlying saprolite. Towards the top, mottled saprolite has suffered solution with resultant collapse of the more resistant hematitic fragments. The base of the collapsed mottled saprolite is irregular; pendants 2-3 m in diameter penetrate the mottled saprolite. Where lateritic residuum is present, it consists of lateritic nodules and pisoliths (5-20 mm diameter), loosely set in a matrix of red-brown silty clay. The nodules are generally angular, platy fragments of mottled saprolite, mainly hematite, goethite, kaolinite, gibbsite, quartz and anatase. Some nodules contain pseudomorphed primary minerals and have about 1 mm thick yellow goethite-rich cutans. Towards the base of this unit, larger nodules, up to 40-50 mm in size, occur in an unconsolidated silty matrix (Crawford, 1994; Varga, 1994; Varga *et al.,* 1997; Anand *et al.,* 2001).

MINERALIZATION

Gold mineralization is associated with veins and dense stockworks of quartz within variably sheared and altered pillow basalts. The basalts have a near-vertical, N-trending, E-dipping schistosity within and peripheral to brittle-ductile structures. The mineralization is within a zone about 2 km long, 500 m wide and open at depth. The veins are generally sulphide-poor, although pyrite may be locally abundant, accompanied by pyrrhotite, minor chalcopyrite, scheelite and visible Au (Phillips *et al.,* 1998). Total indicated and inferred resources at Bronzewing are 4 Moz Au. At the Laterite Pit, Au has accumulated sufficiently in the lateritic residuum and transported gravels to form additional shallow deposits. However, no significant primary mineralization has been discovered there. Supergene enrichment of Au in the saprolite is negligible.

REGOLITH EXPRESSION

Saprolite, ferruginous saprolite and lateritic residuum

Primary mineralization is reflected by similar Au distributions and grades in fresh rock, saprock and the lower saprolite. Gold concentrations (>500 ppb) in the lower saprolite suggest either high-grade primary mineralization or some supergene enrichment. The upper 25-40 m of the saprolite is relatively depleted in Au (50-100 ppb). However, at low abundances (100 ppb), there is significant Au dispersion in fer-

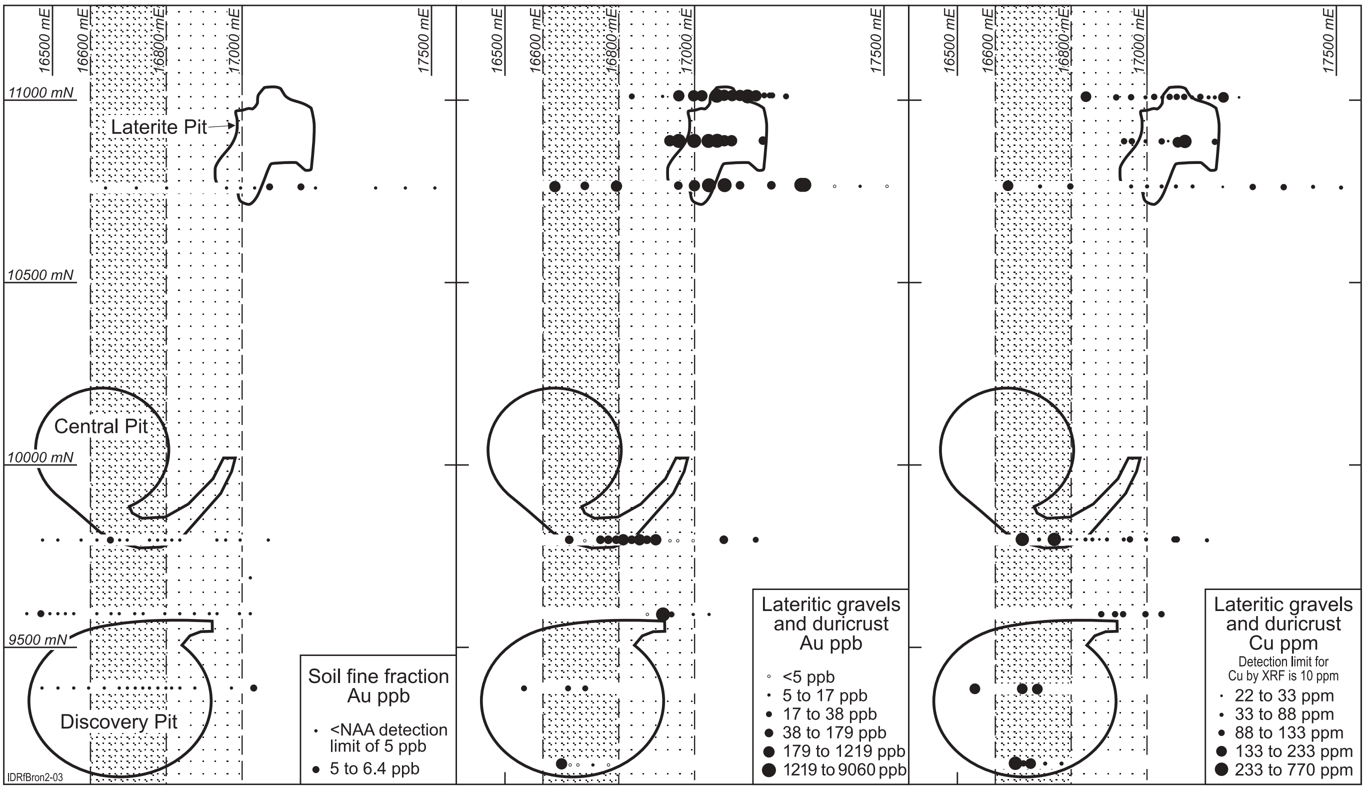

Figure 2. Sample locations across the Bronzewing deposit and Au and Cu distribution in soil fine fraction and lateritic gravel and duricrust. The populations described in the dot size legend were derived from normal probability plots for each element. Heavily shaded area is highly mineralized N structural corridor; lightly shaded area is mineralized E structural corridor.

ruginous saprolite, lateritic residuum and the base of the colluvium (interface). Lateritic residuum (gravel and duricrust) in the Laterite and southern Central pits contains significant Au (Figure 2) over primary mineralization. The most notable zone of Au enrichment in the regolith is within the variably indurated lateritic duricrust of the Laterite Pit, with concentrations of up to 9060 ppb. In contrast, Au anomalies in the Discovery Pit are less consistent. The Au (<5-9060 ppb) distribution shows well developed, consistent Au haloes over the Laterite Pit and along Line 9800N in the Central Pit. The less consistent, poorly-defined Au haloes over the Discovery Pit reflect (i) that lateritic residuum is only patchily preserved and (ii) that some gravels are partly transported. The drill section (Figure 3) shows the discovery RAB drilling plotted onto a schematic section of the Discovery pit. Early RAB drilling was 400 m apart and only one hole occurs on the section. The drill intersection in hole BWRB 65 contained up to 300 ppb Au in the lateritic residuum and 12 m at 1000 ppb Au in the saprolite below. Gold occurs as discrete particles (<5 μm) within nodules or as euhedral secondary Au crystals in cracks and voids.

Copper, Ag, and W are enriched in lateritic residuum above Bronzewing mineralization, but there is no direct correlation between concentrations of these elements and that of Au. The Ag distribution (0.2-2.7 ppm) is similar to that of Au but, despite this, there is again no direct correlation. The lateritic gravel and duricrust are enriched in Cu (mean 97 ppm), relative to the Yilgarn Craton regional data mean of 44 ppm (Smith *et al.,* 1992). The distribution of Cu over the deposit area is even, with the exception of a few scattered peaks (Figure 2). Copper tends to be mobile during weathering but is likely to have originated, in part, from the chalcopyrite of the mineralization. It is considerably enriched in goethite-rich ferruginous saprolite, with a mean concentration of over 250 ppm. High concentrations of Cu are not accompanied by high concentrations of Au. Study by electron microprobe shows that Cu is hosted by clays in lower saprolite, but is associated with goethite in ferruginous saprolite. Copper abundance is lower in the lateritic residuum, presumably lost during dehydration of goethite to hematite.

Scheelite is a common accessory to primary Au and W is erratically distributed in the lateritic residuum. More than half of the samples contain W at less than detection (<2 ppm), but moderate to high W concentrations (up to 50 ppm) are scattered throughout the deposit. Tungsten is generally immobile during weathering; the distribution probably reflects that of primary scheelite.

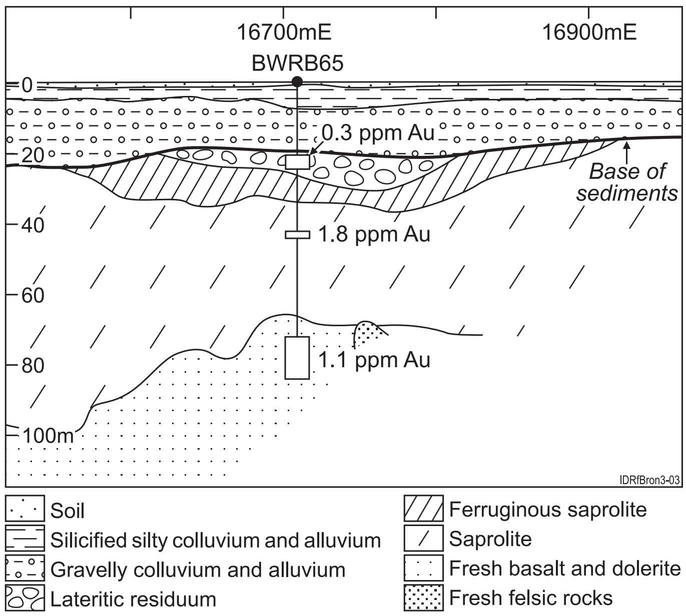

Figure 3. Regolith section along Line 9200 mN showing buried lateritic residuum in the Discovery Pit. The discovery RAB hole is projected onto the section. The discovery hole intersected up to 0.3 ppm Au in lateritic residuum and 12 m at 1 ppm Au in saprolite.

Transported overburden

Soil and ferruginous media. Despite Au concentrations of up to 2 ppm at 10 m depth in the residual profile, there is no anomaly at surface in the <250 μm fraction of the soil (Figure 2) or mottled fragments separated from palaeochannel clays (Table 1). There was no unequivocal expression of mineralization in mottles, pisoliths and clays separated from mottled channel sediments. The maximum Au in mottles rarely exceeded detection (5 ppb). The significance of weak Cu (33 ppm) concentrations in the Fe oxides of the ferruginous mottles and W in clay and ferruginous components (5 and 5.6 ppm respectively) is uncertain.

No dispersion of Au into the soil was detected by selective and partial extraction analysis of the soil, although Enzyme Leach™ gives a single point anomaly over mineralization (Gray *et al.,* 1999). There is an active major drainage (Bates Creek) offset from the mineralization; the

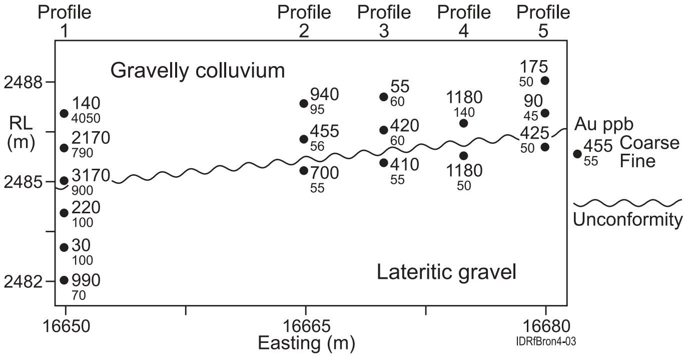

Figure 4. Colluvium dispersion study. Sampling points, coarse (>2000 µm) and fine (<75 µm) fraction analyses for five profiles across the unconformity.

Mn-Co signature shown by most extraction methods is probably due to Mn oxides precipitated in the drainage and is slightly more pronounced in the channel than over mineralization.

Base of transported overburden (interface). There are extensive Au anomalies in gravelly colluvium at the base of the transported overburden. Mechanical dispersion of the >2000 µm and <75 µm size fractions of samples from five profiles across the unconformity in the Central Pit (Figure 4) showed that, in most, Au is concentrated in the >2000 µm fraction relative to the <75 µm fraction and the bulk sample (Figure 3). The only exception is at 2 m above the unconformity in profile 1, where the fine fraction contains over 4 ppm of Au. No explanation could be found for this isolated occurrence. Concentration of Au in the coarse fraction strongly implies that Au has been dispersed dominantly mechanically as particles encapsulated in nodules and fragments of ferruginous saprolite. The unconformity has a 6% slope and there are sufficient mineralized lateritic gravels up slope as a source for Au in the colluvium. Hydromorphic dispersion would be expected to precipitate Au on chemically active Fe oxides and clays in the fine fraction.

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TABLE 1 - COMPARISON OF FOUR SAMPLE MEDIA AND MINERALIZED BEDROCK

	Soil <250µm (n=64)		Mottled cover (n=12)		Lateritic residuum (n=76)		Ferruginous saprolite (n=8)		Mineralised bedrock (n=6)	
	Mean	S. dev.*	Mean	S. dev.*	Mean	S. dev.*	Mean	S. dev.*	Mean	S. dev.*
Au ppb	<	-	<	-	558	1478	16	22	3442	3403
Cu	13	13	67	18	97	96	251	260	132	97
W	<		2	4	6	10	3	3	97	214
Ag	0.6	0.1	0.5	0.2	1	0.5	0.4	0.2	<	-
As	6	1	20	15	26	12	17	6	13	16
Bi	0.4	0.1	0.3	0.1	0.6	0.9	0.3	0.2	NA	-
Pb	21	2	23	10	18	6	10	4	9	3

S. dev.* = Standard deviation
all values in ppm unless indicated
< = below detection limit NA = not analyzed