BOTTLE CREEK GOLD DEPOSITS, MENZIES DISTRICT, WESTERN AUSTRALIA

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LOCATION

The Bottle Creek Au Deposits are approximately 210 km NW of Kalgoorlie at 29º10'S, 120º27'E (Figure 1); Menzies SH51-03 1:250 000 sheet.

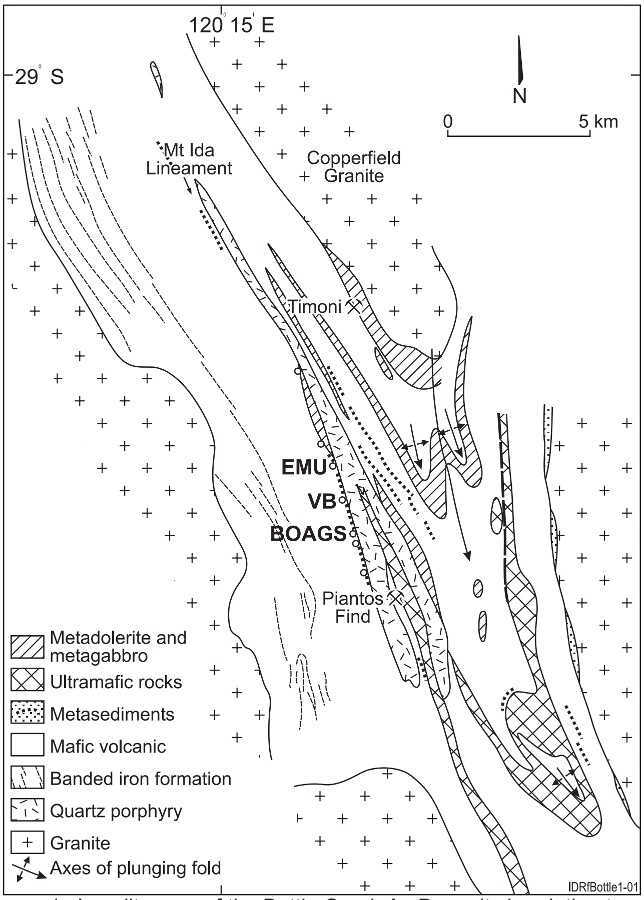

Figure 1. Locality map of the Bottle Creek Au Deposits in relation to local geology (after Legge et al., 1990).

DISCOVERY HISTORY

Bottle Creek was a geochemical greenfields discovery (Legge et al., 1990). Sampling of the nearby Copperfield Au deposits generated the initial interest. An area of low relief with an inferred shear was selected along Bottle Creek and examined by reconnaissance stream sediment sampling (5 kg <180 µm bulk cyanide leach) which revealed some anomalies in its upper reaches. Magnetic lag samples of Fe-rich pisoliths, collected on a 1 km grid, showed a 10 km long As anomaly with some Au anomalies; gossanous material was found on this geochemical trend. Gossan sampling and detailed magnetic lag sampling led to shallow RAB drilling, RC drilling and diamond drilling to define resources at the Emu, VB and Boags deposits.

PHYSICAL FEATURES AND ENVIRONMENT

The area consists of gently undulating uplands interspersed with sheet flood plains that pass into major valleys partly occupied by playas (Churchward et al., 1992). The Bottle Creek deposits lie in an elongate plain about 25 km long, striking NNW, developed on greenstones. The plain has a relict landform regime, with a complete lateritic regolith, to the N, around the Emu deposit, and depositional regimes to the south around VB and Boags. There are hill belts and strike ridges to the west. The lower hills to the east are mesas and breakaways with remnants of a once more extensive land surface. North, south and east, beyond the greenstones, granitic rocks outcrop as domes and pavements or are concealed beneath undulating sand plains.

The area has a semi-arid climate, with an annual rainfall of 180-190 mm (January to April). The vegetation is dominated by mulga (*Acacia aneura*), poverty bush and turpentine (*Eremophila spp*). Mulga scrub is developed on the depositional areas; eucalypts grow in erosional tracts and on the gravelly soils of gentle slopes and there are some isolated kurrajong trees (*Brachychiton spp.*). The area lies very close to the Menzies Line.

GEOLOGICAL SETTING

The Ularring greenstone belt, which contains the Bottle Creek deposits, forms the western part of the Norseman-Wiluna Province of the Yilgarn Craton. Near Bottle Creek, the greenstone belt is folded into a tight, S-plunging anticline (Figure 1) with a granite core (Legge et al., 1990). The eastern margin of the belt contains the magnetic Mt Ida Lineament, an important crustal fracture. The deposits are hosted by carbonaceous shales which lie close to the contact between a lower, westerly sequence of east dipping banded ironstones, mafic volcanic rocks, quartzites and conglomerates and an upper or easterly sequence of mafic and ultramafic rocks with minor interflow sediments, quartz porphyry and tuff. This foliated and metamorphosed basement is cut by Proterozoic dolerites.

Mineralization occurs within altered and metamorphosed easterly-dipping basaltic volcanic rpcks intruded by quartz porphyry. Massive sulphides, hosted by what was possibly a graphitic shale, have been weathered to a depth of approximately 85 m to gossan, which outcrops sporadically over a strike of 26 km.

REGOLITH

The regolith was mapped by Churchward et al., (1992). A previously more widely spread, deeply weathered regolith (relict regime) has been partly dismantled and replaced by erosional and depositional regimes (Figure 2). The lag composition varies with the substrate.

The relict regime consists of an upper lateritic residuum, of ferruginous duricrust with pisoliths set in brown clays, overlying mottled clays and ferruginous saprolite. Gossan-like goethite-rich pods with box-works occur close to carbonaceous host rock. In the erosional regimes, deeper

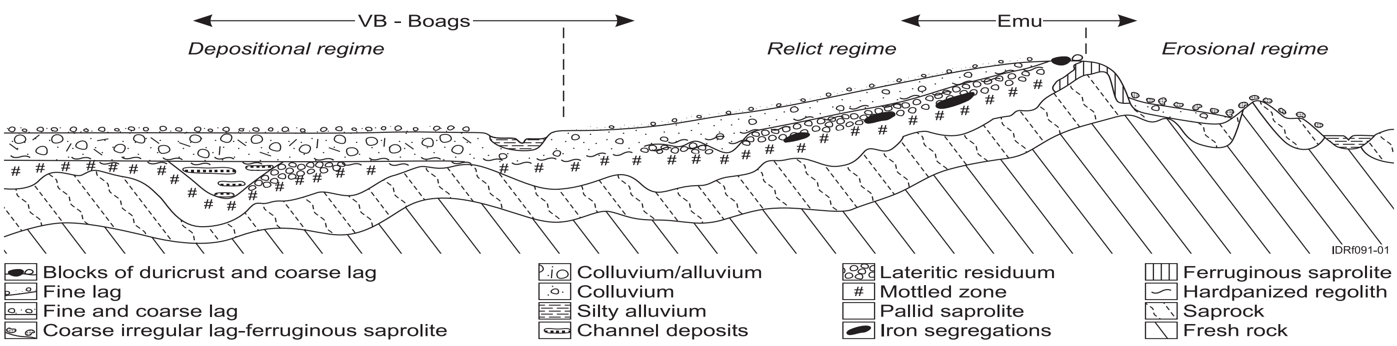

Figure 2. Regolith geology model of the Bottle Creek area after Churchward et al., 1992.

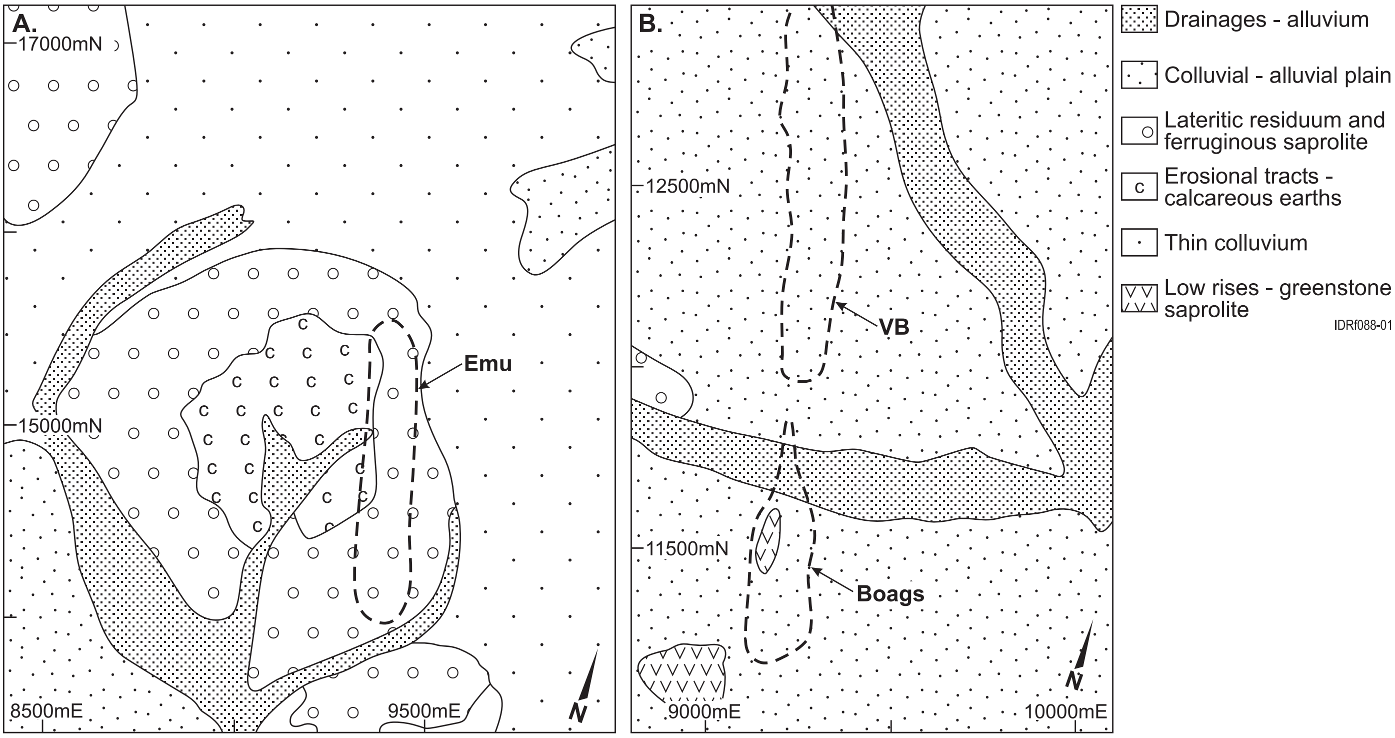

Figure 3. Detailed regolith geology of the Emu deposit (A) and the VB - Boags deposits (B).

units of the weathered profile (mottled zone and ferruginous saprolite) are exposed or covered by a calcareous soil and a lag of lithic fragments. There are outcrops of vein quartz and goethitic Fe-segregations.

The area around Emu has a domal structure of lateritic residuum with an eroded core of ferruginous saprolite, surrounded by very thin colluvial deposits (Figure 3A). Fragments of ferruginous saprolite dominate the bevelled crests. Where lateritic residuum subcrops, the lag is rich in pisoliths with yellow-brown cutans; dark brown to black granules occur down slope.

Colluvial-alluvial deposits of the depositional regime dominate VB-Boags, with a few very small outliers of saprolite. This is cut by branching alluvium-filled drainages and channel deposits (Figure 3B). The polymictic lag is fine, dark brown to black and consists of a mixture of ferruginous saprolite, coated lateritic residuum granules, which are partly worn by transport, and quartz fragments. The lag overlies a veneer (0.5-1.5 m) of dark red-brown sheet-flood colluvium-alluvium, consisting of a red-brown sandy loam with ferruginous clasts, variously on a basement of lateritic residuum, mottled zone, saprolite, and channel deposits.

MINERALIZATION

The mineralization is hosted by the 'Emu formation', a steeply dipping, sheared, graphitic, sulphidic shale that is regarded as a volcanic-related exhalative horizon with chert, quartz, white mica porphyry and felsite. Ore minerals include pyrite, pyrrhotite and magnetite carrying tetrahedrite, sphalerite, arsenopyrite and chalcopyrite. Gold and electrum occur as grains of <45 µm, which accounts for its only recent discovery.

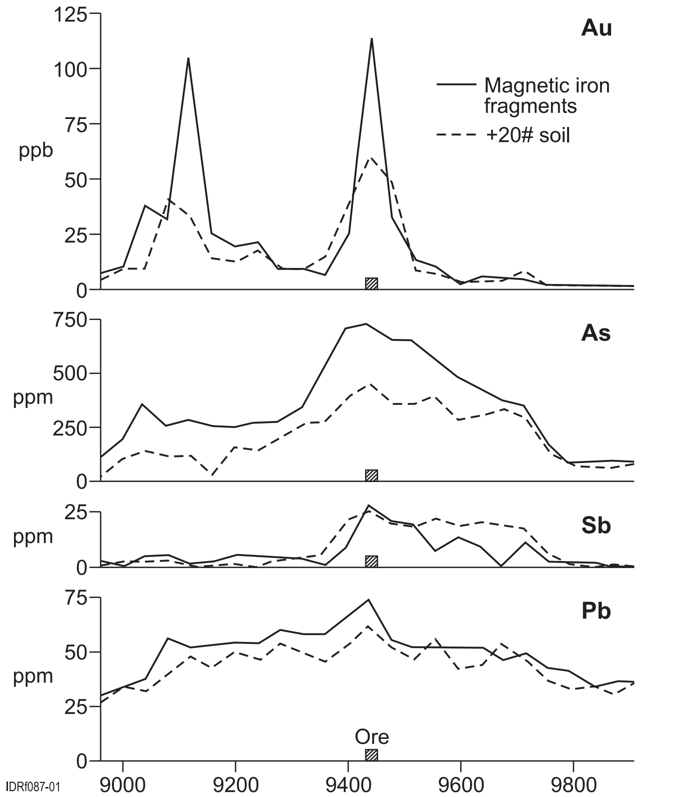

Figure 4. A comparison of soil and magnetic lag geochemistry at Emu (after Legge et al., 1988).

REGOLITH EXPRESSION

Gossan

Taylor (1989) investigated the surface and sub-surface gossans using outcrop, costean exposure and drill intersections. The gossans are derived from massive sulphides in the graphitic shale host, which have been weathered to 85 m. The sulphides are dominantly pyrite with minor tetrahedrite, sphalerite, arsenopyrite, marcasite and magnetite, in a gangue of kaolinite, muscovite, quartz, chlorite, siderite, dolomite and calcite. The gossans consist largely of goethite, hematite quartz, muscovite and kaolinite, with minor talc, rutile, tourmaline and Mn oxides; they are hematite-rich at surface and goethite-rich at depth. The gossans are anomalous in Ag, As, Au, Cu, Pb, Sb, Ba, Mn and Zn, although there is a marked depletion at surface. Secondary beudantite ($PbFe_3(SO_4)(AsO_4)(OH)_6$, a mineral of the jarosite supergroup, probably enriched in Ag, Ba, Cu, Sb and Zn, occurs in the gossan; related minerals alunite group minerals are present in the weathered wallrocks. Manganese, probably from carbonates, occurs as indeterminate oxides. Mercury, Te and Tl were also anomalous but were not be properly assessed due to available analytical constraints. Gold distribution in the gossan is patchy.

Saprolite

There is evidence for supergene enrichment between 30-60 m depth. Above and below this, lower Au concentrations may indicate depletion

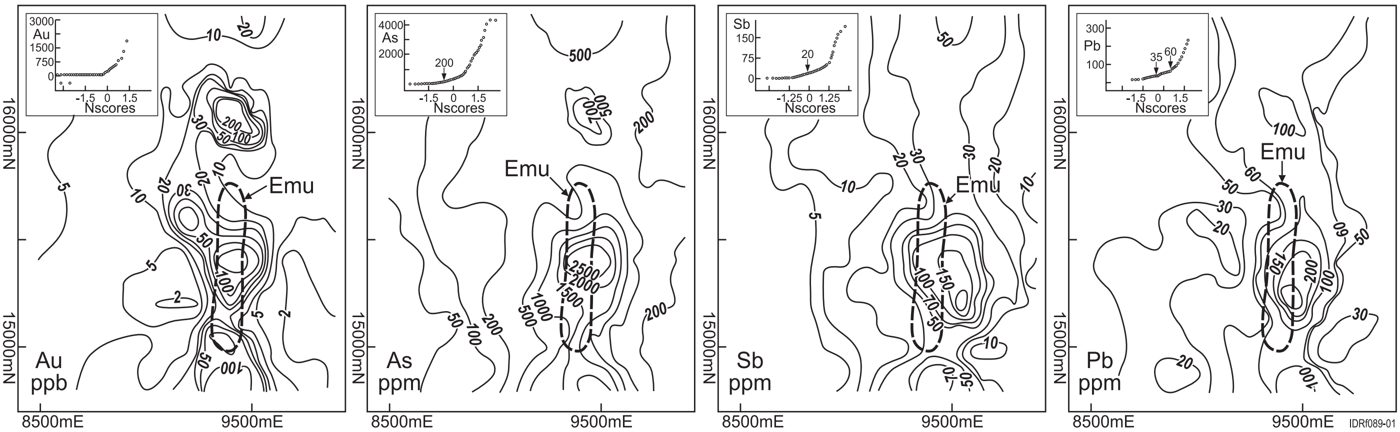

Figure 5. Contoured detailed lag geochemistry at Emu (Robertson and Wills, 1993).

(Legge et al., 1990). Distribution of Au in the saprolite is very even, with little nugget effect.

Lag

Initial magnetic lag sampling by Electrolytic Zinc Co on a 1 km grid covered a broad region around Emu and VB-Boags. This detected an As-Au anomaly around Emu but there was no response over VB-Boags, due to areas of colluvium-alluvium. This was confirmed by more detailed sampling at a 0.5 km interval. Very detailed lag sampling (Robertson and Wills, 1993) on a 0.1 km pattern or less over Emu and VB-Boags showed very clear and substantial anomalies, 300-900 m wide, in As>Sb>Pb>Au over Emu (Figure 5). These defined the mineralization. At VB-Boags, only some extremely small anomalies border areas of outcropping saprolite and where the colluvium was extremely thin (Robertson, 1996).

Soil

The best soil geochemical results (Legge et al, 1988) are obtained from the coarse soil fraction (850-6000 µm) which is petrographically similar to the materials comprising the lag (Robertson and Wills, 1992). Soil results over Emu are almost identical to lag, with a similar broad dispersion though of a slightly lesser magnitude (Figure 4). As for lag, soil detects very narrow anomalies at VB-Boags where the cover is thin or saprolite outcrops but, where there is significant cover, soil geochemistry was unsuccessful.

Groundwater

Groundwater, in contact with weathering sulphides, under non-acid conditions, was sampled at Boags pit (Gray 1992). The water is saline (TDS 20600-21400 mg/L; i.e., about 60% of seawater). Anomalous elements and anions are Ca, Mg and HCO_3^- (from carbonate minerals), SO_4^{2-}, As, Cd and Sb (from oxidizing sulphides), I^- and Br^- (typically enriched in sulphide environments) and Au (as thiosulphate complex formed by neutral oxidation of sulphides). The stability of the thiosulphate complex and, therefore, the expected extent of the Au hydrogeochemical anomaly depend upon groundwater conditions.

DISPERSION MODEL

TBA

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SAMPLE MEDIA - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)
Gossan	Ag	ICP-OES	5			39
	Au	ICP-MS	0.002			90
	As	XRF	2			15600
	Sb	ICP-OES	30	nd	nd	3000
	Pb	ICP-OES	50			5200
	Cu	ICP-OES	10			1660
	Zn	ICP-OES	5			1300
	Ba	ICP	10			7200
	Mn	XRF/ICP	-			36400
Soil	Au	-	-	0.005	0.015	0.050
	As	-	-	50	200	400
	Sb	-	-	5	15	25
	Pb	-	-	25	50	70
Lag	Au	INAA	.005	.005-.015	0.020	2.48
	As	INAA	1	20-150	200	5880
	Sb	INAA	0.2	1-25	50	514
	Pb	XRFp	5	2-50	75	700
Groundwater	Au	C/INAA				.00101
	Ca	AAS				658
	Mg	AAS				1104
	SO4	IC				3660
	As	XRF				.22
	Cd	ASV				.013
	Sb	XRF				.32
	I	IC				2.6
	Br	IC				.018