

# CHALLENGER GOLD PROSPECT, GAWLER CRATON, SOUTH AUSTRALIA

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## LOCATION

The Challenger Gold Deposit lies in the northern Gawler Craton, 750 km NW of Adelaide and 144 km NW of Tarcoola and 147 km SW of Coober Pedy (Figure 1) at 29°52'47"S, 133°35'11"E; 1:250 000 Coober Pedy map sheet (SH53-06).

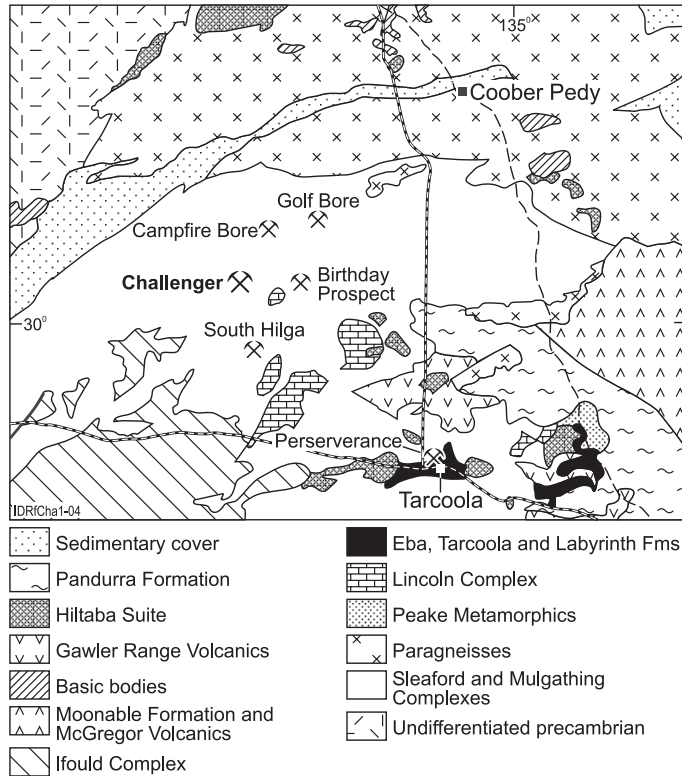


Figure 1. Regional geology of the Challenger and other Au prospects and deposits (after Daly et al., 1998).

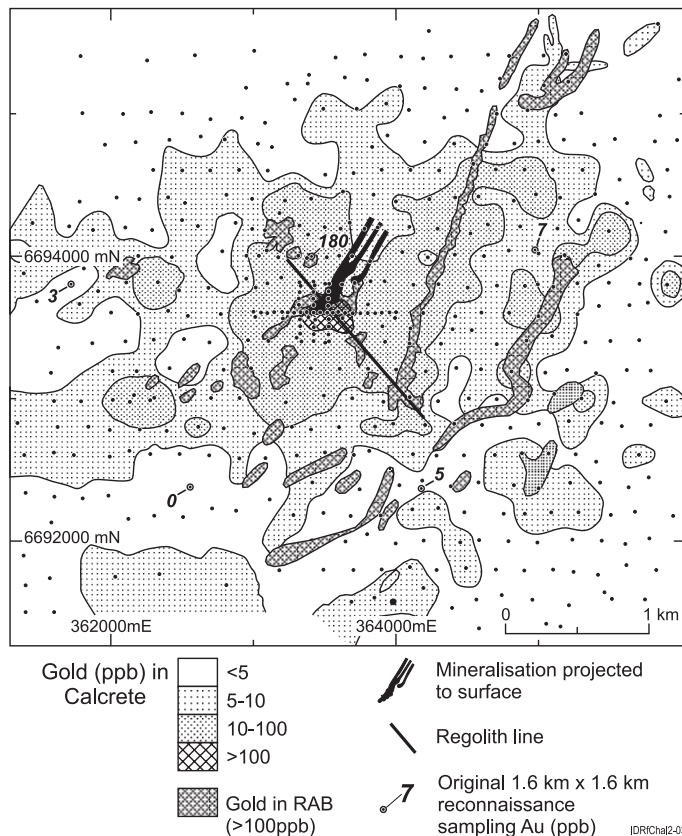


Figure 2. Contoured Au in calcrete on 100 x 100 m grid compared to 1.6 x 1.6 km sampling (shown as numbers) in relation to the mineralization.

## DISCOVERY HISTORY

The deposit was initially located by the Gawler Joint Venture (Dominion Mining Ltd and Resolute Ltd) using broad-spaced calcrete sampling (max 180 ppb Au; Bonwick, 1997). This was followed by in-fill calcrete sampling (Figure 2) and drilling in 1995. The first Au was poured in late 2002.

## PHYSICAL FEATURES AND ENVIRONMENT

The deposit lies beneath an extensive plain, several tens of kilometres square and a relief of <50 m. Locally, the deposit is located on the flanks of a small rise, about 2 km E of an ephemeral drainage. There is no obvious active drainage although, in the sub-surface, there are small (<1 m) to wide (>1000 m) palaeochannels. The climate is arid with an average annual rainfall of about 150 mm, mostly in winter. Temperatures range from 19 to 35°C in January and 4 to 19°C in July. Vegetation has been affected by grazing and consists of scattered open low woodland of *Acacia*, *Eremophila* and *Casuarina* (up to 4 m high) with an understorey of shrubby genera (1-2 m).

## GEOLOGICAL SETTING

The Gawler Craton comprises Archaean to Mesoproterozoic rocks that have remained substantially stable since 1450 Ma. Major shear zones are important in the NW, where Challenger is located. The shears act as local conduits for granitoid intrusion. The host to the mineralization is the Christie Gneiss which is a garnet-rich paragneiss of plagioclase, perthitic K-feldspar, quartz, cordierite, garnet and biotite with minor graphite and Fe-Ti oxides (Bonwick, 1997) and forms part of the Sleaford and Mulgathing complexes (Figure 1).

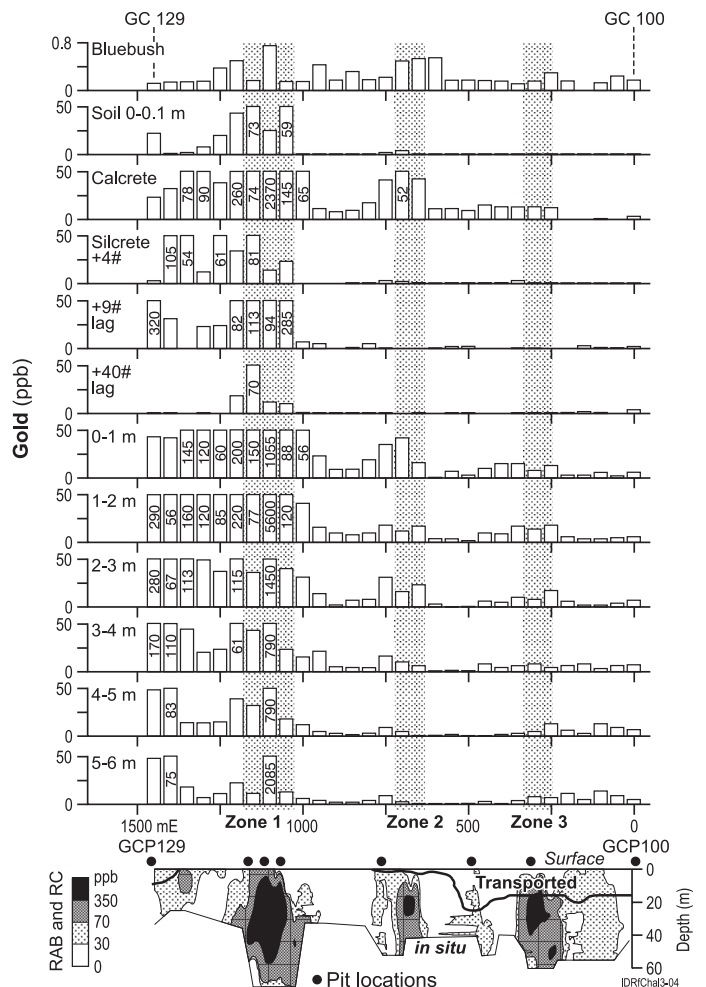


Figure 3. Distribution of Au in the regolith in various sample media along the Regolith Line.

## MINERALIZATION

High-grade Au mineralization is associated with coarse-grained quartz veins containing minor feldspar, garnet and biotite. Wallrock alteration consists of quartz, K-feldspar and biotite haloes around the veins. Gold mineralization is associated with minor arsenopyrite (cored by löllingite - FeAs<sub>2</sub>), pyrrhotite, pyrite and minor graphite. Chalcopyrite and bismuth compounds also occur. Gold forms single grains or aggregates in arsenopyrite and inclusions in quartz, K-feldspar and plagioclase. The estimated Au resource exceeds 0.5 Moz at grades of about 10 g/t (Dominion Mining Ltd., 2004) and is anticipated to increase as underground development proceeds.

## REGOLITH

Craig *et al.*, (1999) produced a 25 km square regolith map of the area. The dominant regolith-landform is depositional (transported). The remaining erosional (*in situ*) units are mostly highly weathered bedrock. There is very little outcrop and no lateritic duricrust; ferruginous materials are scarce. Intense weathering during the Tertiary, and possibly before, has produced a regolith dominated by kaolinite-rich saprolite, with some remnant quartz veining in felsic lithologies, and sericite-chlorite-carbonate-altered saprolite from post-mineralization intrusive mafic and ultramafic dykes. Palaeodrainages are mainly filled with poorly crystalline kaolinite that has been variably silicified. The upper regolith over the *in situ* and transported units has been variably silicified and then, recently, cemented with carbonate. Present erosion is mainly by minor sheet flow, leading to local re-distribution of surface materials, including colluvium and lag, resulting in lowering and continued planation of the landscape. Past aeolian activity has formed small sand dunes.

## REGOLITH EXPRESSION

Regolith materials were sampled on a 1.5 km traverse (the Regolith Line) located approximately perpendicular to strike which crossed three zones of mineralization. The principal mineralization (Zone 1)

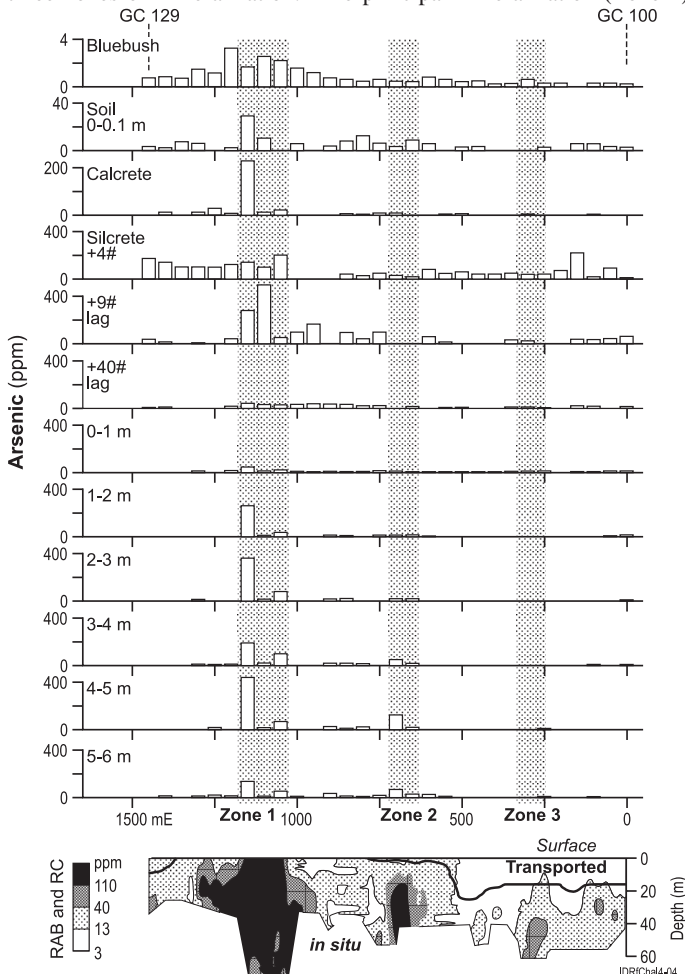


Figure 4. Distribution of As in the regolith in various sample media along the Regolith Line.

subcrops at 1-2 m depth and is semi-continuous throughout the regolith. Zone 2 mineralization also occurs just below the surface and occurs about 400 m to the SE of Zone 1; the top 20 m are depleted in Au. Zone 3 is beneath about 20 m of transported overburden about 800 m to the SE of Zone 1.

Thirty shallow holes (GC100-GC129; 0-6 m) were drilled along the traverse specifically to study the upper regolith. The lower regolith was also sampled to about 60 m, using cuttings from existing drilling, at intervals along the traverse that corresponded with the upper regolith drilling. A series of 8 pits (GCP100, 106, 110, 115, 121-123 and 129) were excavated to 3 m along the traverse and adjacent to the drilling to enable detailed geochemical and stratigraphic examination of the relationships between (i) silcrete and calcrete, and (ii) silcrete/calcrete and mineralized saprolite. Calcrete, silcrete, undifferentiated lag, soil and vegetation were examined with multi-element geochemistry (Lintern and Sheard, 1998).

Calcrete is ubiquitous and is the best sample medium for detecting Au mineralization in *in situ* regolith, providing broad, high-contrast anomalies for several elements, particularly Au, As and Cu. Gold in the surficial calcrete reaches a maximum of 2370 ppb over Zone 1 (Figure 3); this particularly high concentration probably represents particulate Au from quartz veining in the calcrete. Anomalies (>10 ppb) extend for about 500 m over Zone 1 and about 200 m over Zone 2 (max 52 ppb); no Au or other element was anomalous in surficial calcrete over the buried Zone 3 mineralization.

Apart from Au, the response over Zone 1 was more subdued and erratic. Arsenic (Figure 4), Cu and, possibly, Ce, Cr, Fe, K, Mg, Rb, S, Th and

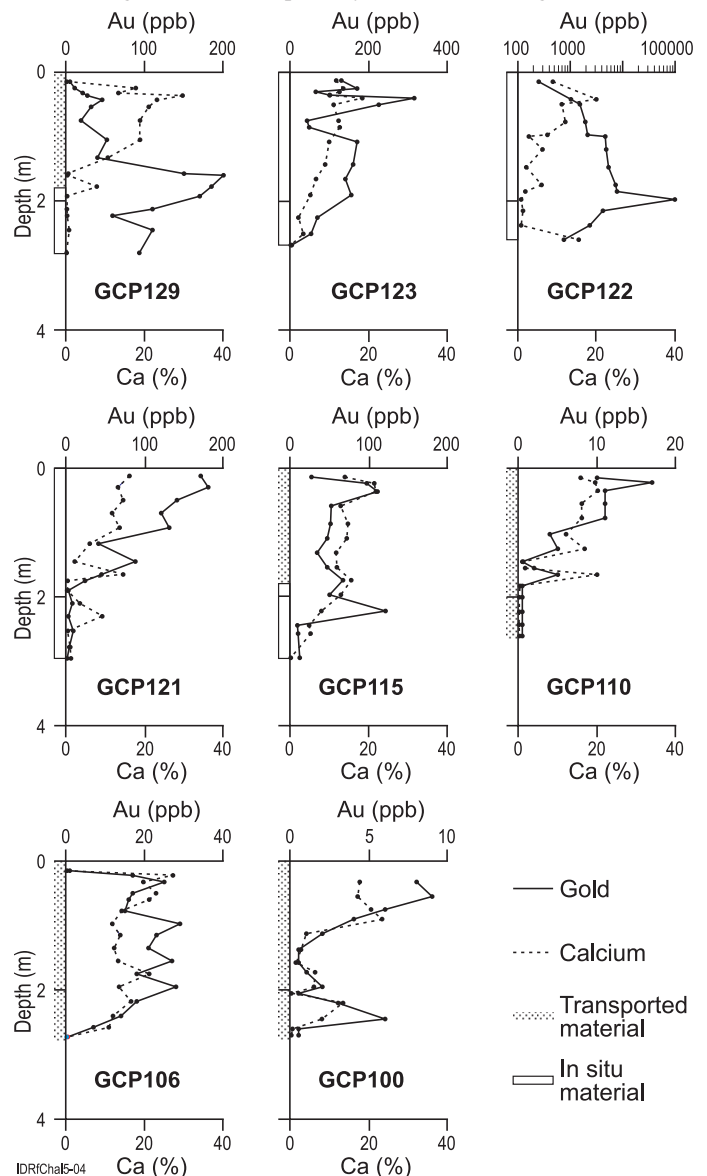


Figure 5. Concentration-depth profiles for Au and Ca for the soil pits.

V, showed one or two point anomalies. A response was not detected over Zone 2 mineralization except perhaps for Cu and Zn. Some smoothing of the data was achieved by normalizing the chalcophile elements to Fe.

Gold contents of the soil pit profiles are extremely variable but there appears to be a general association between Au and Ca (Figure 5). The highest Au concentration (about 100 000 ppb) was recorded at 2.0 m in pit GCP122, over Zone 1, although the Au concentration for the soil was only 250 ppb. For adjacent samples within 5 m of each other, from the same pit, near-surface sample concentrations of 35, 250, 380 and 900 ppb were recorded, indicating extreme Au variability close to mineralization, probably due to detrital Au (Figure 5). The high Ca (15%) at the base of pit GCP122 is almost entirely due to gypsum; the Au concentration here is 760 ppb.

Although near-outcropping mineralization can be relatively easily detected in the regolith using a variety of elements and sample media, the outlook for exploring beneath transported overburden is less certain. Further investigations are needed over Zone 3, to determine if local anomalies of Au, Bi, W, Mo and Fe-normalized elements (e.g., Cu and As) in the upper regolith are related to underlying mineralization beneath approximately 20 m of palaeochannel sediments (see Au in Figure 4).

Delineation of transported units is fundamental to exploration. Although calcrete sampling is effective in the *in situ* regolith at Challenger, it does not appear to be as nearly as effective over thick sediments. In WA, some case studies indicate that calcrete sampling is effective over mineralization beneath transported overburden provided it not exceed 10 m in depth (Bristow *et al.*, 1996), but this needs to be further tested in SA. Until then, areas in SA having low Au concentrations in calcrete on transported material may be regarded as giving a null rather than a negative result. It appears that the broad Au-calcrete anomaly over Challenger (Figure 2) is related to chemical and mechanical down slope dispersion of Au from nearby *in situ* regolith. In areas of *in situ* regolith, alternative sample media such as cuttings from shallow drilling, soil,

silcrete, vegetation, lag and possibly gypsum may be used with caution, if calcrete is absent, and the appropriate thresholds applied.

In summary, the data indicate that elements in the regolith associated with mineralization, other than Au, fall into two broad groups: i) sulphide-related (Ag, As, Bi, Cd, Cr, Cu, Fe, Mo, S, Se, W and Zn) and ii) alteration-related (Ba, Cs, K, Rb and Tl). Their specific use as pathfinders depends on the sample medium and the regolith setting. Anomalous elements in regolith materials, over the three zones of mineralization, are summarized in Table 1.

## REFERENCES

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TABLE 1 - ANOMALOUS ELEMENTS IN REGOLITH AND VEGETATION

Indicator element	Analytical Method	Detection Limit (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)	Dispersion distance (m)
<b>Lower regolith (&lt;6 m)</b>						
Ag	ICP-MS	0.1	0.2	0.3	15	200
As	ICP-MS	0.5	11	63	950	400
Au	AAS-GF	0.001	0.01	0.05	3.4	250
Bi	ICP-MS	0.1	<0.1	0.1	1.3	150
K	ICP-OES	10	8000	22800	35600	300
Mo	ICP-MS	0.1	2	5	9	200
Rb	ICP-MS	0.1	33	105	160	200
S	ICP-OES	500	250	900	12400	50
Se	ICP-MS	0.5	0.3	0.5	2.5	50
W	ICP-MS	0.1	1.6	3.0	47	150
<b>Upper regolith (0-6 m)</b>						
As	ICP-MS	0.5	5	13	440	150
Au	AAS-GF	0.001	0.004	0.03	5.6	150
Bi	ICP-MS	0.1	0.1	0.2	1.1	50
Cr	ICP-OES	2	30	76	300	150
Cs	ICP-MS	0.1	0.3	1.0	4.2	50
Cu	ICP-MS	0.5	13	28	165	150
K	ICP-OES	10	1950	4675	27400	150
Mo	ICP-MS	0.1	0.8	2.1	6.0	150
Rb	ICP-MS	0.1	8	22	175	150
S	ICP-OES	500	250	1300	26200	200
Se	ICP-MS	0.5	0.3	0.5	3.0	100
Tl	ICP-MS	0.1	0.1	0.2	1.3	150
<b>Calcrete</b>						
As	ICP-MS	0.5	5	12	230	200
Au	AAS-GF	0.001	0.01	0.07	2.4	500
Cr	ICP-OES	2	21	41	140	50
Cu	ICP-MS	0.5	13	23	53	150
<b>Silcrete</b>						
Au	AAS-GF	0.001	0.0005	0.01	0.11	400
<b>Soil</b>						
As	ICP-MS	0.5	1	7	30	50
Au	AAS-GF	0.001	0.0005	0.004	0.07	300
Cu	ICP-MS	0.5	11	15	29	150
Mo	ICP-MS	0.1	0.4	0.8	1.5	200
S	ICP-OES	500	250	250	650	150
Se	ICP-MS	0.5	0.3	0.3	1.0	50
W	ICP-MS	0.1	0.5	0.9	2.0	250
<b>Lag &gt;2 mm</b>						
As	ICP-MS	0.5	25	99	500	100
Au	AAS-GF	0.001	0.001	0.03	0.32	200
Cu	ICP-MS	0.5	18	26	64	150
W	ICP-MS	0.1	1.4	2.6	5.5	100
<b>Lag 0.5-2 mm</b>						
Au	AAS-GF	0.001	0.0005	0.002	0.07	200
K	ICP-OES	10	550	1000	2250	150
Rb	ICP-MS	0.1	3	6	12	150
<b>Bluebush</b>						
As	ICP-MS	0.5	0.4	1.2	3.2	300
Au	AAS-GF	0.001	0.0002	0.0003	0.0007	150
W	ICP-MS	0.1	0.1	0.3	0.6	350

ICP-OES after HF/HCl/HNO<sub>3</sub> digest. ICP-OES after HF/HCl/HNO<sub>3</sub> digest. AAS-GF - graphite furnace after aqua regia digest.