McKINNONS GOLD DEPOSIT, COBAR DISTRICT, NEW SOUTH WALES

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LOCATION

The McKinnons Au deposit is approximately 37 km SW of Cobar at 31º46'51"S, 145º41'33"E; Cobar 1:250 000 map sheet (SH 55-14).

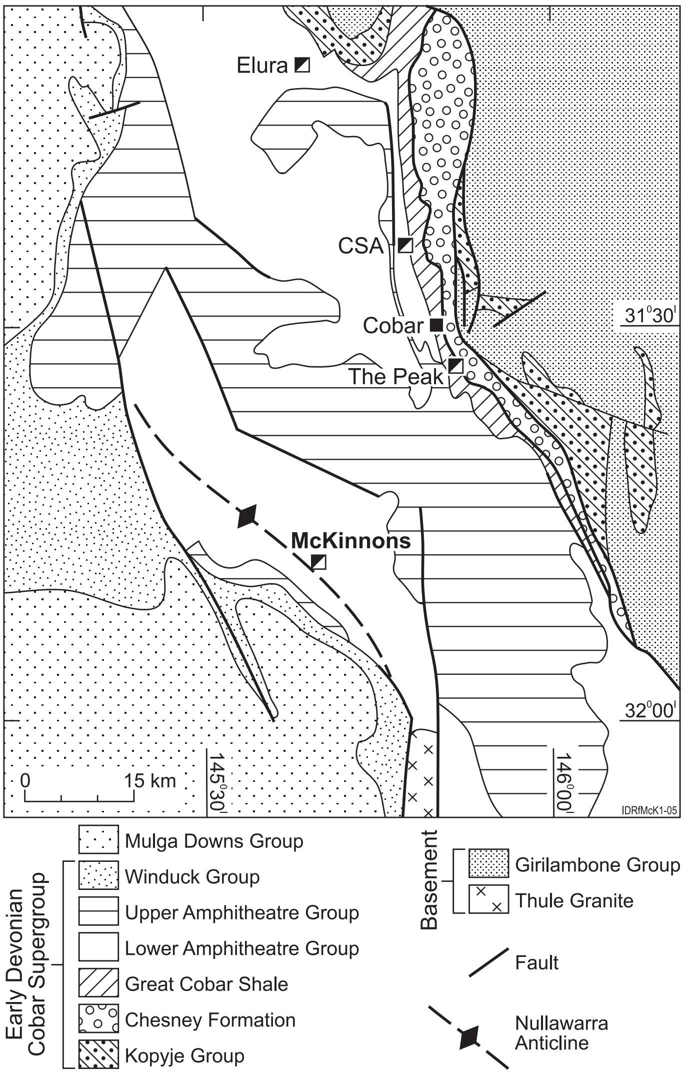

Figure 1. Regional geology and location of the McKinnons Au deposit, Cobar (after Glen 1987).

DISCOVERY HISTORY

Norgold Ltd discovered the deposit in December 1988 by sampling a quartz-veined siliceous outcrop near McKinnons Tank. Rock chip samples along a 380 m traverse assayed at 0.28-4.2 g/t Au (Allan and Taylor, 1989; Discombe and Engelhardt, 1996). Stream sediment data revealed only one low-order BLEG anomaly (0.45 ppb Au) downstream from McKinnons Tank. Drilling between 1989 and 1991 outlined a deposit (380 x 200 m) with probable reserves of 1.4 Mt at 1.65 g/t Au (Bywater *et al.,* 1996). Subsequent mapping, soil geochemistry and geophysics outlined a 400 x 900 m anomaly, but later detailed ground magnetic, reconnaissance total count radiometric and gravity surveys did not produce significant anomalies over the deposit (Discombe and Engelhardt, 1996). Burdekin Resources purchased the deposit in 1993 and, by additional drilling, increased reserves to 2.2 Mt at 1.91 g/t Au at a 0.7 g/t cut-off. Open pit mining commenced in 1995 and was completed in 1996. Stockpiles were processed until mid 2000. Total production was 131 000 ozs of Au.

PHYSICAL FEATURES AND ENVIRONMENT

Regionally, the area is within an elevated palaeoplain (200 m asl) near the boundary between predominantly erosional landforms to the E and extensive depositional plains to the W. A range of hills of the late Devonian Mulga Downs Group occurs 10 km to the S. The deposit occurs on a low ridge and spur of silicified metasedimentary rocks in an area of subdued relief with undulating low rises (<20 m) with slopes of <2º. There is an adjacent alluvial flat to the N. The surrounding area has a broad ephemeral drainage to the W and NW. East of the deposit, in drainage headwaters, there are minor remnants of an erosional plain and to the NW and SW, extensive areas of alluvial valley plain.

The climate is semi-arid with an average annual rainfall of 415 mm and temperature ranges of 19-34ºC (January) and 4-16ºC (July). Mean annual evaporation is 2550 mm. Vegetation around the deposit consists of open woodland dominated by Bimble Box (*Eucalyptus populnea*), Red Box, Cypress Pine (*Callitris glaucophylla*) and Mulga (*Acacia aneura*) in elevated areas. Clearing has disturbed much of the original vegetation. There are areas of woody weed and sparse areas dominated by spear grass.

GEOLOGICAL SETTING

The McKinnons Au deposit is located near the SW margin of the Cobar Basin within the Nullawarra Anticline, a major NW-trending fold hinge (Glen, 1987) (Figure 1). It is hosted by low-grade metasedimentary rocks of the early Devonian Lower Amphitheatre Group. These turbidites are mainly shallow marine siltstones and sandstones with minor volcanic-derived sediments and limestone lenses. At the deposit, the rocks dip 20-40º NW and there is some local faulting. The deposit was the first to be worked on the western margin of the Cobar Basin.

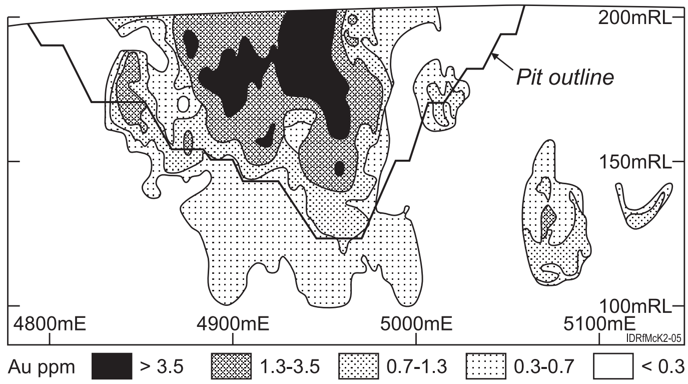

Figure 2. Cross section (15150mN) through the McKinnons deposit.

REGOLITH

There is little outcrop. Weathering penetrates approximately 60 m at the deposit but locally reaches 90 m along faults. The weathered profile consists mainly of strongly bleached saprolite and saprock (quartz, illite and minor kaolinite) extending to 30 m below the surface, overlying a pink-brown slightly mottled ferruginous zone (hematite and goethite), generally between 30-60 m from the surface. A 1 m thick brownish zone of ferruginized and hardened saprolite, enriched in hematite and goethite, marks the top of the profile which has been truncated by erosion. Depth to the water table is about 50 m.

The area surrounding the outcrops is infilled with residual to local colluvium and red soil (hematite, goethite and illite with lesser kaolinite, halloysite and muscovite) and gravel (0.3-1 m thick), and is mantled with a lag of ferruginous pisoliths (hematite with some maghemite and goethite) and lithic fragments. This cover is thin on rises and slightly thicker (commonly >1 m) in valleys. There are minor watercourses with alluvium but few active channels. Transport of surface materials is largely by sheet-wash.

MINERALIZATION

Mineralization at McKinnons consists of a stockwork of narrow quartz-pyrite veins in silicified siltstones that is structurally controlled by sets of complex, subvertical brittle fractures (Bywater *et al.,* 1996). The deposit is zoned from pyrite-Au mineralization near the surface to massive galena-sphalerite veins (0.3-1.5 m thick) at depth (>100 m). Primary ore includes pyrite, sphalerite, galena and minor chalcopyrite, tennantite-tetrahedrite and arsenopyrite. Gold is mainly minute inclusions in pyrite in the host rock and as discrete grains in high-grade epithermal quartz-chalcedony veins. Gold grades in primary sulfide ore are generally <1 g/t and less than 50% of this primary Au can be recovered (Elliot *et al.*, 1998). Gold production is largely from oxidized supergene ore, where Au has been released from pyrite and variably enriched (Marshall and Scott, 1999). The Au grade of this is 0.5-2.5 g/t with isolated high-grade pods of 10-20 g/t (Figure 2).

The Au-Ag mineralization has been described as a low sulphidation epithermal type (strong silicification of the upper part; no high-level felsic or intermediate intrusives; adularia and carbonate in the quartz-mineralized veins; sphalerite and galena below the boiling zone). Alteration assemblages are quartz-chalcedony with interstitial sericite-illite in the upper levels (metamorphosed argillic alteration) and an increase in quartz-sericite-chlorite-K-feldspar alteration with depth (Forster and Seccombe, 1999).

The primary ore zone (below 60 m) contains quartz, muscovite, kaolinite, weakly altered pyrite and minor illite. Primary geochemical trends in drilling below the base of oxidation (60 m) are consistent with this epithermal model (Rugless and Elliott, 1995). Gold is enriched above 100 m depth. In contrast, As, Cu and Zn are anomalous below 100 m. Antimony closely follows the Au dispersion and Pb is broadly dispersed at depth. Manganese has an antipathetic relationship with Au and, along with Cu and Zn, is enriched peripherally to the more intensely altered zone.

REGOLITH EXPRESSION

Saprolite

Sulphate minerals (alunite-jarosite and anglesite) are important minor minerals in the regolith. Barren profiles consist of quartz, muscovite and kaolinite, with kaolinite increasing above 16 m depth; mineralized profiles contain illite instead of muscovite and very minor kaolinite (Marshall and Scott, 1999). Acid conditions, due to pyrite weathering, have transformed muscovite to illite and destroyed kaolinite.

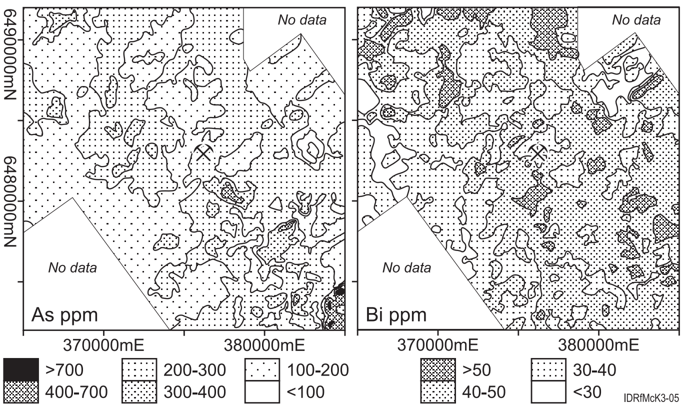

Figure 3. Contoured plots of gridded As and Bi fine fraction (<200 μm) soil data, using a partial dilute HCl digest, showing depletion haloes.

Host minerals control element trends throughout the weathered profile. In the ferruginous zone, near the surface, hematite hosts anomalous Cu, Pb, Zn, Ag, As and Sb. The strongly weathered and bleached saprolite below has a low Fe oxide content and is consequently depleted in Cu, Zn, Ag and As. The underlying ferruginous saprolite contains more abundant goethite and hematite, and so is enriched in Cu, Zn, As, Ag and Ni (Tan, 1996). Gold and Pb persist through both the strongly weathered and underlying ferruginous saprolite zones. Alunite-jarosite group minerals, particularly hinsdalite $(Pb,Sr)Al_3(SO_4)(PO_4)(OH)_6$, persist through the profile. Most of the Au in the weathered zone has very high fineness (>99% Au; Tan, 1996), with Ag occurring

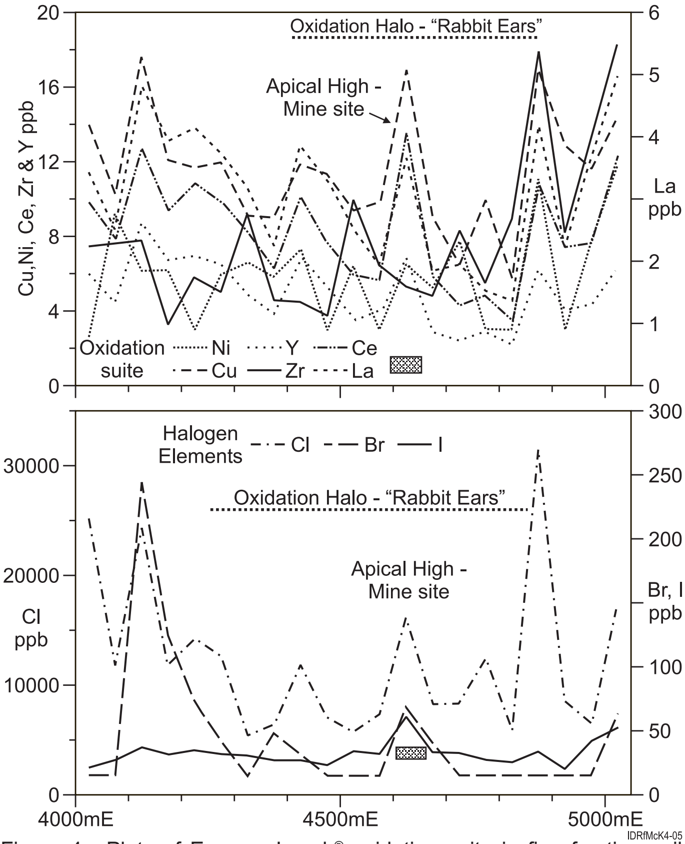

Figure 4. Plots of Enzyme Leach® oxidation suite in fine fraction soil samples on Traverse 15500N showing that apical high values correspond with the Au intercept at depth (shaded box) occurring within a broad chargeability anomaly outlined by distinctive 'rabbit ears' anomalies for most of the elements.

as native Ag and chlorargyrite (AgCl). Where the upper levels of the mineralization intersects the regolith, weathering and supergene processes have enhanced and redistributed Au.

Soil

The regional soil geochemical program in 1995-97 analysed <75 μm B horizon soils after a partial digest in 40% HCl (see Summary Table). This highlighted the deposit with a 450 x 200 m Au, As, Ag, Sb and Pb anomaly but failed to locate additional mineralization. These Au analyses suffered from batch variations, mainly due to varying temperatures, making Au dispersion difficult to interpret. Anomalous Au extends up to 5 km N of the mine and would appear to mark a N trending splinter fault. Both Au and Ag dispersions also follow the palaeodrainage that is infilled by maghemite gravel. There is a 40 km^2 As and Bi depletion halo extending to the N and W of the deposit (Figure 3) associated with mineralized hydrothermal alteration coinciding with a broad aeromagnetic anomaly.

Soil samples, analysed at ppb levels after a weak, partial, dilute HCl digest, revealed both positive, apical Au, Ag, Sb and negative As anomalies over potential mineralization. Regional depletion haloes in As, Bi and, possibly, Sb occur over an area of 40 km^2. They are similar to the anomaly revealed by the Enzyme Leach® technique (see below). These are thought to relate to a reduced body, possibly a large hydrothermal alteration cell, associated with a buried felsic intrusive inferred from the regional aeromagnetic data.

Enzyme Leach® analysis of soil, which produces distinctive 'rabbit ears' negative anomalies above potential mineralization (Hill *et al.,* 2001) and outlines a continuous geological feature extending over a strike of 700 m to the N of McKinnons on traverse 15500mN for the oxidation suite elements. There are apical highs for Zr, indicating shear-related mineralization on traverses 15800mN and 16200mN (not shown). The Enzyme Leach® response (Figure 4) confirms that buried Au mineralization, shown by RC drilling, corresponds with apical Br, Cl, I, Ce, La and Cu highs. The chargeability IP anomaly is associated with a 'rabbit ears' depletion anomaly extending over a width of 400 m.

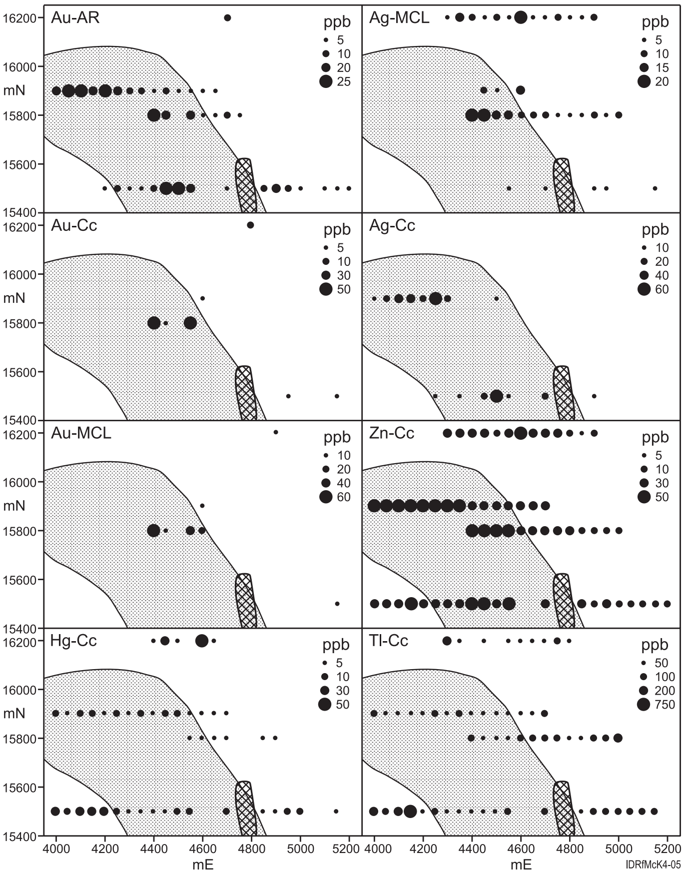

Figure 5. Circle plots of magnetic lag samples analysed for Au and Ag after Aqua regia (AR), Conc. HCl (Cc) and Micro cyanide leach (MCL) digests on orientation traverses N of the McKinnons Au Mine. The IP chargeability anomaly is the stippled area, the Au mineralization intercept is the cross-hatched zone and potential lode Au trends outlined.

Lag

An extension of mineralization N of the McKinnons Mine is concealed by up to 20 m of colluvium. This extension corresponds to an IP chargeability anomaly that includes the McKinnons Deposit. Magnetic lag, rich in hematite and goethite, was analysed by aqua regia, concentrated HCl and cyanide leach. This shows positive Au, Ag, Zn and Hg anomalies and a negative Tl anomaly over the IP chargeability anomaly (Figure 5). The concentrated HCl and micro-cyanide digests detected the buried Au mineralization on traverse 15500mN. These results are similar to those reported by Rugless *et al.,* (1999) interpreted to show a response through >20 m of cover.

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SAMPLE MEDIA – SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Maximum anomaly (ppm)	Dispersion distance (m)
Soil (<75 µm)	Au	Cx	0.00004	0.0001	0.00022	0.00018	250
	Ag	Cx	0.001	0.02	0.026	0.230	100
	As	Cx	0.050	0.25	0.280	0.850	400
	Sb	Cx	0.0005	-	-	0.066	250
	Bi	Cx	0.0002	0.04	0.046	0.100	100
	Cu	Cx	0.2	3.8	4.5	12	500*
	Pb	Cx	0.0005	4.8	5.5	9.0	250
	Zn	Cx	0.0001	1.4	2.2	14	500*
	Mo	Cx	0.005	0.055	0.072	0.14	50
	Mn	Cx	5	70	180	480	500*
	Co	Cx	0.02	2.5	3.4	7.2	500*
	Ba	Cx	0.001	0.025	0.04	0.190	400
	Hg	Cx	0.001	0.02	0.025	0.087	100
	Tl	Cx	0.0005	0.018	0.023	0.092	100
Magnetic Lag (<2 mm)	Au	AR	0.0005	0.0005	0.002	0.024	400
	Au	Cc	0.0005	0.0005	0.0022	0.054	400
	Ag	Cc	0.001	0.005	0.01	0.06	600
	As	Cc	0.2	3.5	13.5	31	600
	Ba	Cc	0.010	40	57	147	150
	Bi	Cc	0.001	0.345	0.56	0.899	800
	Cu	Cc	0.2	6	8	15.8	600*
	Pb	Cc	0.2	13.4	25	43	800
	Zn	Cc	0.1	17.6	32	48.6	600
	Hg	Cc	0.010	0.007	0.016	0.053	100
	Mo	Cc	0.005	0.61	1.03	1.44	800
	Te	Cc	0.010	0.044	0.186	0.254	800
	Tl	Cc	0.001	0.07	0.12	0.249	250
	Th	Cc	0.001	5.29	7.5	13	400
	U	Cc	0.001	0.025	0.382	0.640	-
	Mn	Cc	2	96	250	617	600*
Soil (<2 mm)	As	EL	0.005	0.008	0.009	0.014	350
	Mo	EL	0.001	0.002	0.004	0.015	300
	Zr	EL	0.002	0.006	0.01	0.05	500
	V	EL	0.03	0.09	0.12	0.167	800
	Ni	EL	0.005	0.008	0.01	0.066	200
	Sb	EL	0.001	0.001	0.002	0.007	200
	Br	EL	0.03	0.045	0.095	0.789	450
	I	EL	0.02	0.035	0.05	0.119	300
	Cl	EL	3	12	20	60.8	450
Saprolite	Au	MA	0.05	0.2	0.6	>100	250
	Ag	MA	0.5	2	5	28	100
	As	MA	0.15	10	50	480	300
	Sb	MA	0.1	20	50	200	300
	Cu	MA	0.5	15	30	95	1000
	Fe	MA	500	10000	15000	90000	-
	Pb	MA	2	30	100	480	1500
	Zn	MA	2	50	120	950	1500
	Mn	MA	2.5	30	80	280	900*

*Depletion halo
AR = Aqua regia digest with ICP-MS finish by Ultra Trace, Perth
Cc = Concentrated HCl (10M) digest with ICP-MS finish by Ultra Trace Perth
Cx = Dilute HCl (4M) digest with ICP-MS finish by Ultra Trace Perth
EL = Enzyme Leach with ICP-MS finish by ActLabs, Perth
MA = Mixed acid digest with ICP-MS finish by SGS Laboratory, Orange