QUASAR GOLD DEPOSIT, MT MAGNET, WESTERN AUSTRALIA

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LOCATION

The Quasar Au deposit is about 5 km SW of Mt Magnet, Western Australia, at 28º05'39"S, 117º47'40"E (Figure 1); Kirkalocka 1:250 000 map sheet (SH50-03).

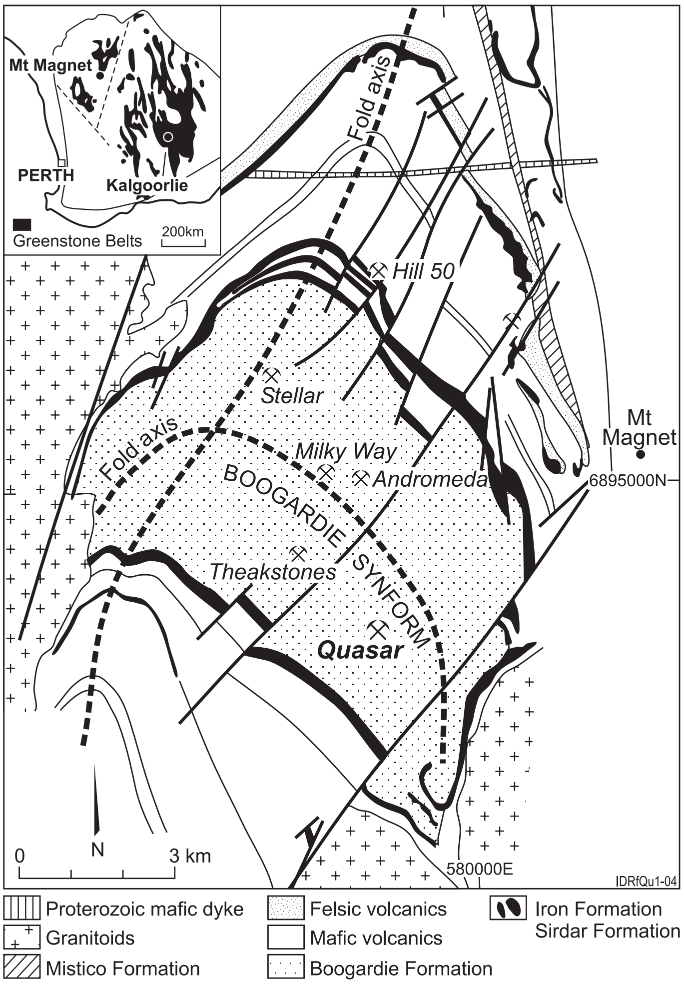

Figure 1. Geology of the Mt Magnet District after Thompson et al., (1990). The Boogardie Formation is largely blanketed by Cainozoic deposits.

DISCOVERY HISTORY

The Mt Magnet district has been a Au producer since 1888, yielding about 70 t Au from about a dozen mines in outcropping areas around the edges of the Boogardie Synform. The core of the Boogardie Synform initially remained unexplored due to the cover of colluvium-alluvium, although the Synform contains potential host lithologies (ultramafic schists and dacitic quartz porphyry; Marjoribanks, 1989), and known mineralized structures (Vann, 1989; Perriam, 1990). Exploration was hampered by the extent of this transported cover, which has a high Au-background (55 ppb Au) due to its derivation from Au-bearing rocks. The underlying residual regolith is intensely weathered and variably eroded, commonly with very localized anomalies and, in places, Au depletion from upper horizons. Exploration began in the 1980s, with intensive programs by Carpentaria Exploration Co Ltd, Renison Goldfields Consolidated Ltd, Metana Minerals NL Pty Ltd and WMC Resources (as Hill 50 Gold Mine NL). Metana Minerals NL, using systematic RAB drilling on 400 m centres through the colluvium-alluvium to recognizable bedrock, discovered the Quasar Deposit in 1989. Similar methods by Renison Goldfields Consolidated Ltd, targeting buried laterites and mottled zones, discovered Au deposits at Stellar, Milky Way and Andromeda.

PHYSICAL FEATURES AND ENVIRONMENT

Quasar is situated in an almost flat depositional plain, with a barely perceptible N-trending rise over the centre of the deposit and a slight slope to a palaeochannel to the SE. The nearest outcrops are about 3 km to the NNE, where low hills of weathered volcanic rocks and ridges of banded iron formation (BIF) form the rim of the Boogardie Synform. The climate is semi-arid with a mean annual rainfall of 234 mm. Average temperature ranges are 22-34ºC in January and 7-19ºC in July. Vegetation is mainly *Acacia* spp., poverty bush and turpentine (various *Eremophila* spp.), with isolated kurrajong (*Brachychiton* spp.).

GEOLOGICAL SETTING

The Archaean greenstone belt at Mt Magnet consists of ultramafic, mafic and felsic volcanic rocks with subordinate sediments, BIF and chert. The greenstones have been deformed into a domal structure with a steeply plunging synformal configuration - the Boogardie Synform (Figure 1). This comprises talc-carbonate and other Mg-rich rocks cut by felsic intrusives of the Boogardie Formation and BIFs, mafic, ultramafic and felsic flows and felsic tuffs of the Sirdar Formation. In the core of the Synform, this sequence has been overlain by at least two cycles of Tertiary sedimentation.

REGOLITH

Regionally, erosional regimes comprise about 25% of the area, and are largely restricted to outcropping, semi-continuous BIF ridges on

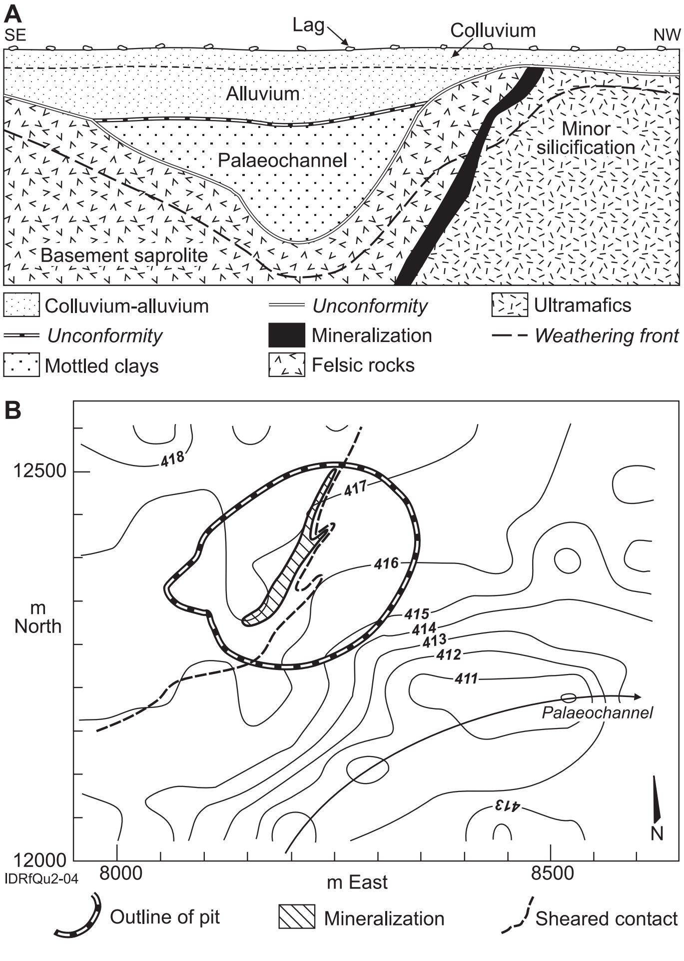

Figure 2. A. Regolith model showing an eroded basement, a palaeovalley filled with mottled clay and a cover of colluvium-alluvium. The contact between ultramafic and silicified felsic rocks is mineralized. B. Basement topography at Quasar showing curved palaeochannel to the SE. Local mine grid.

the margins of the Synform, flanking upland slopes and, in the NE, breakaways on the northern margin of the BIF ridges. Scattered patches of lateritic duricrust are preserved. Depositional regimes occupy the remaining 75% of the area, mainly in the core of the Synform. The colluvium-alluvium, which is locally underlain by palaeochannel sediments, obscures most of the Boogardie Formation. The thickness of the colluvium-alluvium generally increases away from the enclosing BIF ridges. It has a local to distal provenance and is up to 20 m thick, overlying both complete and variably truncated lateritic profiles (Robertson *et al.*, 2001).

Locally, at Quasar (Figure 2A), the hardpanized colluvium-alluvium has a fairly uniform thickness of 4-8 m. It is largely composed of lateritic nodules and pisoliths, with and without cutans, fragments of quartz and ferruginous saprolite, in a silty-clay matrix. The upper part of the transported cover consists of poorly sorted gravel with coarse, angular fragments of quartz and lithic material, typical of colluvium. At lower levels, it is mainly matrix dominated, Mn oxide-stained, lateritic debris. Towards the base, coarse, poorly-sorted gravel lenses, consisting of rounded quartz pebbles and lateritic debris, indicate an alluvial environment.

The transported overburden overlies a truncated regolith and, in the SE, it overlies sediments filling a shallow, arcuate palaeochannel (Figure 2A and B). Drilling has indicated that the palaeotopography, beneath the colluvium at Quasar, slopes gently towards the palaeochannel. The northern bank of the palaeochannel is steep, the southern more gradual. Sediments in the palaeochannel are generally 3-6 m thick and consist of mottled, white, kaolinitic clays with layers of lateritic gravel. The underlying residual profile consists of weakly mottled, clay-rich saprolite derived from ultramafic rocks and silicified, kaolinitic saprolite derived from felsic porphyry. The weathering front on the ultramafic rocks is at about 35 m depth and, on the felsic rocks, it ranges from a few metres to over 40 m near the sheared contact, where the saprolite is weakly mottled.

MINERALIZATION

Gold mineralization at Quasar is associated with ductile shearing in high-Mg mafic-ultramafic rocks that have been altered to talc-chlorite-sericite schists at the contact with a felsic porphyry stock. Mineralization is sulphide-poor (quartz-chlorite-pyrite±carbonate) and has little quartz veining. Weakly mineralized quartz-tourmaline veining is restricted to the felsic porphyry, occurring marginal to the contact. The Quasar Au deposit yielded 21 094 oz Au (111 755 t of ore at 5.87 g/t; S Huffadine, personal communication 2003) and was mined as an open pit by Hill 50 Gold Mine NL.

REGOLITH EXPRESSION

Available materials

A suite of lag and RAB-drilled orientation samples was taken by WMC Resources just prior to mining (Robertson *et al.*, 1994). This provided samples of colluvium-alluvium, the colluvium-basement interface and the top of the weathered basement. The interface sample (Figure 3) is considered to be a highly effective medium in this environment (Robertson, 2001).

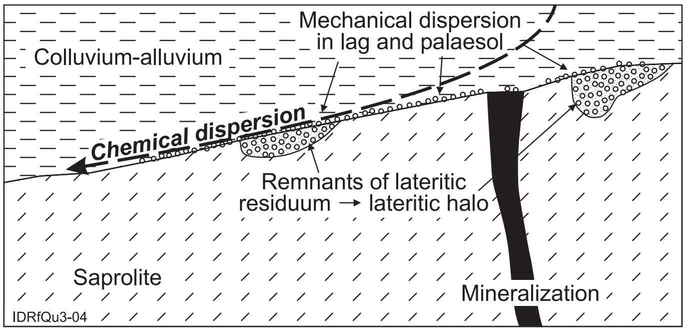

Figure 3. Dispersion model for a colluvium-covered erosional regime. Dispersion in the top of the basement consists of weak, limited saprolitic dispersion and scarce remnant pockets of lateritic residuum. Dispersion along the unconformity consists of mechanical dispersion in a lag or palaeosol and chemical dispersion along the interface.

Comparison of upper residuum with colluvium-basement interface

Gold. There are no significant anomalies within the pit, despite the close (50x100 m) drill spacing. There is a single point anomaly of 1460 ppb at the top of the residual profile, above the sheared contact immediately S of the pit (Figure 4A). Lower, single point anomalies of 330-460 ppb occur further SW and SE. Adjacent drilling revealed background abundances (<20 ppb). In contrast, in the interface sample, there is a much broader, but lower order, anomaly of about 100 ppb, locally reaching 250 ppb, over the southern part of the Quasar pit (Figure 4B). Background around the pit is about 20 ppb.

Bismuth shows a localized concentration of 6 ppm to the ESE of the pit at the top of the residual profile (Figure 4C). Lesser anomalies (about 1 ppm) occur at the SW end of the pit and immediately to the S. Anomalies are of similar strength but are more widespread in the interface over the W part of the pit (Figure 4D).

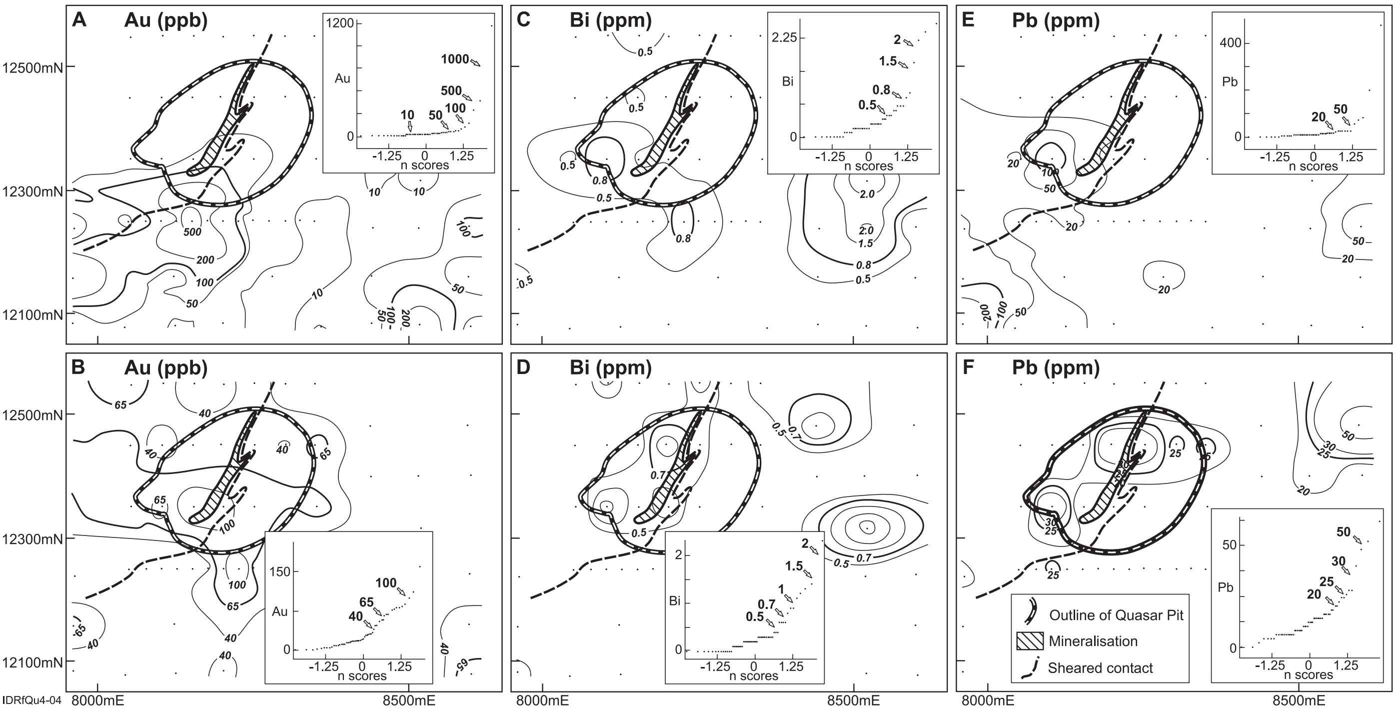

Figure 4. Comparison of anomalies for Au, Bi and Pb in top of the basement (a, c, e) with the interface (b, d, f). Insets are normal probability plots to show the relationship between contours and data distributions. Local mine grid.

Lead shows a single point anomaly of 200 ppm at the top of the residual profile at the W side of the pit (Figure 4E), coinciding with the Bi anomaly. Again, the interface sampling has a broadened target over most of the pit, with an anomaly of 35-40 ppm against a background of 10 ppm (Figure 4F).

Using the interface sample data, a linear combination (CHI) of Bi, Pb and Zn was investigated (Figure 5). Gold was excluded because its distribution is extremely skewed. Threshold abundances (in ppm) were subtracted and the remainders scaled by relative abundance so that the ranges (above threshold) were approximately equal. These products were then summed: -

$$CHI = 100(Bi-1) + 2(Pb-10) + 2.2(Zn-30)$$

This combination of pathfinder elements increased the size of the interface anomaly and accurately targeted the mineralization. Apart from highlighting the multi-element nature of the geochemical halo, this additive technique allowed neighbouring anomalies in different elements to reinforce one another, which is not achieved by processing single element data. It is a similar technique to that used by Smith and Perdrix (1983).

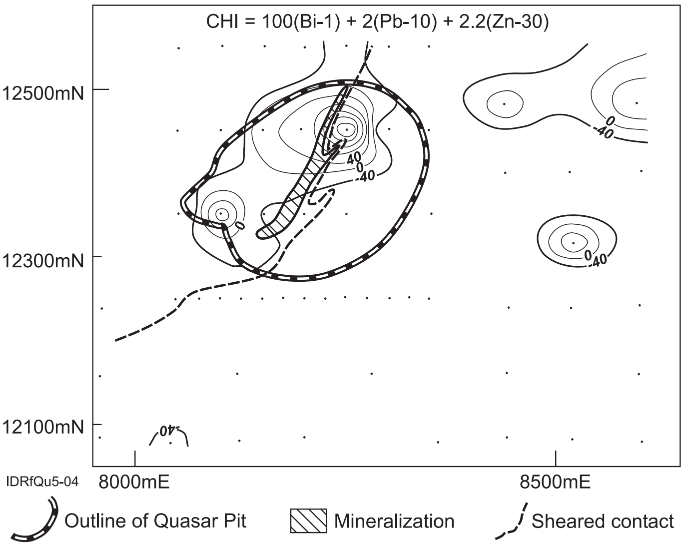

Figure 5. An additive weighted multi-element index using Bi, Pb and Zn that targets the mineralization. Local mine grid.

The As and Sb contents of the primary mineralization are very low; significant anomalies are absent in either sample medium. Much higher concentrations of As (>120 ppm) and Sb (>17 ppm) occur to the E. Arsenic and Sb are ineffective in detecting Quasar-style mineralization

At the top of the residual profile, high Cr, Ni, Cu, V and Zn delineate the mafic-ultramafic rocks, with lower concentrations over felsic rocks. Abundances are less in the interface samples but the patterns are more homogeneous and indicate the local lithology well. Uranium and Y, in the interface samples, depict the sheared contact.

Colluvium-alluvium and lag

The colluvium-alluvium has a mean background of 55 ppb, with a maximum of 305 ppb Au. This makes it difficult to detect subtle responses in the cover that may be related to buried mineralization. The distribution of Au and other pathfinder elements in lag and in horizontal slices through the colluvium have no spatial correspondence with one another and with the basement (Figure 6). A few weak correlations between layers in the colluvium for Co, Cr, Fe, Ga, Nb and Ni are either related to provenance, or in the case of Mn, to hardpanization.

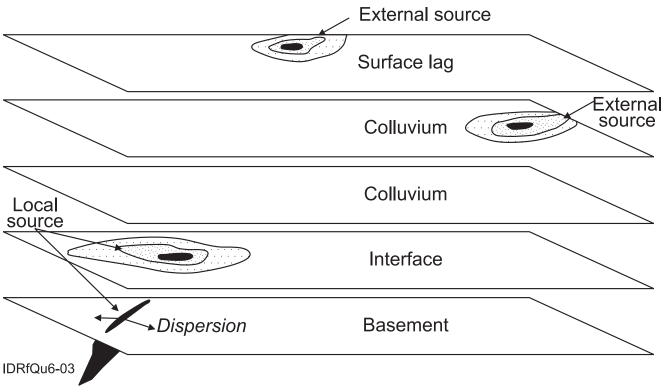

Figure 6. Model of dispersion from basement into the interface and the lack of correlation between rootless ‘anomalies’ in the overlying colluvium and lag.

Conclusion

Sampling the colluvium-basement interface (unconformity) would have readily detected the Quasar Deposit using relatively shallow open-spaced drilling. Deeper, close-spaced drilling would only have been necessary into saprolites beneath palaeochannel sediments. The interface at this site is readily identified due to the contrast between the granular and ferruginous colluvium-alluvium and the underlying weathered felsic and ultramafic rocks, which retain their lithic fabrics.

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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)
Top of basement	Au	ICP*	0.001	0.020	0.100	1.46	10
	Bi	ICP**	0.1	0.4	0.7	2.6	10
	Pb	ICP**	2	15	50	480	10
Colluvium-basement interface	Au	ICP*	0.001	.020	.080	0.255	100
	Bi	ICP**	0.1	0.3	0.8	2.3	70
	Pb	ICP**	2	8	10	60	100
Colluvium-alluvium	Au	ICP*	0.001	0.055	-	-	-
	Pb	ICP**	2	17	-	-	-
Lag	Au	ICP*	0.001	0.050[3]	-	-	-
	Bi	ICP**	0.1	0.5[4]	-	-	-
	Pb	ICP**	2	22[5]	-	-	-

Maxima: [1] 0.3; [2] 67; [3] 0.66; [4] 1.0; [5] 150

* Probably graphite furnace after aqua regia digestion ** After HF/HNO_3/$HClO_4$ digestion