FENDER GOLD DEPOSIT, CUE, WESTERN AUSTRALIA

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LOCATION

The Fender deposit is approximately 2 km south of the Big Bell mine (Figure 1), 28 km WNW of Cue, and about 700 km NNE of Perth at 27°20'36"S, 117°37'58"E; Cue 1:250 000 Map Sheet SG 50-15.

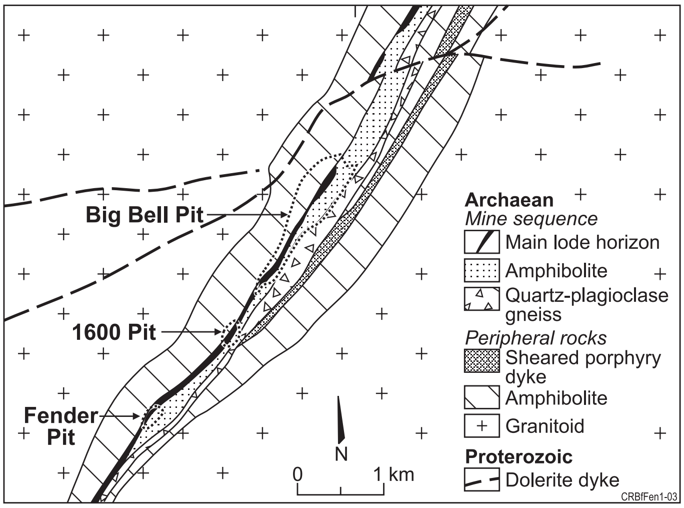

Figure 1. Regional geological setting of the Fender deposit (after a compilation by Barnes, 1996).

DISCOVERY HISTORY

Fender was discovered in 1993 by stratigraphic RAB drilling across the southern continuation of the Big Bell Shear Zone. Two lines (400N and 600N) were drilled to bedrock on 20 m centres over approximately 850 m, between the W and E granite contacts. Mineralization was encountered on both lines and further RAB, RC and diamond drilling defined a small gold resource (Dries, 1996; Radford and Burton, 1999), which was mined from September 1995 to July 1996. This exploration strategy was adopted because of the extent of transported overburden and a perception that surface techniques would be unsuccessful. Subsequent investigation showed that mineralization was expressed by a >250 m Sb-As-W±Au anomaly in ferruginous nodules in transported silty clay at the base of the transported overburden, and by anomalous Sb and As in outcropping ferruginous pisoliths 125-150 m W of the southern end of the deposit. Recognition, sampling and multi-element analysis of these remnant outcrops would have led to earlier discovery.

PHYSICAL ENVIRONMENT

Fender is on the margin of a gently NE-sloping colluvial-alluvial plain. Residual regolith is exposed 150 m W of the deposit (Figure 2) and there are rocky granite outcrops 1 km W. The climate is semi-arid, with a mean annual rainfall of 225 mm, falling mainly January-June. Mean minimum and maximum temperatures are 23 and 38ºC (January) and 7 to 18ºC (July). Vegetation consists of scattered shrublands dominated by *Acacia* and *Eremophila* spp., with ephemeral grasses and herbs.

GEOLOGICAL SETTING

Big Bell and Fender are hosted by a regional volcano-sedimentary sequence within the Murchison Province of the Archaean Yilgarn Craton (Handley and Cary, 1990). This greenstone belt is narrow, steeply-dipping, strongly attenuated and overturned. It forms the W limb of a N-plunging regional anticline, which closes 14 km N of Big Bell. Deformation increases to the S and the whole belt, which is only about 1500 m wide at Big Bell, narrows to about 830 m at Fender, between confining granitic rocks to both E and W. The regional metamorphic grade is lower to middle greenschist. At Fender, amphibolitic, porphyritic and schistose rocks, dipping about 75 ° E, are equivalent to the lower mafic (Hanging wall) and felsic volcanic (Host) sequences at Big Bell.

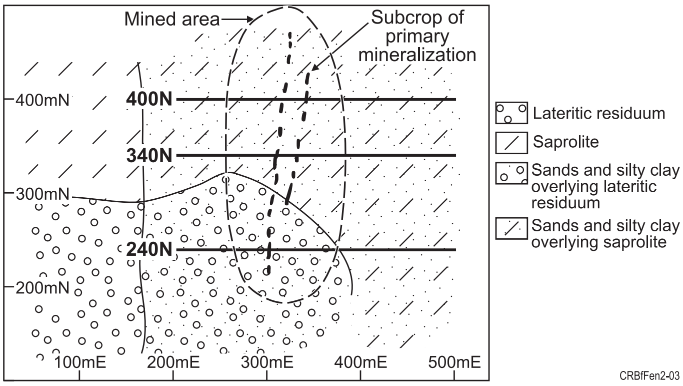

Figure 2. Regolith landform setting of the Fender deposit, indicating the pit outline and section lines.

REGOLITH

The Fender deposit is entirely concealed by 3-5 m of transported overburden and the sediments thicken to over 13 m about 200 m to the E. In the vicinity of the deposit, they consist of 1-5 m of fine- to medium-grained sand and sandy clays, overlying silty clays. Both the sands and the silty clays locally contain detrital lateritic gravels and authigenic nodules. The sands are weakly cemented in the top metre to form hardpan and some deeper sediments are mottled; there is no pedogenic carbonate. The sediments, which contain some unweathered feldspar (5-10 mm), are probably derived from the granites to the W.

There are two principal types of residual profile beneath the sediments. In the S, there is an apparently complete lateritic profile. The ferruginous upper unit consists of pisoliths and nodules in a sandy and clay-rich matrix (Figure 3A). In the N, the profile is truncated and sediments directly overlie saprolite (Figure 3B). These two profile types are also evident where the ferruginous unit and saprolite outcrop.

The depth of weathering exceeds 50 m over the mineralized felsic sequence but, in places, the amphibolites of the hanging-wall in the E are almost fresh at the unconformity (12-14 m depth). The unconformity between the sediments (generally the silty clays) and saprolite is recognizable by changes in fabric, the presence of muscovite in drill cuttings and/or fragments with lithic fabrics. The unconformity is less easy to identify where the material underlying the sands and silty clays is highly ferruginous, because muscovite (if originally present) and lithic fabrics have been destroyed by weathering. This unit is thought to be largely residual because of the monomictic coarse fraction, cutans on the nodules and pisoliths that comprise this fraction and some apparently residual structures (Butt, 1996). Radford and Burton (1999), however, viewing the whole ferruginous unit in mine exposure, considered the sand to be distal in origin and that the whole unit is a ferricrete (*i.e.*, transported) rather than lateritic residuum.

MINERALIZATION

Economic mineralization at Fender is confined to the weathered zone. There are two styles, namely a small 'laterite' resource, in the southern part of the deposit, and weathered primary mineralization in the saprolite. A reserve of 243 000 t at 2.01 g/t Au was determined; a total of 497 kg of Au was produced. Primary mineralization, with mean grades of about 1.85 g/t Au, occurs in two zones, with distinctive multi-element associations, namely the Main Lens (Au-Sb-W-Hg-Mo) and the Hanging-wall Zone (Au-Fe-As-Cu-Zn) (Table 1). Mercury (to >100 ppm) in the Main Lens is possibly in cinnabar or metacinnabar.

REGOLITH EXPRESSION

Residual regolith

The Au distribution in the regolith varies along strike (Figure 4). In the S, weathered mineralization has a mean Au content of 2.7 ppm in saprock and lower-middle saprolite, with depletion to <50 ppb Au in the

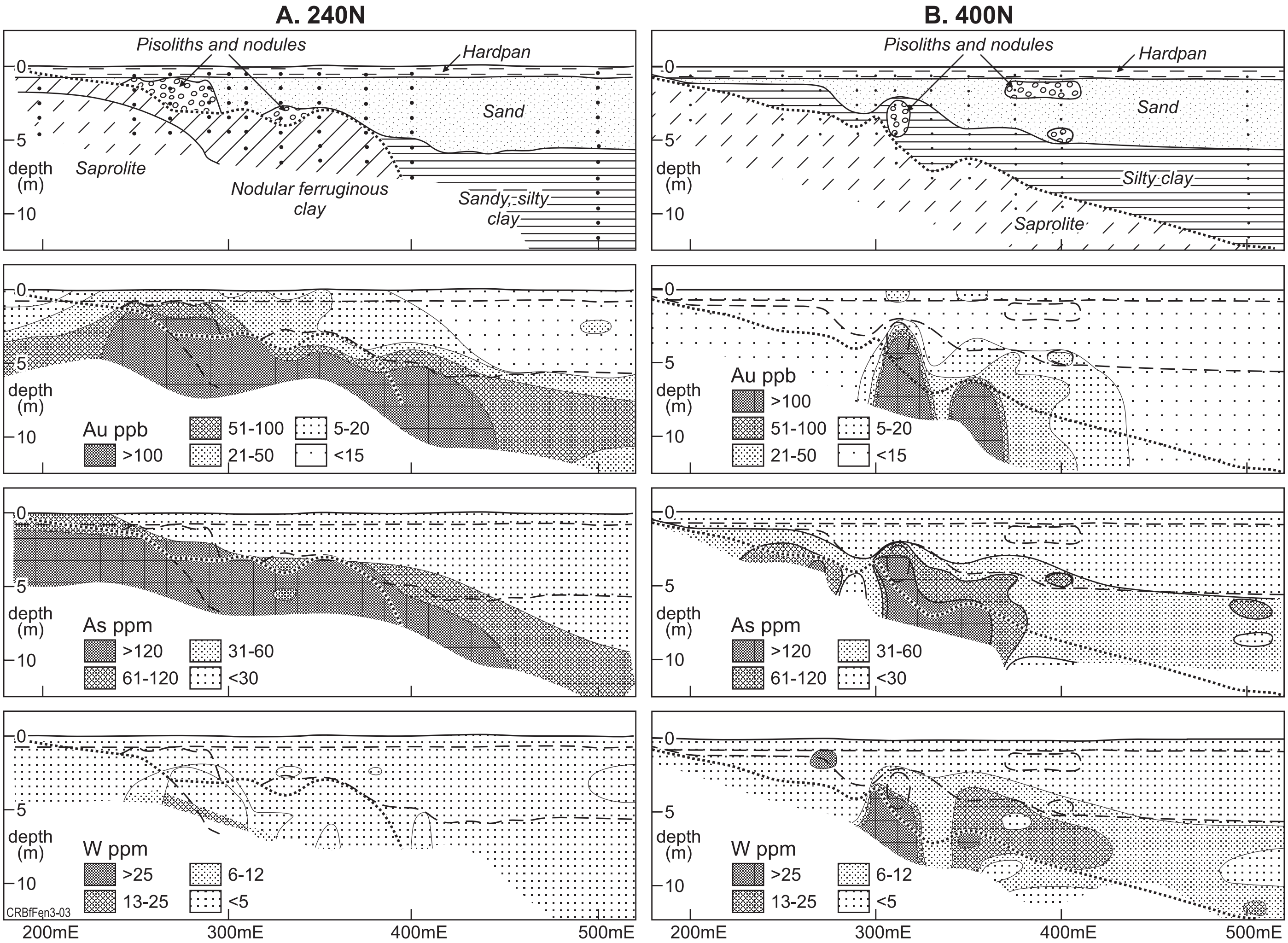

Figure 3. Regolith materials and Au, As and W distributions in transported overburden, Fender. (A): section 240N and (B): section 400N (from Butt, 1996).

top 5-25 m of the upper saprolite. This directly underlies a widespread zone of Au enrichment (to 9 ppm) in the ferruginous horizon; the latter represents the 'laterite' resource. In the N, weathered mineralization in saprolite commonly persists at ore grades to the unconformity over the Main Lens, but shows some minor depletion over the Hanging-wall Zone. There is generally little or no lateral dispersion in saprolite.

The different multi-element signatures of the primary mineralization persist in the residual regolith. For example, saprolite in the Main Lens has 40-300 ppm As, >330 ppm Sb and >150 ppm W, compared to >500 ppm As, <33 ppm Sb and 4-40 ppm W in the Hanging-wall, reflecting the primary compositions. Unlike Au, there is no depletion of these elements from the upper saprolite, *e.g.*, beneath the 'laterite' resource. In comparison, Hg concentrations decrease steadily upwards through the saprolite from over 10 ppm in Main Lens primary mineralization to 0.14 ppm in upper, mottled saprolite. Nevertheless, these concentrations are exceptionally high and, on limited data, a 70 m wide halo having >0.14 ppm Hg persists from bedrock through to top of saprolite.

The ferruginous nodular clays and ferruginous saprolite that comprise the 'laterite' resource are enriched in Au, As, Sb and, in part, W. The most widespread anomaly in this material is provided by As (100 - >300 ppm) and Sb (30 - >130 ppm), and this extends to the surface 150 m W of the deposit. Gold enrichment (100 to >6000 ppb) is also quite extensive but with no surface exposure. Tungsten (10-16 ppm) is confined centrally within ferruginous nodular clays, possibly indicating the position of the primary source; Hg is <0.14 ppm.

There is also a 70-100 m Au-As-Sb-W-Hg halo in saprolite.

Transported overburden

Dispersion in transported overburden was examined by specific RAB drilling to the top of residuum, minimizing cross-contamination, with sampling at 1 m intervals (Butt, 1996). The lower silty clay unit is significantly anomalous in Au (60 ppb) for over 100 m E of the subcropping ferruginous horizon (Figure 3). In the N, where these clays directly overlie saprolite, they generally contain <5 ppb Au, although there are spot concentrations of 80-250 ppb immediately over subcropping saprolite mineralization. An associated weak Au enrichment (5-16 ppb) extends 50 m downslope. Arsenic (30-120 ppm), Sb (12-50 ppm) and, in the north, W (5-17 ppm), are also enriched in the silty clays, and an anomaly extends at least 200 m downslope to the E. The enrichment of As, like Au, is strongest in the ferruginous silty clays closest to the lateritic residuum. Essentially all of the As and Sb in the silty clays is hosted by ferruginous nodules (300-450 ppm As, 80->100 ppm Sb); normalization to Fe strongly enhances and potentially extends the anomaly. In contrast, W concentrations are below detection in the silty clays proximal to the ferruginous horizon, but increase to the N. Neither W nor Au are concentrated in the ferruginous nodules in the silty clays.

The medium-coarse sand is slightly enriched in Au (20-80 ppb) where it directly overlies the lateritic resource, and there is a greater concentration of Fe-rich nodules and clay. Elsewhere, Au abundances are less than 5 ppb. Arsenic, Sb and W contents are at background concentrations.

Soil and hardpan

Over the lateritic resource, the sands are only 2-4 m thick and the overlying soil/hardpan is weakly anomalous in Au (10-27 ppb, 1 m composite sample) compared to a background of less than 5 ppb Au. The As, Sb and W contents of the soils are at background abundances over mineralization, but As and Sb contents increase to the W, reflecting the contribution of the shallowly buried and outcropping ferruginous horizon to the soil. To the N, where the sands and silty clays overlie saprolite, Au, As, Sb and W are at background abundances, although once again, As and Sb contents increase to the W. No response was obtained from any of a range of partial and selective analyses from the 1 m samples (Butt *et al.*, 1997). Radford and Burton (1999) and Radford (in Butt, 1996) similarly found no response in soils from

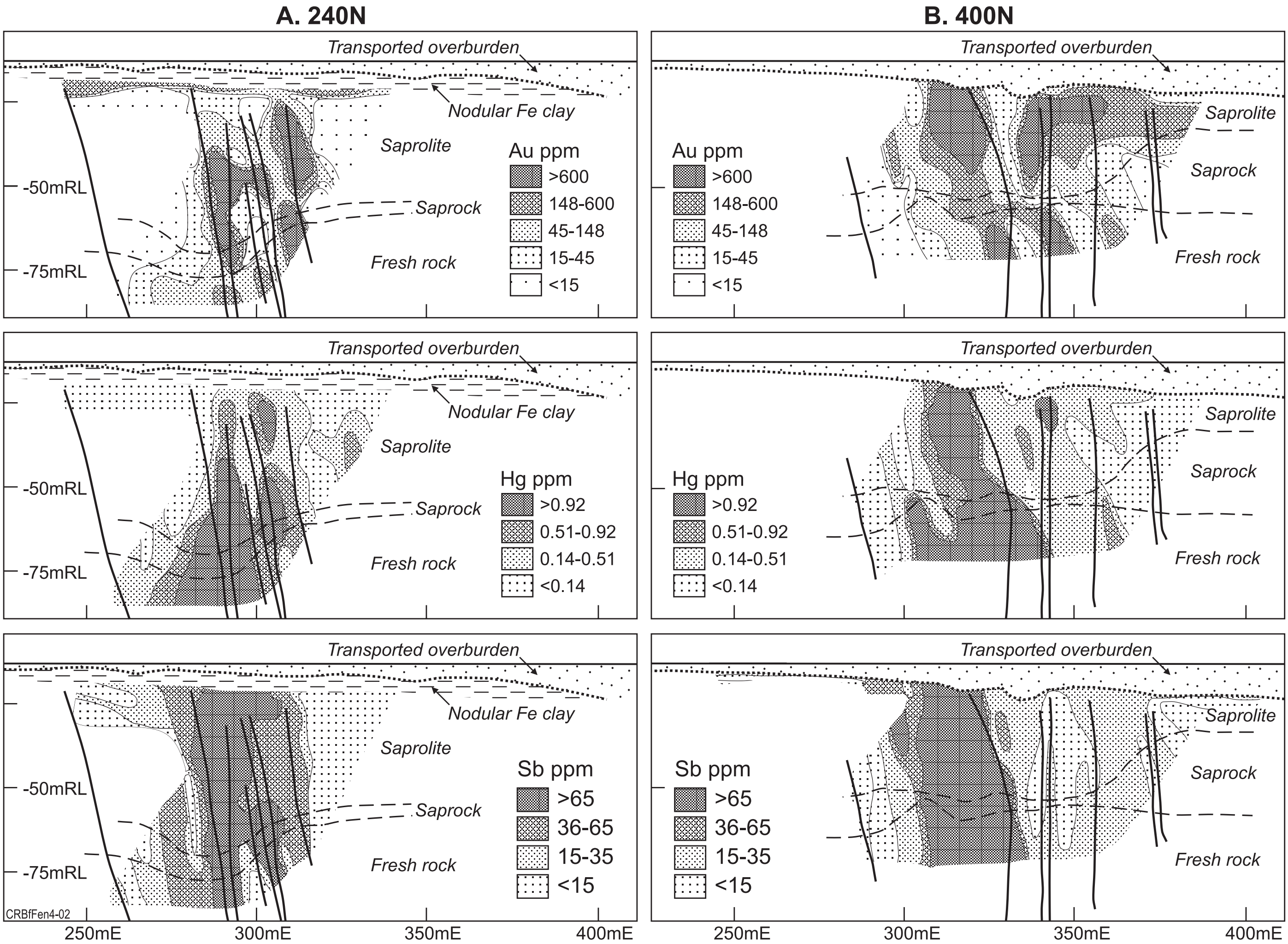

Figure 4. Distributions of Au, Sb and Hg in saprolite, Fender. (A): section 240N and (B): section 400N (from Dries, 1996).

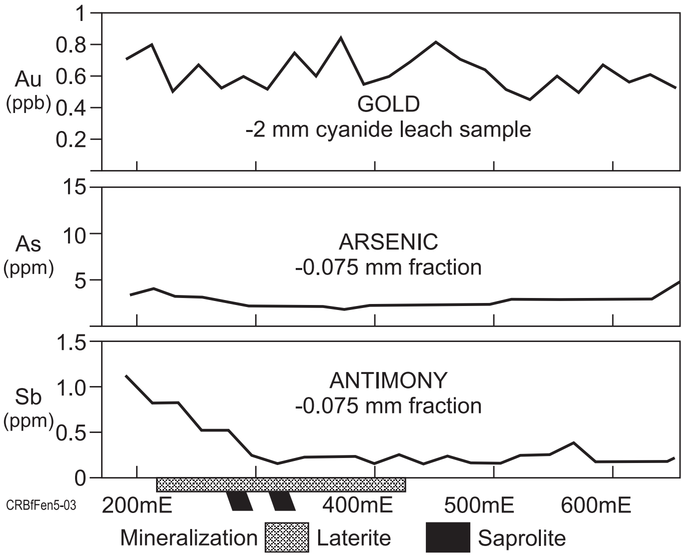

Figure 5. Gold, As and Sb in some soil fractions, line 200N, Fender: note lack of geochemical response (from Radford and Burton, 1999).

15-20 cm depth by total analysis of any fraction, cyanide extraction of the <2000 µm fraction or by the Mobile Metal Ion proprietary digestion, except where the soils were developed from the outcropping ferruginous horizon (Figure 5). Cyanide extraction gave a higher background (0.6 ppb Au) over the greenstone belt than the granites (0.2 ppb), but with no enhancement over mineralization.

ACKNOWLEDGEMENTS

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TABLE 1.
MEAN COMPOSITION OF PRIMARY MINERALIZATION
(cut-off 0.5 g/t Au)

	Au g/t	W ppm	Sb ppm	As ppm	Hg ppm	Cu ppm	Zn ppm
Main Lens	1.83	135	470	110	6.85	115	65
Hangingwall Zone	1.89	18	33	505	0.38	185	150

TABLE 2
SAMPLE MEDIUM SUMMARY TABLE
(compiled from research data)

Sample	Element	Method	DL	Minimum	Maximum	Dispersion/cut-off
Bedrock	Au	INAA	5 ppb	<5	10800	75 m @ > 15 ppb
(Butt, 1996;	As		2 ppm	8	1710	>75 m @ > 25 ppm
Dries, 1996)	Sb		0.2 ppm	5	1120	>70 @ > 15 ppm
	W		3 ppm	<3	240	70 m @ > 7 ppm
	Hg	Vapour AAS	0.05 ppm	0.07	500	70 m @ > 0.14 ppm
Lower saprolite	Au	INAA	5 ppb	<5	2750	75 m @ >15 ppb
and saprock	As		2 ppm	3	1730	>100 m @ >25 ppm
(Dries, 1996)	Sb		0.2 ppm	5	250	80 m @ > 15 ppm
	W		3 ppm	<3	230	70 m @ > 7 ppm
	Hg	Vapour AAS	0.05 ppm	<0.05	21.3	70 m @ > 0.14 ppm
Upper saprolite	Au	INAA	5 ppb	<5	5130	100 m @ > 15 ppb
(Dries, 1996)	As		2 ppm	4	1200	75 m @ > 25 ppm
	Sb		0.2 ppm	2	1400	80 m @ > 15 ppm
	W		3 ppm	<3	220	75 m @ > 7 ppm
	Hg	Vapour AAS	0.05 ppm	<0.05	4.16	70 m @ > 0.14 ppm
Ferruginous	Au	INAA	5 ppb	20	6680 ppb	>200 m @ >20 ppb
horizon	As		2 ppm	105	410	>200 m @ >120 ppm
(Butt, 1996)	Sb		0.2 ppm	40	83	>200 m @ >13 ppm
	W		3 ppm	<3	22	90 m >6 ppm
Silty clay	Au	INAA	5 ppb	<5	250	100 m @ > 20 ppb
(Butt, 1996)	As		2 ppm	28	250	>300 m @ > 30 ppm
	Sb		0.2 ppm	5	90	>250 m @ > 13 ppm
	W		3 ppm	<3	40	>200 m @ >6 ppm
Alluvial sand	Au	INAA	5 ppb	<5	50	130 m @ >20 ppb
(Butt, 1996)	As		2 ppm	3	100	130 m @ >30 ppm
	Sb		0.2 ppm	0.4	47	180 m @ >13 ppm
	W		3 ppm	<3	7	100 m @ >6 ppm
Soil/hardpan	Au	INAA	5 ppb	<5	27	130 m @>20 ppb
Top 1 m	As		2 ppm	4	90	Maximum displaced
(Butt, 1996)	Sb		0.2 ppm	1	70	Maximum displaced
	W		3 ppm	<3	5	Nil
Soil (15-20 cm)	Au (<2 mm)	Dilute CN	0.01 ppb	~0.5 ppb	~2.1 ppb	Anomaly displaced
(Radford and		leach				>50 m @ >1 ppb Au Nil
Burton, 1999)	As (<75 µm)	Aqua regia	1 ppm	3	5	Anomaly displaced
	Sb (<75 µm)	Aqua regia	0.1 ppm	0.2	1.1	>50 m @ 0.5 ppm Sb