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# REGOLITH BENCHMARK ATLAS, GAWLER CRATON, SOUTH AUSTRALIA

# VOLUME II

*Compiled by*
*M.J. Sheard*

**CRC LEME OPEN FILE REPORT 210 /**
**PIRSA MINERAL RESOURCES REPORT BOOK RB 2008/07**

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CRC LEME is an unincorporated joint venture between CSIRO-Exploration & Mining, and Land & Water, The Australian National University, Curtin University of Technology, University of Adelaide, Geoscience Australia, Primary Industries and Resources SA, NSW Department of Primary Industries and Minerals Council of Australia.

*Headquarters:* CRC LEME c/o CSIRO Exploration and Mining, PO Box 1130, Bentley WA 6102, Australia

This report presents outcomes of a CRC LEME project involving the Department of Primary Industries and Resources, Adelaide, South Australia (PIRSA) that commenced in mid 2006 and continued until late 2007. There were no confidentiality agreements entered into regarding any aspects of this project or covering any primary data and images or derived data and images obtained during the execution of this project. All contents, data and samples associated with this report are open file items. All reference materials (regolith samples, thin and polished sections) have been retained by PIRSA at their Drill Core Storage Facility, 23 Conyngham St, Glenside, South Australia, 5065. Those materials can be viewed without restriction by prior arrangements with the Drill Core Storage Facility Manager [ph: (08) 8379 9574 ; Fax: (08) 8338 1925].

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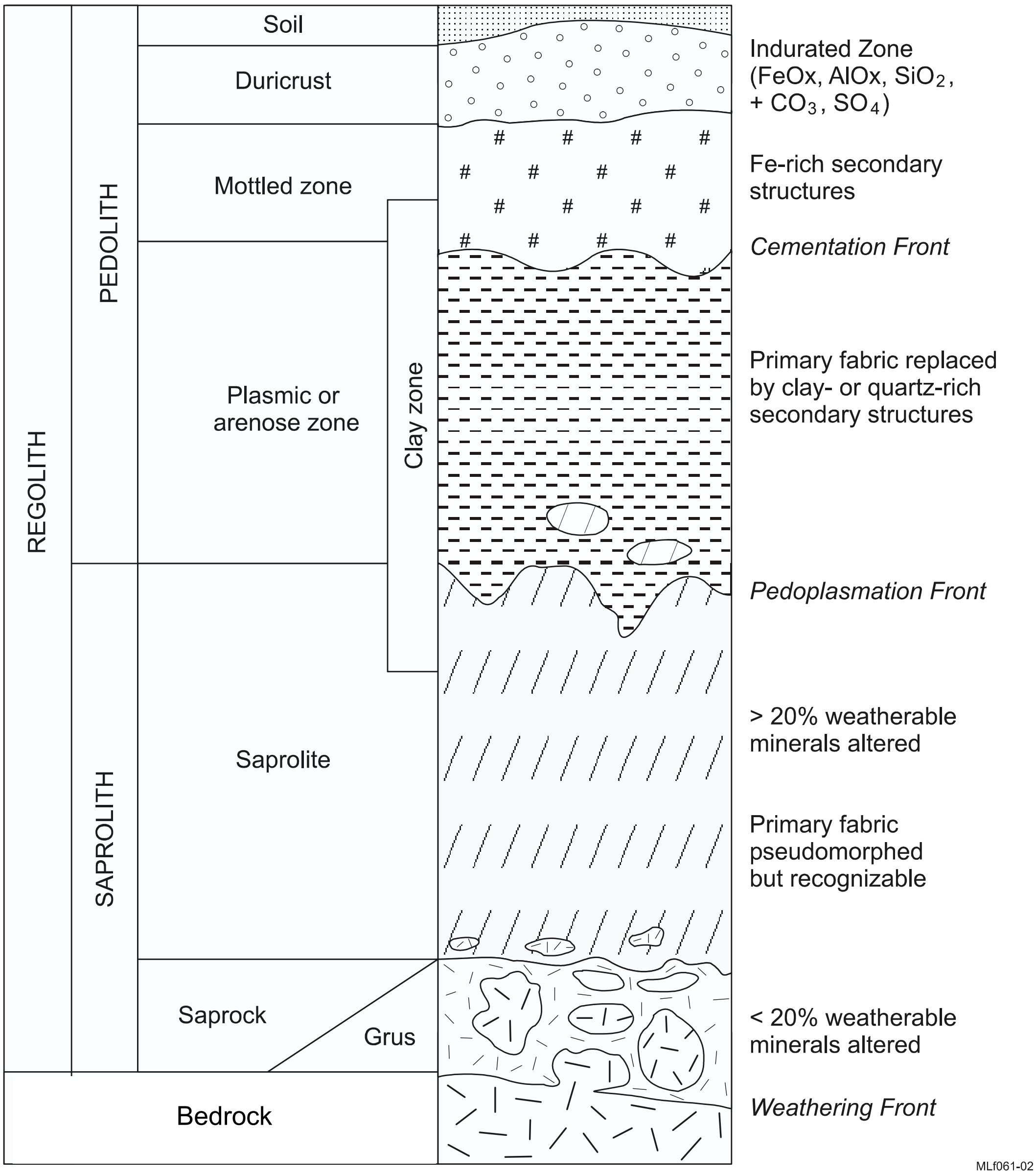
# REGOLITH BENCHMARK ATLAS, GAWLER CRATON, SOUTH AUSTRALIA – Volume 2

## Introductory Comments

A detailed introduction to Benchmarking is provided in Volume 1, covering the following: Benchmark Types, Methods, Regolith Profile Terminology, and Benchmarks 1 to 20, located within the Harris Domain, Central Gawler Gold Province and Yorke Peninsula. Volume 2 includes 13 Benchmarks dominantly located within the Archaean Christie Domain, these are drawn from CRC LEME & PIRSA regolith investigations, and a series of university Honours theses covering prospect scale regolith studies. The case history extracts presented herein are drawn from work done during 1997-2006.

To assist the user of this Volume, as a stand-alone reference, the Regolith Terminology chart from Volume 1 is reproduced below (Figure 1). A regional location plan for the Benchmarks contained herein follows as Figure 110.




*(Adapted from: CRC LEME - Atlas of Weathered Rocks 1997, Open File Report 1; CSIRO Division of Exploration Geoscience, Report 390, 1st Revision.)*

**Figure 1:** Generalised Regolith Terminology after Robertson and Butt (1997) modified slightly to better represent South Australian regolith. Weathering can affect both crystalline basement and overlying sedimentary cover, but erosion may also truncate portions of that weathering profile. In numerous areas, the weathering profile may be repeated more than once – especially within sedimentary basins. (duplicated from Vol. 1).

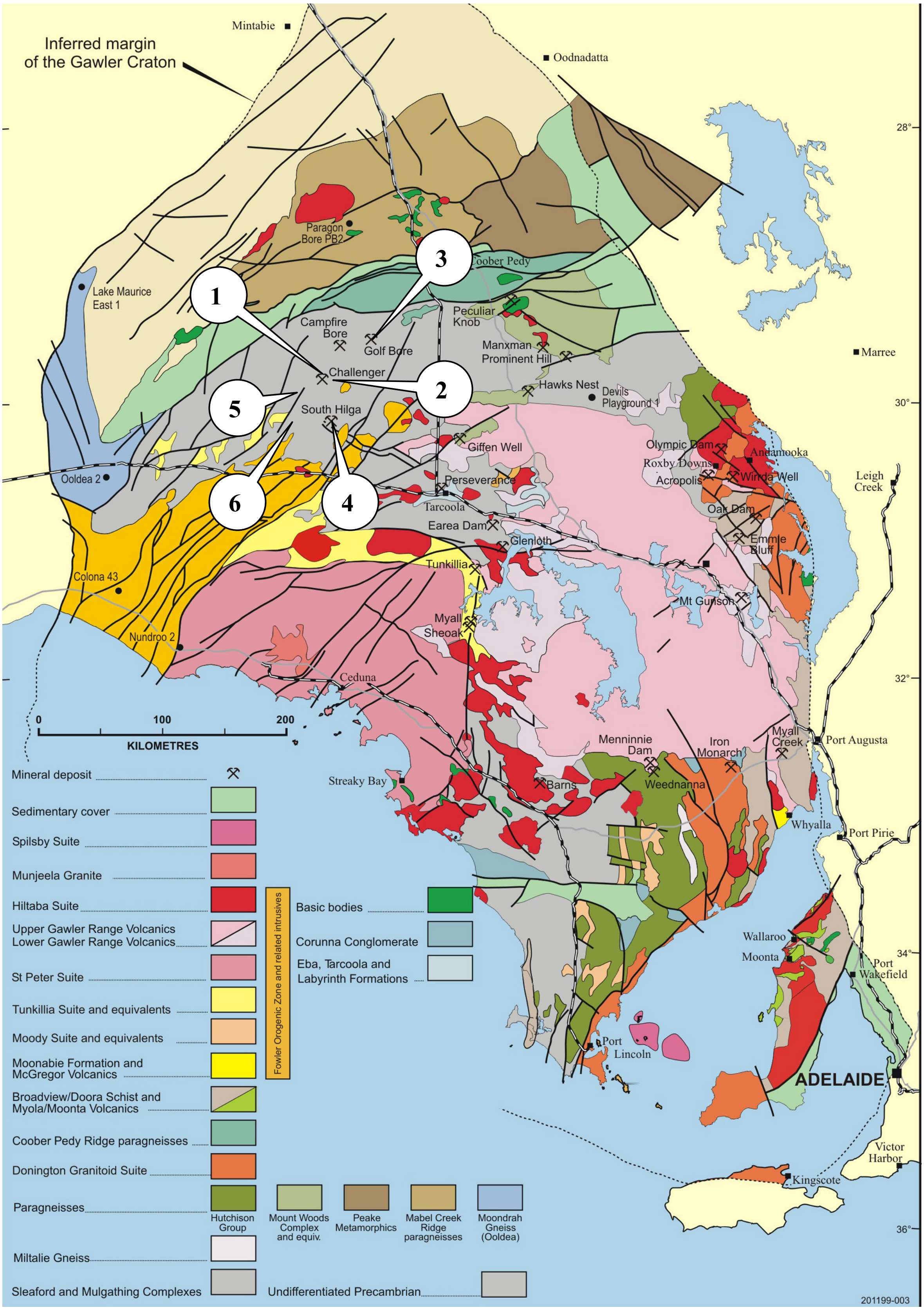



**Figure 110:** Gawler Craton, Christie Domain Benchmarks 21-33, CRC LEME + PIRSA 1996-2004: **1.** 21-23 Challenger Gold Deposit, **2.** 24, 25 Jumbuck gold prospect, **3.** 26, 27 Golf Bore gold prospect, **4.** 28, 29 South Hilga gold prospect, **5.** 30, 31 Monsoon gold prospect, and **6.** 32, 33 ET gold prospect.

# BENCHMARKS

Benchmark profile details are drawn from many sources, where uniformity of presentation and data between sources were not consistent. Ideal formats would include the items as set out in Table 1, however, not every site will necessarily have data or those particular items for each indicated level because benchmarking was not the original investigative focus. New photography was taken where samples or sites were amenable and additional data drawn from other sources, to infill any serious information gaps.

**Table 1:** Benchmark data that will be displayed where available.

| # | Type 1 (natural outcrop) | Type 2 (drilled profiles) | Type 3 (excavations) |
|---|---|---|---|
| 1 | Regional location map | Regional location map | Regional location map |
| 2 | Local-site location map | Local-site location map | Local-site location map |
| 3 | GPS coordinates & elevation | GPS coordinates, attitude & elevation | GPS coordinates & elevation |
| 4 | Site access, owner | Site access, owner | Site access, owner |
| 5 | Related sites | Related drillholes | Related excavations |
| 6 | Profile photos + logs | Drill sample photos + logs | Excavation photos + logs |
| 7 | Sample storage location | Sample storage location | Sample storage location |
| 8 | Lithotypes | Lithotypes | Lithotypes |
| 9 | Petrology (if available) | Petrology (if available) | Petrology (if available) |
| 10 | Geochemistry (if available) | Geochemistry (if available) | Geochemistry (if available) |
| 11 | XRD data (if available) | XRD data (if available) | XRD data (if available) |
| 12 | PIMA data (if available) | PIMA data (if available) | PIMA data (if available) |
| 13 | Dating (if available) | Dating (if available) | Dating (if available) |
| 14 | Target elements | Target elements | Target elements |
| 15 | Potential Pathfinder Elements | Potential Pathfinder Elements | Potential Pathfinder Elements |
| 16 | Useful sampling media | Useful sampling media | Useful sampling media |
| 17 | Key reference sources | Key reference sources | Key reference sources |

## Christie Domain

The original Christie Sub-domain of Parker (1990) has been subsequently subdivided to exclude the Fowler Domain (Fowler Orogenic Zone), the Coober Pedy Domain and the Mount Woods Domain. The Christie Domain comprises Archaean to earliest Palaeoproterozoic rocks (original bedrock) onto which younger units were deposited and/or incorporated (Daly and Fanning, 1993; Teasdale, 1997). Major rock units include low magnetic intensity Mulgathing Complex paragneiss (e.g. host of the Challenger Gold Deposit) interlayered with, linear high magnetic zones of banded iron formation and ultramafic rocks, including peridotite, and intruded by highly magnetic ~1690-1670 Ma intrusives. The western boundary is the Karari Fault Zone and the eastern boundary is the Coorabie and Tallacootra Shear Zones (Figure 110; Fairclough and Schwarz, 2003; Daly and Fanning, 1993).

### *Christie Gneiss*

The Christie Gneiss – paragneiss Type Locality includes the following sites and cores: the Mt Christie banded iron formation outcrop (TARCOOLA 1:250,000 & 5637 1:100,000 map sheets; Zone 53, 357200 m E, 6646450 m N) plus three short (angled) diamond drill holes intersecting the Mt Christie sequence at depth, and gneisses exposed at Christie Corner (356800 m E, 6644700 m N; 1.9 km SSW of Mt Christie. Daly and Fanning, 1993; Daly, 2003). These granulite facies metasediments are currently considered probable correlatives of the Carnot Gneiss partly exposed along the coast in the southern Gawler Craton, with both sequences undergoing granulite facies metamorphism at ~2440 Ma (Fanning *et al*., 2007). More recent work on the Harris Domain (see Vol 1) in the central Gawler Craton, indicates possible equivalents to the Christie Gneiss, intercalated with the greenstones and basalts, to be coeval (extrusion age 2510 Ma; Fanning, 2002). Detrital zircon geochronology on the nearby sediments at Kenella indicate ages of 2560 Ma, 2680 Ma and 2760 Ma (Swain, 2002).

Well exposed Christie Gneiss at Christie Corner reveals north trending gneissic banding, with coarse pegmatitic quartz, K-feldspar ± cordierite and garnet interlayered with finer darker layers of plagioclase, hypersthene (partly regressed to biotite during the Kimban Orogeny) diopside (partly regressed to hornblende) and quartz. The characteristic coarse garnets (purple-maroon) are partially regressed to chlorite and when weathered consist of iron oxides (expressed as brown mottles in pallid saprolite; Lintern and Sheard, 1999a). The pegmatitic layers are considered to have developed during peak metamorphism from a layered sedimentary sequence (Daly, 2003).

Christie Gneiss metasediments were isoclinally folded during the Sleafordian Orogeny. Small-scale isoclinal $SD_2$ folds are common. More open small-scale M-shaped folds (N closure) are considered associated with the later $SD_3$ folding, contemporaneous with the more open gently northerly plunging Mulgathing Antiform. Christie Corner outcrop is interpreted as part of a western limb to the Mulgathing Antiform. Boudins of metabasic rock (presumed basalt) also occur in the Christie Gneiss at this locality (N side) where small-scale $SD_3$ folding can also be observed. Small-scale Palaeoproterozoic shearing (trending ~NE) rotating Archaean layering to the NE occurs here too (Daly and Fanning, 1993; Daly, 2003).

Banded iron formation and interlayered aluminous metasediments at Mt Christie are interpreted as forming part of the western limb to the Mulgathing Antiform. Folding within the banded iron formation includes both isoclinal $SD_2$ and more open $SD_3$ folds which are coaxial at this location. The subhorizontal axies plunge more steeply on the northern and southern parts of the main outcrop due to inferred Proterozoic shearing. In the late 1960’s the South Australian Geological Survey sponsored angled drilling at three sites through (below) the Mt Christie outcrop, each drillhole provided HQ cores from surface to fresh rock (PIRSA Mt Christie drillcores CD 1-3). Core exposes finely banded iron formation, oxidised–extremely weathered at the surface, it comprises: quartz, magnetite, diopside and hypersthene. Thin inter-layers of feldspar and carbonate with accessory garnet, clinopyroxene and olivine also occur. The banded iron formation is structurally overlain by banded coarse-grained quartz, plagioclase, K-feldspar, cordierite, garnet gneiss. Garnet-rich and cordierite-rich metasediments (seen only within the drill core) are identical to gneissic rocks hosting the Challenger Gold Deposit (Plate 9). Retrogression, presumed to be the result of Kimban Orogeny deformation (dated at the Challenger Gold Deposit as ~1710 Ma; Fanning, 2002), has partially altered the granulite facies orthopyroxene (to biotite) clinopyroxene (to amphibole) and cordierite (to sillimanite) (Daly and Fanning, 1993; Daly, 2003). Additional U-Pb zircon dating for this rock sequence is available in Fanning *et al*. (2007).

The Mt Christie drillcores CD 1-3 are not discussed further as benchmarks herein, however, they do provide additional visual access to the natural exposures of that area, and well present the weathering zone not seen in the local area outcrop.

## Challenger Gold Deposit

### Background

The Challenger Gold Mine is located in the Western Gawler Craton 750 km NW of Adelaide and 140 km NW of Tarcoola (Figures 110, 111). This deposit was discovered in 1995 using broad spaced (1.6 km grid) calcrete sampling and Au analysis (local maximum of 180 ppb Au), followed by in-fill calcrete sampling, where the anomaly gave a peak calcrete-Au value of 620 ppb (Lintern, 2004b; GJV, 1998; Edgecombe, 1997; Figures 111-113). Subsurface mineralization was defined by RAB and RC drilling during 1995-97, diamond coring in 1996-97 provided structural and more specific assay data. Gold production commenced in late 2002, initially from an open-cut pit, followed by underground mining operations. Those commenced late in 2004, where a spiral decline and stopes continued mining of the NE plunging loads below where the open-cut operations ceased. Production of gold from the underground workings began in 2005. The open cut mine produced 120,000 oz Au, and the underground operations have produced 190,000 oz Au (to late Nov. 2006). Reserves of 270,000 oz have been announced with another 410,000 oz Au projected as an in-ground resource from drilling and mine forward developments (Poustie *et al.*, 2002; Poustie, 2006). Dominion Mining announced to the ASX in late July 2007 that Challenger Gold Deposit has current reserves standing at 2.2 million tonnes at 7.2 grams per tonne Au for 512,000 oz. This places the pre-mined Deposit size at equal to or more than 1.1 M oz.

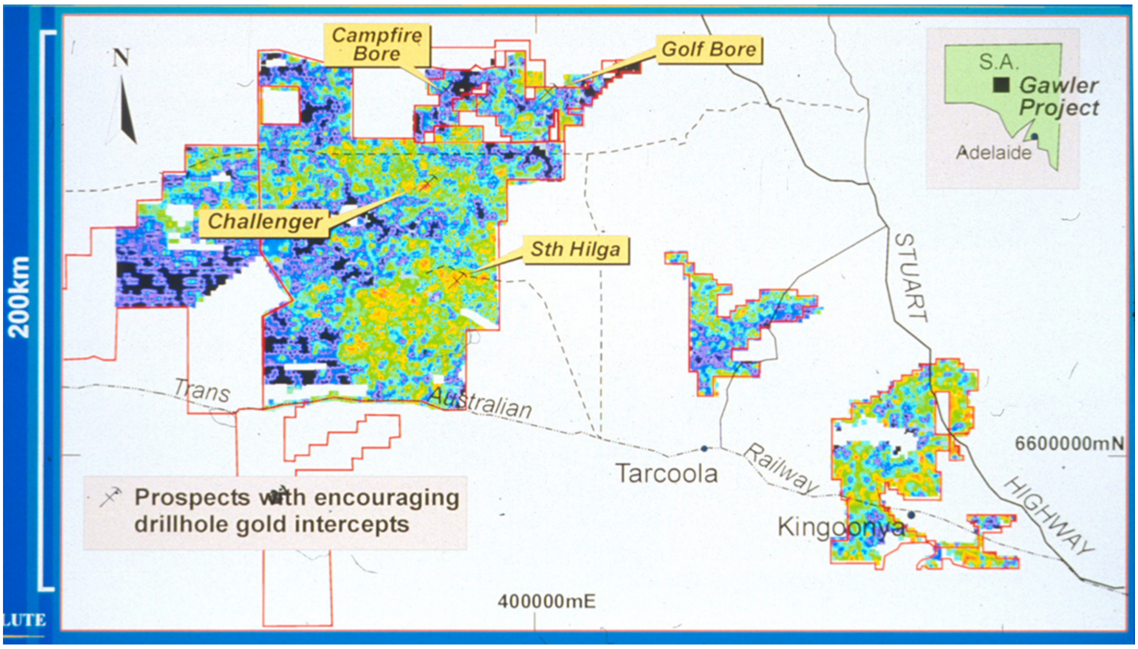



**Figure 111:** Colour contoured Au-in-calcrete geochemical anomalism on prospects held by the Gawler Joint Venture (Dominion Mining Ltd & Resolute Resources Ltd), including the Challenger Gold Deposit. Western Gawler Craton regional roads, rail and towns are also marked. Image courtesy of Resolute Resources Ltd.

The deposit is located beneath an expansive plain of several tens of kilometres square, with generally low relief (<50 m) consisting of: sparse longitudinal sand dunes, various terrigenous and marine sediments, occasional eroding escarpments in deeply weathered crystalline basement, and rare silcrete armoured remnant low rises of deeply weathered Christie Gneiss. Locally the Challenger Gold Deposit cropped out on the flanks of a low rise about two kilometres east of a poorly defined ephemeral drainage. There was no obvious active drainage within the outcrop-subcrop area, although in the subsurface there is evidence for small (<1 m) to wide (>1000 m) palaeochannels, the largest now provides groundwater to the Challenger Gold Mine (see later sections). Regional climate is arid with rainfall of about 150 mm per annum, falling mostly in the winter. Vegetation has been affected by grazing and consists of scattered open low woodland of *Acacia*, *Eremophila* and *Casuarina* spp. (up to 4 m in height) with an understory of shrubby genera (1-2 m in height), the most significant being ‘Pearl Blue Bush’ *Maireana sedifolia* (Lintern and Sheard, 1999; Lintern, 2004b).

**Figure 112:** Gold in calcrete geochemical anomalies and significant prospects held by the Gawler Joint Venture (Dominion Mining Ltd & Resolute Resources Ltd), including Challenger Gold Deposit. Drill tested Au values are also indicated (GJV, 1998).

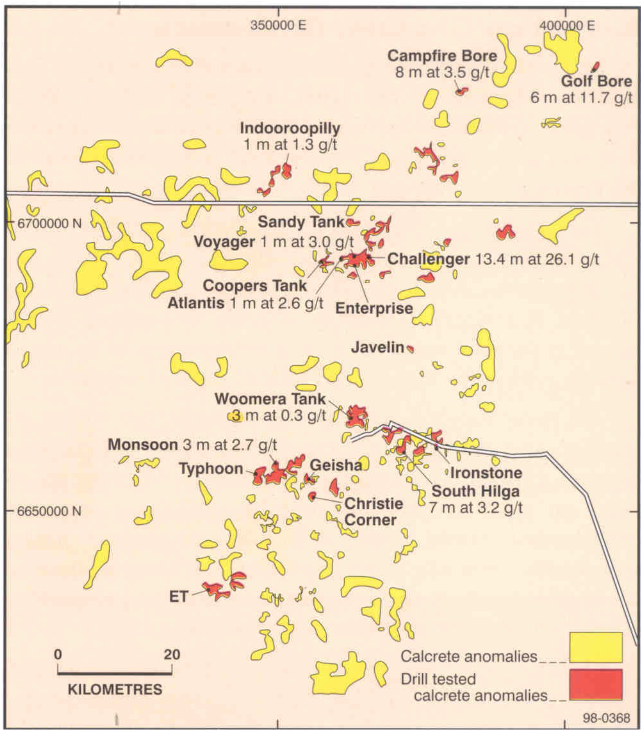
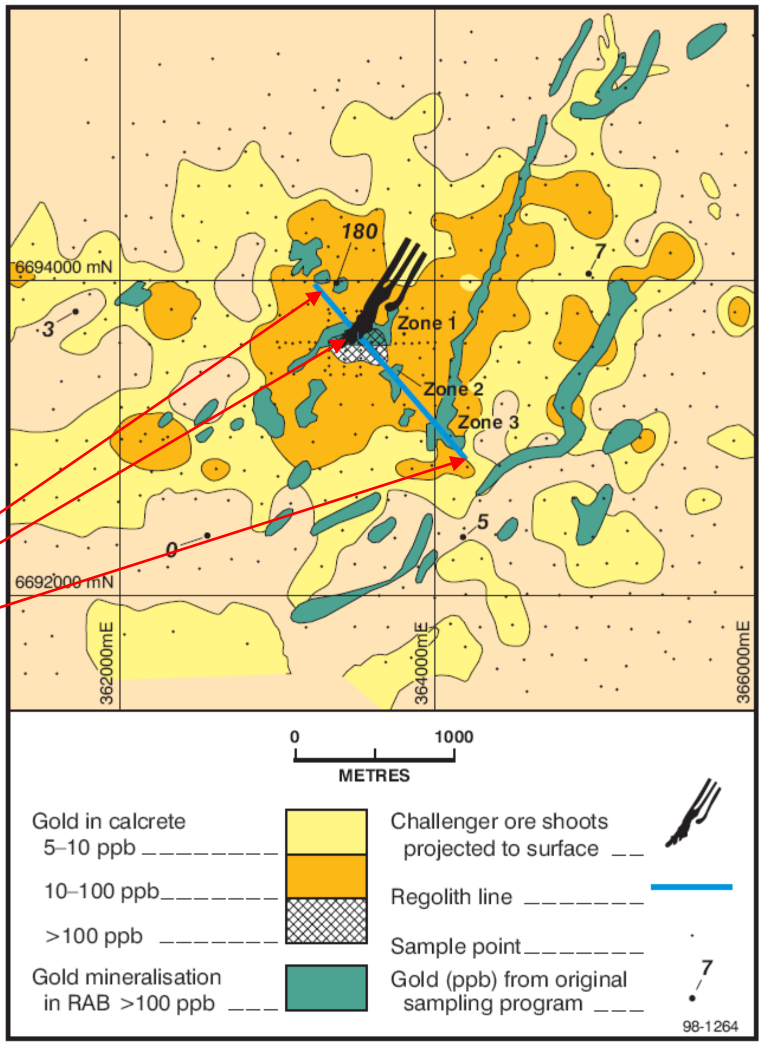



**Figure 113:** Challenger Gold Deposit in plan, showing the surficial Au-in-calcrete anomaly (max. regional grid sample value is indicated), subsurface mineralization (as defined by RAB drilling), ore shoots (as defined by RC drilling), and the regolith sampling drill line of Lintern and Sheard, 1998, 1999a. Some data derived from the Gawler Joint Venture partners.

Benchmark locations are shown.

**Benchmarks:**
**21**
**22**
**23**



## *Geology and Mineralization*

The Challenger lode systems are contained within the Archaean metasedimentary Christie Gneiss, where the local lithology is a feldspar-quartz-cordierite-garnet-biotite gneiss (Poustie *et al*., 2002). Geochronology indicates peak metamorphism of the host rock at ~2440 Ma. Monazite intergrown with gold gives a similar age (Fanning, 2002). Work by Tomkins and Mavrogenes (2002) indicates that the gold was present within the sedimentary pile prior to metamorphism and was concentrated during peak metamorphism. Later heating and possible gold remobilisation, recorded by growth of monazite rims, occurred at ~1710 Ma.

The high grade coarse-grained Au mineralization occurs within and adjacent to coarse-grained quartz, feldspar, garnet and biotite-bearing veins, and is associated with minor disseminations of arsenopyrite, loellingite ($FeAs_2$) and pyrrhotite. Bluish quartz, bluish feldspar and greyish cordierite porphyroblasts can attain dimensions of many centimetres in some mineralization associated gneissic bands (Plate 9). Bismuth minerals, tellurides, chalcopyrite, pentlandite, sphalerite and graphite are also present in small amounts (Poustie *et al*., 2002; Lintern and Sheard, 1999b; Mason and Mason, 1998; Bonwick, 1997).

Mineralization occurs within structurally controlled shoots which plunge ~30$^{o}$ towards 055$^{o}$ local grid Figures 114, 115). The internal vein geometry is oblique to the plunge azimuth of the shoots. Mineralized veins have short strike lengths but are very consistent and are elongated down plunge. This consistency is supported by the fact that every drill section has intersected the mineralization over a down plunge distance of more than 800 m (Poustie *et al*., 2002; Poustie, 2006).

**Figure 114:** Challenger Gold Mine in long section, displaying four NE plunging mineralized lodes, M1, M2 and two others (unlabeled). The main pit in outline and the first stage underground access decline with sublevel workings are indicated. Angled diamond drillholes (black lines) have provided pre-mining strategic data (Poustie *et al*., 2002).

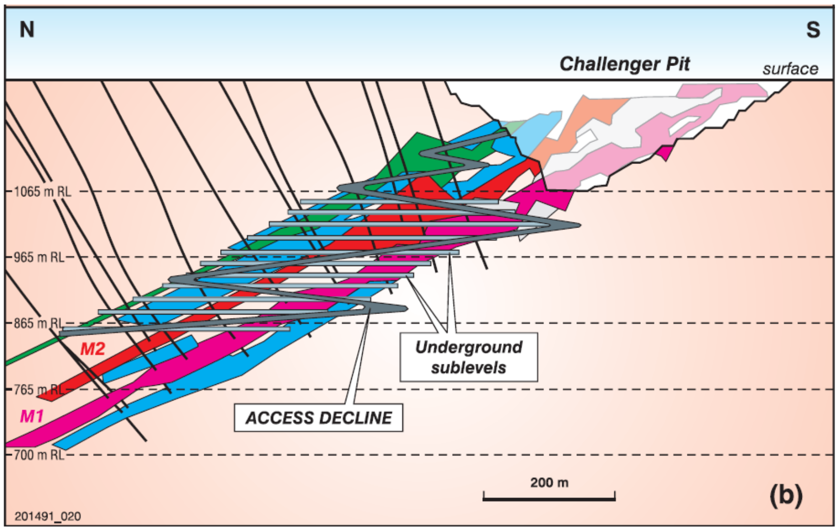



**Figure 115:** Challenger Gold Deposit: projected 'M' folding along the M1 lode, with the actual intersections by deep drill coring (~600 m below ground level), indicating a very persistent structural trend within which a quite variable high grade gold distribution occurs (Poustie, 2006).

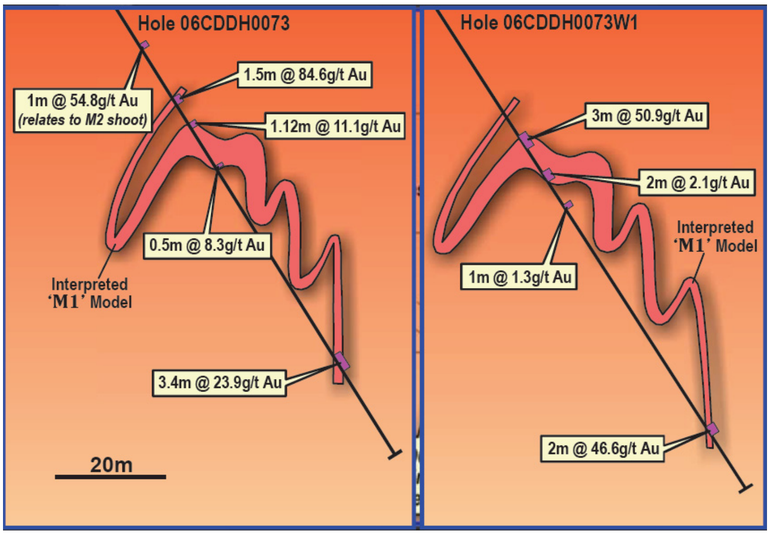


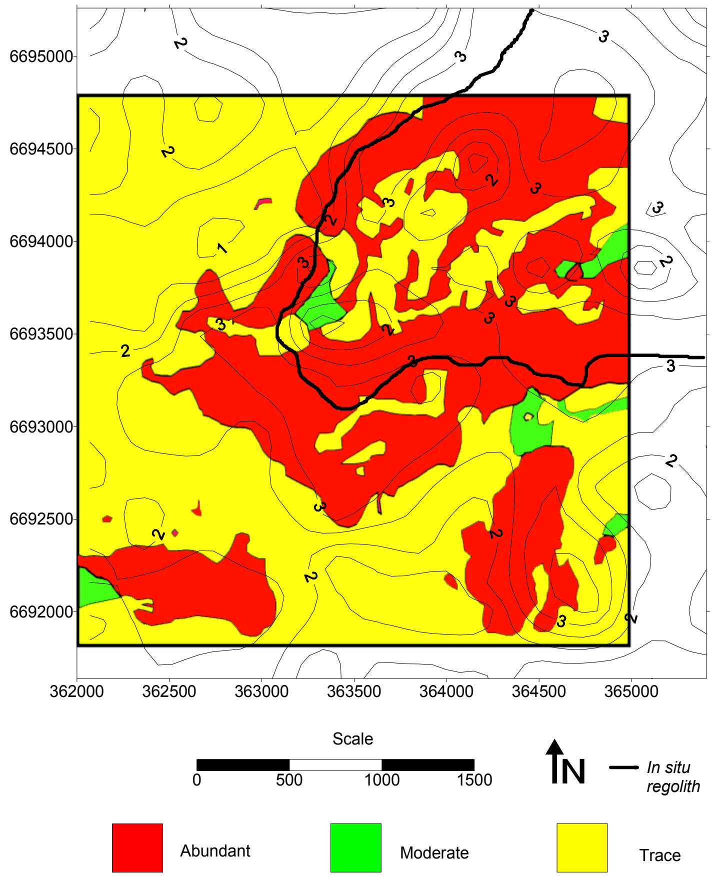
**Plate 9:** Christie Gneiss bedrock (wet), collected from the main pit at Challenger Gold Mine, ~100 m below ground level. Note the banding; the bluish quartz, cordierite and feldspar + dark pink coarse-grained garnets. The black bands contain abundant biotite, amphibole and pyroxene.


## *Regolith Studies*

Regolith studies at the Challenger Gold Deposit were undertaken by CRC LEME, PIRSA and two university Honours students, and as a result, a more detailed understanding of the regolith landforms, distributions of materials and geochemistry was made possible (Lintern and Sheard, 1998, 1999a, b; Povey, 1999, van der Wielen, 1999; Lintern, 2004b). Several regolith landform maps were compiled for the area including 1:100,000, 1:50,000 (Craig and Wilford, 1997a, b; Wilford *et al.*, 2001) and a 3 x 3 km 1:5,000 detailed map (Povey, 1999).

**Figure 116:** Lag distribution plan of Povey (1999) displaying a 3 x 3 km area centred on the Challenger Gold Deposit. The unconformity (as defined by drilling) is indicated by the thick black line. Lag distribution, via surface visual appraisal mapping, is coloured, while contours display laboratory work involving sample weights.

Lag dispersal away from the unconformity has been strongly influenced by the very low topographic relief. Two red areas, south of and well away from the unconformity, represent fluvially transported ferruginous granule lags derived from a ferruginous pisolith-rich duricrust (Craig and Wilford, 1997b; Povey, 1999; Wilford *et al.*, 2001; Lintern, 2004b).



## *In situ Regolith*

*In situ* regolith (weathered basement) occurs principally in the area central to the Challenger Au-in-calcrete anomaly displayed in Figure 113, where an outcrop-subcrop tongue (closing towards ~SW) of weathered *in situ* regolith is surrounded by transported regolith (sediments). That is, the major unconformity (transported on *in situ* regolith), as defined by drilling, could also roughly be defined at the surface by examining lag distributions and shallow soil pit profiles (Figure 116; Povey, 1999; Lintern, 2004b). Full-section regolith (Figure 117), constructed from re-logged exploration RAB drill cuttings, reveals moderately deep weathering in Christie Gneiss, yielding a generally pale coloured (typically yellowish and reddish) clay-rich saprolite. Its mineralogy is predominantly kaolinite, with less illite and smectite, plus residual quartz as grains and veins (Figure 118-120).

The lower regolith consists of either (i) mottled clay, overlying variably coloured clay (and partly ferruginous saprock fragments and/or corestones) with abundant quartz, grading to less weathered rock and abundant quartz with depth, or (ii) as above but with mottled clay absent. The boundary between highly weathered, mostly clay-rich saprolite, and moderately weathered saprolite-saprock containing appreciable quantities of saprock (partially weathered gneiss) is variable but lies between 20 to 40 m (Figure 118). Primary gneissic fabric is preserved within saprolite even to within <3 m of the surface (Figures 118G, H & 119) indicating that weathering has been essentially isovolumetric – at least below the silcrete horizon. Other relict minerals encountered within the weathering profile include occasional biotite (as inclusions within quartz) garnet and graphite (Figure 118, Plate 10).

The upper regolith (0-6 m) is more complex, consisting in the lower half (~6-3 m) of pallid saprolite overprinted and coloured by iron and manganese oxides and/or sesquioxides, while the upper half (~3-0 m) is pedolith. The upper few metres of pedolith is variably cemented by silica (silcrete ± hyaline opal ± potch opal), along with calcrete and gypsum (Figures 118, 121). Some pedogenic silcrete displays features consistent with surficial physical disruption and dislodgement, to form locally derived slope talus breccias and/or debris flow deposits (pedolith; Plates 11-13) later recemented by secondary or tertiary silica. These breccias can contain resistate mineral grains that have low to moderate rounding due to short distance transport; some clasts have been incorporated deeper into the profile via coeval surface shrinkage cracks. Any original ferruginous pedolith has been stripped from the outcropping relict profile (it was still within an erosional regime prior to mining) – possibly by similar processes that formed the talus breccias and now typically bearing potch opal blebs-lenses, fragments and veins (Lintern and Sheard, 1998, 1999b; Mason and Mason, 1998).

## *Calcrete*

Calcrete in this area is highly variable and ranges from massive to laminar to nodular and to earthy types, where the more indurated forms occur on saprolite or within palaeochannel fluvial sands. At some locations laminar calcrete has a very complex internal structure and mineralogy (Plate 14). Calcrete cements have invaded 1-3 m into the upper regolith (Figure 121) to infill voids, fractures and commonly yielding a significant expansion of the profile – typically forming jig-saw-fit textures and complex profiles (Plate 13).

## *Transported Regolith*

Transported regolith includes fluvial sediments in palaeochannels to the W and E of the mineralization (Figure 117, 122). Those sediments include clay ± silt ± sand in variable thicknesses and mixtures. The largest palaeochannel, west of the Deposit, in a northerly draining palaeovalley (infilled to >150 m) now supples the Challenger Mine and Processing Plant with groundwater. Upper portions of those sediments have been both silcreted and calcreted (Figure 121). Aeolian sand, as minor dunes (<2 m thick) and thin interdune sheet deposits, partly covered the area around the weathered *in situ* regolith outcrop. Nodular to earthy pedogenic calcrete was observed to occur in those sands at depths of 20-30 cm. Colluvium, including a variety of lags, forms a minor (<25 cm thick) transported component to this relatively flat landscape (Plate 15).

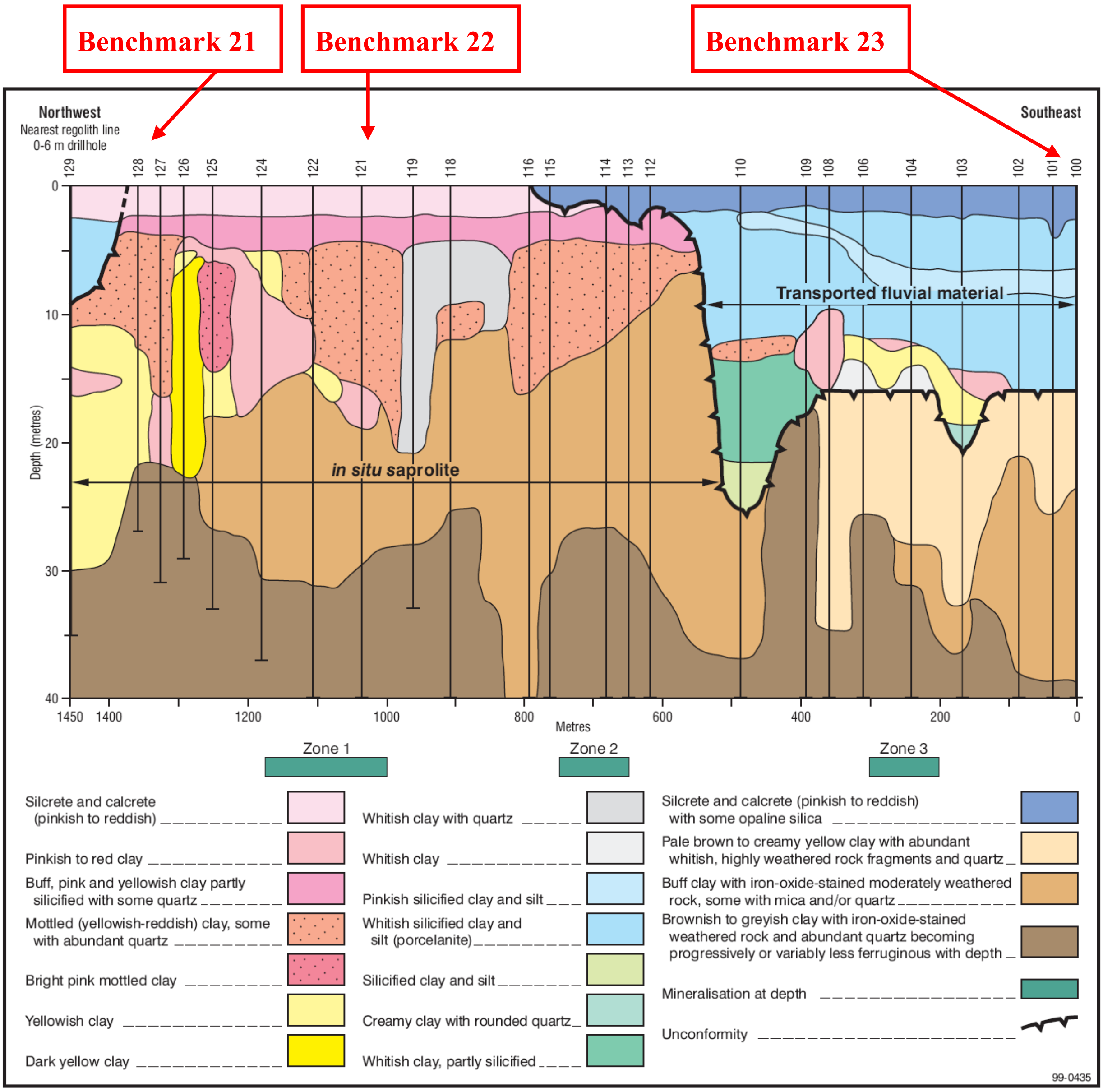



**Figure 117:** Regolith Line cross-section at Challenger, the position on Figure 113 is indicated with a grey line (Lintern and Sheard, 1999a). Benchmarks 21-23 locations are indicated. RAB drilling was carried out by the Gawler Joint Venture partners to define mineralization below the surficial Au-in-calcrete geochemical anomaly. Gold mineralized zones are marked by dark green horizontal bars below the x-section. Chiptray samples are lodged with PIRSA's Drillcore Storage Facility.

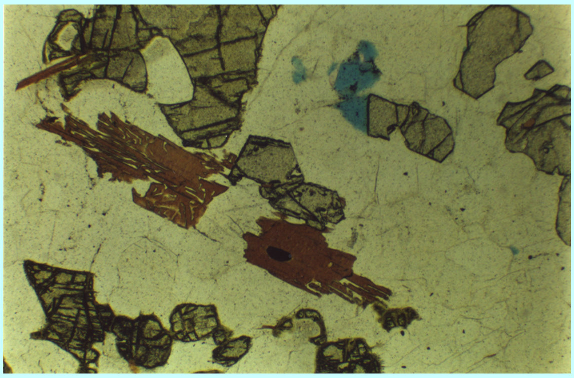
## *Regolith Exposure*

An overview of the regolith profile, as exposed by mining within the main pit, is displayed in Figure 120 where regolith weathering zonation is also indicated. Subsequent mining has deepened the main pit to ~125 m below ground level, where an underground decline and stope mining operations have taken over. Due to the effects of continued mining and ongoing haulage ramp maintenance–use, the inclusion herein of Challenger Gold Mine's current pit faces as regolith benchmarks wasn't practical. However, the main pit wall exposures do provide an excellent regolith overview that can be safely observed from several surface vantage points and more closely by prior arrangement with the mine management. Those deep sections offer the best local 3D regolith exposures in this region, so typified by terrain of low relief with ubiquitous cover.

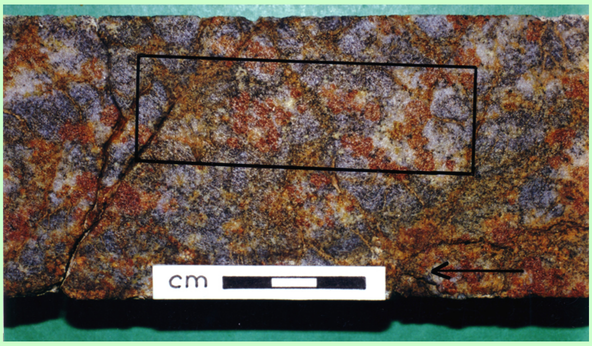
Explanations to Figure 118 on next page (petrography to segments of geotechnical drillhole 97CHDH1361-A).

| | |
|---|---|
| **A:** Christie Gneiss, bedrock (¼ HQ core) at 40.43-40.51 m, top is on LHS. A medium- to coarse-grained gneiss with rounded pink garnet aggregates scattered through a pale to medium grey crystalline matrix. Sample #: R367483. | **B:** Thin-section view (transmitted plane polarised light) of fresh felsic gneiss with biotite (brown), orthopyroxene (dull grey, cleaved, bottom & top left), garnet (high relief, uncleaved, top right), felsic minerals (plagioclase, K-feldspar & cordierite) and quartz. Field of view 1.5 x 2.5 mm. Sample #: R367483, thin-section #: C69890. |
| **C:** Christie Gneiss, saprock (½ HQ core) at 26.62-26.72 m, top is on LHS. Weathered medium-grained felsic crystalline rock with large spongy reddish garnet porphyroblasts (partly reddened by weathering) in a dull grey felsic matrix with tiny dark flecks (biotite). Scattered throughout are small pale cream alteration patches (clay after cordierite). Sample #: R367484. | **D:** Thin-section view (transmitted plane polarised light) of partly weathered gneiss. Thin trails of dark iron oxide (goethitic) have developed along micro-cracks in a large garnet poikiloblast (high relief, pale grey), other minerals remain fresh (except for complete alteration of cordierite and orthopyroxene, not shown). Field of view 1.5 x 2.5 mm. Sample #: R367484, thin-section #: C69891. |
| **E:** Christie Gneiss, lower saprolite (½ HQ core) at ~20 m, top is on LHS. Very weathered felsic crystalline rock in which abundant medium-grained felsic grains have suffered pervasive weathering to a cream colour with diffuse pale orange to pink ferruginous discolouration. Centimetre-sized mottle-like dark brown patches are irregularly scattered through the rock. Sample #: R367485. | **F:** Thin-section view (transmitted plane polarised light) of severely weathered gneiss. A large garnet poikiloblast has suffered complete replacement by goethite (dense dark red-brown) and clays (not readily seen at this magnification). Note the characteristically round shape of the unaltered quartz inclusions in the relict garnet poikiloblast site. *C.f.* with less weathered garnets shown above from fresher rock. Field of view 1.5 x 2.5 mm. Sample #: R367485, thin-section #: C69892. |
| **G:** Christie Gneiss, upper saprolite (¼ HQ core) at 4.77-4.85 m, top is on LHS. Extremely weathered felsic crystalline rock composed of fine-grained soft cream clay through which are scattered indistinct ovoid white patches. A precursor foliation is defined by relict translucent grey quartz grains, which tend to be aligned in thin quartz-rich lamina. Sample #: R367486. | **H:** Thin-section view (transmitted light, cross polarisers) of extremely weathered felsic gneiss as saprolite. Image reveals tiny biotite flakes (centre, bright colours) these are preserved as inclusions within relict quartz grains (white to grey). Elsewhere, kaolinite clay (dark) forms a microcrystalline massive replacement mat. Field of view 1.5 x 2.5 mm. Sample #: R367486, thin-section #: C69893. |

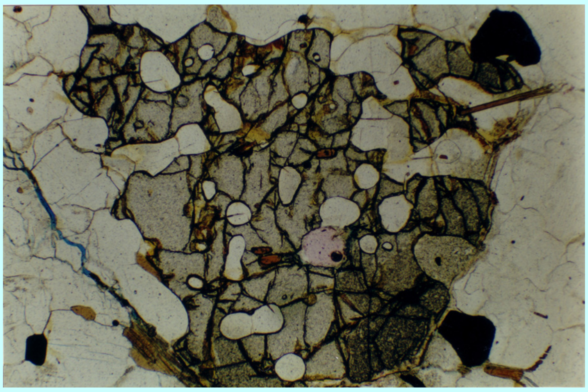

**A** *(photo 45689)*.



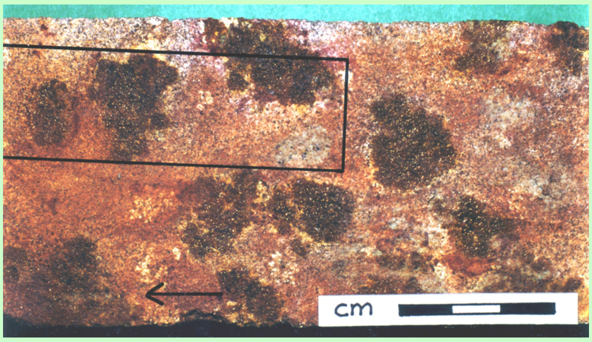
**B** *(photo 45889)*.



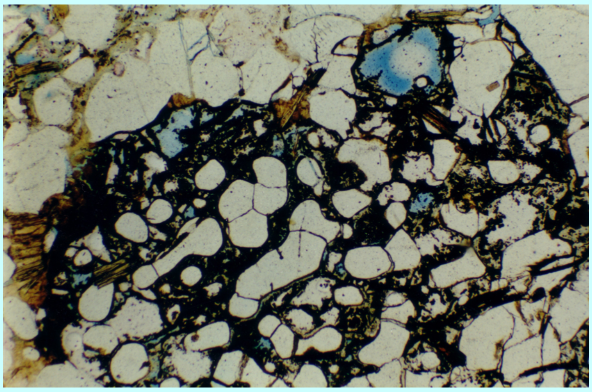

**C** *(photo 45690)*.



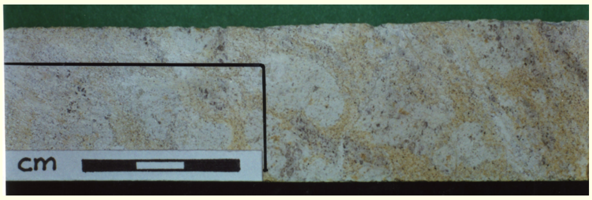
**D** *(photo 45890)*.



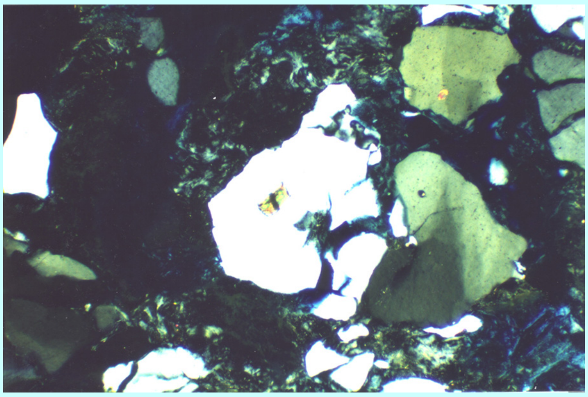

**E** *(photo 45691)*.



**F** *(photo 45891)*.

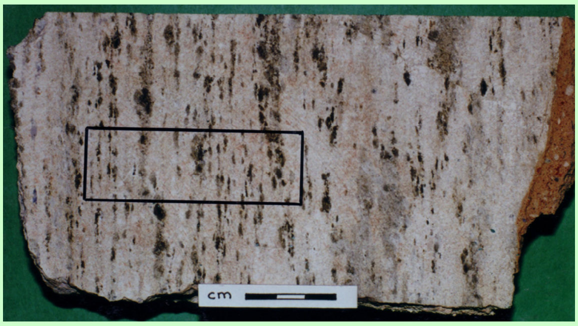



**G** *(photo 45694)*.

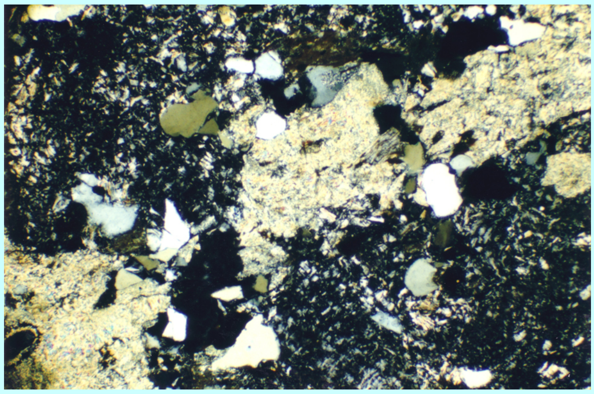


**H** *(photo 45892)*.

**Figure 118:** Major stages of profile weathering in strategic core segments from geotechnical drillhole 97CHDH1361-A (Zone 53, 365892E, 6694533N). LHS displays cut core faces and RHS displays thin-section photomicrographs. Simplified petrographic explanations are on the previous page (after Mason and Mason, 1998). Black rectangles marked on cut faces indicate thin-section placement.



**A** *(photo 45625)*



**B** *(photo 45857)*

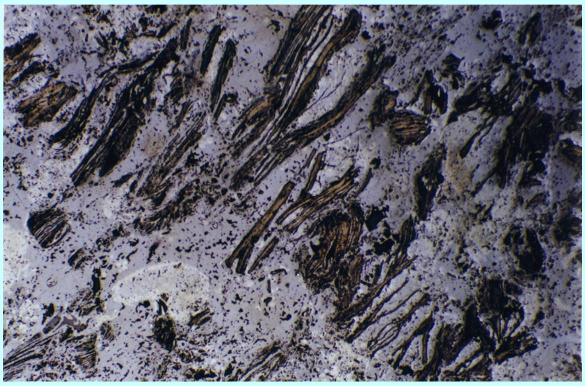
**Figure 119:** A grab sample extracted from Challenger Regolith Pit GCP 122 of Lintern and Sheard (1999b). Sample #: R214050, thin-section #: R214050.

**A**: Sawn face of pervasively altered clay-rich saprolite (after gneiss) is composed of abundant fine-grained massive white clay (mostly kaolinite) through which are distributed darker waxy greenish grey rods that define a strong lineation in the precursor metamorphic rock. Black rectangle, left of centre, indicates thin-section placement. Sample #: R214050.

**B**: Thin-section view (transmitted light, cross polarisers). Fine-grained massive sericite (larger pale yellow areas) has replaced a lineated aggregate (oriented NE-SW) of a metamorphic mineral (?cordierite). Fine-grained microcrystalline clay (kaolinite, dark grey) is abundant. Minor relict metamorphic quartz is preserved. Field of view 1.5 x 2.5 mm.

**Plate 10:** Challenger Gold Deposit regolith. Thin-section view (reflected plane polarised light) of silicified-ferruginous graphite-bearing saprolite (lag sample collected above mineralized zone 1). Imaged area: schistose rock with aligned flakes of relict metamorphic graphite (oriented NE-SW) that lie in a fine-grained matrix of goethite (medium grey). Field of view 1.5 x 2.5 mm (Lintern and Sheard, 1999b; Mason and Mason, 1998).

Sample #: R214180, thin-section #: R214180.



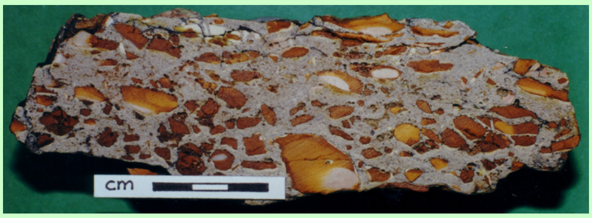
*(photo 45878)*

**Plate 11:** Challenger Gold Deposit regolith, slabbed sample from Regolith Pit GCP 100 of Lintern and Sheard (1999b). A porcellanite-silcrete-ferruginous claycrete-breccia, cemented by later calcrete and minor hyaline silica. Large clasts are subangular to subrounded, are polymict and resemble a talus deposit.

Sample #: R367482.

*(photo 45526)*

**Plate 12:** Challenger Gold Deposit regolith, slabbed sample from Regolith Pit GCP 100 of Lintern and Sheard (1999b). Brecciated porcellanite in a matrix supported framework of grey silcrete. Clasts are subangular-subrounded. Material resembles a debris flow deposit where the clay fines have later been totally replaced by silica. Sample #: R214153.



*(photo 45521)*

**Plate 13:** Challenger Gold Deposit, a slabbed sample from Regolith Pit GCP 106 of Lintern and Sheard (1999b). Brecciated porcelanite (+ grey potch opal cores) + kaolinite-rich saprolite in matrix supported framework of brown ferruginous calcrete + quartz grit. Subangular-subrounded clasts as an expanded talus deposit (original fines + voids have been totally replaced-infilled by iron sesquioxide stained calcrete). Sample #: R214137.


*(photo 45556)*

**Plate 14:** Challenger Gold Deposit regolith, slabbed sample from Regolith Pit GCP 110 of Lintern and Sheard (1999b). Colourful, complexly laminated calcrete containing: ferruginous lithic fragments and/or cement (claycrete 20%, silcrete <1%) + quartz grains (5%) + calcrete cement (70%) + dolomite (<1%) + opaline silica (~2%) + remnant voids (~3%).
Sample #: R214109. *(photo 45566)*.

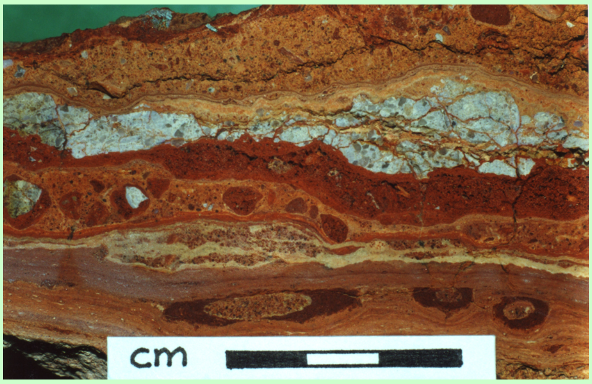



**Plate 15:** The initial 296 ppb Au calcrete sample site at the Challenger prospect (at the pink pin flag; after Edgecombe, 1997). Note the sparse low vegetation and abundant surface lag that includes calcrete, silcrete, siliceous-ferruginous saprolite, ferruginous granules and exotic rounded pebbles. *(photo 44292)*.

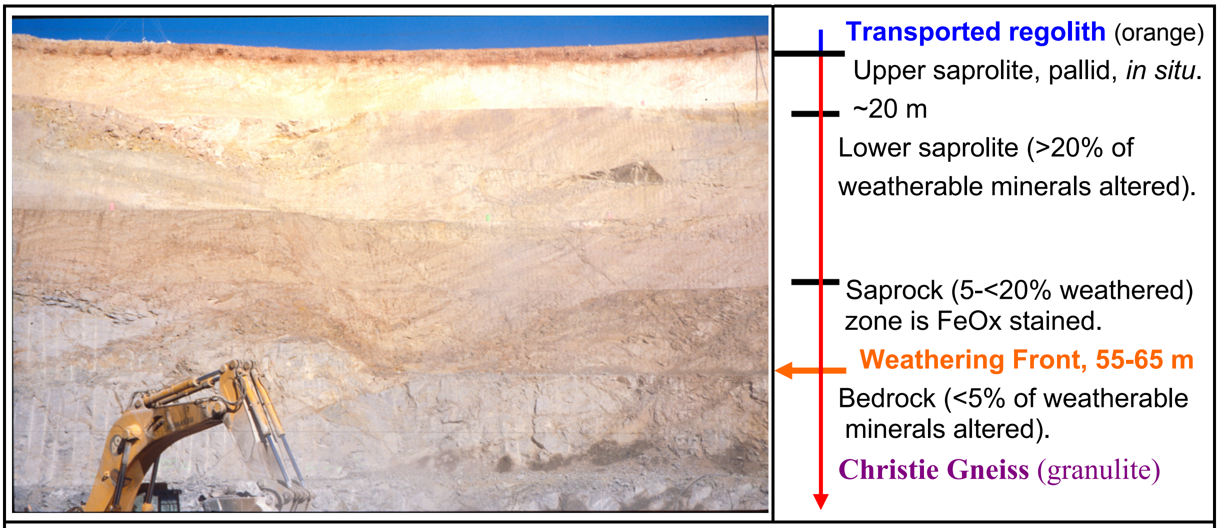



**Figure 120:** Challenger Gold Mine eastern face (main pit), as exposed in September 2003. Major regolith zones are indicated in the RHS column. Note the >10-20 m irregularities in the Weathering Front and the lower saprolite–saprock boundary. Pit base was at ~100 m below ground level at this stage of development. Ore loads plunge at ~ 30° to the LHS but never extended laterally into the eastern face portion imaged here.

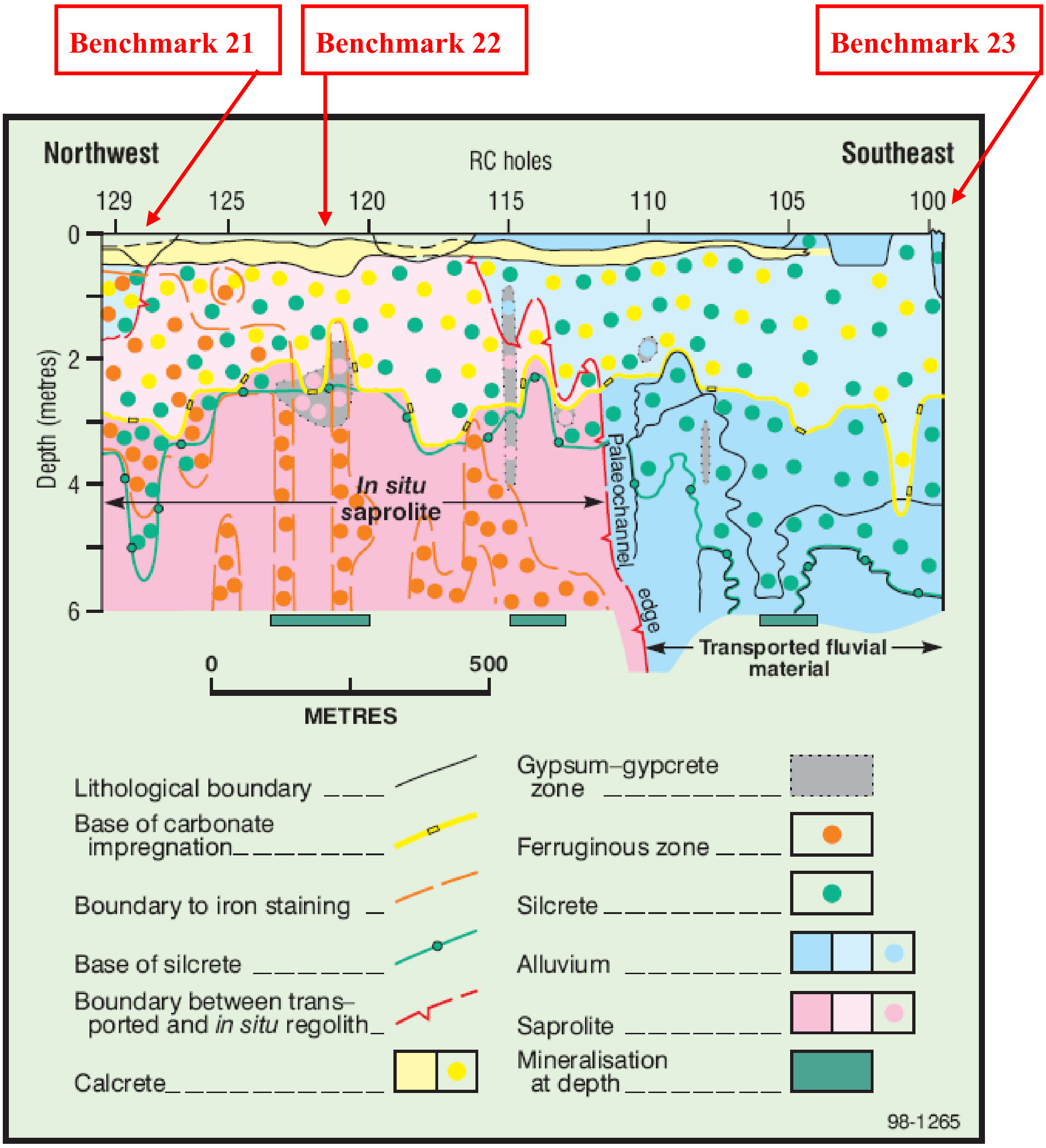



**Figure 121:** Section along the regolith line of Figure 117 but displaying only upper regolith (0-6 m) at Challenger. Section position is marked as the grey Regolith Line on Figure 113. RC drillholes used for this more detailed interpretation were placed as close as practical to existing company exploration drillholes along the same alignment. Benchmarks 21-23 are indicated. Pink colours represent weathered *in situ* regolith, blues represent transported regolith, separated by a red unconformity line (Lintern and Sheard, 1998). Significant overprinting by ferruginous + siliceous + calcareous + gypseous cements and duricrusts have complicated this near surface weathered profile. Deeper mineralized zones of significance are indicated by the grey horizontal bars immediately below the x-section. Chiptray samples to all 30 (0-6 m) drillholes are lodged with PIRSA's Drillcore Storage Facility.

b

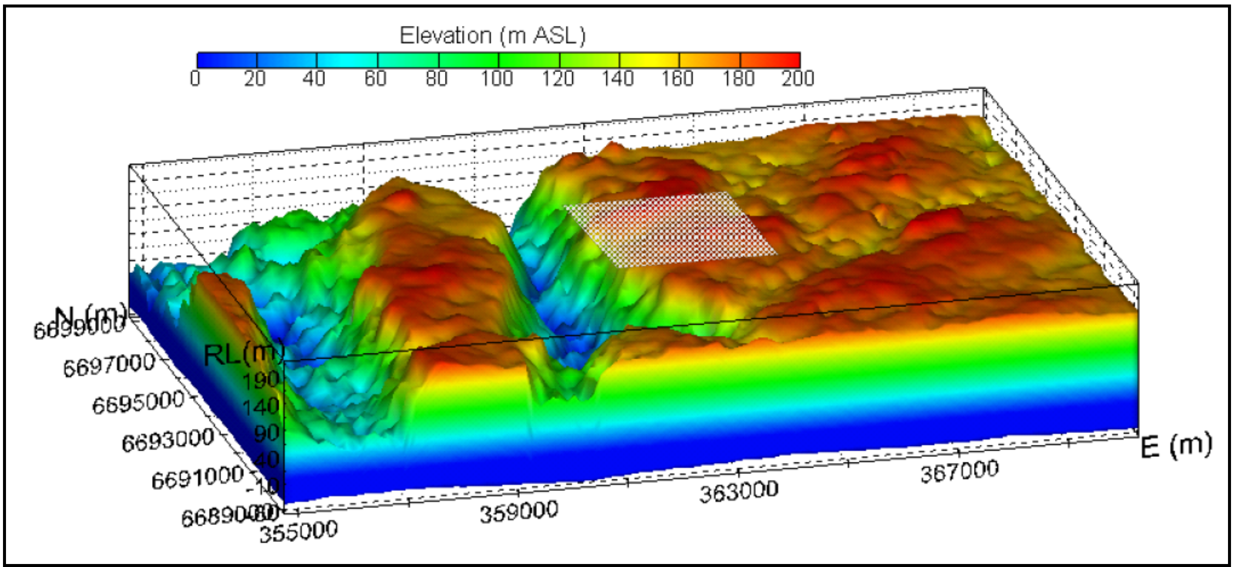



**Figure 122:** Elevation model of the AEM basal conductor surrounding the Challenger Gold Deposit. Hatched area indicates location of the lag distribution plan of Figure 116 (Lintern, 2004b). Note the two deep palaeovalleys to the west of the hatched area. Grid coordinates are in AGD84 projection.

## *Geochemical expression*

Detailed geochemical analysis was carried out in 1997 by Lintern and Sheard (1999a, b) along a 1.6 km line encompassing both company exploration drillholes (0-<60 m) and purpose drilled RC holes (0-6 m). Subsequently, a series of eight ~12 x 6 x 3 m regolith pits were excavated, along the same alignment at strategic sites, to enable additional detailed regolith and geochemical examination. During 1999, 3D regolith and geochemical dispersion modelling was carried out by van der Wielen (1999) over a 3 x 3 km area, using available company exploration drill samples and assays, along with additional strategic assays. At the same time, and over the same 3 x 3 km area, a geochemical survey, using a 100 m sample grid, provided more detailed information on subtle differences in Au distribution for calcrete, soil and two forms of lag (Povey, 1999).

The Au in calcrete and soil showed similar distributions but soil Au concentrations were much lower. The calcrete data appear to indicate Zone 1 (see Figure 113) mineralization better than does soil data but this may also be a sampling artefact, where more calcrete samples were available. Some lag over mineralization was also anomalous. Geochemical data from the initial regolith investigations of Lintern and Sheard (1998, 1999b) are shown in Figure 123.

Gold concentrations in surficial calcrete reach a maximum of 2390 ppb over Zone 1; this particularly high concentration was due to coarse Au, derived from the subcropping gold-bearing quartz veins being incorporated into the calcrete. Anomalous values (>10 ppb) extend for about 500 m over Zone 1 mineralization, and about 200 m over Zone 2 (maximum of 52 ppb); but no Au or other pathfinder element anomalism was detected in surficial calcrete over the buried Zone 3 mineralization (Figure 113). For other elements, the response over Zone 1 was more subdued and erratic with As and Cu, and, possibly, Ce, Cr, Fe, K, Mg, Rb, S, Th, and V exhibiting 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 after normalising the chalcophile elements with respect to Fe.

Gold abundances in regolith and soil pit profiles are extremely variable but there appears to be a general association between Au and Ca (Figure 124). The highest Au concentration (~100 ppm) was recorded at 2.0 m in regolith pit GCP122, immediately over Zone 1, although the concomitant Au concentrations for the soil was only 250 ppb. For adjacent profiles from the same pit, located within 5 m of each other, the near surface sample concentrations of 35, 250, 380 and 900 ppb Au were recorded. These indicate the extreme variability close to mineralization where there is probably detrital Au present. The high Ca concentrations (15%) at the base of pit GCP122 is almost entirely due to the presence of gypsum; the Au concentration there is 760 ppb. Interestingly, Au concentrations in the order of 20-30 ppb in regolith pit GCP106 (within fluvial sediment over Zone 3 mineralization) are relatively higher than in the adjacent pits GCP110 and GCP100 (within fluvial sediment but no underlying mineralization) suggesting the possibility of Au enrichment related to mineralization further away (perhaps from upstream subcrop).

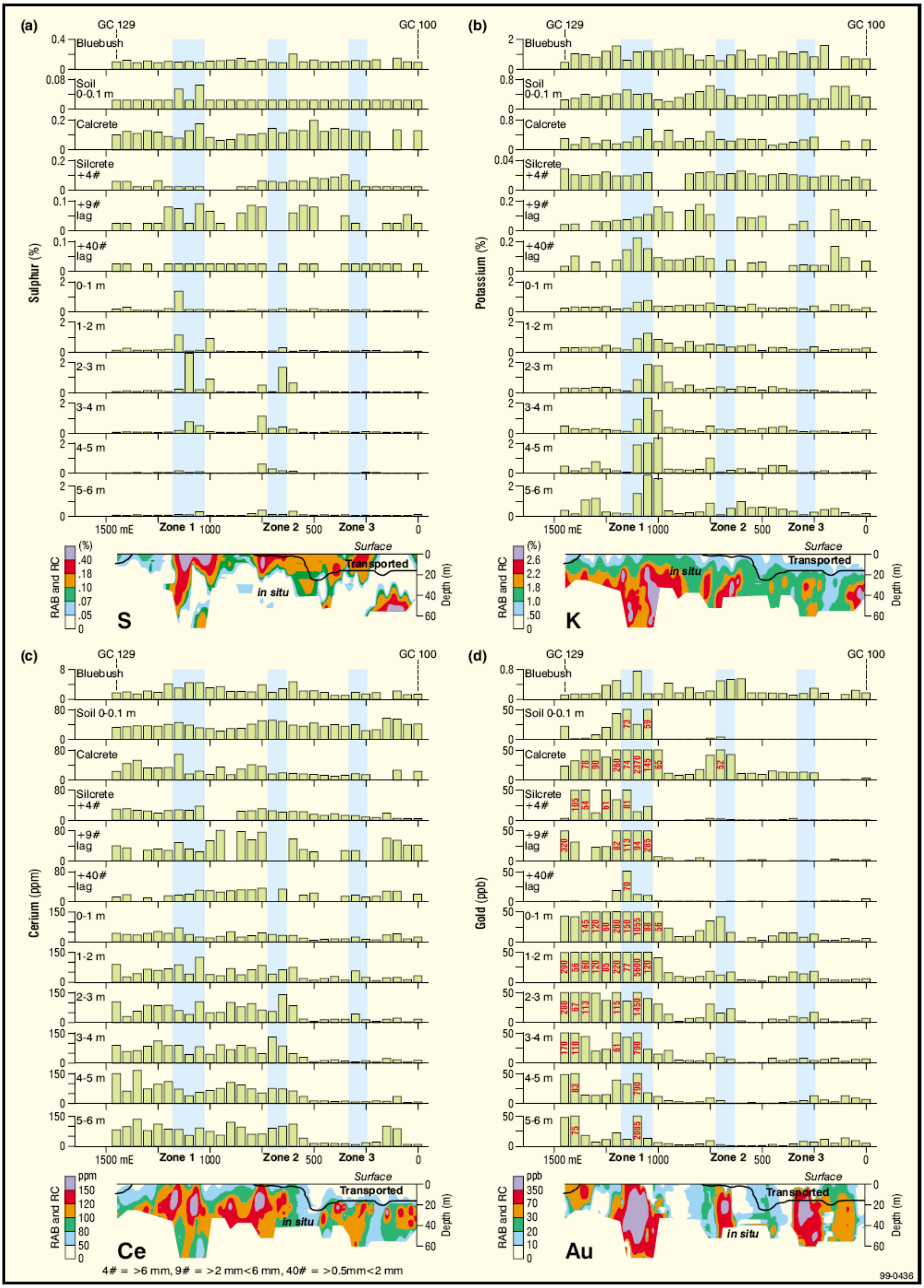



**Figure 123:** Elemental distribution plots for different regolith materials and 'Blue Bush' (*Maireana sedifolia*) as exemplified by: (a) S (%), (b) K (%), (c) Ce (ppm) and (d) Au (ppb). LHS of each profile is at the NW end of the NW-SE oriented Regolith Line on Figure 113 (Lintern and Sheard, 1999a).

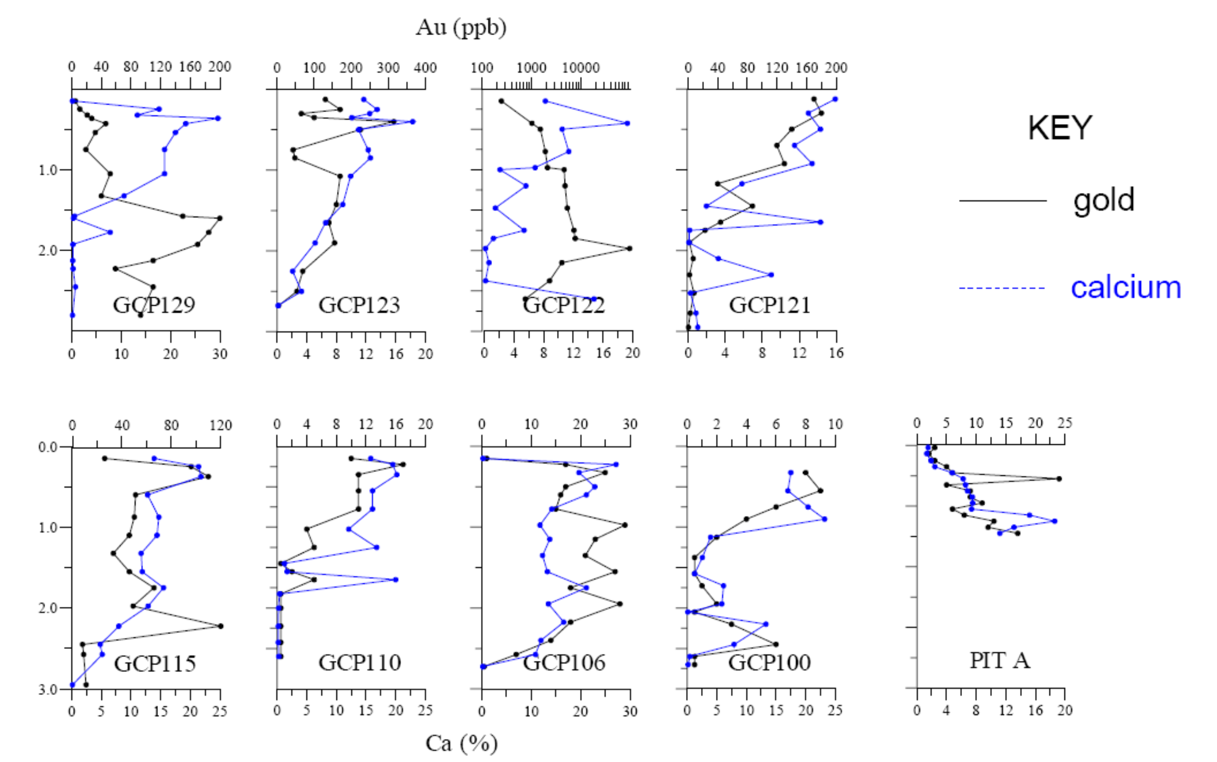



**Figure 124:** Concentration *vs* depth for Au and Ca within the Challenger regolith–soil pits of Lintern and Sheard (1999a, b; Lintern 2004b). All pits except Pit A are located along the Regolith Line indicated on Figure 113 and the pit numbers correspond to drillhole numbers displayed in Figure 123.

Geochemistry in summary: whereas it appears that near outcropping mineralization can be relatively easily detected using a variety of elements and sample media, the outlook for exploring in transported cover in the Challenger area is less certain. Further investigations would be required over Zone 3 mineralization, located under ~20 m of palaeovalley sediments, to test whether locally anomalous concentrations of Au, Bi, W, Mo and Fe normalised elements (*i.e.* Cu and As), detected in the upper regolith drill cuttings and in regolith pits GCP106, are related to underlying mineralization or some other factor.

Calcrete is ubiquitous and is recommended as the best sample medium for detecting Au mineralization in the weathered *in situ* regolith, providing broad high contrast anomalies for several elements, in particular, Au, and to a lesser extent, As and Cu.

The Challenger studies indicate that elements in the regolith, other than Au, associated with mineralization, fall into two broad groups: sulphide-related (Ag, As, Bi, Cd, Cr, Cu, Fe, Mo, S, Se, Zn and possibly W; and alteration-related (Ba, Cs, K, Rb, Tl). The specific use of these elements and others as pathfinders depends on sample medium to be used and the regolith setting. Elements that appeared to be present in anomalous concentrations in regolith materials, specifically over the three mineralized zones are summarised in Table 49.

Challenger 3D modelling and geochemistry studies incorporated surface and subsurface regolith detail extracted from company drill samples which were integrated with company logging and assay, and some new assays (van der Wielen, 1999; Lintern, 2004b). They have differentiated the following units: (i) transported overburden (thin hardpan overlying a silt horizon, commonly 10-20 m thick, with gravels at the base; (ii) residuum – highly to weakly weathered; (iii) rock, unweathered apart from limonite staining of cracks; and (iv) bedrock. Both Zone 1 (main Challenger ore lodes) and Zone 2 mineralization show Au depletion at the completely- to highly-weathered interface (Figure 125). At Zone 1 this depletion is incomplete and residual Au is maintained at the surface, albeit at lower concentrations; whereas at Zone 2 the depletion is complete (Lintern, 2004b). A significant proportion of the Au in Zone 1 is hosted within quartz veins (Poustie *et al.*, 2002, Poustie, 2006) and therefore has been substantially protected from weathering processes and metallic dissolution-remobilisation, this may account for the persistence of Au to surface as the residual chimney effect revealed in Figure 125.

**Table 49:** Anomalous concentrations of elements over the 3 zones of mineralization in different materials and vegetation at Challenger (from Lintern and Sheard, 1999b).

| Regolith line component | Zone 1 (*in situ*) | Zone 2 (*in situ*) | Zone 3 (transported) |
|---|---|---|---|
| **Lower regolith** | **Au Ag As Bi Cd Cr Cs** Cu **K Mo** Rb S **Se Tl W** Zn | **Au Ag As Bi** Cd Cr Cu **K Mo Rb S Tl** Fe Zn | **Au** Ag **As** K Mo Rb W |
| **Upper regolith (0–6 m)** | **Au As** Bi Ba *Cd* **Cr** Cs **Cu Fe K Mo Rb S Se Tl** V Zn | **Au As Cr Cu Fe Mo S Se V** Zn | As* Cu* Mo W (possibly Au) |
| **Silcrete** | **Au** *As Ag* Bi Cd Tl *Th* Fe *W* | Au Cd **Cu** | |
| **Calcrete** | **Au As** Ba Cr Ce **Cu** Fe K Mg Rb S Th V | **Au** Cu Zn | |
| **Ferricrete**** | Au As Cr Cu Mo Se | | |
| **Lag** | **Au As Cu K Na Rb W** | Bi Cu | |
| **Soil** | **Au** Ag As **Cu** Na *Mo* P S Se *W* | Au K Mo Na W | |
| **Vegetation** | **Au As Cr W** | **Au** | |

Cu*, As* - anomalous once normalized with respect to Fe
Ferricrete** - not systematically collected since it does not comprise a major surface component.
**Bold** - strongly anomalous and/or showing more than a single peak maximum.
*Italics* - having a broad anomaly in the western end of the regolith line without being specifically associated with Zone 1 mineralization.
Underlined – element not associated with mineralization but, nevertheless, anomalous.

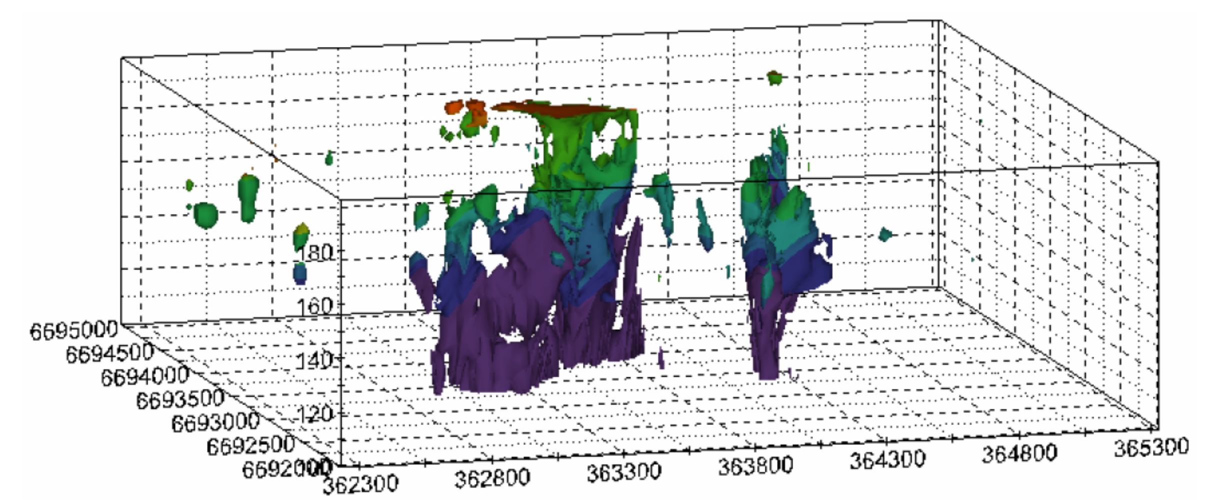



**Figure 125:** 3D modelling of Au distribution at Challenger using a 70 ppb cut off, showing the top of the supergene Au enrichment zone at the completely- to highly-weathered interface.
Key: purple = bedrock, blue = limonite stained bedrock, light blue = weakly weathered (saprock), aqua = moderately weathered (lower saprolite), dark green = highly weathered (upper saprolite), green = completely weathered (pallid saprolite), yellow/orange/red = transported units (after Lintern, 2004b). Grid coordinates are in AGD84 projection.

## Benchmark 21 composite: drillholes 95CHAR312 + GC128

Quick reference items are set out in Table 50; detailed descriptions, figures and data tables follow on below. Sites were about one kilometre N from the original unsealed road between Commonwealth Hill to Mobella Pastoral Station Homesteads (Figures 110-113). Drilling for these holes was vertical, of RAB and RC type, and to the west of the established gold lodes mineralization. A summary of these profiles is provided in Figure 126, Plate 16 and Table 51. Geochemical data are presented in Figures 123-125, 127 plus Table 49.

**Table 50**: Benchmark 21 reference data; composite of drillholes 95CHAR312 & GC128 (Type 2, drill cuttings profiles).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-111. |
| Local-site location map | Figure 113. |
| GPS coordinates, attitude & elevation | • RAB drillhole 95CHAR312: Zone 53, 363335 E, 6694008 N, GDA 94. Vertical. **AHD:** ~200 m (estimated from map data).<br>• RC drillhole GC128: Zone 53, 363371 E, 6694003 N, GDA 94. Vertical. . **AHD:** ~200 m (estimated from map data). |
| Site access, owner | About 1 km N of the track between Commonwealth Hill and Mobella Pastoral Station Homesteads, on E end of Mobella Pastoral Lease. Site Lease holders: Mobella Pastoral Station & Dominion Mining NL. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photos + logs | Yes, Figure 126, Plate 16 and Table 51. |
| Sample types | Drill chips, chiptrays & ~1 kg bags for RC drillhole GC128. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | No. |
| Geochemistry | Yes, Figures 123-125, 127 and Table 49. |
| XRD mineralogy | No. |
| PIMA spectral data | Not for this drillhole but many others have data available (van der Wielen, 1999). Analytical Spectral Detection (ASD, an advanced PIMA) was carried out on all available drilled samples within ~2 km radius of the Challenger Mine in 2003; however, that data remains restricted access (Gray & Lintern, 2004; Lintern, 2004b; Figure 125). |
| Dating | Yes, for Christie Gneiss bedrock, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | Complex & sample media dependent, refer to Table 49. |
| Useful sampling media | Calcrete, soil, vegetation, silcrete. |
| Key reference sources | Lintern and Sheard (1999a, b); Lintern and Sheard (1998); Povey (1999); van der Wielen (1999); Poustie *et al.* (2002); Lintern (2004b); Poustie (2006); Edgecombe (1997). |


| | |
|---|---|
| **0-2 m** | Soil not recovered (**minor transported**). Pink to orange massive-laminar calcrete entrapping lithic grit, + also present are lags + ***in situ*** silicified saprolite + ferruginous saprolite + red to brown ?mottled saprolite. |
| **2-3 m** | silicified upper saprolite, pale greenish grey + grey vein quartz + fracture in-fill calcrete (pale pink). |
| **4-13 m** | upper saprolite, pallid, kaolinite-rich + grey quartz grit + bluish grey vein quartz. |
| **13-19 m** | lower saprolite, pate yellow-brown, clay-rich with scattered brown FeOH cemented segregations + grey quartz grit. |
| **19-23 m** | lower saprolite, grey-brown to greyish olive-brown, clayey with relict harder material + grey quartz grit. |
| **23-<27 m** | lower saprolite to saprock, grey-brown to greyish olive-brown, clays + relict less weathered foliated rock + grey vein quartz. |
| **>27 m** | saprock, greyish olive-brown, clay + relict partially weathered foliated rock + grey vein quartz, more competent than above interval. |
| **EOH** | Regolith logged by M.J. Sheard |

**Figure 126:** Benchmark 21 chiptray photo and regolith log to RAB drillhole 95CHAR312. Drilling depth was <28 m and terminated in saprock near its upper boundary with lower saprolite.

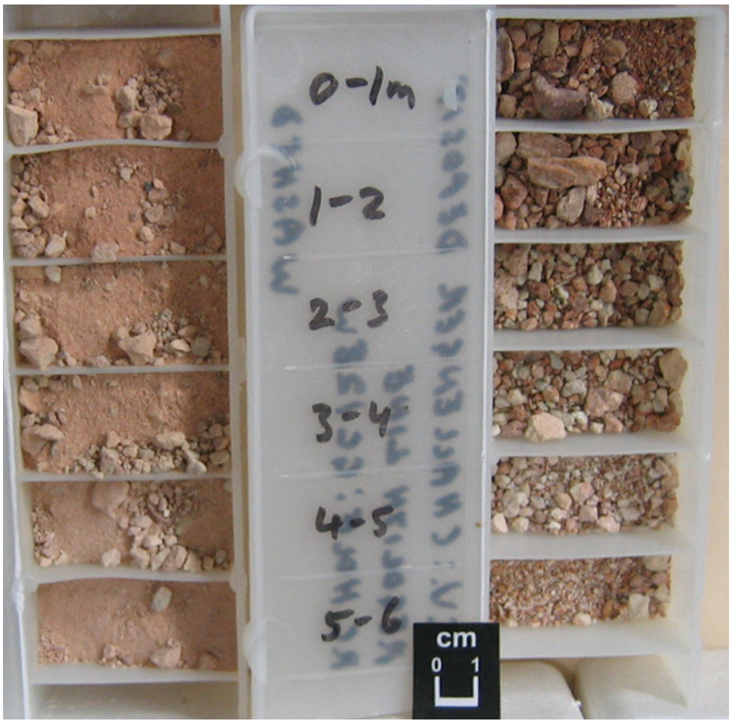



**Plate 16:** Benchmark 21 composite (continued), chiptray samples to RC drillhole GC128 (0-6 m).

LHS displays unprocessed samples.

RHS displays washed samples, where clay and silt have been removed. Granular residue becomes less abundant with depth below 3 m.

Sample interval was one metre.

See Table 51 for log.

## *Background*

Drillholes 95CHAR312 and GC128 have been selected to form this composite benchmark because their adjacent sites are away from the major Au mineralization, these sites have minimal transported cover and the weathered *in situ* regolith is relatively straight forward regarding its interpretation. Comparisons are provided through composite Benchmarks 22 and 23. From mid 2002 all of these sites were rehabilitated or covered by the Challenger Gold Mine developments, Processing Plant and associated facilities. The initial phase of exploration grid drilling at Challenger during 1995 involved RAB methods (mostly without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore those drillholes typically end in saprock or lower saprolite rather than within bedrock (fresh gneiss). Cuttings were sampled either on alternate metre intervals or as 2 m composites (not ideal for regolith investigations). Later drilling phases employed hammer assisted RAB and/or RC, and targeted diamond coring methods to obtain better sample control and bedrock structural representation.

The initial phase of exploration grid drilling at Challenger during 1995 involved RAB methods (mostly without hammer) and therefore drillholes commonly terminated at or near blade refusal. Therefore those drillholes typically end in saprock or lower saprolite rather than within fresh gneiss. Cuttings were sampled either on alternate metre intervals or as 2 m composites (not ideal for regolith investigations). Later drilling phases employed hammer assisted RAB and/or RC, and targeted diamond coring methods to obtain better sample control, geotechnical appraisal of weathered rock competency, and bedrock structural representation.

**Table 51:** Benchmark 21 composite (continued) regolith log to RC drillhole GC128 (Lintern and Sheard, 1999b).

Drillhole: GC128, Reverse Circulation, vertical.
Location: Zone 53, 363371 E, 6694003 N, GDA 94
Site: W. side of *Mt Challenger* on E. side of low reddish dune with quite a lot of gibber deriving from *Mt Challenger.*
Vegetation: Acacia-dominated open woodland.
Soil: sand, moderate reddish brown (wet) (10R 4/5).
Calcrete: nodular aggregates to platy to massive on silcrete, at ~25-50 cm.
Logged by: M.J. Sheard.

| Sample # | Depth | Description |
|---|---|---|
| GC128A | 0-1 m | UNWASHED: light red - brown (dry) crushed calcrete (cream – white, dry) and silcrete fragments, sandy and gravelly, strong carbonate acid reaction; texture – sand and rock fragments, brownish orange (wet, 5YR 5/7).<br>WASHED: orange stained frosted quartz sand (fine-medium) ~10%, calcrete ~50% – pale and red-brown to reddish and cream, silcrete 30% – greys, browns and reds, some potch opal and porcelanitic forms – all with quartz fragments within – some of these contain black grain inclusions, quartz ~10% - bluish-grey-milky (<1 to 3 mm). Saprolitic. |
| GC128B | 1-2 m | UNWASHED: orange brown (d) as above; texture – rock fragments and fines, brownish orange (w) (5YR 5/7).<br>WASHED: as above. |
| GC128C | 2-3 m | UNWASHED: pale orange (d) as per 1-2 m; texture – rock fragments and fines, light brown (w) (7.5YR 5/6).<br>WASHED: as above, with more silicified kaolinitic relict gneiss, grey and pale brown hyaline silica chips common, Mn oxide as dendrites, coatings and inclusions. |
| GC128D | 3-4 m | UNWASHED: as per 2-3m, moderate carbonate acid response; texture – rock fragments and fines, light brown (w) (7.5YR 6/5).<br>WASHED: as per 2-3 m. |
| GC128E | 4-5 m | UNWASHED: pale yellow brown (d), clayey sand, silicified claystone fragments, moderate carbonate acid reaction; texture – clayey grit, light brown (w) (7.5YR 5.5/5).<br>WASHED: mostly pale coloured and cream silicified kaolinitic relict gneiss, white to cream hyaline silica coatings and chips, quartz as above. Saprolite. |
| GC128F | 5-6 m | UNWASHED: pale pink brown (d) sandy loam with claystone fragments as per 4-5 m, moderate to weak acid response; texture – clayey grit, light brown (w) (7.5YR 6/4).<br>WASHED: much less grainy matter, silicified saprolite as above with some pink and yellowish Fe-staining and coatings. Saprolite. |

## *In situ Regolith*

Bedrock (fresh Christie Gneiss, <5% weathered) was not penetrated in drillhole 95CHAR312 and the Weathering Front is presumed to be below ~35 m (Figure 126) based on evidence from adjacent drillholes. Examples of Christie Gneiss bedrock are provided earlier (Plate 9, Figure 118).

Saprock (>5-<20% weathered) was only just penetrated, near its upper boundary with lower saprolite. Here all biotite is altering to chlorite; pyroxene and amphiboles are partially altering to clay ± goethite ± chlorite; while feldspars and cordierite are partly altering to clay and sericite. Saprock at this site is moderately competent and may display considerable yellowing or brown staining by FeOH distributed along fractures and intergrain boundaries. Clays are present within altering minerals and/or as fracture infill.

Lower saprolite (>20% weathered) is characterised by a reduced competency + yellow-brown colours overprinting greys and olive-greys; clay is commonly more abundant; FeOH segregations and/or cementation is present; abundant quartz grit and vein quartz are also evident.

Upper saprolite (>50% weathered) is typically strongly leached, exhibits either pallid or subdued hues and is generally chalky (kaolinite-rich + quartz grit; low competency material). This sub-zone may also exhibit FeOx/FeOH mottling or staining in a variety of colours (red-brown-yellow) and the relict quartz (grit + veins) is more visually obvious (Lintern and Sheard, 1999b).

Regolith drillhole GC128 (drilled with RC method) provides more detailed information on the 0-6 m interval within upper saprolite. Sampling involved 1 m composites that were logged in both the raw and washed states (Plate 16, Table 51). This 6 m interval is complex due to an advanced state of *in situ* weathering and the intensity of overprinting by siliceous, calcareous and ferruginous cements to form a significantly indurated duricrust (~3-5 m thick: silcrete + calcrete). Some profile collapse, repeated erosive episodes and the incorporation of surface lags and/or finer sediments into the upper 1-3 m profile, have combined to further complicate near surface regolith. Any original ferruginous pedolith (± Fe-pisolith horizon) was stripped prior to silcrete duricrust development. Some evidence for it once having been present was observed at nearby and more distal sites (transported Fe-pisoliths, Fe-pisoliths incorporated into silcreted sediments; Craig and Wilford, 1997b; Mason and Mason, 1998; Lintern and Sheard, 1999b; van der Wielen, 1999; Wilford *et al*., 2001). Exactly how much of the upper saprolite has been eroded away or reduced by fines removal is not clear but it may include ~3-5 m of section. Calcrete forms a massive to laminar coating (~20-150 mm thick, very indurated) on the silcrete duricrust at the soil-rock or sand-rock interface, but it also invades the silcrete along fractures and partings where it has gradually jacked apart the silcrete to form a jig-saw-fit assemblage.

## Transported Regolith

Transported regolith was relatively thin (~1 m), consisting of orange aeolian dune sand (30-<50 cm; edge of a low dune), mostly loose and free running, quartz dominant, containing nodular to earthy calcrete in mid profile. Underlying the sand was a thin wedge (<50 cm thick) of fluvial sediment, thickening to the NW towards drillhole GC129 and regolith pit GCP129 (refer to detail in Figure 6 of Lintern and Sheard, 1999b). Calcrete, silcrete (including hyaline and potch opal) and FeOH have overprinted this sediment wedge and partially disguised the underlying unconformity. Some colluvium is included within the silcrete horizon (pedolith including: slope talus, ± debris flows, ± short transport distance sediment, ± pedogenic brecciation).

## Geochemistry

Detailed geochemical analysis of the 0-6 m samples using a 50 element assay package is available in Lintern and Sheard (1999b). An extract of that work is provided below. Down profile elemental abundance plots are set out in Figure 127. Gold is present within the <1 m of transported sediment at 40-60 ppb but Au and Ca aren't particularly well associated here nor at depth, suggesting that Au is not related to calcrete presence or absence. Neither is Au particularly associated with As, Bi, Fe or Mn, indicating that Au may be dominantly in a micro-nuggetty form (peak abundance 110 ppb Au at ~3.5-4 m) and either within quartz veins (weathering-alteration protection) or shedding there from. It is worth noting though, that this site was well away from the recognised main Au mineralization. High S within the upper 3 m is most likely entirely due to the presence of gypsum. A more general account of the broader geochemistry is provided earlier in the Challenger Gold Deposit summary under Geochemistry and includes Figures 123-125 plus Table 49.

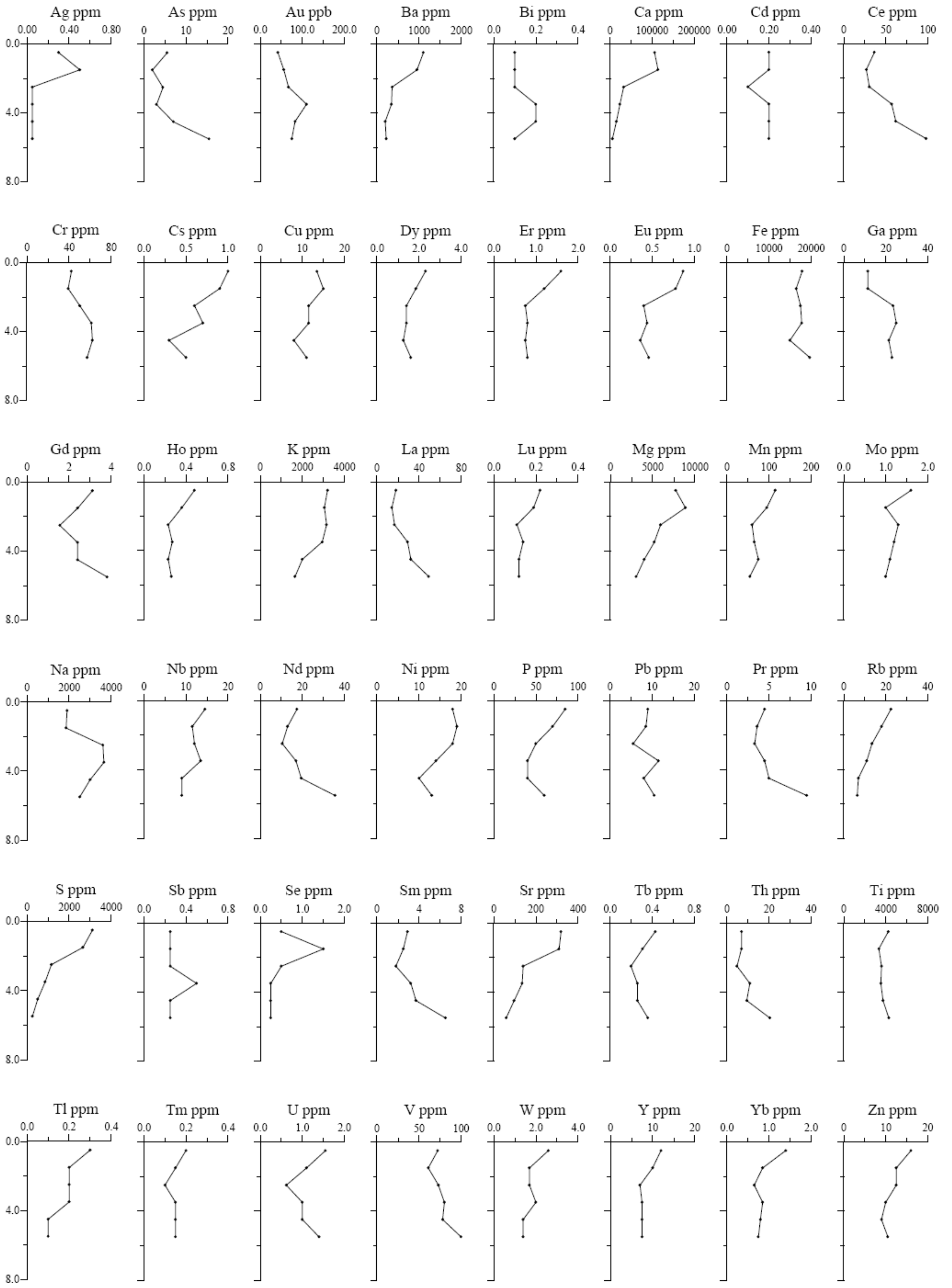


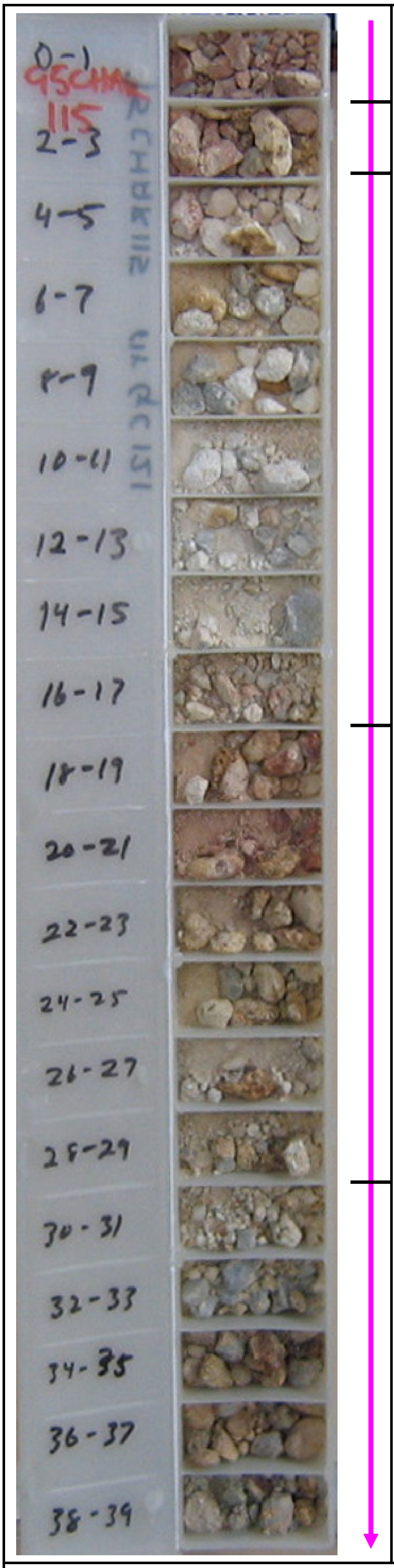

**Figure 127:** Elemental abundances *vs* depth (m) for Benchmark 21, RC drillhole GC128, Challenger Gold Deposit (Lintern and Sheard, 1999b).

## Benchmark 22 (composite): drillholes 95CHAR115 + GC121 + regolith pit GCP121

Quick reference items are set out in Table 52; detailed descriptions, figures and data tables follow on below. Sites were about one kilometre N from the original unsealed road between Commonwealth Hill to Mobella Pastoral Station Homesteads Figures 110-113. Drilling for these holes was vertical, of RAB and RC type, and immediately over the established gold lodes mineralization. A summary of these profiles is provided in Figure 128, Plates 17-23 and Tables 53, 54. Geochemical data are presented in Figures 123-125, 130, 131 plus Table 49.

**Table 52:** Benchmark 22 reference data; composite of drillholes 95CHAR115 & GC 121 (Type 2, drill cuttings profiles) + regolith pit GCP121 (Type 3, excavation).

| **Items** | **Figures, Data, Sources** |
|---|---|
| Regional location map | Figures 110-112. |
| Local-site location map | Figure 113. |
| GPS coordinates, attitude & elevation. | • RAB drillhole 95CHAR115: Zone 53, 363622 E, 6693740 N, GDA 94. Vertical. **AHD:** ~208 m (estimated from map data).<br>• RC drillhole GC121: Zone 53, 363619 E, 6693752 N, GDA 94. Vertical. **AHD:** ~208 m (estimated from map data).<br>• Regolith pit GCP121: Zone 53, 363619 E, 6693752 N, GDA 94 |
| Site access, owner | About 1 km N of the track between Commonwealth Hill and Mobella Pastoral Station Homesteads, on E end of Mobella Pastoral Lease. Site Lease holders: Mobella Pastoral Station & Dominion Mining NL. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill / Pit sample photos + logs | Yes, Figures 128, 129, Plates 17-23 and Tables 53, 54. |
| Sample types | Drill chips, chiptrays & ~1 kg bags for RC drillhole GC121, ~1 kg bags and numerous 0.5->5 kg blocks for Regolith Pit GCP121. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Yes, for regolith pit samples, Plates 22, 23.<br>See also Challenger Regolith section above, Figure 118, and Mason and Mason (1998). |
| Geochemistry | Yes, Figures 123-125, 130, 131 and Table 49. |
| XRD mineralogy | No. |
| PIMA spectral data | Not for this drillhole but many others have data available (van der Wielen, 1999). Analytical Spectral Detection (ASD, an advanced PIMA) was carried out on all available drilled samples within ~3 km radius of the Challenger Mine in 2003; however, that data remains restricted access (Gray & Lintern, 2004; Lintern, 2004b; Figure 125). |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | Complex & sample media dependent, refer to Table 49. |
| Useful sampling media | Calcrete, soil, vegetation, silcrete. |
| Key reference sources | Lintern and Sheard (1999a, b); Lintern and Sheard (1998); Povey (1999); van der Wielen (1999); Poustie *et al.* (2002); Lintern (2004b); Poustie (2006); Edgecombe (1997). |




| | |
|---|---|
| **0-1 m** | *In situ* cream to pink-orange massive-laminar calcrete entrapping lithic grit, + *in situ* grey vein quartz + silicified saprolite (pallid). |
| **1-3 m** | silicified upper saprolite, pink + minor calcrete + pallid saprolite. |
| **3-17 m** | upper saprolite, pallid, kaolinite-rich + grey quartz grit + grey vein quartz + yellow-brown FeOH mottling and staining (4-5 m). |
| **17-30 m** | lower saprolite, pate yellow-brown to yellow-brown, clay-rich + dark yellow-brown FeOH cemented segregations + grey quartz grit + some bluish grey vein quartz. |
| **30-39 m** | lower saprolite to saprock, pale yellow-brown to reddish grey to grey, clayey + abundant grey and bluish grey vein quartz. |
| **39-48 m** | saprock, greyish, partially weathered gneiss + abundant grey vein quartz, more competent than above interval, weathering becomes less with depth. |
| **EOH** | |

Regolith logged by M.J. Sheard

**Figure 128:** Benchmark 22 chiptray photo and regolith log to RAB drillhole 95CHAR115. Drilling depth was to 48 m but chiptray samples stop at 39 m (in saprock).

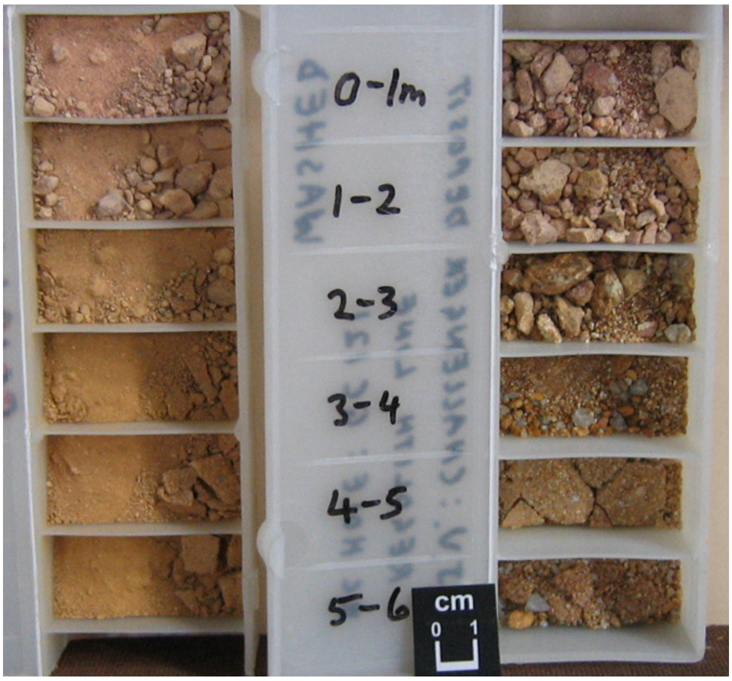



**Plate 17:** Benchmark 22 composite (continued), chiptray samples to RC drillhole GC121 (0-6 m).

LHS displays unprocessed samples.

LHS displays washed samples, where clay and silt have been removed. Granular residue becomes less abundant with depth below 3 m.

Sample interval was one metre.

See Table 53 for log.

## ***Background***

Drillholes 95CHAR115 and GC121 and regolith Pit GCP121 have been selected to form this composite benchmark because their adjacent sites overlie the major Au mineralization. These sites have very little transported cover and the weathered *in situ* regolith is relatively straight forward regarding its interpretation. Comparisons are provided through composite Benchmarks 21 and 23. From mid 2002 all of these sites were rehabilitated or covered by the Challenger Gold Mine developments, Processing Plant and associated facilities. The initial phase of exploration grid drilling at Challenger during 1995 involved RAB methods (mostly without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore those drillholes typically end in saprock or lower saprolite rather than within bedrock (fresh gneiss). Cuttings were sampled either on alternate metre intervals or as 2 m composites (not ideal for regolith investigations). Later drilling phases employed hammer assisted RAB and/or RC, and targeted diamond coring methods to obtain better sample control and bedrock structural representation.

Excavation of eight strategically sited pits (12 x 6 x 3 m) cut using explosives and a bulldozer, into the indurated upper regolith provided ready access for detailed sampling (assay, petrology, XRD, PIMA, etc) and offered a valuable 3D exposure of regolith development and irregularities.

**Table 53:** Benchmark 22 composite (continued) regolith log to RC drillhole GC121 (Lintern and Sheard, 1999b).

Drillhole: GC121, Reverse Circulation, vertical.
Location: Zone 53, 363619 E, 6693752 N, GDA 94
Site: Lower eastern flank of *Mt Challenger*, flat sandy site with scattered small gibber of exotics, silcrete and quartz. Gravel – pebbles, reddish sand.
Vegetation: shrubland.
Soil: sandy loam, light brown (wet) (5YR 6/6).
Calcrete: massive to laminar, at ~15-20 cm.
Logged by: M.J. Sheard.

| Sample # | Depth | Description |
|---|---|---|
| GC121A | 0-1 m | UNWASHED: dark pink (dry) sand, calcrete plate fragments, strong carbonate acid reaction; texture – sand and rock fragments, strong brown (wet) (7.5YR 4/6).<br>WASHED: creamy grey and brown platy calcrete fragments enclosing grey-milky-bluish angular quartz fragments with chlorite inclusions, reddish and grey silcrete enclosing white quartz grains, loose quartz grains – angular to subrounded – similar to the cemented grains, rare rounded black Fe oxide granules. Saprolitic. |
| GC121B | 1-2 m | UNWASHED: yellow (d) sand and rock fragments, many calcrete fragments, strong carbonate acid reaction; texture – rock fragments and fines, light brown (w) (7.5YR 5/6).<br>WASHED: as above, with no Fe granules, more quartz fragments – clear and grey. |
| GC121C | 2-3 m | UNWASHED: strong yellow (d) rock chips and fines, many grey shale and quartzite fragments with ferruginous nodules, no carbonate acid reaction; texture - rock fragments and fines, strong yellowish brown (w) (10YR 5/8).<br>WASHED: yellow-brown to brown calcrete fragments (5%), yellowish brown - yellowish grey silcrete fragments (~60%), conspicuous angular quartz fragments and grains (1-5 mm) - grey-clear-milky and mostly bluish – some to 10 mm, some quartz with black equant grain inclusions <0.1 mm (?magnetite or ilmenite). Saprolitic. |
| GC121D | 3-4 m | UNWASHED: pale yellow (d) clay with some fragments of yellow and cream shale siltstone, weak carbonate acid reaction; texture - gritty light clay, light yellowish brown (w) (10YR 6/6).<br>WASHED: small quantity of grainy matter, small (<2 mm) fragments of silcrete as per 2-3 m, abundant quartz – angular fragments – cream-milky-grey-bluish, bluish quartz with black equant grain inclusions <0.1 mm (?magnetite or ilmenite), kaolinite grains and fragments. Saprolitic. |
| GC121E | 4-5 m | UNWASHED: yellow (d) clay, small shale and quartz fragments, no carbonate acid reaction; texture – gritty light clay, moderate orange yellow (w) (7.5YR 6.5/8).<br>WASHED: quartz sand (fine-coarse) as above, mostly sub-mm grit, bluish quartz fragments 1-3 mm. Saprolitic. |
| GC121F | 5-6 m | UNWASHED: yellow (d) clay, yellow, grey and white shale fragments and thin quartz vein fragments, no carbonate acid reaction; texture – light clay, dark orange yellow (w) (10YR 6/8).<br>WASHED: as per 4-5 m, with higher % of coarse bluish grit, ~30% of washed sample is yellowish Fe-stained psammite and claystone. Saprolitic. |

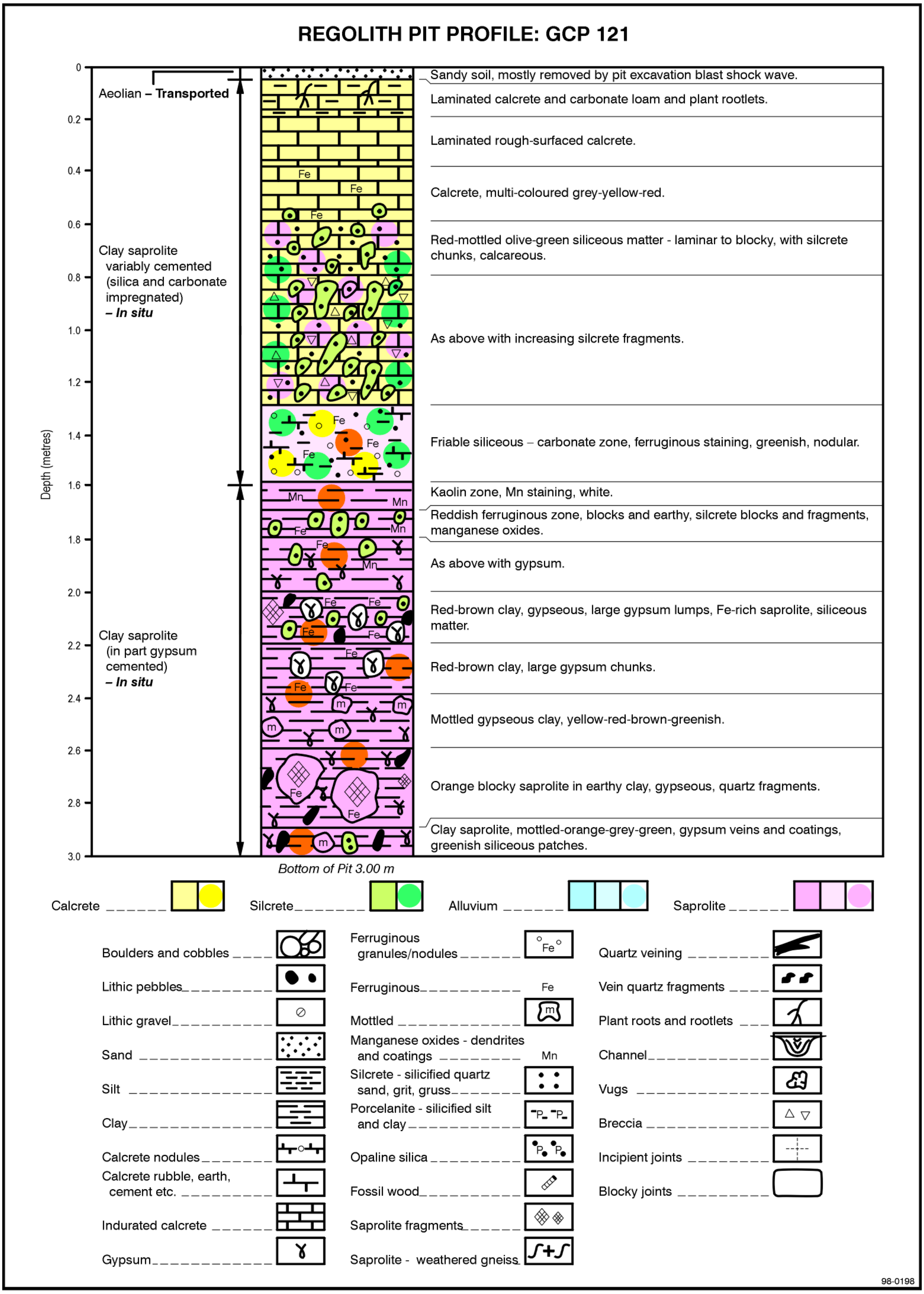



**Figure 129:** Benchmark 22 continued, composite profile to Challenger regolith pit GCP121 (Lintern and Sheard, 1999b). Data from laboratory, microscope and in-field logging are included.

**Table 54:** Benchmark 22 composite (continued) regolith profile in-field log, sampling points and sample numbers to excavation GCP121 (pit size 12 x 6 x 3 m).

| | |
|---|---|
| **Pit: GCP121** | Profile of SE face, centre (Excavated by blasting and bulldozing). |
| Location | Zone 53, 363619 E, 6693752 N, GDA 94.<br>Nearest Regolith RC Hole: GC121. |
| Site | Eastern side of a vegetation denuded area E of *Mt Challenger;* flat sandy (reddish) with scattered small gibber (gravel to pebbles) of exotic lithic, silcrete and quartz clasts. Sandy soil removed by pit excavation blasting and exploration vehicular traffic. |
| Logged by: | M.J. Sheard (PIRSA) & M.J. Lintern (CSIRO-E&M). |
| Photographic images (PIRSA). | (45481 to 45484, 45599, 45865) Plates 18-23. |

| Sample # | Depth (cm) | Description |
|---|---|---|
| GCP121-1 | 5-20 | Laminar calcrete with fine plant rootlets and calcareous loam. Sample: R214071. |
| GCP121-2 | 20-40 | Laminar calcrete – rough surfaced. Sample: R214072. |
| GCP121-3 | 40-60 | Calcrete – greys, zone is multi-coloured in pastel shades of red and yellow. Sample: R214073. |
| GCP121-4 | 60-80 | Red-mottled olive-green laminar to blocky material, calcareous, with silcrete chunks. Sample: R214074. |
| GCP121-5 | 80-105 | As per 60-80 cm. Sample: R214075. |
| GCP121-6 | 105-130 | As per 60-80 cm. Sample: R214076. |
| GCP121-7 | 130-160 | Friable siliceous and calcareous zone with greenish colour and Fe-staining and nodules of unknown mineral within. Sample: R214077. |
| GCP121-8 | 160-170 | White zone – marker band right around pit, possibly kaolinite, some Mn oxide staining. Sample: R214078. |
| GCP121-9 | 170-180 | Reddish FeOx zone below white zone, blocks of earthy material, olive silcrete and blocky to platy mineral with Mn oxide coatings. Sample: R214079. |
| GCP121-10 | 180-200 | As above with gypsum. Sample: R214080. |
| GCP121-11 | 200-220 | Gypsum pieces up to 10 cm in a red-brown clay, Fe-rich saprolite and nodules, lumps of siliceous matter. Sample: R214081. |
| GCP121-12 | 220-240 | Gypseous chunks in a red-brown clay. Sample: R214082. |
| GCP121-13 | 240-260 | Mottled gypseous yellow clay, mottling - red-brown and greenish. Sample: R214083. |
| GCP121-14 | 260-290 | Clay saprolite, gypseous and intensely mottled – orange and grey-green, gypsum fine to medium well crystallised coatings and veins, siliceous patches – greenish. Sample: R214084. |
| GCP121-15 | 290-300 | Orange saprolite with greenish grey blotches, gypseous, quartz, clay, Ferruginous earthy material surrounding blocks, small crystals of dark red vitreous mineral (?rutile). Sample: R214085. |

**Plate 18:** Pit GCP121, wide angle view, SE face with logged and sampled profile marked by measuring tape (Lintern and Sheard, 1999b). *(photo 45481)*.

**Plate 19:** Pit GCP121, SE face, top metre (red mark at 1 m) with central logged and sampled profile marked by measuring tape (Lintern and Sheard, 1999b). *(photo 45482)*.

**Plate 20:** Pit GCP121, SE face, ~1-2 m (red marks at 1 and 2 m) with central logged and sampled profile marked by measuring tape (Lintern and Sheard, 1999b). *(photo 45483)*.

**Plate 21:** Pit GCP121, SE face, ~2.5-3 m (red marks at 2 m) with central logged and sampled profile marked by measuring tape (Lintern and Sheard, 1999b). *(photo 45484)*.

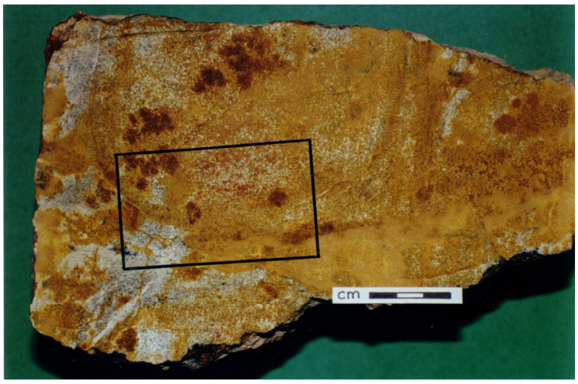



**Plate 22:** Pit GCP121, saprolite from 1.7-1.8 m, fine pallid kaolinite with ovoid and diffuse yellow-brown to dark brown ferruginous patches. Black rectangle marks location of thin-section in Plate 23 opposite. Sample R214079. *(photo 45599)*.

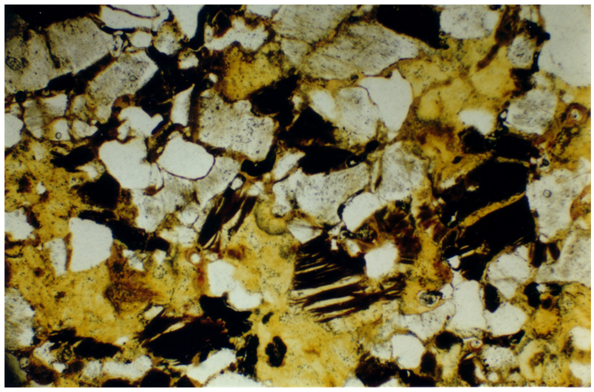


**Plate 23:** Pit GCP121, sample R214079, in transmitted plane polarised light. Saprolite with relict metamorphic quartz (colourless), K-feldspar (colourless, slightly turbid & cleaved), + alteration clay (pale yellow) and goethite (dark brown after altered biotite flakes. View 1.5 x 2.5 mm (Mason and Mason, 1998). *(photo 45865)*.

## *In situ Regolith*

Bedrock (fresh Christie Gneiss, <5% weathered) was not penetrated in drillhole 95CHAR115 and the Weathering Front is presumed to be below ~50 m based on evidence from adjacent drillholes. Examples of Christie Gneiss bedrock are provided earlier (Plate 9, Figure 118) from a cored geotechnical drillhole located reasonably close to this site.

Saprock (>5-<20% weathered) was penetrated but its lower boundary was not encountered. All biotite is altering to chlorite; pyroxene and amphiboles are partially altering to clay ± goethite ± chlorite ; while feldspars and cordierite are partially altering to clay and sericite. Saprock at this site is moderately competent and may display considerable yellowing or brown staining by FeOH distributed along fractures and intergrain boundaries. Clays are present within altering minerals and/or as fracture infill (Figure 128).

Lower saprolite (>20% weathered) is characterised by a reduced competency + yellow-brown colours; clay is commonly more abundant; dark yellow-brown FeOH segregations and/or cementation is present; quartz grit and some vein quartz also occur (Figure 128).

Upper saprolite (>50% weathered) is typically strongly leached, exhibits either pallid or subdued hues and is generally chalky (kaolinite-rich + quartz grit; low competency material). This sub-zone may also exhibit FeOx/FeOH mottling or staining in a variety of colours (red-brown-yellow) and the relict quartz (grit + veins) is more visually obvious (Lintern and Sheard, 1999b) (Figures 128, 129; Plate 17, Tables 53, 54).

Regolith drillhole GC121 (drilled with RC method) and pit excavation GCP121 provide far more detailed information on the 0-6 m and 0-3 m intervals (respectively) within upper saprolite. Drill sampling involved 1 m composites that were logged in both the raw and washed states (Plate 17, Table 53); while the pit sampling involved bulks and blocks (at 10-30 cm intervals) removed from one or more selected vertical profiles (Plates 18-23, Figure 129, Table 54). The 6 m drilled interval is complex due to an advanced state of *in situ* weathering and the intensity of overprinting by siliceous, calcareous and ferruginous cements that form a significantly indurated duricrust (~2-3 m thick: calcrete + silcrete overlying gypsum). Excavation GCP121 provided further detail in 3D that drill cuttings cannot and allowed the collection of bulk samples for petrography and more detailed assay. Relict metamorphic fabric is retained in upper saprolite even to within <2 m of the surface (Plates 22, 23, Figure 119). Some profile collapse, repeated erosive episodes and the incorporation of surface lags and/or finer sediments into the upper 1-3 m profile, have combined to further complicate near surface regolith. Any original *in situ* developed ferruginous pedolith (± Fe-pisolith horizon) was stripped prior to silcrete duricrust development. Some evidence for it once having been present was observed as ferruginous granules within the calcrete capping (lags) and at nearby to more distal sites (transported Fe-pisoliths, Fe-pisoliths incorporated into silcreted sediments; Craig and Wilford, 1997b; Mason and Mason, 1998; Lintern and Sheard, 1999b; van der Wielen, 1999; Wilford *et al*., 2001). Exactly how much of the upper saprolite has been eroded away or reduced by fines removal is not clear but it may include ~3->5 m of section. Calcrete forms a massive to laminar coating (~20-150 mm thick, very indurated) on the silcrete duricrust at the soil-rock interface, but it also invades the silcrete along fractures and partings where it has gradually jacked apart the silcrete to form a jig-saw-fit assemblage.

## *Transported Regolith*

Transported regolith was very thin (<0.1 m), consisting of an eroding-deflating soil that included quartz dominant aeolian dune sand as a major component. Over grazing by animals plus the vehicle traffic associated with exploration work around this site, where thin soil overlay hard rock, have exacerbated soil erosion locally. The remnant soil and the underlying massive calcrete both contained lags of small ferruginous granules, larger silcrete clasts (ferruginous and grey billy types) and well rounded exotic clasts (Lintern and Sheard, 1999b). Some colluvium is included within the silcrete horizon (pedolith including: slope talus, ± debris flows, ± short transport distance sediment, ± pedogenic brecciation).

## *Geochemistry*

Detailed geochemical analysis of the 0-6 m samples using a 50 element assay package is available in Lintern and Sheard (1999b). An extract of that work is provided below. Down profile elemental abundance plots are set out in Figures 130, 131. Gold is present throughout the upper ~3 m regolith (180-<5 ppb), where Au and Ca abundances are synchronously varying, suggesting that Au is associated with calcrete (see Figure 124 and compare results across all pits). However, Au only appears to be loosely associated with As, Bi, Fe and Mn, indicating that some Au may be in a micro-nuggetty form while the remainder is in a more soluble form. High S within the upper 3 m is most likely entirely due to the presence of gypsum, which here and in adjacent pits seems more likely to have derived from the *in situ* weathering of sulphides (Lintern *et al*., 2006). A general account of the broader geochemistry is provided earlier in the Challenger Gold Deposit summary under Geochemistry and includes Figures 123-124 plus Table 49.

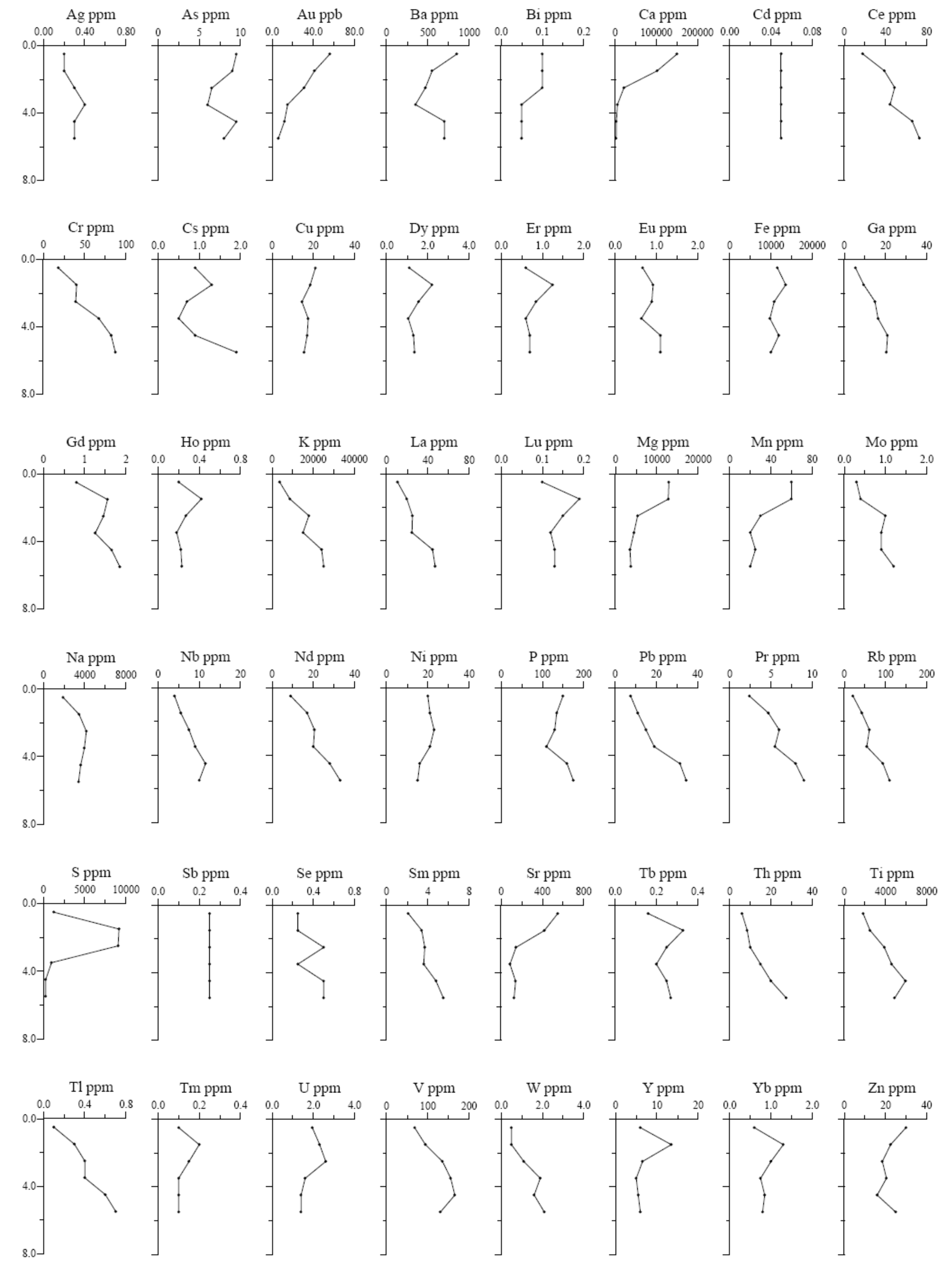



**Figure 130:** Elemental abundances *vs* depth (m) for Benchmark 22, RC drillhole GC121, Challenger Gold Deposit (Lintern and Sheard, 1999b).

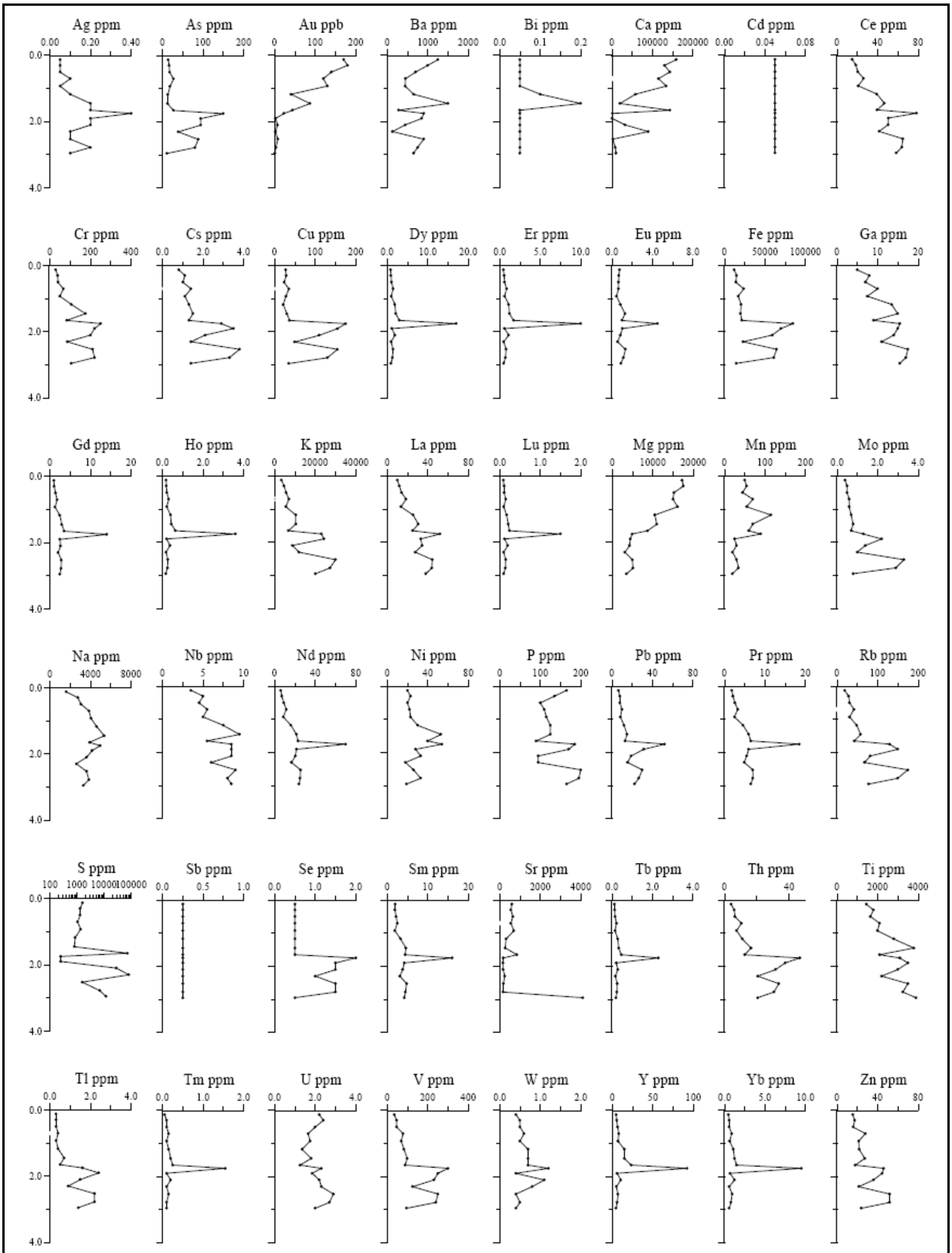



**Figure 131:** Elemental distributions *vs* depth (m) for Benchmark 22, Regolith Pit GCP121, Challenger Gold Deposit (Lintern and Sheard, 1999b). There is a strong correlation between Fe and numerous other elements (e.g. Bi, Cr, Cs, Cu, Mo, Nd, Pb, Sm, Th, Tl, V, Y, Zn & some REE) at ~1.7 m. An iron-rich halo surrounds weathered mineralization in the upper saprolite and is intersected at this depth, it is likely that this Fe (goethite ± hematite) may have scavenged other metallic ions (*c.f.* Figure 121. This effect is not seen at Benchmarks 21 or 23.

## Benchmark 23 (composite): drillholes 95CHAR558 + GC100 + regolith pit GCP100

Quick reference items are set out in Table 55; detailed descriptions, figures and data tables follow on below. Sites were about one kilometre N from the original unsealed road between Commonwealth Hill to Mobella Pastoral Station Homesteads (Figures 110-113). Drilling for these holes was vertical, of RAB and RC type, they are to the E of the established gold lodes mineralization and intersected ~15 m of transported cover. A summary of these profiles is provided in Tables 56, 57 and chiptray photographs are in Figure 132 and Plates 24-33. Geochemical data are presented in Figures 123-125, 134, 135.

**Table 55**: Benchmark 23 reference data; composite of drillholes 95CHAR558 & GC100 (Type 2, drill cuttings profiles) + regolith pit GCP100 (Type 3, excavation).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-112. |
| Local-site location map | Figure 113. |
| GPS coordinates, attitude & elevation. | • RAB drillhole 95CHAR558: Zone 53, 364342 E, 6693024 N, GDA 94. Vertical. AHD: ~200 m (estimated from map data).<br>• RC drillhole GC100: Zone 53, 364315 E, 6693033 N, GDA 94. Vertical. AHD: ~200 m (estimated from map data).<br>• Regolith pit GCP100: Zone 53, 364315 E, 6693033 N, GDA 94 |
| Site access, owner | About 1 km N of the track between Commonwealth Hill and Mobella Pastoral Station Homesteads, on E end of Mobella Pastoral Lease. Site Lease holders: Mobella Pastoral Station & Dominion Mining NL. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photos + logs | Yes, Figures 132, 133, Plates 24-33 and Tables 56, 57. |
| Sample types | Drill chips, chiptrays & ~1 kg bags for RC drillhole GC100, ~1 kg bags and numerous 0.5->5 kg blocks for Regolith Pit GCP100. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Yes, for regolith pit samples, Plates 30-33, Table 57.<br>See also Challenger Regolith section above, Figure 118, and Mason and Mason (1998). |
| Geochemistry | Yes, Figures 134, 135 and Table 49. |
| XRD mineralogy | No. |
| PIMA spectral data | Not for this drillhole but many others have data available (van der Wielen, 1999). Analytical Spectral Detection (ASD, an advanced PIMA) was carried out on all available drilled samples within ~3 km radius of the Challenger Mine in 2003; however, that data remains restricted access (Gray & Lintern, 2004; Lintern, 2004b; Figure 125). |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). Regolith date: petrified wood in palaeochannel fluvial sediment, latest Eocene to latest Miocene (Rowett, 1997). |
| Target elements | Au. |
| Potential Pathfinder Elements | Complex & sample media dependent, refer to Table 49. |
| Useful sampling media | Calcrete, soil, vegetation, silcrete. |
| Key reference sources | Lintern and Sheard (1999a, b); Lintern and Sheard (1998); Povey (1999); van der Wielen (1999); Poustie *et al*. (2002); Lintern (2004b); Poustie (2006); Edgecombe (1997). |

| Depth | Description |
|---|---|
| **0-2 m** | **Transported:** No soil recovery, silicified fluvial sands (grey billy silcrete, cream, & porous red FeOx-stained form) sand is poorly sorted quartz, angular-rounded, fine- to medium-grained. No calcrete recovered / noted. |
| **2-6 m** | silicified fluvial sand (grey billy silcrete, grey & cream) sand is poorly sorted quartz, angular-rounded, fine- to medium-grained. Porcelanite (cream, grey & yellowish) + yellow potch opal also present. |
| **6-8 m** | Pink uniform clay to claystone, fluvial deposit. |
| **8-10 m** | Pallid uniform clay to claystone, fluvial deposit. |
| **10-15 m** | Fluvial sand, fine- to medium-grained quartz + fines (clay + silt) poorly sorted, may be bedded. |
| **15-16 m** | Fluvial sand and gravel, fine- to medium-grained quartz sand + fine-grained gravel (includes <3% lithics as gneiss & multi-grained metamorphic quartz aggregates) poorly sorted + ~40% fines (clay, silt + fine quartz grit). Channel basal sand-gravel. **Unconformity** in interval. |
| **16-20 m** | ***In situ*:** upper saprolite, pallid to pinkish, kaolinite (>60%) + grey quartz grit + white & grey & bluish grey vein quartz +lithics (felsic gneiss & pink K-feldspar as quartz vein inclusions). |
| **20-31 m** | upper saprolite, pallid, kaolinite-rich + vein quartz & quartz grit + minute relict red garnet grains + lithic corestone remnants (garnet gneiss, K-feldspar). |
| **31-37 m** | lower saprolite, pale brown-grey to yellow-grey, clayey + quartz grit, relict foliation preserved in weathered rock. |
| **37-38 m** | lower saprolite to saprock, yellowish khaki, variably weathered gneiss + fresher corestones of felsic gneiss. |
| **38-41 m** | saprock, khaki, partly weathered gneiss + corestones of felsic gneiss (chloritic biotite-quartz-k-spar-garnet) **EOH**. Regolith logged by M.J. Sheard |

**Figure 132:** Benchmark 23 chiptray photo and regolith log to RAB drillhole 95CHAR558. Drilling depth was to 41 m but chiptray samples stop at 40 m (in saprock).

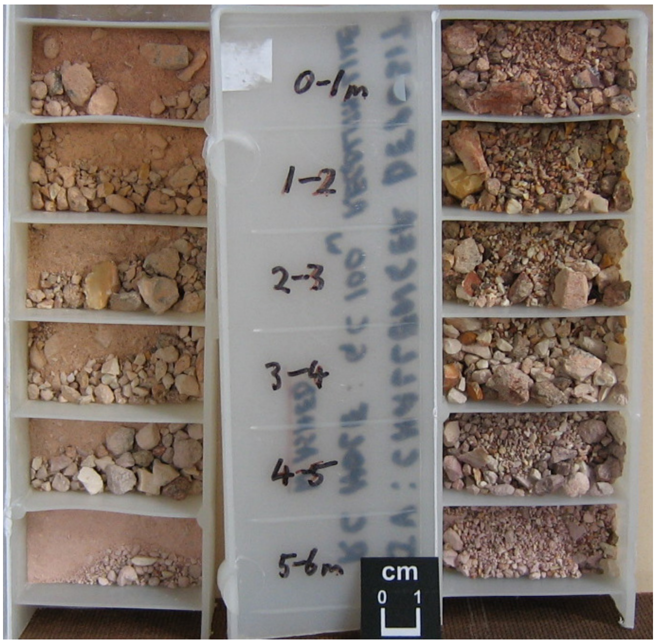



**Plate 24:** Benchmark 23 composite (continued), chiptray samples to RC drillhole GC100 (0-6 m).

LHS displays unprocessed samples.

RHS displays washed samples, where clay and silt have been removed. Granular residue becomes less abundant with depth below 3 m.

Sample interval was one metre.

See Table 56 for log.

## *Background*

Drillholes 95CHAR558 and GC100 and Pit GCP100 have been selected to form this composite benchmark because their adjacent sites occur within a significant palaeochannel tributary away from the major Au mineralization, these sites have significant transported cover, while the weathered *in situ* regolith is relatively straight forward regarding its interpretation. Comparisons are provided through composite Benchmarks 21 and 22. From mid 2002 all of these sites were removed or covered by the Challenger Gold Mine developments, Processing Plant and associated facilities. The initial phase of exploration grid drilling at Challenger during 1995 involved RAB methods (mostly without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes typically end in saprock or lower saprolite rather than within fresh gneiss. Cuttings were sampled either on alternate metre intervals or as 2 m composites (not ideal for regolith investigations). Later drilling phases employed hammer assisted RAB and/or RC, and targeted diamond coring methods to obtain better sample control and bedrock structural representation.

Excavation of eight strategically sited pits (12 x 6 x 3 m) cut using explosives and a bulldozer, into the indurated upper regolith provided ready access for detailed sampling (assay, petrology, XRD, PIMA, etc) and offered a valuable 3D exposure of regolith development and irregularities.

**Table 56:** Benchmark 23 composite (continued) regolith log to RC drillhole GC100 (after Lintern and Sheard 1999b).

| | | |
|---|---|---|
| Drillhole: GC100, Reverse Circulation, vertical.<br>Location: Zone 53, 364315 E, 6693033 N, GDA 94<br>Site: within silcrete outcrop area on a slight rise on otherwise flat ground. Silcrete is massive to vuggy with quartz clasts, x-bedded sandstone and ferruginous stains along fractures. Outcrop is bouldery. Fluvial sedimentary structures are preserved in the silcrete. Potch opal veins, stringers and blebs are also observable in outcrop. Opalised and silicified wood fragments noted in silicified sediments or as loose float on the surface.<br>Vegetation: shrubland.<br>Soil: clayey sand, moderate reddish brown (wet) (2.5YR 4/5); as discontinuous patches within silcrete outcrop.<br>Calcrete: not at surface, thin plates and slabs coating silcrete below soil at ~25-30 cm.<br>Logged by: M.J. Sheard. | | |
| **Sample #** | **Depth** | **Description** |
| GC100A | 0-1 m | UNWASHED: cuttings and fines, pale pink (dry), strongly calcareous silcrete, calcrete with some of the reddish sandy soil included, strong carbonate acid reaction; texture – gritty sand and rock fragments, light brown (wet) (5YR 6/6).<br>WASHED: fragments of calcrete, silcrete and calcrete coating silcrete, creamy quartz fragments, Fe oxides as orange-brown coatings on silcrete. |
| GC100B | 1-2 m | UNWASHED: cuttings and fines, pale grey (d) silcrete, many angular broken fragments, calcareous, pale pinkish (d), moderate to strong carbonate acid reaction; texture – rock fragments, brownish orange (w) (5YR 5/8).<br>WASHED: cuttings of brown, grey and buff coloured silcrete, and cream, yellow, orange and grey potch opal and porcelanite, very calcareous, Fe oxides as above. |
| GC100C | 2-3 m | UNWASHED: as above, silcrete – very fine grained sand within each fragment, strong carbonate acid reaction; texture as above, colour – light yellowish brown (w) (7.5YR. 7/5).<br>WASHED: as per 1-2 m. |
| GC100D | 3-4 m | UNWASHED: cuttings and fines, creamy-grey, calcareous silcrete, mostly finer fragments (<3 mm), moderate carbonate acid reaction; colour – moderate yellowish pink (w) (5YR 7/4).<br>WASHED: creamy silcrete and porcelanite fragments. |
| GC100E | 4-5 m | UNWASHED: cuttings and fines, creamy grey (d), slightly clayey gritty material, contains clasts of silcrete as both large (5-10 mm) and smaller sand-sized fragments no carbonate acid reaction; texture – rock fragments, light yellowish brown (w) (7.5YR 7/4).<br>WASHED: silcrete and porcelanite as above plus purple to pink silicified claystone. |
| GC100F | 5-6 m | UNWASHED: cuttings and fines, pale pink (d) clay with some angular grit, no carbonate acid reaction; texture – sticky gritty loam to gritty medium clay, greyish yellowish pink (w) (2.5YR 7/2.).<br>WASHED: pink to purple clay and claystone with some contamination from above of silcrete and potch opal fragments. |

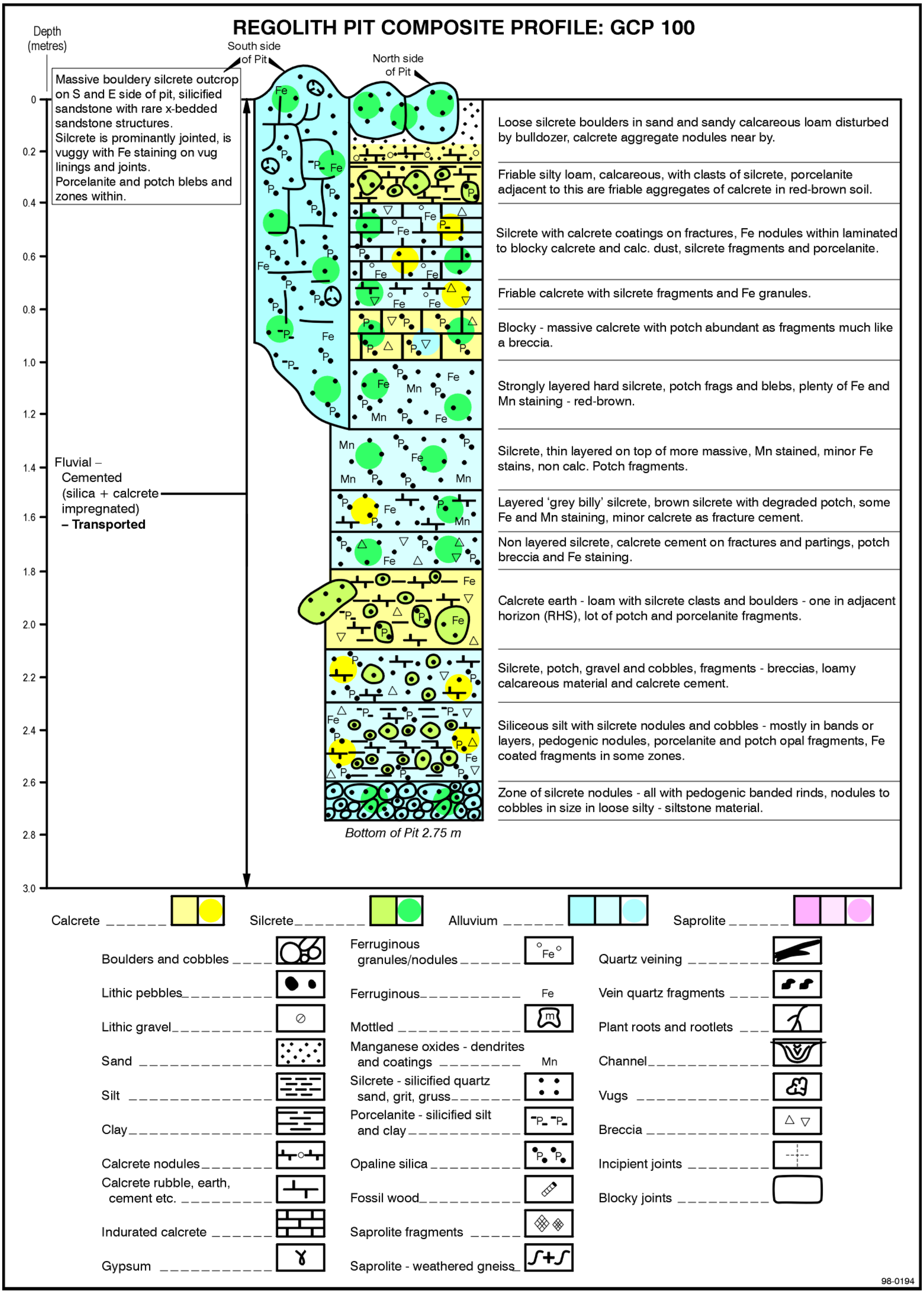



**Figure 133:** Benchmark 23 continued, composite profile to Challenger regolith pit GCP100 (Lintern and Sheard, 1999b).

**Table 57:** Benchmark 23 composite (continued) regolith profile in-field log, sampling points and sample numbers to excavation GCP100 (pit size 12 x 6 x 3 m).

| | |
|---|---|
| **Pit: GCP100** | Regolith Profile on NW face, centre (excavated by blasting and bulldozing). |
| Location: | Zone 53, 364315 E, 6693033 N, GDA 94<br>Nearest Regolith RC Hole: GC100. |
| Site: | Bouldery silcrete outcrop area with thin patchy reddish sandy soil and sparse shrubby vegetation. Pit excavation too difficult for bulldozer at hand, pit messed up in process. The most accessible face (northern) was not typical of the pit S side – this consisted of massive to bouldery pedogenic "grey billy" silcrete with a sporadic thick massive calcrete capping. That silcrete was vuggy with Fe-staining on fractures and vugh linings, and ferruginous granules within. |
| Logged by: | M.J. Sheard (PIRSA) & M.J. Lintern (CSIRO-E&M). |
| Photographic images (PIRSA) | (45504 to 45508) Plates 25-33 |

| **Sample #** | **Depth (cm)** | **Description** |
|---|---|---|
| GCP100-1 | 25-40 | NOTE: top soil (0-25 cm) disturbed by blasting and pit excavation. Friable calcareous silty loam soil (B horizon) with clasts of calcrete, silcrete, porcelanite and potch opal. Adjacent to sample line are friable aggregates of calcrete in a red-brown sandy soil. Sample: R214139. |
| GCP100-2 | 40-70 | Silcrete with calcrete coatings and dust with Fe granules (to 3 mm) and nodules within, laminated to blocky calcrete with silcrete and porcelanite fragments. Sample: R214140. |
| GCP100-3 | 70-80 | Calcrete – friable with small fragments (to 20 mm) of silcrete and Fe granules. Sample: R214141. |
| GCP100-4 | 80-100 | Blocky to massive calcrete with abundant potch opal as fragments and ?breccia clasts . Sample: R214142. |
| GCP100-5 | 100-125 | Beginning of a strongly layered zone – non calcareous, siliceous with fragments of silcrete and potch opal – with silica cement containing much Fe- and Mn-staining, distinctly layered, it forms the top of this zone. Quite a reddish brown horizon with layers on a cm scale. Sample: R214143. |
| GCP100-6 | 125-150 | Siliceous, thin layers over larger block silcrete, Mn-stained, minor Fe-staining, some potch opal fragments, non calcareous. Sample: R214144. |
| GCP100-7 | 150-165 | Silcrete, layered "grey billy" and brown forms with ?weathered potch (dull), some Mn- and Fe-staining, with minor calcrete cement. Sample: R214145. |
| GCP100-8 | 165-180 | Base of layered zone, various silcretes as layers, potch opal breccias and Fe-staining, with calcrete cement and coatings. Sample: R214146. |
| GCP100-9 | 180-210 | Calcareous loam with silcrete boulder ("grey billy") in an adjacent horizon, silcrete nodules and fragments with plenty of potch opal and porcelanite bands and fragments. A band within calcareous earth of Fe-stained silcrete. Large silcrete block (Sub-sample A). Samples: (9) R214147, (9A) R214148. |
| GCP100-10 | 210-230 | Calcrete cemented silcrete, potch opal, gravels and cobbles of the same, matrix is calcareous loamy material. Silcrete is pedogenic. Sample: R214149. |
| GCP100-11 | 230-260 | Silcrete with bands of potch opal – yellow and grey, basal horizon of silcrete cobble, pebble and gravel sized concretions—nodules in a matrix of calcareous silty loam. Ferruginous coated silcrete fragments in indurated calcrete. Sample: R214150. |
| GCP100-12<br><br><br>**Cont. below** | 260-275 | silcrete as rounded nodules 2-15 cm diameter (single small boulder as sub-sample 12A), bands and nodules of yellow to grey potch opal in a siliceous dust or earth (?calcareous). Samples: R214151, (12A) R214152 and R367478. |

| | | |
|---|---|---|
| GCP100-grab | pit spoil pile | Vitreous potch opal, mostly yellow creamy, some has reddish Fe-coating. Sample: R214153. |
| GCP100-grab | pit spoil pile | Greenish grey silcrete with Fe-granules and angular gravel encapsulates, partly calcreted. Sample: R214154. |
| GCP100-grab | pit spoil pile | Grey billy massive silcrete – silicified sandstone, from near the surface. Sample: R214155. |
| GCP100-grab | pit spoil pile | Pure potch opal – yellow and cream and grey with no other adhering matter (curiosity assay). Sample: R214156. |
| GCP100 -grab m | pit spoil pile | Potch opal-calcrete breccia. Sample: R367479. |
| GCP100 -grab f | pit spoil pile | Ferruginous granules in calcrete. Sample: R367480. |
| GCP100 -grab j | pit spoil pile | Porcelanite chunk with potch opal core. Sample: R367481. |
| GCP100 -grab h | pit spoil pile | polymict breccia – silcrete-porcelanite-potch-ferricrete-calcrete. Sample: R367482. |

**Plate 25:** Pit GCP100, view of the bouldery grey billy silcrete on the SE side of the pit, in marked contrast to the laminar calcrete-silcrete breccia on the N and W sides of the pit. View from atop the sampled profile (Lintern and Sheard, 1999b). *(photo 45508)*.

**Plate 26:** Pit GCP100, wide angle view, NW face with logged and sampled profile marked by measuring tape (Lintern and Sheard, 1999b). *(photo 45504)*.

**Plate 27:** Pit GCP100, NW face, top metre (red mark at 1 m) central logged profile indicated by tape (Lintern and Sheard, 1999b). *(photo 45505)*.

**Plate 28:** Pit GCP100, NW face, top 1-2 m (red mark at 1 m) central logged profile indicated by tape (Lintern and Sheard, 1999b). *(photo 45506)*.

**Plate 29:** Pit GCP100, NW face, 1.5-2.75 m (red mark at 2 m) central logged profile indicated by measuring tape (Lintern and Sheard, 1999b). Silcrete is more bouldery-concretionary between 1.85-2.15 m. *(photo 45507).*

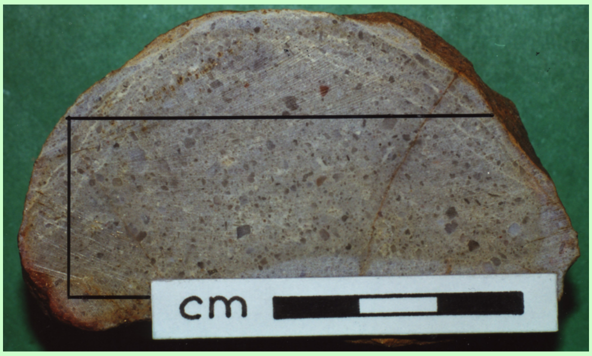



**Plate 30:** Challenger Gold Deposit regolith, slabbed sample from Regolith Pit GCP100 of Lintern and Sheard (1999b). Silcrete (grey billy) composed of small translucent grey quartz grains distributed uniformly through a pale cream-grey matrix. (see Plate 31 for petrography). Sample R213794, *(photo 45537).*

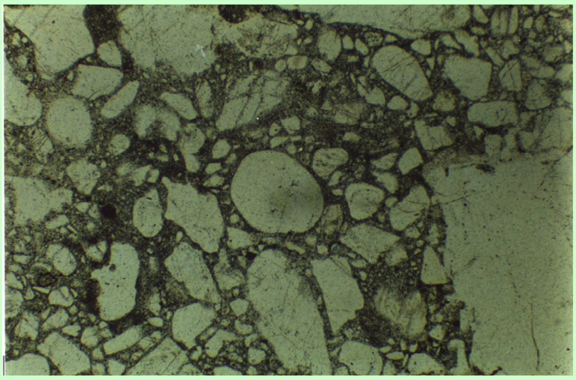


**Plate 31:** sample R213794, in transmitted plane polarised light. Rounded and angular quartz fragments (colourless) lie in a cryptocrystalline siliceous cement pervaded by submicron dusty material (possibly leucoxene). Silicified sediment with colluvial and alluvial grains. View 1.5 x 2.5 mm (Mason and Mason, 1998). *(photo 45837).*

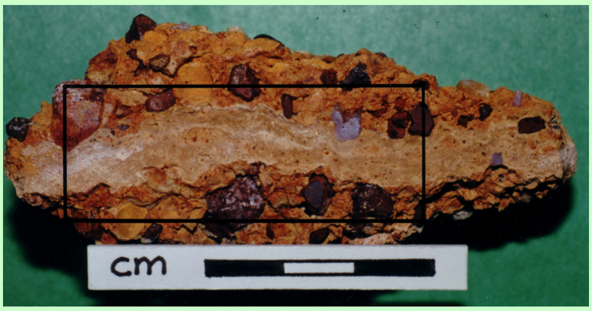



**Plate 32:** Challenger Gold Deposit regolith, slabbed sample from Regolith Pit GCP100 of Lintern and Sheard (1999b). Calcrete bearing Fe-stained lithic fragments in a fine-grained pink-cream matrix. A 1 cm thick irregular band without Fe-lithic fragments defines layering. (see Plate 33 for petrography). Sample R367480, *(photo 45524).*

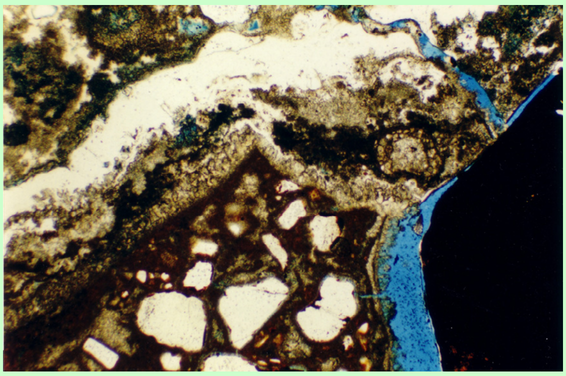


**Plate 33:** sample R367480, in transmitted plane polarised light. Large Fe-fragment (lower right) lies in a matrix of quartz particles (colourless) & cryptocrystalline-microcrystalline calcite (lower left), + overgrowths of colloform opaline silica (colourless) and microcrystalline calcite (pale brown). View 1.5 x 2.5 mm (Mason and Mason, 1998). *(photo 45885).*

## *In situ Regolith*

Bedrock (Christie Gneiss, <5% weathered) was not penetrated in drillhole 95CHAR558 and the Weathering Front is presumed to be below ~50 m based on evidence from adjacent drillholes. Examples of Christie Gneiss bedrock are provided earlier (Plate 9, Figure 118) from a cored geotechnical drillhole located reasonably close to Benchmark 22.

Saprock (>5-<20% weathered) was penetrated but its lower boundary was not encountered. All biotite is altering to chlorite; pyroxene and amphiboles are partially altering to clay ± goethite ± chlorite ; while feldspars and cordierite are partially altering to clay and sericite. Saprock at this site is moderately competent, is mostly khaki-grey but may display considerable yellowing or brown staining by FeOH distributed along fractures and intergrain boundaries (Figure 132). Clays are present within altering minerals and/or as fracture infill.

Lower saprolite (>20% weathered) is characterised by a reduced competency + yellow-brown to yellowish grey colours; clay is commonly more abundant; darker yellow-brown FeOH segregations are present; quartz grit and some vein quartz also occur (Figure 132).

Upper saprolite (>50% weathered) is typically strongly leached, exhibits either pallid or subdued hues and is generally chalky (kaolinite-rich + quartz grit; low competency material). This sub-zone may also exhibit FeOx/FeOH mottling or staining in a variety of colours (red-brown-yellow) and the relict quartz (grit + veins) is more visually obvious (Lintern and Sheard, 1999b). Some small red garnets (<1 mm) were encountered and unlike the larger garnets, have survived weathering alteration to ~22 m below the surface. Palaeovalley incision-erosion into the upper saprolite has truncated possibly half of its original thickness (Figures 122, 132).

## *Transported Regolith*

Transported regolith formed a substantial cover sequence at these sites (Lintern and Sheard, 1999b). Regolith drillhole GC100 (drilled with RC method) and pit excavation GCP100 provide detailed information on the 0-6 m and 0-3 m intervals (respectively) within totally transported materials. Drill sampling involved 1 m composites that were logged in both the raw and washed states (Plate 24, Table 56); while the pit sampling involved bulks and blocks (at 10-30 cm intervals) removed from a selected vertical profile (Plates 25-33, Figure 133, Table 57). The 6 m drilled interval is complex due to the intensity of overprinting by siliceous and calcareous cements that form a significantly indurated duricrust (5->6 m thick: silcrete + calcrete). Excavation GCP100 provided further detail in 3D that drill cuttings cannot and allowed the collection of bulk samples for petrography and more detailed assay. Outcrop at the regolith pit location consisted of scattered low domes and boulders of massive grey billy silcrete protruding orange sand and thin soil. Some silcrete exhibited overgrowth lamellae and preserved sedimentary structures (cross-bedded sands, graded bedding), veins and blebs of yellow potch opal, and fragments of dark grey-brown petrified wood (Plates 11,12, 25-31).

However, pit excavation revealed that the massive dense silcrete was patchy and irregularly developed in amongst less densely massive silcrete-calcrete duricrust (Figure 133, Plates 25-29). The siliceous duricrust overprints fluvial quartz sand containing some layers of colluvial quartz grit (both being fine- to coarse-grained, clasts range from well rounded to angular, Plate 30). Beds of >300 mm to lamellae of <2 mm occur throughout and were best preserved in the larger blocks-boulders of massive grey billy silcrete.

Repeated erosive episodes and the incorporation of surface clasts into the upper 1-2 m profile, have combined to form complicated breccia beds within the upper transported regolith here (Plate 12). These indicate surface erosive-colluvial and pedogenic processes, yielding slope talus and debris flow deposits. Subsequent pedogenic silica and carbonate solutions have cemented those breccias and colluvium with hyaline opal and calcrete.

Calcrete forms occasional massive coatings on the silcrete duricrust but also substantially invades the silcreted sandstone along joints, bedding partings and infills remnant voids (clay ball and wood moulds). On one side of regolith Pit GCP100, calcrete has gradually jacked apart the silcrete to form a jig-saw-fit assemblage while on the other side it has only invaded between silcrete boulders or remains as a surface capping below thin sandy soil, sometimes the calcrete encloses lithic lags derived from up slope (Plates 32, 33).

## *Geochemistry*

Detailed geochemical analysis of the 0-6 m samples using a 50 element assay package is available in Lintern and Sheard (1999b). An extract of that work is provided below. Down profile elemental abundance plots are set out in Figures 134, 135. Gold is at very low levels in the upper ~3 m regolith (<9 ppb) where there is ~15 m of transported cover and the nearest Au mineralization being ~200 m NW. Gold and Ca abundances are well correlated (see Figure 124 to compare across all pits). However, Au only appears to be poorly associated with As, Bi, Fe and Mn. High S within the upper 3 m is most likely due to the presence of gypsum (presence logged in cuttings), which in adjacent pits seems more likely to have derived from the *in situ* weathering of sulphides (Lintern *et al*., 2006). A more general account of the broader geochemistry is provided earlier in the Challenger Gold Deposit summary under Geochemistry and includes Figures 123-125 plus Table 49.

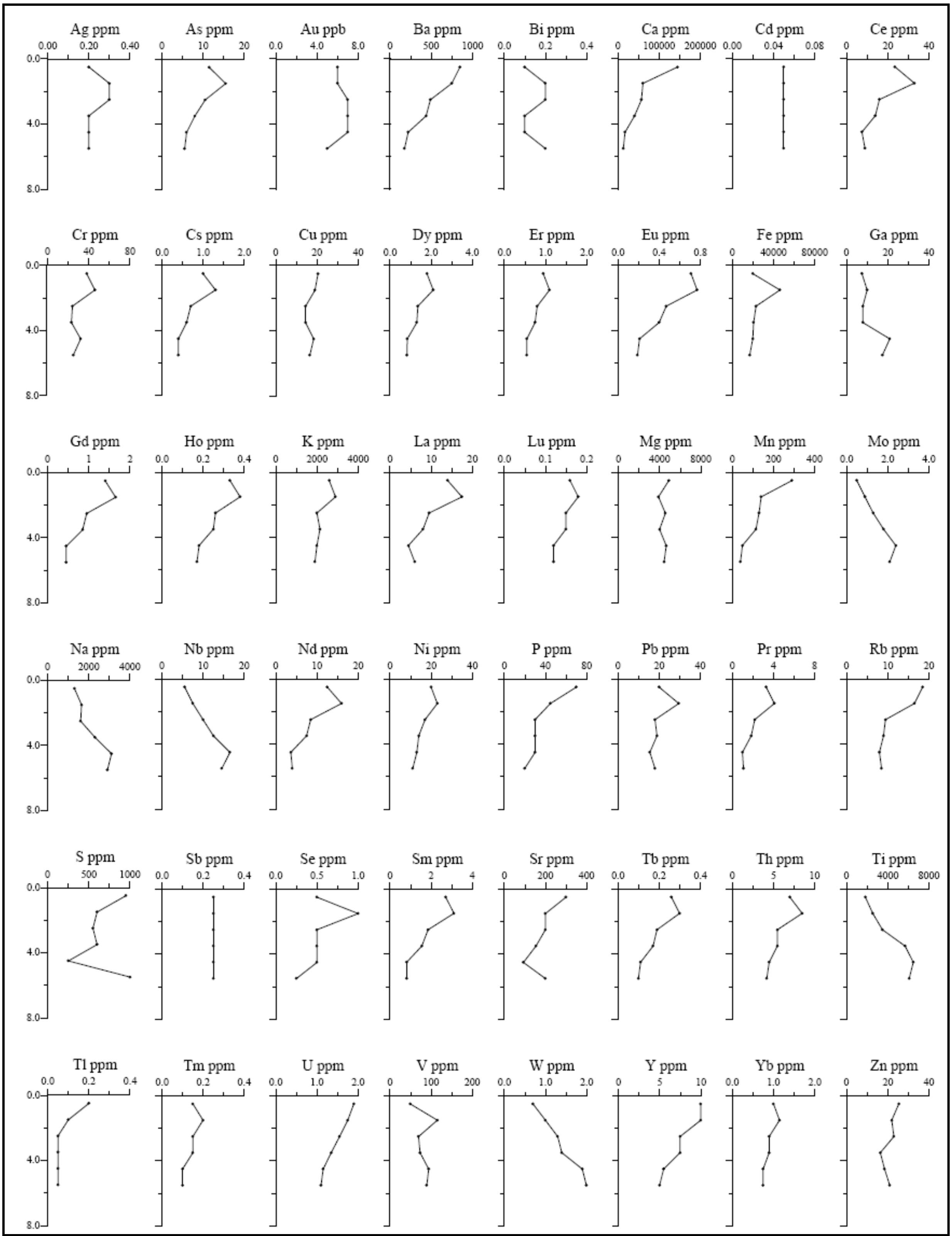



**Figure 134:** Elemental abundances *vs* depth (m) for Benchmark 23, RC drillhole GC100, Challenger Gold Deposit (Lintern and Sheard, 1999b).

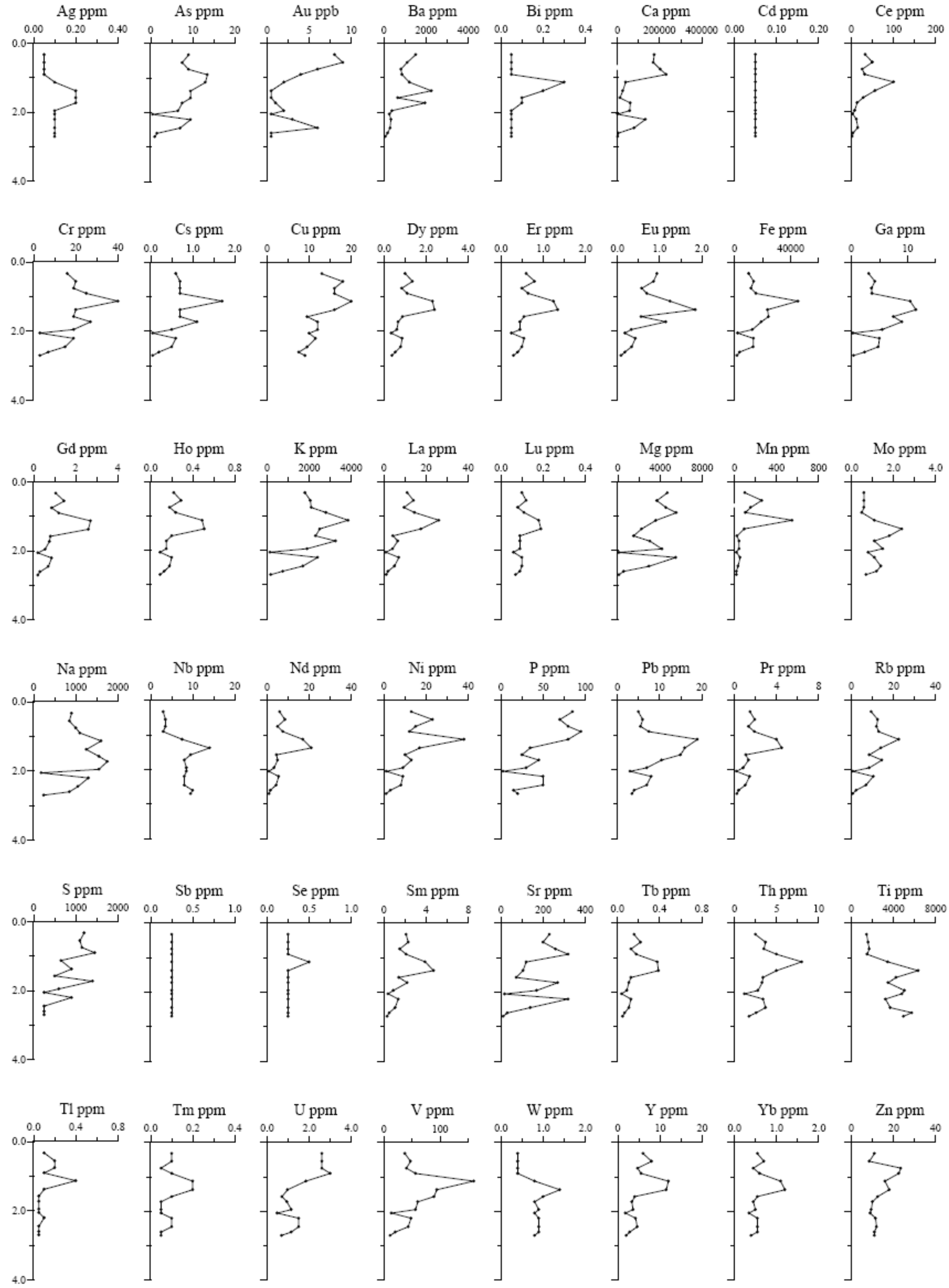



**Figure 135:** Elemental distributions *vs* depth (m) for Benchmark 23, RC Regolith Pit GCP100, Challenger Gold Deposit (Lintern and Sheard, 1999b).

# *Jumbuck gold prospect*

## *Background*

The Jumbuck gold prospect lies about 40 km W of Commonwealth Hill Pastoral Station Homestead, about 5 km E of the Challenger Gold Mine and ~140 km NW of Tarcoola (Figure 136). The prospect covers undulating terrain in an area occupied by ~E-W trending orange longitudinal dunes of Pleistocene age that form an easterly outlier of the Great Victoria Desert. Dunes cover a substrate of deeply weathered and silcrete capped Archaean Christie Gneiss with a variety of overlying sediments. In part, the dunes infill basement depressions with up to 6 m of sand ± other sedimentary deposits. Vegetation has stabilised the dunes and includes deep rooted woodland (*Eucalyptus* and *Acacia*), numerous woody shrubs (e.g. *Acacia, Eremophila* and *Maireana*) and various ground cover plants (e.g. *Ptilotus, Eragrostis, Sclerolaena* and *Thyridolepis*) (after Lintern *et al*., 2002).

Jumbuck prospect formed part of the larger Gawler Joint Venture tenement coverage, occupying most of the area in Figure 136. The Jumbuck Au anomaly was discovered in 1995 using regional Au-in-calcrete methods (anomaly area ~2 x 3 km at >3 ppb Au). It was drilled early in 1997, but assays soon indicated that mineralization is weak despite the anomaly size. Regolith investigations by Lintern *et al.* (2002) began in 1998 as part of a broader regional study examining Au-in-calcrete anomalism. A series of ~EW trending company RAB drill-lines provided samples for regolith logging, characterisation, and analysis. Field inspection of drill spoil piles aided selection of a suitable study line of drillholes (local grid 6690400 N AMG66 [ = 6690571 N GDA94]). Figure 137 indicates the location of that regolith study line in relation to the topography and Au-in-calcrete anomaly.

## *In situ Regolith*

Bedrock (<5% weathered) was not penetrated by any of the exploration drilling on this prospect, however, remnant corestone fragments in saprock indicate bedrock to be a biotite-rich (?mafic) form of Christie Gneiss.

Saprock (>5% to <20% weathered) was penetrated by most drilling (Figure 138), it is generally complexly weathered and its boundary with lower saprolite is not easy to define from cuttings (possibly a gradational interval). It consists of a strongly foliated mafic to biotite-rich gneiss, and is commonly grey to dark grey in colour, and possibly dark brown at one drill site (FeOH staining after weathered chlorite). Thickness is indeterminate because its base was not intersected, however, it is likely to be in the range 5->10 m.

Saprolite (>20% weathered) is quite a complex weathering zone at Jumbuck (Figures 138, 139), lower saprolite was more uniform of colour and is less weathered than upper saprolite. Lower saprolite is typically greyish, but also brownish to olive or mixtures of those near more mafic bands, and there are intervals at depth where extremely weathered rock is surrounded by much less weathered rock. Remnant biotite and chlorite plus abundant clay and quartz grit are typical components. Upper saprolite is highly variable of colour (pallid, pink, yellow, brown and olive-brown), is of variable competency, and in places has FeOx-FeOH segregations and/or ?mottles, and/or fracture staining. Kaolinite plus quartz grit are the dominant mineral assemblage. As a whole, saprolite is at least 30 m thick and may exceed 55 m.

Pedolith along the entire regolith section (Figures 138, 139) is intensely silicified and is partly enclosed by a silcrete horizon that commonly extends up into the overlying sediments, where the weathered *in situ* pedolith top is an erosional unconformity located wholly within that silcrete (best seen in outcrop but can be located with PIMA and a formula for determining the “kaolin crystallinity index” or KCI, refer to Lintern *et al*., 2002). Pedolith nearer its base is less silicified and in places retains a clay-rich texture. At one location drilling revealed a relict ferruginous-siliceous granule horizon (granules not cemented together, pale brown to pale khaki-brown) within the silcrete horizon and presumed to be part of the pedolith (requires drill core to elaborate further upon). Those granules-pisoliths (5-11 mm) retained intact cutans and so are more likely to be *in situ* rather than transported.

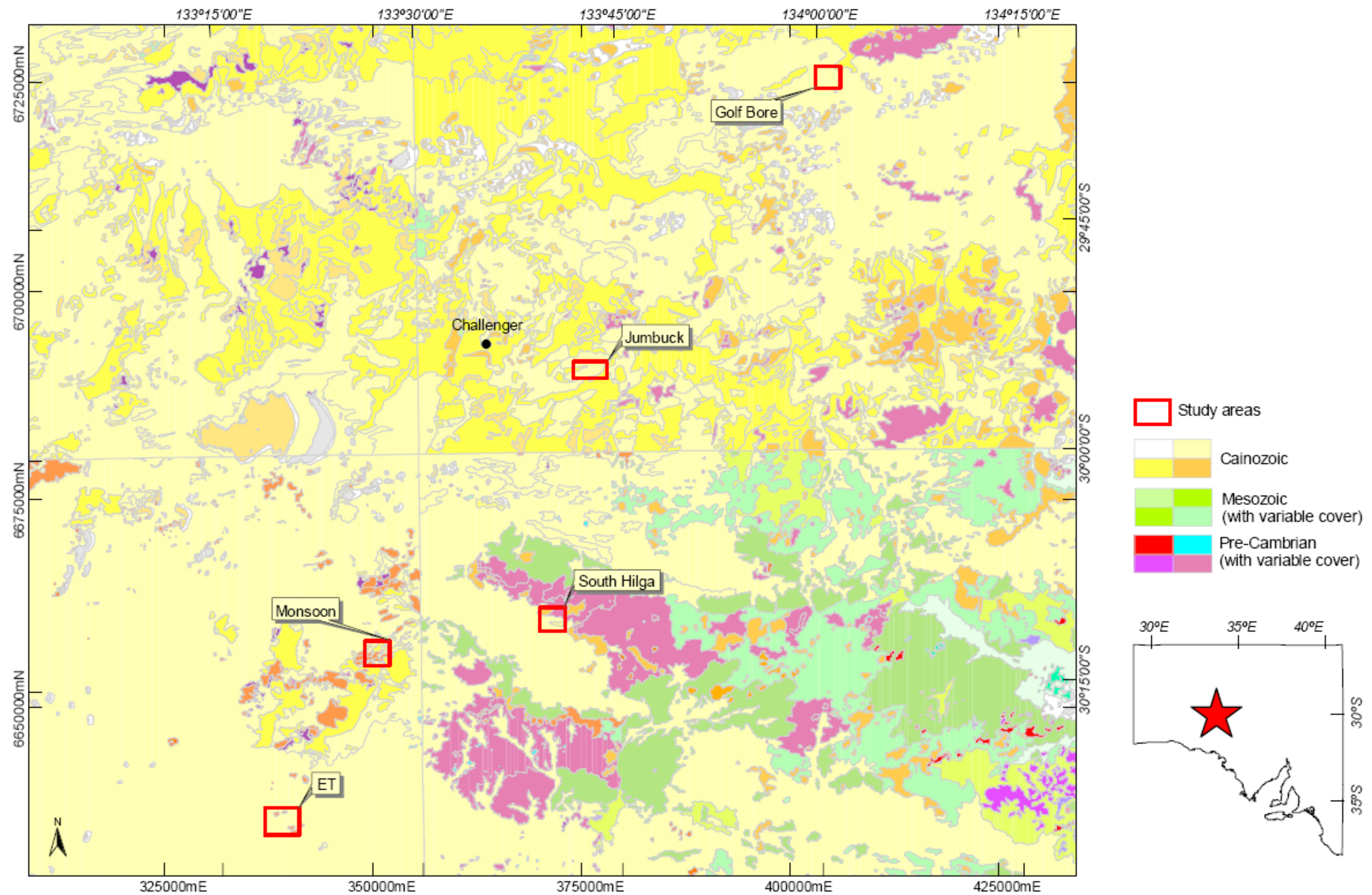



**Figure 136:** Locations marked on the 1:250,000 scale geology for five prospects where benchmark sites are described herein (map coordinates are in AMG66 projection). For geology interpretive key refer to the geological map sheets BARTON & TARCOOLA (1:250,000 scale).

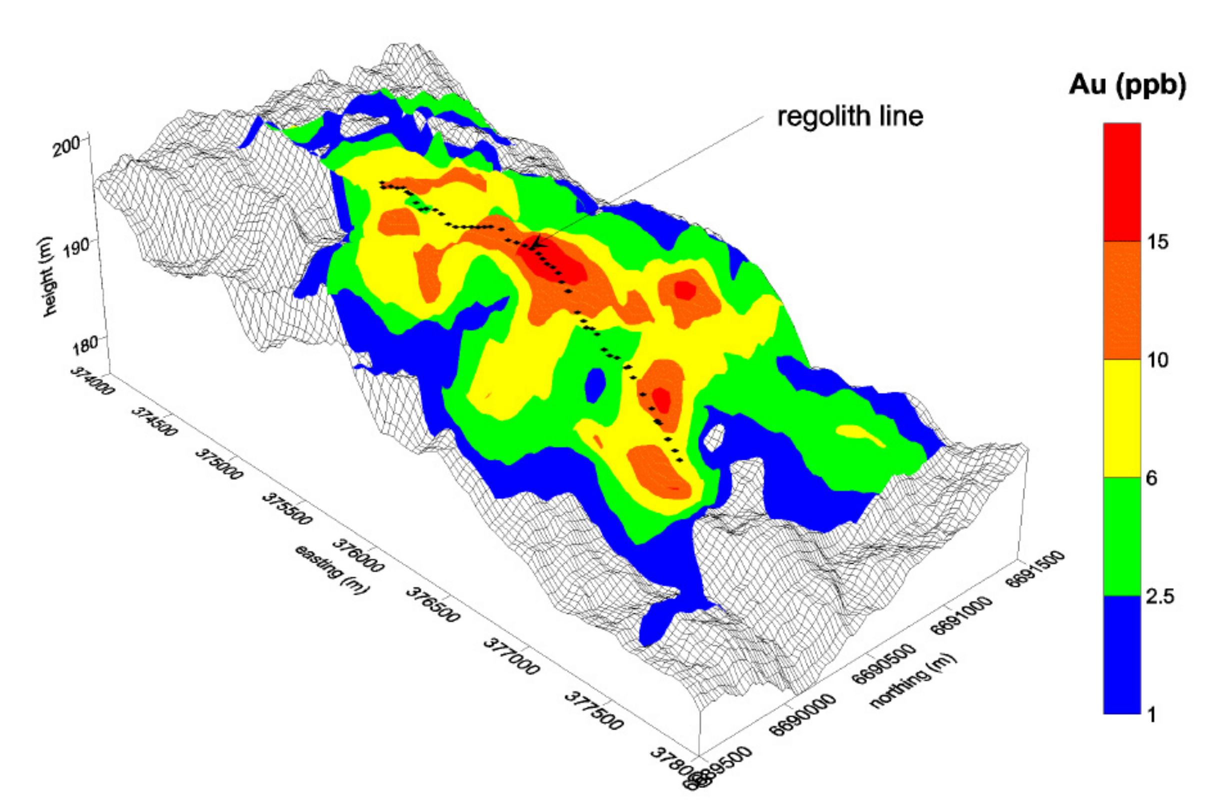



**Figure 137:** Jumbuck gold prospect in 3D, showing Au-in-calcrete anomaly draped over the local DEM and indicating the regolith (sampling) line. Exposed "wireframe" grid indicates data below 1 ppb. View from SE. Original data supplied from the Gawler Joint Venture (Lintern *et al*., 2002).

## *Transported Regolith*

Positioning the unconformity was difficult at Jumbuck due to its loci being mostly within the silcrete horizon. In-field and microscopic examinations were compared with PIMA derived kaolinite crystallinity indices (KCI). However, the paucity of kaolinite remaining within silcrete and the presence of interfering smectite made use of KCI problematic (see the red line on Figures 138, 139).

Fluvial sediment, composed of clay and sandy silt that infills a 5 m deep by >250 m wide channel, running roughly orthogonal to the section (Figures 138, 139). This sediment is silcreted near its top.

Red-brown hardpan, forms a distinctive strongly coloured but discontinuous horizon above the silcrete (Figures 138, 139). Composed of clay plus quartz clasts (angular to subrounded) in a matrix supported framework, this colluvial unit is typically partly cemented with silica (hyaline opal) and possibly other cements (FeOH, gypsum, calcite) to form an indurated strongly coloured horizon. Here it is discontinuous but elsewhere it forms a more useful laterally extensive marker bed. Red-brown hardpan also possibly interdigitates with another clay-rich, multicoloured unit of uncertain affinity.

Aeolian dune sand, orange, siliceous, is generally free-running except where cemented by calcrete. Sand grains are frosted, rounded to subangular, and of medium-grain size (uniformly sorted), they are coated with a thin ferruginous skin and elsewhere have been dated by optical methods to age range from ~250 ka to <20 ka (Sheard *et al*., 2006). There is no illuviated clay or silt within the dunes (Figures 138, 139)

Calcrete occurs as pisoliths, nodules and earthy forms within the dunes, while it occurs as indurated laminar to more massive forms on outcropping silcrete. Within the dunes, calcrete has developed at more than one level (Figure 139) but when initially sampled by explorationists it is the uppermost level that would have been taken for assay.

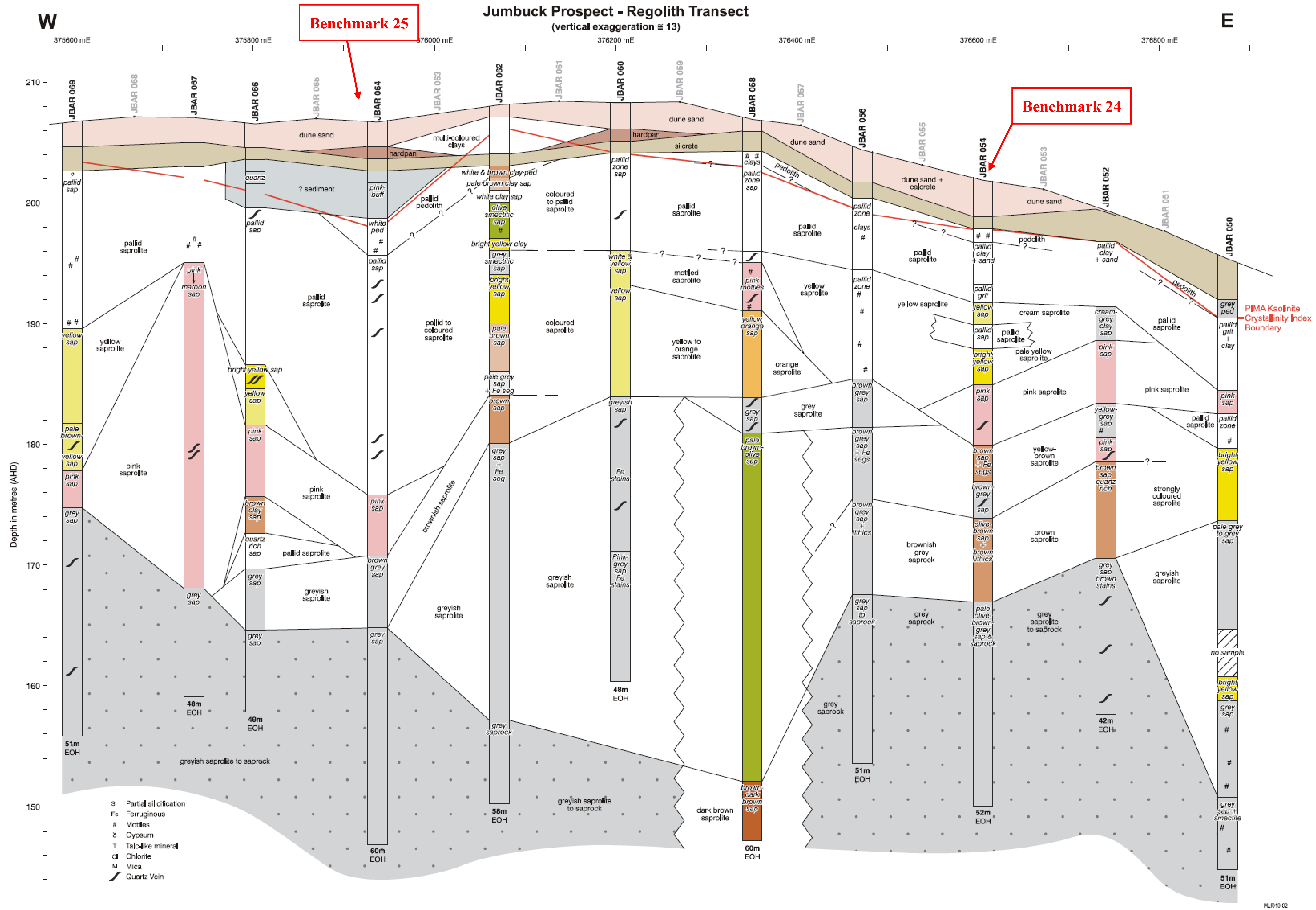



**Figure 138:** Jumbuck gold prospect, full regolith section along line displayed in Figure 137 (Lintern *et al*., 2002). Benchmarks 24 and 25 are indicated.

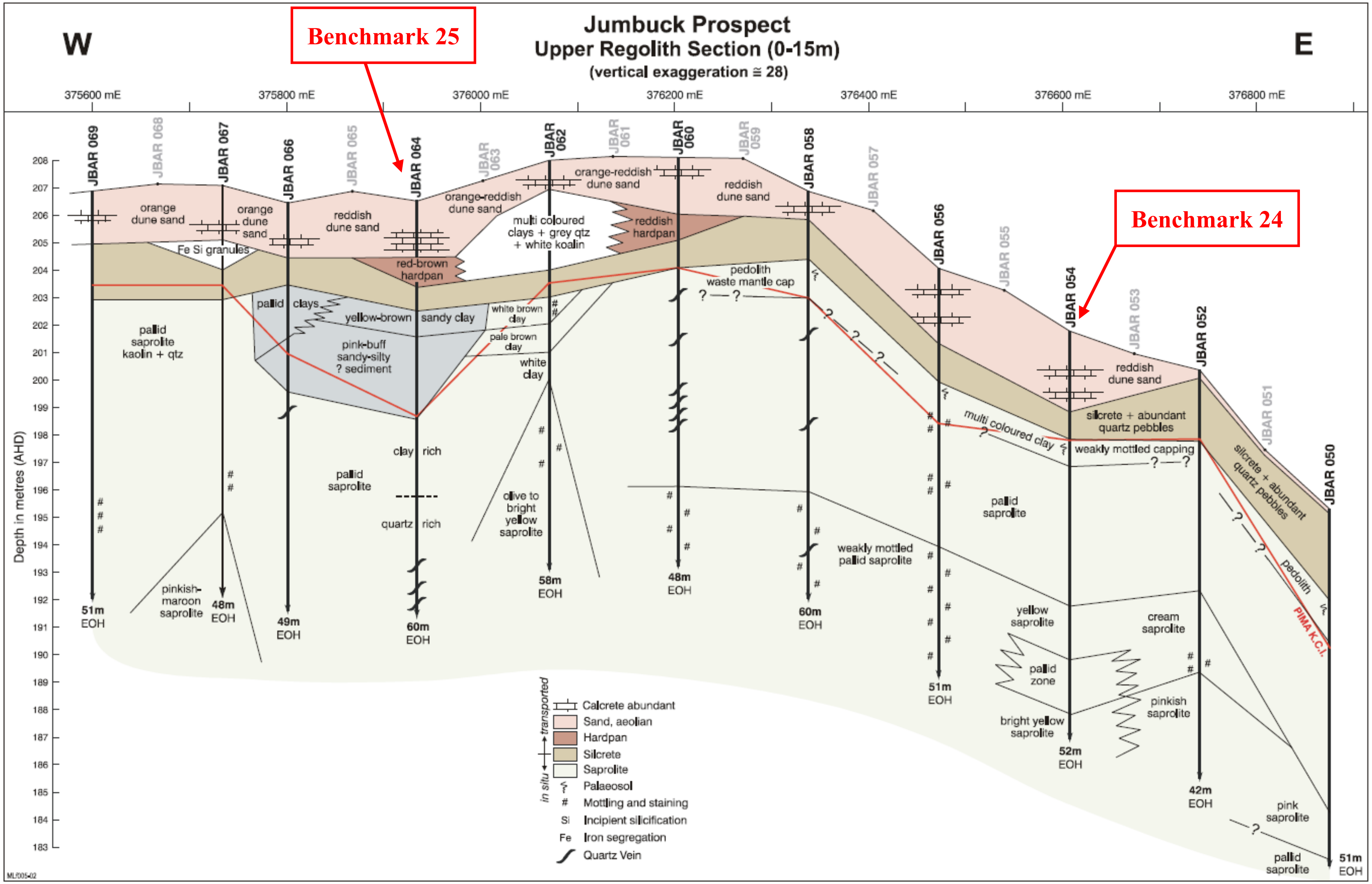



**Figure 139:** Jumbuck gold prospect, upper regolith section along line displayed in Figure 137 (Lintern *et al*., 2002). Benchmarks 24 and 25 are indicated.

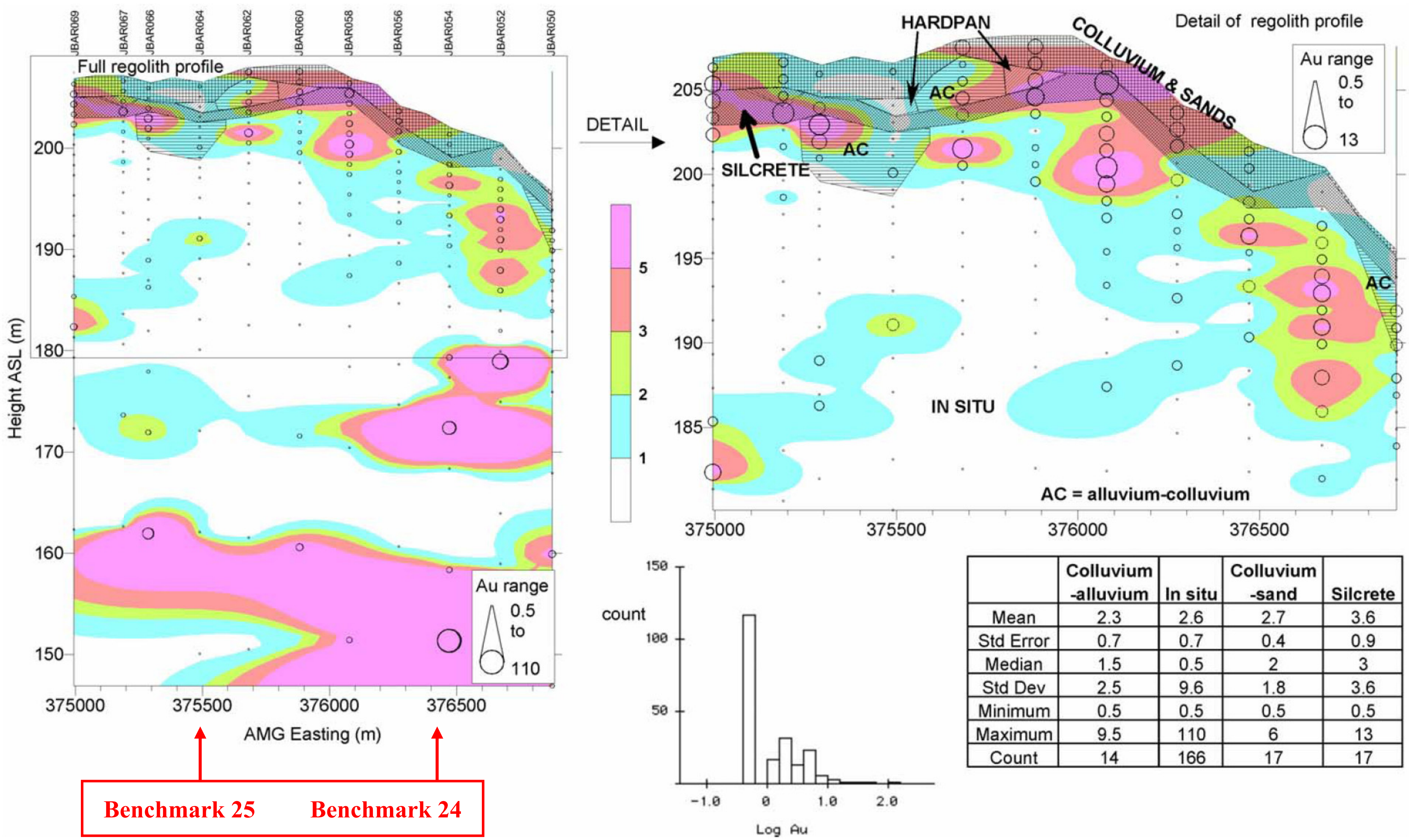
### *Geochemical expression*

The anomaly in calcrete has a maximum of 20 ppb (Figure 137). Significant Au concentrations in the regolith are listed in Table 58. Gold concentrations above background (>1 ppb) were measured in both the transported cover and upper *in situ* weathered regolith at Jumbuck (Figure 140). The eastern part of the regolith section has higher concentrations of Au (13 ppb) in the upper regolith and this corresponds with higher Au concentrations (110 ppb) found in the deeper regolith in drillhole 97JBAR054 (Benchmark 24). For the upper regolith, the highest Au concentration (13 ppb) is found in a calcrete-silcrete sample towards the centre of the section and on the edge of the slope. Lower but still elevated Au concentrations were found sporadically in surficial calcrete developed in colluvium and sand (1-6 ppb). Iron is correlated with As, Co, Cr, Cu, Ni, V and Zn, and moderately with Mg, although the low K concentrations suggest a lack of sericitic alteration (Lintern *et al*., 2002). Left of centre section, at drillhole 97JBAR062 occurs a mafic-enriched basement intersection that has much higher values of As, Co, Cr, Cu, Fe, Mg, Ni, Ti, V, Zn, and REE than do most of the other drillholes, including another mafic intersection in drillhole 97JBAR058 (see Benchmark 24 geochemistry section).

**Table 58:** Jumbuck gold prospect, highest Au concentrations and other anomalous drillhole intervals (Lintern, 2004b).

| Drillhole | Interval (m) | Analyses (ppm unless stated) | Regolith type |
|---|---|---|---|
| 97JBAR054 | 50-51 | Au 110 ppb | saprock |
| 97JBAR054 | 29-30 | Au 32 ppb | saprolite |
| 97JBAR052 | 20-21 | Au 44 ppb | saprolite |
| 97JBAR066 | 44-45 | Au 21 ppb | saprolite |
| 97JBAR062 | 15-16 | Au <1 ppb Cu 250, Zn 270 | saprolite |
| 97JBAR062 | 11-12 | Au <1 ppb Cu 220, As 33, Zn 290 | saprolite |

<u>In Summary</u>: Jumbuck is a good example of a prospect characterised by a spatially large, but weak, Au-in-calcrete anomaly overlying low grade mineralization. Maximum Au concentration in calcrete is 20 ppb, and the >3 ppb Au contour spreads over an area of 2 x 3 km. Calcrete is associated with aeolian dune sand and a relict silcrete outcrop forming a palaeo-breakaway (now partly obscured by the dune sand cover).




| | Colluvium -alluvium | In situ | Colluvium -sand | Silcrete |
|---|---|---|---|---|
| Mean | 2.3 | 2.6 | 2.7 | 3.6 |
| Std Error | 0.7 | 0.7 | 0.4 | 0.9 |
| Median | 1.5 | 0.5 | 2 | 3 |
| Std Dev | 2.5 | 9.6 | 1.8 | 3.6 |
| Minimum | 0.5 | 0.5 | 0.5 | 0.5 |
| Maximum | 9.5 | 110 | 6 | 13 |
| Count | 14 | 166 | 17 | 17 |

**Figure 140:** Jumbuck gold prospect regolith section, regolith architecture and Au geochemical expression (*c.f.* Figures 93-95). All data are in ppb (Lintern, 2004b). Benchmarks 24 and 25 are indicated.

## Benchmark 24: drillhole 97JBAR054

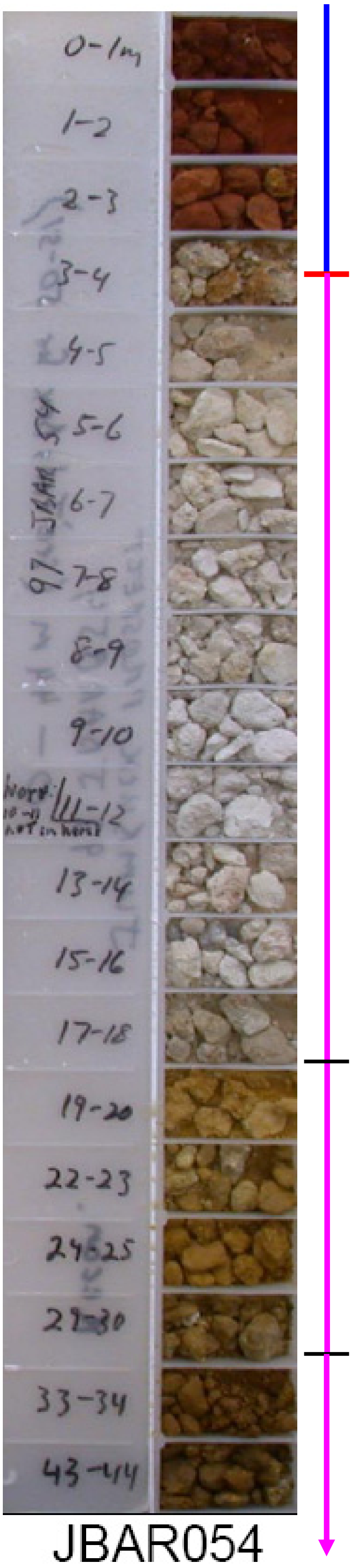
Quick reference items are set out in Table 59; detailed descriptions, figures and data tables follow on below. Jumbuck prospect is ~3 km SE of Jumbuck Outstation on Commonwealth Hill Pastoral Station. Sites were about 2 kilometres S of the original unsealed road between Commonwealth Hill to Mobella Pastoral Station Homesteads, and via station-mineral exploration dirt tracks (Figures 110-112, 136, 137). Drilling for these holes was vertical, and of RAB type. A summary of this profile is provided in Table 60 and chiptray photograph with regolith zonation is in Figure 141. Geochemical data are presented in Figures 140, 142-145 and Table 58.

**Table 59**: Benchmark 24 reference data; drillhole 97JBAR054 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-112, 136. |
| Local-site location map | Figures 137-139. |
| GPS coordinates, attitude & elevation | RAB drillhole 97JBAR054: Zone 53, 376599 E, 6690643 N, GDA 94. Vertical. **AHD:** 201.853 m (differential GPS data). |
| Site access, owner | About 3 km SE of Jumbuck Outstation on the Commonwealth Hill Pastoral Lease, and ~5 km E of the Challenger Gold Mine. Site Lease holder: Commonwealth Hill Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 141, Table 60. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 140, 142-145 and Table 58. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite crystallinity indices for unconformity picks. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | Ag, Bi, ?Cu, Zn. |
| Useful sampling media | Calcrete, silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 97JBAR054 is selected to form this benchmark because it has the most significant Au mineralization, and it has relatively thin transported cover, while the weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 25 and the regolith cross-sections of Figures 138, 139. The exploration grid drilling involved RAB methods (mostly without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes typically end in saprock or lower saprolite rather than within fresh gneiss. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks, they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




**0-3 m** **Transported**: dune sand, aeolian, orange, siliceous uniformly sorted fine to medium sand grains, + earthy carbonate 1-2 m, + nodular calcrete 2-3 m.

**3-4 m** **Mixed provenance**: silcrete, greyish to yellowish, cements coarse-grained alluvial quartz in some drill chips and angular quartz grit in others. **Unconformity** >3 m.

**4-18 m** ***In situ***: upper saprolite (?+ remnant pedolith), pallid, kaolinite-rich + quartz grit, 4-5 m has red + yellow staining and/or mottling, 9-10 m is yellow throughout, occasional vein quartz.

**18-33 m** Saprolite, pinkish to brownish hued, clay-rich + quartz grit, occasional quartz veins. Greyish interval 25-28 m, FeOH staining of saprolite either side of grey interval.

**33-35 m** Lower saprolite, olive-brown, clayey + quartz grit.

**35-52 m** Saprock-lower saprolite, pale olive-brown to greyish, more competent than above, irregularly weathered.

**NOTE: bedrock not penetrated. E.O.H. at 52 m.**

Regolith logged by M.J. Sheard

**Figure 141:** Benchmark 24, Jumbuck gold prospect drillhole 97JBAR054, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). Drilling penetrated to 52 m but regolith chiptray sampling stopped at 44 m. In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehab. work.

**Table 60:** Benchmark 24 regolith log to RAB drillhole 97JBAR054 (after Lintern *et al*., 2002).

**Hole:** 97JBAR054. **Regolith Line**, Jumbuck gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 376599 E, 6690643 N, GDA 94. **AHD:** 201.833 m (differential GPS data)

**Site:** gently sloping ground on reddish sand dune, vegetated.

**Vegetation:** *Acacia aneura* as Tall Open Shrubland over *Senna artemisioides* sub sp. *petiolaris* + Open Shrubland over *Ptilotus obovatus* and *Maireana georgei* + Low Shrubland over *Eragrostis eriopoda* + Very Open Grassland (Botanical log by S. Lintern).

**Soil:** Um (sand, loose, medium grained throughout).

**Calcrete:** nodular.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-1 | Reddish siliceous dune sand with podsol horizonation developed, loose, medium-grained sand, frosted sub-rounded grains. |
| 1-2 | Pale red siliceous dune sand as above + earthy carbonate. |
| 2-3 | Pale red siliceous dune sand as above + nodular calcrete. |
| 3-4 | Greyish to yellowish silcrete encapsulating rounded fluvial coarse-grained sand + rounded quartz pebbles (20-40 mm) + angular quartz grit. Unconformity within this interval. |
| 4-5 | ?Pedolith – Saprolite, white, red and yellow clay, kaolinite + fine- to medium-grained quartz grit (+ pebble & gravel contamination from above interval). |
| 5-9 | Pallid saprolite, white to grey kaolinite + angular quartz grit (+ contamination from above intervals). |
| 9-10 | Pallid saprolite, kaolinite-rich + angular quartz grit. |
| 10-12 | Saprolite, yellowish, kaolinite-rich + angular quartz grit. |
| 12-14 | Pallid saprolite, greenish tinted, kaolinite-rich + angular quartz grit. |
| 14-17 | Saprolite, bright yellow to pale yellow, kaolinite + angular quartz grit. |
| 17-22 | Saprolite, pinkish, clay-rich + vein quartz at 20 m. |
| 22-25 | Saprolite, brown, Fe-stained, + yellow-brown cemented segregations. |
| 25-28 | Saprolite, brownish grey, clay-rich + vein quartz at 26 m. |
| 28-33 | Saprolite, brownish grey to olive-brown, clay + quartz grit. |
| 33-35 | Lower saprolite, olive-brown, clayey + quartz grit + dark brown lithic fragments (gneissic remnants). |
| 35-52 | Lower saprolite + Saprock (?corestones or irregularly weathered), pale olive-brown to greyish, mostly more competent than above interval. Greyish gneissic remnants. |
| E.O.H. | |

## *In situ Regolith*

Bedrock wasn't penetrated by any drillholes on this prospect, but remnant corestones within the saprock indicate it is typical of the Christie Gneiss. Generally saprolite and most of the weathered *in situ* regolith at this site follows descriptions for this prospect set out earlier. However, pedolith appears to be severely truncated here, probably by erosion (the site is on a buried escarpment where the silcrete roughly follows that palaeotopography). What remaining pedolith there is, is partly encapsulated by the silcrete horizon, and the remainder is difficult to be certain about (cuttings alone don't provide large enough fragments for complex weathering fabrics to be properly observed-described).

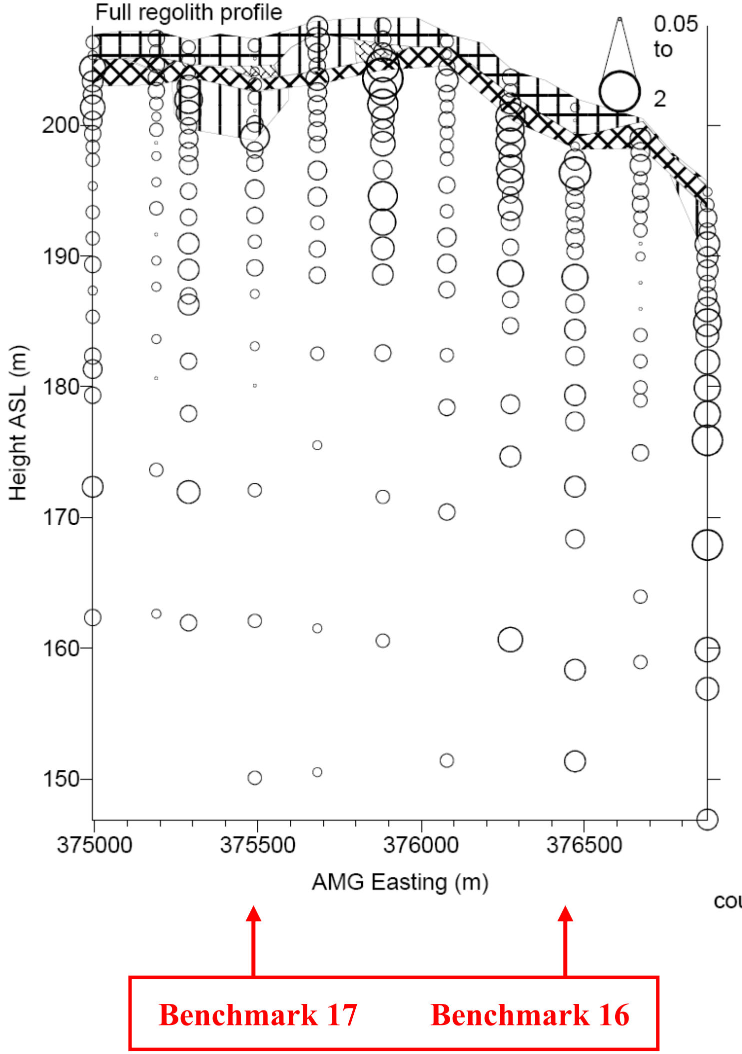
## *Transported Regolith*

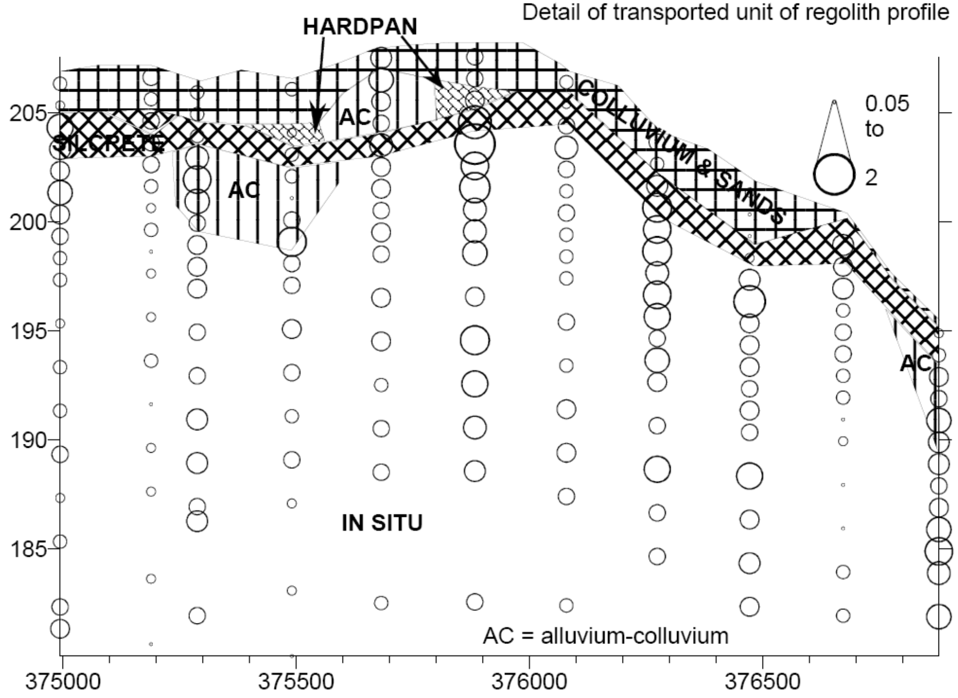
Aeolian dune sand forms the primary transported cover (3 m thick) with an additional <1 m of primarily fluvial sediment (sand + gravel + pebbles +?colluvium) encapsulated by the silcrete duricrust. That silcrete possibly forms a major barrier or impediment to the upward migration of weathering associated solutions derived from buried mineralization.

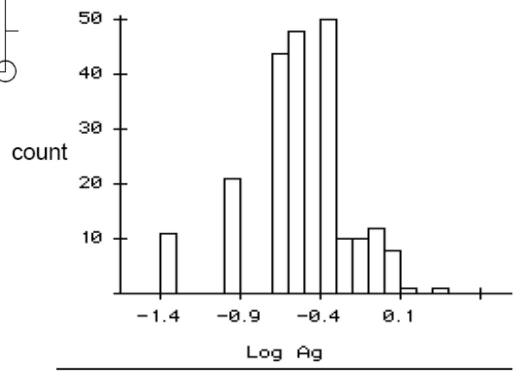
It is worth noting here that well rounded fluvial pebbles were shaken loose during drilling, from the silcrete and associated overlying sediments, and similarly for nodular calcrete in the dune sands. These together formed significant down-hole contaminants in the RAB samples (to sample depths of ~30 m) and could mislead unwary sample loggers.

## *Geochemistry*

Significant Au concentrations in the regolith are listed in Table 58. Gold concentrations above background (>1 ppb) were measured in both the transported cover and upper weathered *in situ* regolith at Jumbuck (Figure 140). Benchmark 24 (drillhole 97JBAR054) has the highest Au concentrations (13 ppb) in the upper regolith and this corresponds with higher Au concentrations (110 ppb) found in the deeper regolith. Near surface, the highest Au concentration was located in a calcrete-silcrete sample towards the centre of the section and on the edge of the slope. More general comments on associated elemental abundances and dispersion are made under the Jumbuck gold prospect heading. A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including Ag, Bi, U and Zn, appear in Figures 142-145.



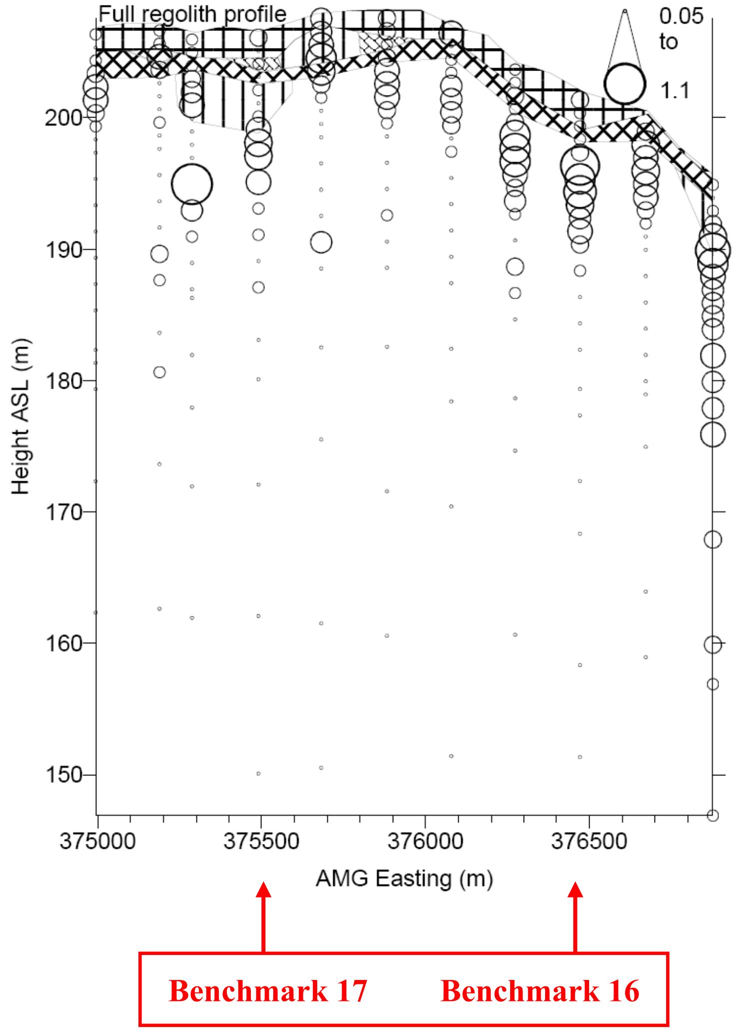



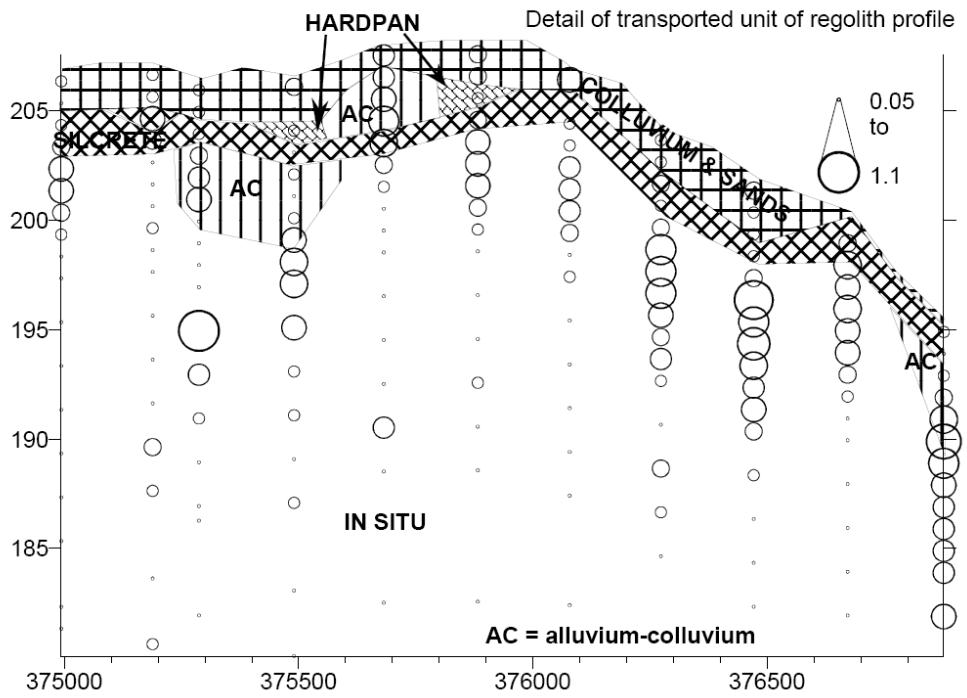

| | Colluvium -alluvium | In situ | Colluvium -sand | Silcrete |
|---|---|---|---|---|
| Mean | 0.49 | 0.39 | 0.20 | 0.44 |
| Std Error | 0.07 | 0.02 | 0.03 | 0.08 |
| Median | 0.4 | 0.3 | 0.2 | 0.3 |
| Std Dev | 0.28 | 0.27 | 0.12 | 0.34 |
| Minimum | 0.05 | 0.05 | 0.05 | 0.1 |
| Maximum | 1 | 2 | 0.5 | 1.3 |
| Count | 14 | 166 | 17 | 17 |

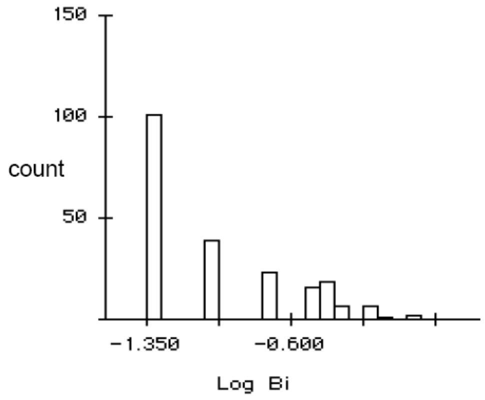
Ag (ppm)

Jumbuck

**Figure 142:** Jumbuck gold prospect regolith section, regolith architecture and Ag geochemical expression (*c.f.* Figures 140, 143-145). Lintern *et al*. (2002).



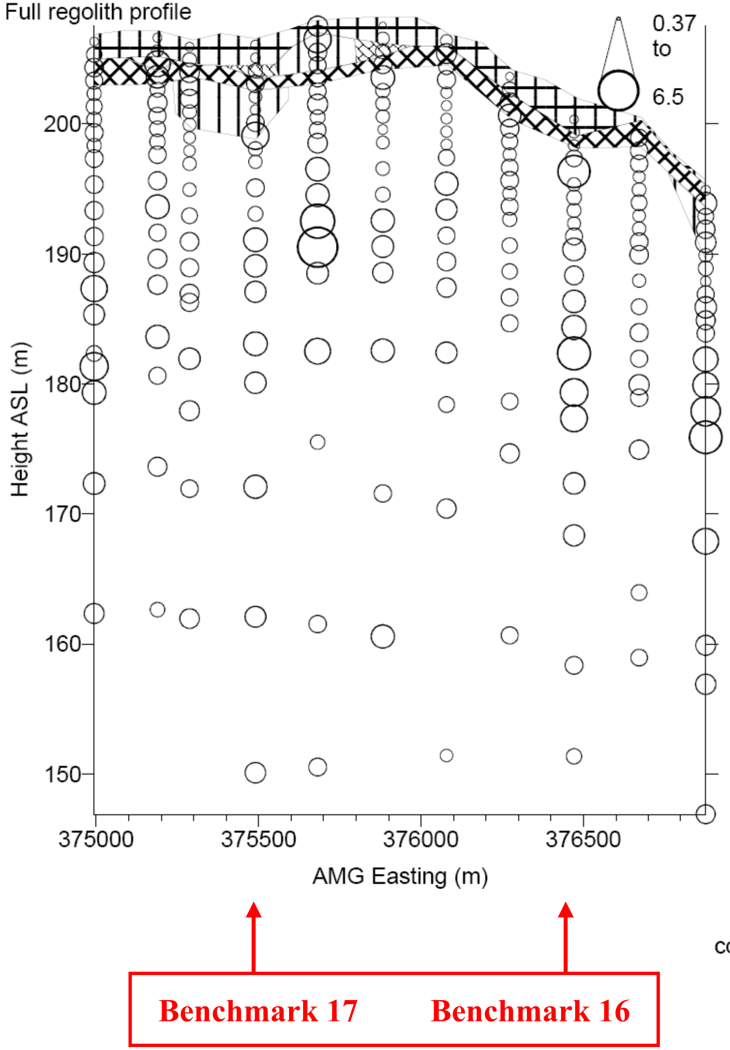



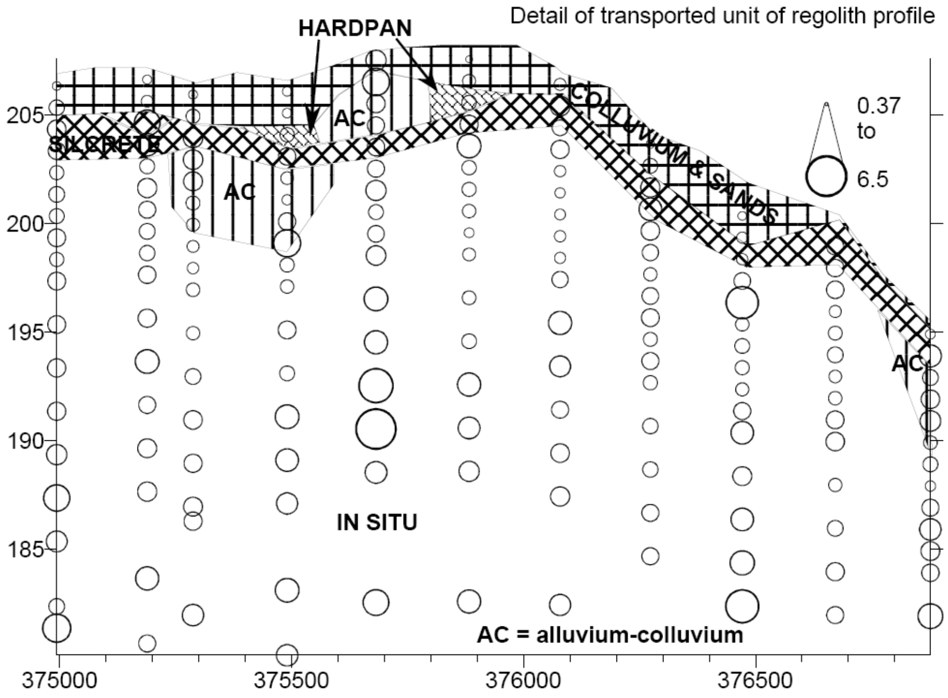

| | Colluvium -alluvium | In situ | Colluvium -sand | Silcrete |
|---|---|---|---|---|
| Mean | 0.26 | 0.16 | 0.15 | 0.19 |
| Std Error | 0.05 | 0.01 | 0.02 | 0.04 |
| Median | 0.25 | 0.05 | 0.1 | 0.1 |
| Std Dev | 0.18 | 0.19 | 0.09 | 0.15 |
| Minimum | 0.05 | 0.05 | 0.05 | 0.05 |
| Maximum | 0.6 | 1.1 | 0.4 | 0.5 |
| Count | 14 | 166 | 17 | 17 |

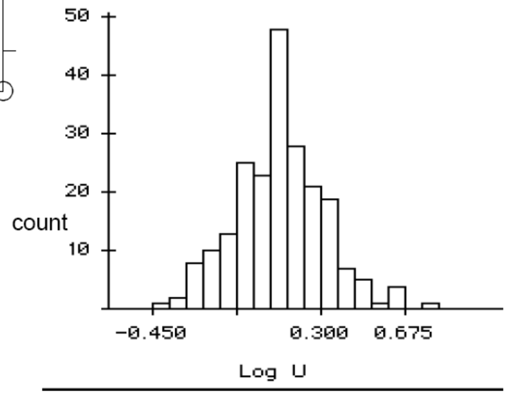
Bi (ppm)

Jumbuck

**Figure 143:** Jumbuck gold prospect regolith section, regolith architecture and Bi geochemical expression (*c.f.* Figures 140, 142, 144, 145). Lintern *et al*., (2002).



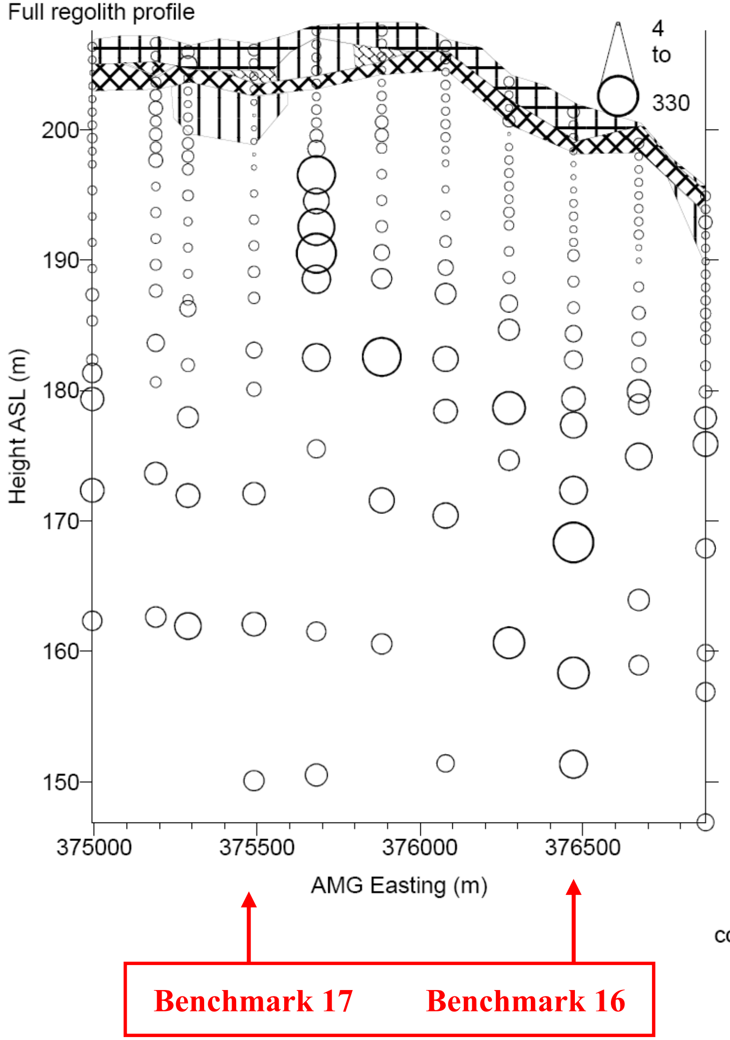



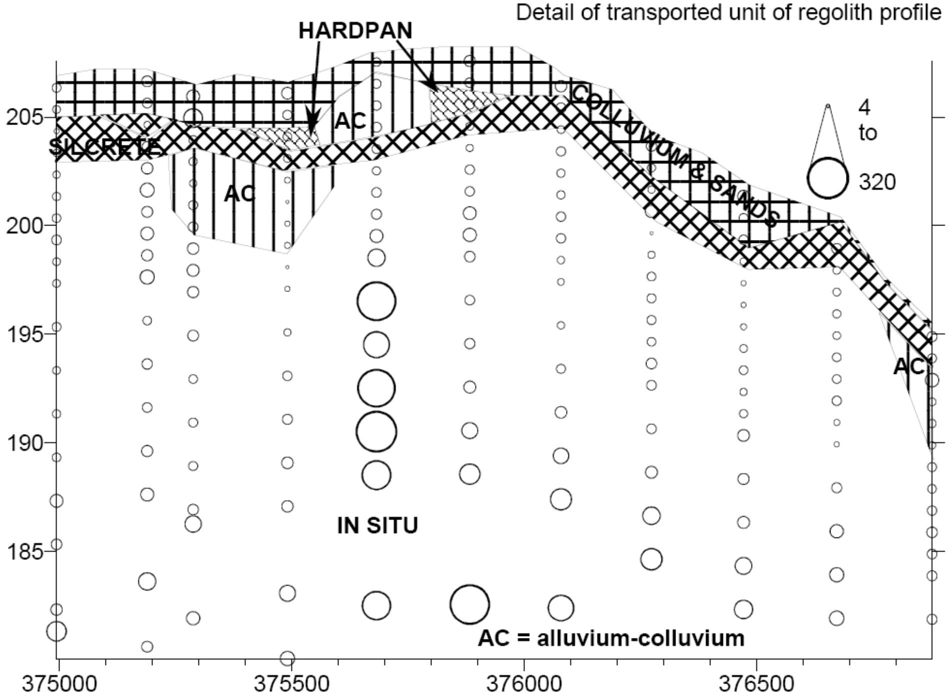

| | Colluvium -alluvium | In situ | Colluvium -sand | Silcrete |
|---|---|---|---|---|
| Mean | 1.5 | 1.5 | 0.7 | 1.5 |
| Std Error | 0.2 | 0.1 | 0.1 | 0.1 |
| Median | 1.4 | 1.4 | 0.6 | 1.4 |
| Std Dev | 0.7 | 0.8 | 0.3 | 0.5 |
| Minimum | 0.6 | 0.6 | 0.4 | 0.6 |
| Maximum | 3 | 6.5 | 1.7 | 2.7 |
| Count | 14 | 166 | 17 | 17 |

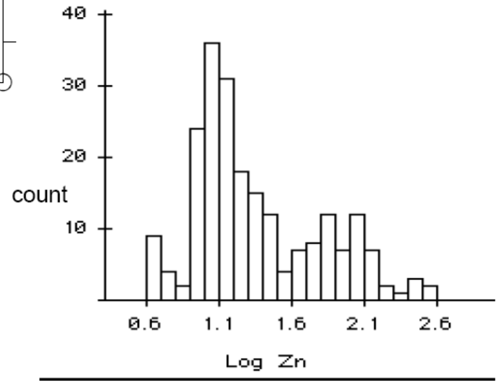
U (ppm)

Jumbuck

**Figure 144:** Jumbuck gold prospect regolith section, regolith architecture and U geochemical expression (*c.f.* Figures 140, 142, 143, 145). Lintern *et al.*, (2002).




| | Colluvium -alluvium | In situ | Colluvium -sand | Silcrete |
|---|---|---|---|---|
| Mean | 11 | 49 | 18 | 11 |
| Std Error | 2 | 5 | 3 | 1 |
| Median | 10 | 20 | 14 | 9 |
| Std Dev | 6 | 63 | 12 | 5 |
| Minimum | 4 | 4 | 9 | 5 |
| Maximum | 29 | 330 | 61 | 24 |
| Count | 14 | 166 | 17 | 17 |

Zn (ppm)

Jumbuck

**Figure 145:** Jumbuck gold prospect regolith section, regolith architecture and Zn geochemical expression (*c.f.* Figures 140, 142-144). Lintern *et al*., (2002).

## Benchmark 25: drillhole 97JBAR064

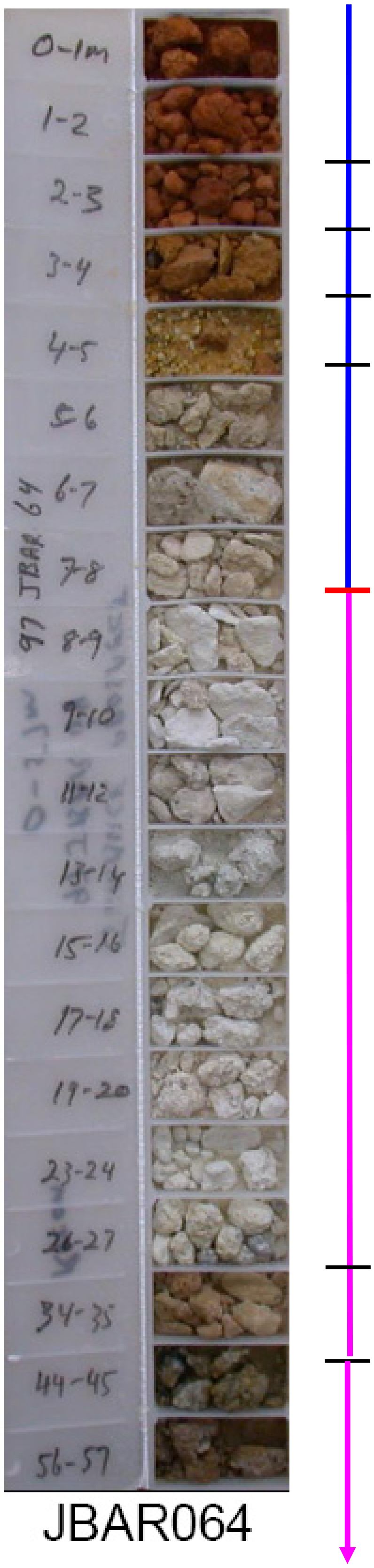
Quick reference items are set out in Table 61; detailed descriptions, figures and data tables follow on below. Jumbuck prospect is ~3 km SE of Jumbuck Outstation on Commonwealth Hill Pastoral Station. Sites were about 2 kilometres S of the original unsealed road between Commonwealth Hill to Mobella Pastoral Station Homesteads, and via station-mineral exploration dirt tracks (Figures 110-112, 136, 137). Drilling for these holes was vertical, and of RAB type. A summary of this profile is provided in Table 62 and chiptray photograph with regolith zonation is in Figure 146. Geochemical data are presented in Figures 140, 142-145 and Table 58.

**Table 61**: Benchmark 25 reference data; drillhole 97JBAR064 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-112, 136. |
| Local-site location map | Figures 137-139. |
| GPS coordinates, attitude & elevation | RAB drillhole 97JBAR064: Zone 53, 375619 E, 6690615 N, GDA 94. Vertical. **AHD:** 206.593 m (differential GPS data). |
| Site access, owner | About 3 km SE of Jumbuck Outstation on the Commonwealth Hill Pastoral Lease, and ~5 km E of the Challenger Gold Mine. Site Lease holder: Commonwealth Hill Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 146, Table 62. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 140, 142-145 and Table 58. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite crystallinity indices for unconformity picks. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | Ag, Bi, ?Cu, Zn. |
| Useful sampling media | Calcrete, silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 97JBAR064 is selected to form this benchmark because it intersects the thickest transported cover, while the weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 24 and the regolith cross-sections of Figures 138, 139. The exploration grid drilling involved RAB methods (mostly without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes typically end in saprock or lower saprolite rather than within fresh gneiss. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks, they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




**0-2 m** **Transported**: dune sand, aeolian, orange, siliceous uniformly sorted fine to medium sand grains, + earthy carbonate 1-2 m, + nodular calcrete 2-3 m.

**2-3 m** **Transported**: red-brown hardpan, clay-rich, cemented colluvial.

**~3-~4 m** **Duricrust**, silcrete developed in fluvial sands, brown to yellowish, cemented coarse-grained rounded to subrounded to subangular quartz grains.

**~4-5 m** **Transported**: yellow to reddish sandy clay + rounded sand grains.

**5-8 m** **Transported**: pale pink to buff coloured fluvial sand + silt & clay.

**8 m** **Unconformity**

**8-11 m** ***In situ***: ?remnant pedolith, plasmic (clay-rich), yellow flecked & stained.

**11-31 m** Upper saprolite, pallid, kaolinite-rich + quartz grit, bluish vein quartz at 13-15 + 17-18 + 26-28 m.

**31-36 m** Saprolite, pinkish grey to creamy mottled interval, clay-rich.

**36-60 m** Lower saprolite-Saprock, irregularly weathered, greyish with some pink staining, red staining at 55, 57, & 60 m; more competent than above interval. Greyish gneissic remnants (corestones).

**NOTE: bedrock not penetrated. E.O.H. at 60 m.**

Regolith logged by M.J. Sheard

**Figure 146:** Benchmark 25, Jumbuck gold prospect drillhole 97JBAR064, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). Drilling penetrated to 60 m but regolith chiptray sampling stopped at 57 m. In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehab. work.

**Table 62:** Benchmark 25 regolith log to RAB drillhole 97JBAR064 (after Lintern *et al*., 2002).

**Hole:** 97JBAR064. **Regolith Line**, Jumbuck gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 375619 E, 6690615 N, GDA 94. **AHD:** 206.593 m (differential GPS data)

**Site:** near flat area on reddish sand dune, vegetated.

**Vegetation:** *Acacia aneura* as Tall Open Shrubland over *Acacia aneura* Open Shrubland over *Ptilotus obovatus* and *Maireana georgei* + Low Shrubland over *Eragrostis eriopoda* + Very Open Grassland (Botanical log by S. Lintern).

**Soil:** Um (sand, loose, medium grained throughout).

**Calcrete:** nodular.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-1 | Reddish siliceous dune sand with podsol horizonation developed, loose, medium-grained sand, frosted sub-rounded grains + some earthy carbonate. |
| 1-2 | Pale red siliceous dune sand as above + ubiquitous nodular calcrete. |
| 2-~3 | Red-brown hardpan, non calcareous but peds and clods are carbonate dusted, ferruginous. |
| ~3-~4 | Hardpan as above + brown to yellowish silcrete encapsulating rounded fluvial coarse-grained sand + rounded quartz pebbles (20-40 mm) + angular quartz grit. |
| ~4-5 | Yellow to reddish sandy clay with rounded sand grains, fluvial deposit. |
| 5-8 | Pale pink to very pale yellow-brown sand + silt + kaolinite. Unconformity at ~8 m. |
| 8-11 | Pallid saprolite, kaolinite-rich, yellow staining & flecks, very little quartz grit. |
| 11-31 | Pallid saprolite, as above but with more quartz grit, abundant bluish vein quartz at 13-15 m + 17-18 m + 26-28 m. |
| 31-36 | Saprolite, pinkish grey to creamy mottled interval, clay-rich. |
| 36-42 | Lower saprolite, brownish grey + yellow mottles, becomes pale olive-grey with depth, more competent than above interval. |
| 42->60 | Lower saprolite to Saprock (?corestones or irregularly weathered), greyish with some pink staining, red staining at 55, 57, & 60 m; more competent than above interval. Greyish gneissic remnants. |
| E.O.H. | |

## *In situ Regolith*

Bedrock wasn't penetrated by any drillholes on this prospect, but remnant corestones within the saprock indicate it is typical of the Christie Gneiss. Generally saprolite and most of the weathered *in situ* regolith at this site follows descriptions for this prospect set out earlier. However, pedolith appears to be severely truncated by a fluvial channel development. What little pedolith remains is difficult to be certain about regarding pedogenic fabrics and mottling (cuttings alone don't provide large enough fragments for complex weathering fabrics to be properly observed-described).

## *Transported Regolith*

Aeolian dune sand forms the upper most transported cover unit (2 m thick) with an additional ~1 m of primarily colluvial sediment forming a distinctive red-brown hardpan horizon below. Underlying the hardpan is a silcrete duricrust (~1 m thick) cementing fluvial sediment. That silcrete possibly forms a major barrier or impediment to the upward migration of weathering associated solutions derived from buried mineralization. Underneath the silcrete duricrust, more fluvial material occurs (sand + silt + clay, ~4 m thick, containing well rounded to subangular grains) as infill to a section cross-cutting fluvial channel (Figures 138, 139). Together these transported units form an 8 m covering on the weathered basement

It is worth noting here that well rounded fluvial granules were shaken loose during drilling, from the silcrete and associated overlying sediments, and similarly for nodular calcrete in the dune sands. These together formed a significant down-hole contaminant component in the RAB samples (to sample depths of ~30 m) and could mislead unwary sample loggers.

## ***Geochemistry***

Significant Au concentrations in the regolith are listed in Table 58. Gold concentrations above background (>1 ppb) were measured in both the transported cover and upper weathered *in situ* regolith at Jumbuck (Figure 140). Benchmark 25 has low order Au concentrations. Especially through the transported cover Near surface, the highest Au concentration was located in a calcrete-silcrete sample towards the centre of the section and on the edge of the slope. More general comments on associated elemental abundances and dispersion are made under the Jumbuck gold prospect heading. A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including Ag, Bi, U and Zn, appear in Figures 142-145.

## Golf Bore gold prospect

### Background

The Golf Bore gold prospect lies about 36 km NE of the Challenger Gold Mine (Figure 136) and can be accessed via a pastoral lease track running NW to Sandstone Bore from Commonwealth Hill Pastoral Station Homestead. The prospect covers undulating terrain in an area occupied by isolated W trending orange longitudinal dunes of Pleistocene age that form an easterly outlier of the Great Victoria Desert. Dunes cover a substrate of deeply weathered and silcrete capped Archaean Christie Gneiss with a variety of overlying sediments. Basement depressions have been infilled with up to 6 m of sediment. A silcrete duricrust has cemented both weathered *in situ* basement and overlying colluvium-alluvium into a single horizon that has been partly truncated by erosion on one side of a minor palaeochannel. This terrain supports open woodland vegetation (*Eucalyptus* and *Acacia*), numerous woody shrubs (e.g. *Acacia, Eremophila* and *Maireana*) and other plants (*Ptilotus, Eragrostis* and *Atriplex*) (after Lintern *et al*., 2002).

Golf Bore prospect formed part of the larger Gawler Joint Venture tenement coverage, occupying most of the area in Figure 136. This Au anomaly was discovered in 1995 using regional Au-in-calcrete methods (a complex anomaly, with ~NE-SW trend, and has a maximum of 260 ppb Au; Figure 147). It was drilled in 1996, mineralization appears to be restricted to a narrow corridor running diagonally across the prospect, where a resource of 0.72 million tonnes grading 3.29 g/t for 76,814 ounces of Au has been reported (Dominion Mining NL data).

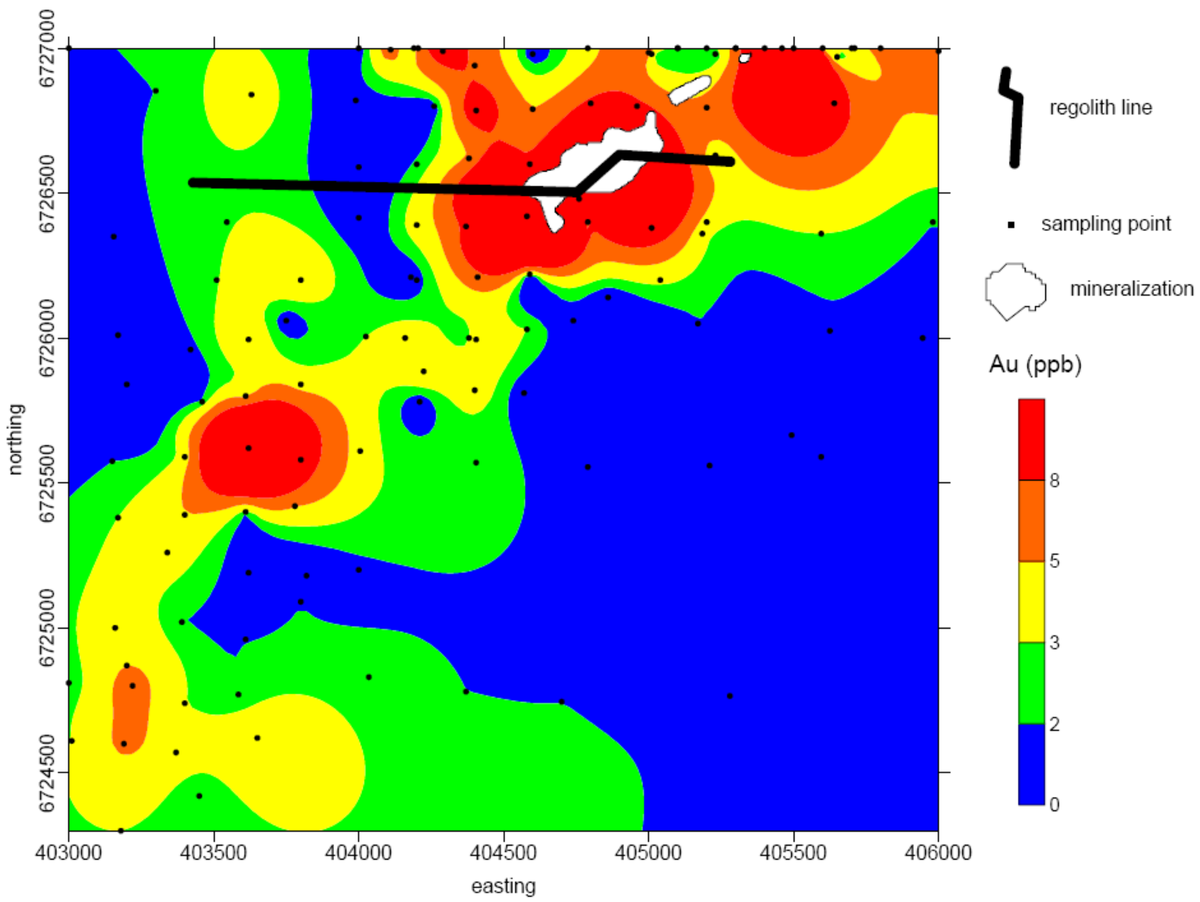



**Figure 147:** Golf Bore prospect in plan, showing Au-in-calcrete anomaly. Black dots are sample points, black line is the Regolith sampling section of Lintern *et al*. (2002) and Figures 148, 149. No detailed DEM is available for this area. Original data supplied by the Gawler Joint Venture. **Note**: grid coordinates are in AGD66 projection.

Regolith investigations by Lintern *et al*. (2002) began in 1998 as part of a broader regional study examining Au-in-calcrete anomalism. A series of ~EW trending company RAB and RC drillhole lines provided samples for regolith logging, characterisation, and analysis. Field inspection of drillhole spoil piles aided selection of two suitable study lines (local grid 6726500 N and 6726600 N AGD66 [respectively: 6726672 N & 6726772 N GDA94] Figure 147), joined as a single section to investigate the surface geochemical anomalism and mineralization identified by drilling.

## *In situ Regolith*

Bedrock (<5% weathered) was not penetrated by any of the exploration drilling on this prospect, however, remnant corestone fragments in saprock indicate bedrock to be a dark grey quartz-feldspar-biotite-muscovite gneissic granulite of fine- to medium-grain size (Christie Gneiss, Archaean). A more mafic character is expected in drillholes 96GBAR093-96GBAR028 due to the presence of ubiquitous chlorite in the overlying saprock and lower saprolite (Figures 148, 149).

Saprock (>5% to <20% weathered) was penetrated by most drilling (Figures 148, 149), it is generally complexly weathered but its boundary with lower saprolite is not easy to define from cuttings (possibly a gradational interval). It consists of a strongly foliated mafic (chloritic) to biotite-muscovite-rich gneiss, and is commonly coloured grey to greenish grey to near black. Thickness is indeterminate because its base was not intersected, however, it is likely to be in the range 10->20 m.

Saprolite (>20% weathered) is quite a complex weathering zone at Golf Bore (Figures 148, 149), lower saprolite was more uniform of colour and is less weathered than upper saprolite. Lower saprolite is typically greyish to olive-grey or dark green near more mafic lithotypes, and there are intervals at depth where extremely weathered rock is surrounded by much less weathered rock (? faults or shear zones). Remnant biotite and chlorite, plus abundant clay and quartz grit, with some talc are typical components. Upper saprolite is highly variable of colour (pallid, pale to strong yellow, greenish and pink), is of variable competency, and in places has FeOx-FeOH ?mottles and/or fracture staining. Kaolinite plus quartz grit ± chlorite ± sericite are the dominant mineral assemblage. As a whole, saprolite ranges from ~33 to >50 m thick.

Pedolith was difficult to recognise from cuttings because much of the indicator pedogenic fabric is not retained by such small fragments. Along most of the regolith section (Figures 148, 149) pedolith is in-part silicified and/or capped by silcrete. That duricrust commonly extends up into the overlying fluvial sediments, where the pedolith top forms an unconformity located wholly within that silcrete (best seen in outcrop but can be located with PIMA and a formula for determining the "kaolin crystallinity index" or KCI; refer to Lintern *et al*., 2002). Pedolith nearer its base is mostly unsilicified where it retains a clay-rich texture, some FeOH/FeOx staining or mottling is also evident. A thickness range of <1 to >4 m was observed.

## *Transported Regolith*

Positioning the unconformity was difficult at Golf Bore due to its loci being either totally within the silcrete horizon or just below it. Microscopic examinations were checked against the PIMA derived kaolinite crystallinity indices (KCI) but there were some conflicting outcomes due to the paucity of kaolinite remaining within silcrete and the presence of interfering smectite making utility of KCI's problematic (see location of red line on Figures 148, 149). Examining numerous eroding silcrete outcrops on the prospect provided valuable clues on just where the unconformity most likely occurs.

Fluvial sediment, is composed of alluvial sand ± gravel ± pebble-cobble beds in thin sheets (<1-<3 m thick) and these are all totally contained within the silcrete horizon. Clasts are well rounded, although not all have a high degree of sphericity, they are dominantly varieties of quartz with few to no lithics – indicating a relatively mature sediment derived from a well weathered terrain.

Silcrete, is thickest (2 m) at either end of the section and is thinnest (<1 m) to absent below the channel. As stated earlier, the silcrete contains both transported alluvium and silicified residual pedolith-saprolith where angular quartz grit dominates, along with some relict graphite grains. Part of the silcrete horizon may have been removed by erosion within the channel, and where outcropping it mostly displays an erosion truncated profile.

Red-brown hardpan, forms a distinctive strongly coloured colluvial-alluvial unit, infilling a palaeochannel above the silcrete (Figures 148, 149). Composed dominantly of clay with less quartz clasts (angular to subrounded) in a matrix supported framework, this colluvial-alluvial unit is typically partly bound by brown to black FeOx-MnOx cements ± hyaline silica to form an indurated horizon. Here it is restricted to the palaeochannel, elsewhere it forms a more extensive and useful marker bed.

Aeolian dune sand, orange, siliceous, is generally free-running except where cemented by calcrete. Sand grains are frosted, rounded to subangular, and of medium-grain size (uniformly sorted), grains are coated with a thin ferruginous skin and elsewhere have been dated by optical methods to age range from

~250 ka to <20 ka (Sheard *et al*., 2006). There is no illuviated clay or silt within these sands (Figures 148, 149)

Gypsum, dominantly very crystalline, occurs across the section, within and/or below the siliceous horizon, the pedolith and upper saprolite. It forms another indurated zone where interlocking pencil sized colourless to honey coloured crystals abound. Gypsum may comprise ~20-40 % of this zone, ranging from <1 to ~3 m thick (thickest below the palaeochannel, Figure 149), it therefore potentially dilutes any host materials and remnant geochemical signatures.

Calcrete, pale hues, occurs across the upper regolith within the dune sand, coating exposed silcrete and within thin soils. Nodules are dominant within the dunes but earthy powders and coatings occur on or within the upper hardpan, with laminated coatings to fracture infill on silcrete. Within the dunes, calcrete has developed at more than one level (Figure 149) but when initially sampled by explorationists it is the uppermost level that would have been taken for assay.

## *Geochemical expression*

Gold concentrations in calcrete (n=6) sampled from above mineralization have a mean concentration of 20 ppb against a background of about 3 ppb (n=8) (Figure 150). Calcrete over the mineralization zone has developed in about 2 m of colluvium over silcrete (non-calcareous) also containing elevated Au concentrations similar to those within the calcrete. The highest Au concentrations (85 ppb) are in silicified saprolite immediately beneath a Au- and Ca-rich silcreted horizon indicating a possible origin for the Au anomaly. Unfortunately, the corresponding colluvium and sand above these materials was not sampled due to poor drill spoil condition, so it was not possible to establish whether the Au anomaly is continuous to the surface. The effect of gypsum on the distribution of Au is unclear here but elsewhere gypsum dilutes the Au geochemical signal (see Volume 1, Boomerang gold prospect). Gold concentrations in the gypseous zone are not anomalous (<10 ppb) and they appear to be slightly diluted relative to the surface (Lintern *et al*., 2002, Lintern 2004b).

Gold is weakly correlated with As, Mn, and W in drill cuttings. Some of the more significant correlations between major and trace elements are available in Table 63, Selected drillhole intervals with elevated Au and basemetal concentrations are summarised in Table 64.

Saprolite and saprock are relatively rich in Fe, Mg, As, Co, Cr, Cs, Mn, Ni and Zn, derived from cordierite, garnet, feldspar, muscovite (sericite) and biotite in the bedrock. Higher in the profile, these minerals have largely weathered to kaolinite, with a subsequent depletion of chalcophile and siderophile elements. However, the upper regolith still retains the elemental signatures noted at depth, though at a lower concentration.

**Table 63:** Golf Bore gold prospect, the association between major and trace elements (Lintern 2004b).

| Major element | Trace element association | Interpretation |
|---|---|---|
| Ca | S and Sr | gypsum, calcrete. |
| K | Ba, Cs, Rb, Tl and (mainly) light REE | white micas and feldspars. |
| Mg | Co, Cu, Cs, Fe, Mn and Zn | adsorption by Fe oxides and/or original mafic composition. |
| Ti | Th, Nb, and U | similar ionic radii (Nb). |

**Table 64:** Golf Bore gold prospect, highest Au concentrations and other anomalous drillhole intervals (Lintern 2004b).

| Drillhole | Interval (m) | Analyses (ppm except Au) | Regolith zone |
|---|---|---|---|
| 96GBAR102 | 22-23 | Au 85 ppb, As 145 | saprolite |
| 96GBAR93 | 46-47 | Au 284 ppb, As 120 | saprolite |
| 96GBAR93 | 35-36 | Au 483 ppb | saprolite |
| 96GBAR249 | 19-20 | Au 5 ppb, Cu 420, As 100 | saprolite |
| 96ORAR10 | 25-26 | Au 2 ppb, Cu 600 | saprolite |

In Summary: the Golf Bore gold prospect case study outlined above indicates that elevated Au concentrations in calcrete can be detected in thin (<6 m) transported cover over mineralization. Gold also occurs in silcrete developed over mineralization (as was also demonstrated at the Challenger Gold Deposit) and may argue for a localised river bank origin for the Au in transported cover. The effect of gypsum on Au concentrations is unclear – not notably diluted nor enhanced (after Lintern 2004b).

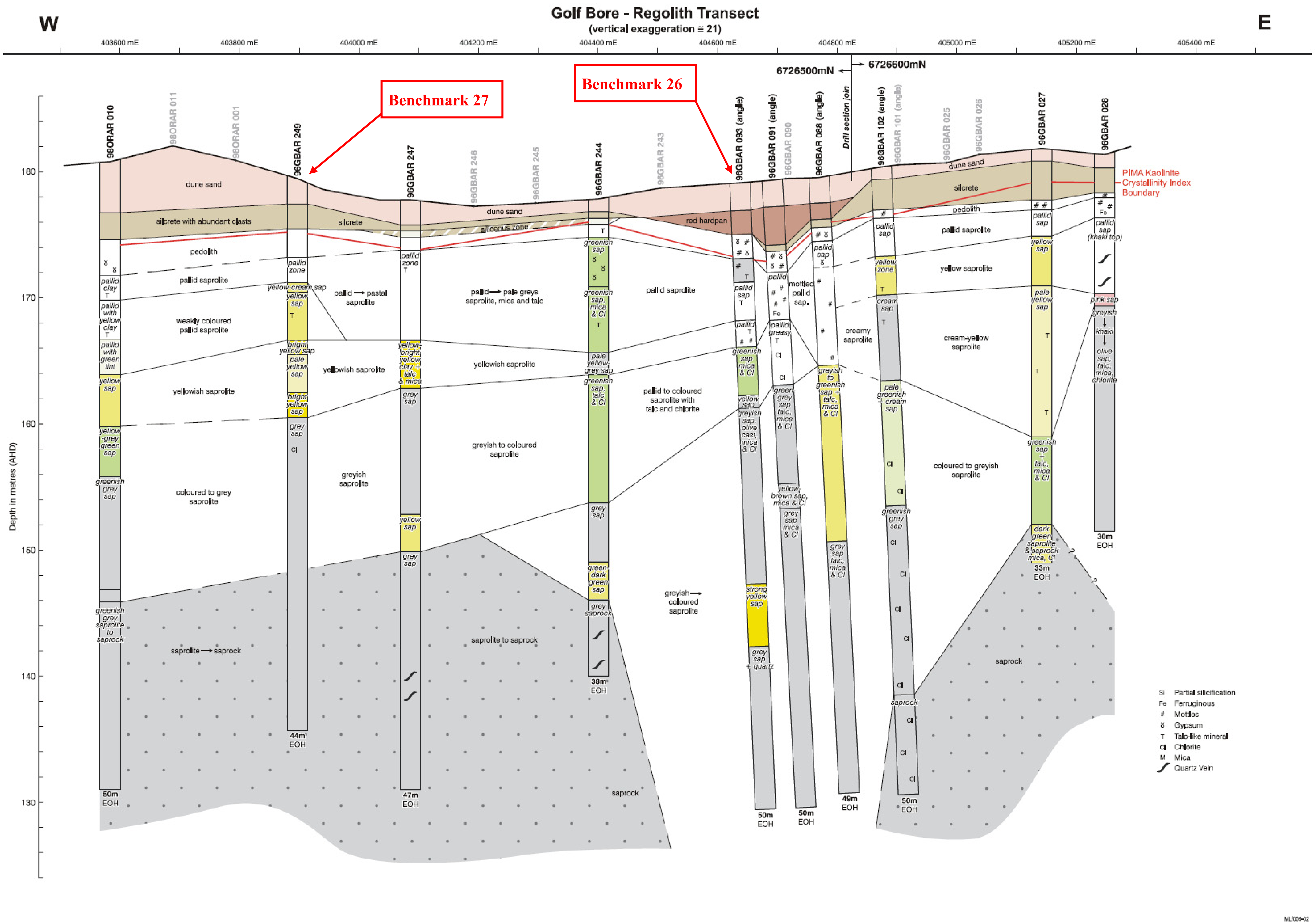



**Figure 148:** Golf Bore gold prospect, full regolith section along line displayed in Figure 147 (Lintern *et al.*, 2002). Benchmarks 26 and 27 are indicated.

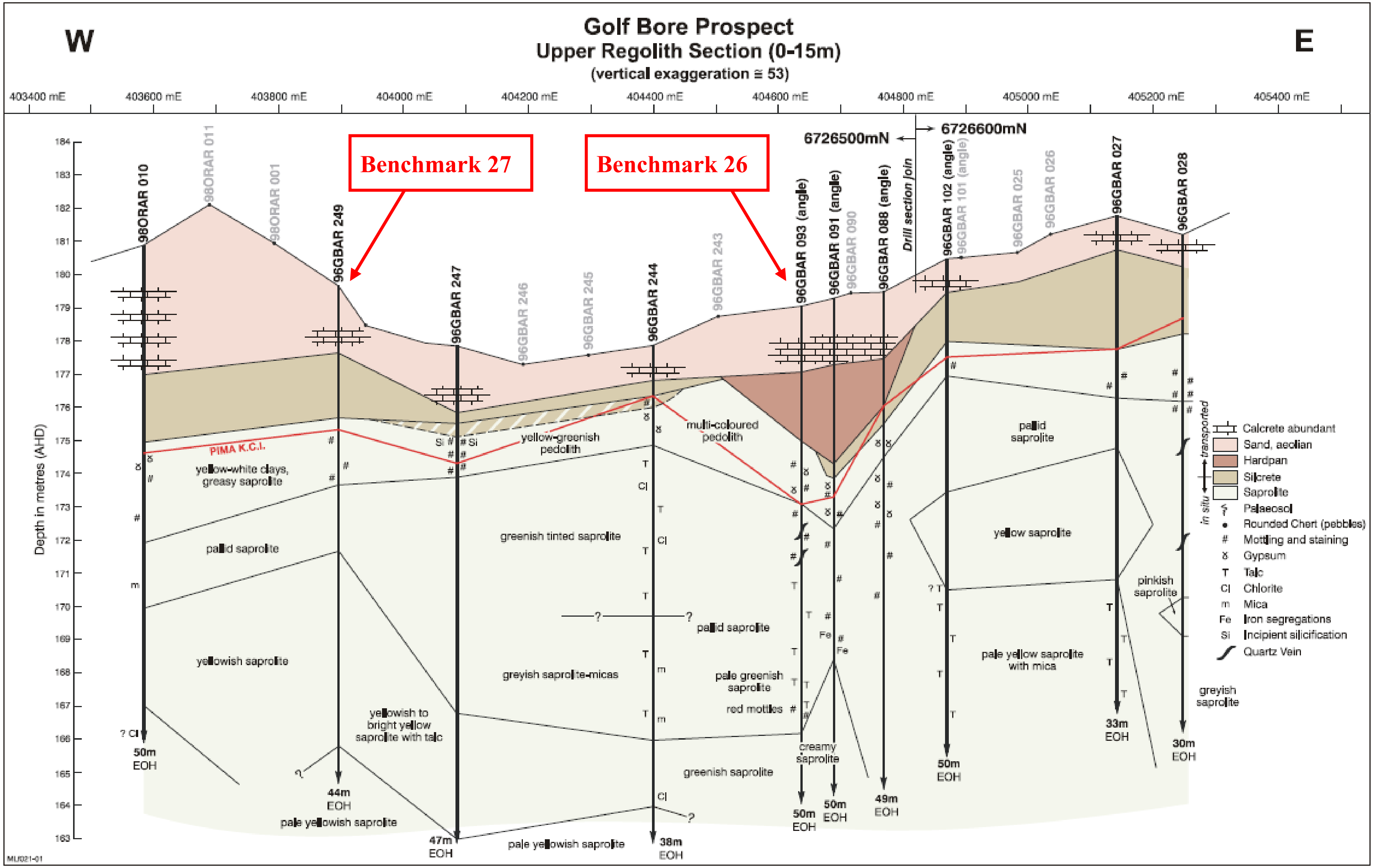
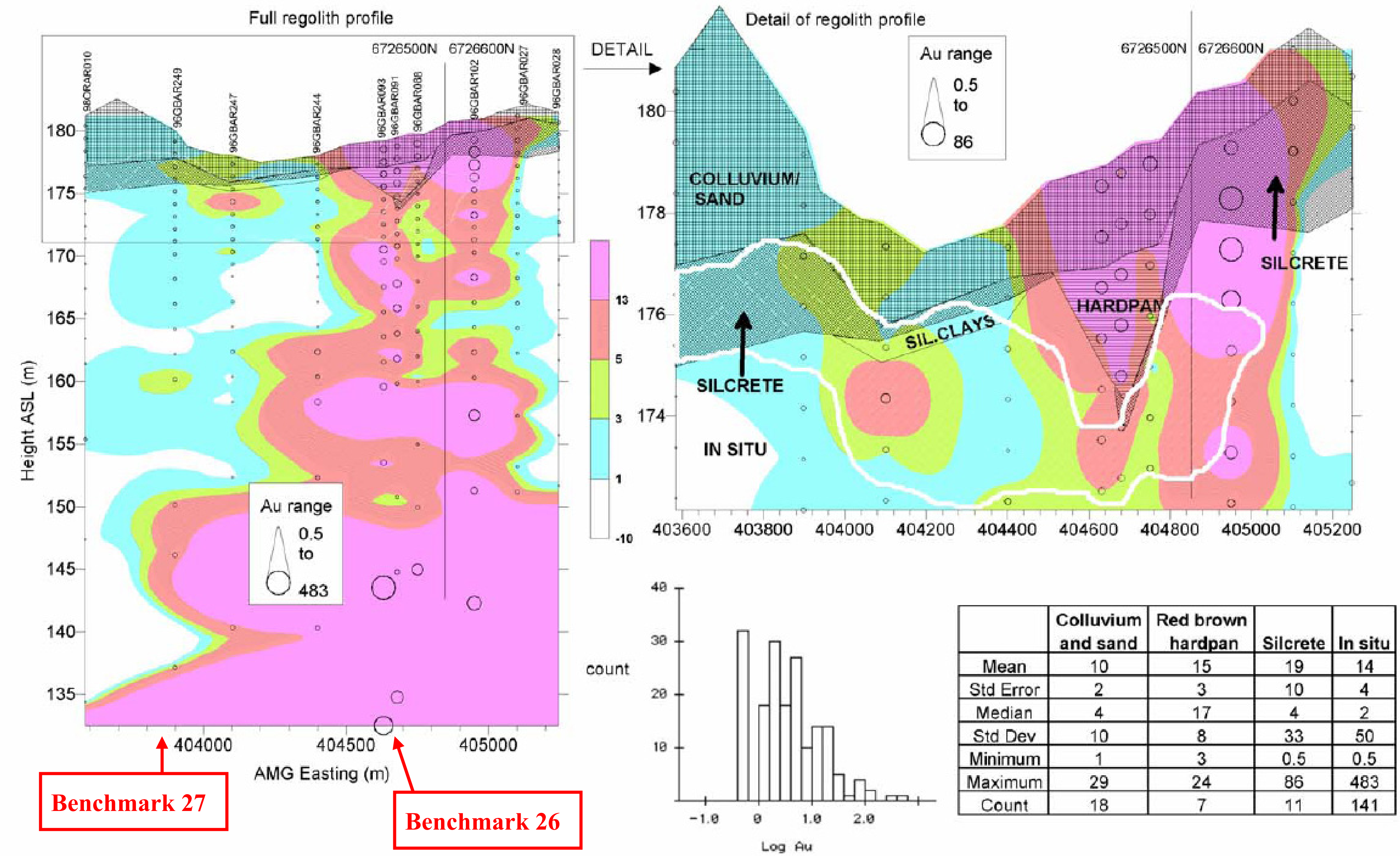



**Figure 149:** Golf Bore gold prospect, upper regolith section along line displayed in Figure 147 (Lintern *et al*., 2002). Benchmarks 26 and 27 are indicated.




| | Colluvium and sand | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 10 | 15 | 19 | 14 |
| Std Error | 2 | 3 | 10 | 4 |
| Median | 4 | 17 | 4 | 2 |
| Std Dev | 10 | 8 | 33 | 50 |
| Minimum | 1 | 3 | 0.5 | 0.5 |
| Maximum | 29 | 24 | 86 | 483 |
| Count | 18 | 7 | 11 | 141 |

**Figure 150:** Golf Bore gold prospect regolith section, regolith architecture and Au geochemical expression (*c.f.* Figures 147-149). All data are in ppb (Lintern, 2004b). Benchmarks 26 and 27 are indicated.

## Benchmark 26: drillhole 96GBAR093

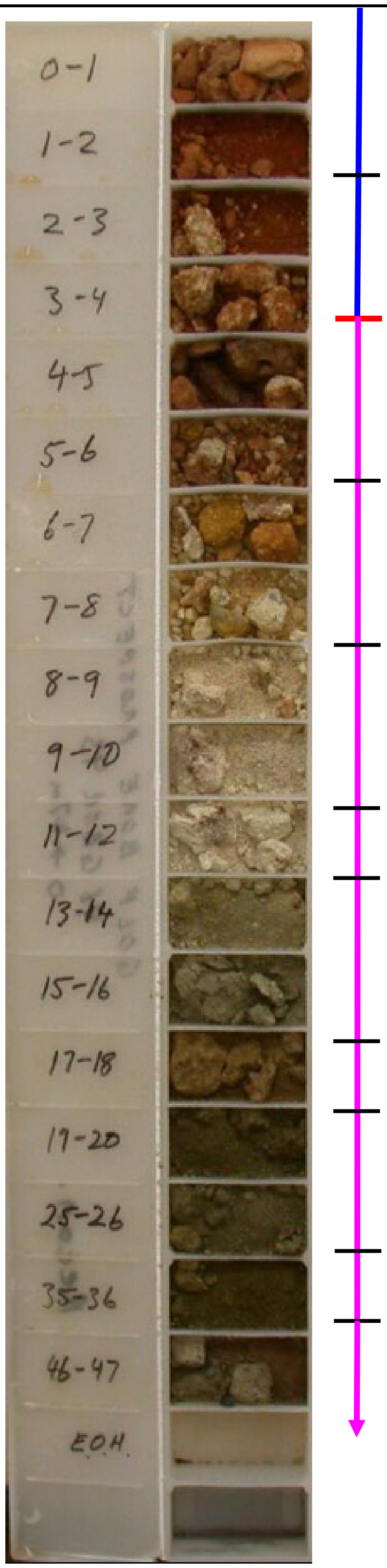
Quick reference items are set out in Table 65; detailed descriptions, figures and data tables follow on below. Golf Bore prospect lies about 36 km NE of the Challenger Gold Mine and can be accessed via a pastoral lease track running NW to Sandstone Bore from Commonwealth Hill Pastoral Station Homestead (Figures 110-112 136, 147). Drilling for this RC hole was angular (60$^o$ dip → 090$^o$) while all RAB holes were vertical. A summary of this profile is provided in Table 66 and chiptray photograph with regolith zonation is in Figure 151. Geochemical data are presented in Figures 150, 152-155 and Tables 63, 64.

**Table 65**: Benchmark 26 reference data; drillhole 96GBAR093 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-112, 136. |
| Local-site location map | Figures 147-149. |
| GPS coordinates, attitude & elevation | RC drillhole 96GBAR093: Zone 53, 404759 E, 6726683 N, GDA 94. **Attitude**: 60$^o$ dip → 090$^o$. **AHD:** 179.026 m (differential GPS data). |
| Site access, owner | About 36 km NE of the Challenger Gold Mine (Figure 136) and can be accessed via a pastoral lease track running NW to Sandstone Bore from Commonwealth Hill Pastoral Station Homestead. Site Lease holder: Commonwealth Hill Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 151, Table 66. |
| Sample types | Drill chips in chiptrays + ~1 kg bags |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 150, 152-155 and Tables 63, 64. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite crystallinity indices for unconformity picks. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | As, ?W. |
| Useful sampling media | Calcrete, alluvium-colluvium & silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 96JGAR093 is selected to form this benchmark because it intersects a thick segment of palaeochannel sediment and other transported cover, while the weathered *in situ* regolith is relatively straight forward regarding its interpretation. This drillhole also contains some high Au concentrations and so do the overlying transported cover units. A comparison is provided through Benchmark 27 and the regolith cross-sections of Figures 148, 149. Exploration grid drilling on this prospect mostly involved RAB methods (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes terminated in saprock or lower saprolite rather than within fresh gneiss. Moreover, the same is true for all infill RC drilling, in that those mineralization targeting drillholes also terminated in saprolite-saprock due to the weathering front dropping well below 55 m around mineralization. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




96GBAR93

| | |
|---|---|
| **0-2 m** | **Transported**: aeolian sand, orange, siliceous uniformly sorted fine to medium sand grains, + nodular calcrete. |
| **2-<4 m** | **Transported**: red hardpan, clay-rich + rounded gravel and pebbles, cemented colluvial-alluvial. |
| **4 m** | **Unconformity** |
| **<4-6 m** | ***In situ***: remnant pedolith (waste mantle) plasmic (clay-rich), multicoloured + abundant crystalline gypsum. |
| **6-8 m** | Pallid saprolite, bright yellow mottles/stains, abundant grey vein quartz {+ down hole contamination from hardpan as water worn gravel & pebbles]. |
| **8-11 m** | Pallid saprolite, greasy feel (? talc) + kaolinite & quartz grit. |
| **11-13 m** | Upper saprolite, greenish tint, kaolinite + talc + quartz, red mottling at 12-13 m. |
| **13-17 m** | Upper saprolite, greenish, quartz + kaolinite + micas + chlorite. |
| **17-18 m** | Saprolite, yellowish, quartz + kaolinite + micas. |
| **18-32 m** | Saprolite, greyish with olive-green tint, quartz + kaolinite + micas + chlorite. |
| **32-37 m** | Saprolite, strong yellow, clay-rich. |
| **36->47 m** | Saprolite, greyish with abundant grey vein quartz; more competent than above interval. |

**NOTE: saprock and bedrock not penetrated.**
**E.O.H. at 50 m.**

Regolith logged by M.J. Sheard

**Figure 151:** Benchmark 26, Golf Bore gold prospect drillhole 96GBAR093, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). Drilling penetrated to 50 m but regolith chiptray sampling stopped at 47 m. In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work. **Note:** depths have not been corrected for hole angle; to obtain true depths multiply by 0.86.

**Table 66:** Benchmark 26, regolith log to RC drillhole 96GBAR093 (after Lintern *et al*., 2002).

**Hole:** 96GBAR093. **Regolith Line**, Golf Bore gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 404759 E, 6726683 N, GDA 94. **AHD:** 179.026 m (differential GPS data)

**Attitude:** $60^o$ dip → $090^o$.

**Site:** flat sandy area, vegetated.

**Vegetation:** *Acacia aneura* as Tall Shrubland over *Eremophila latrobei, Maireana georgei* and *Atriplex vesicaria* Low Open Shrubland, + many vehicle tracks (Botanical log by S. Lintern).

**Soil:** Um (sand, loose, medium grained throughout).

**Calcrete:** nodular.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-2 | Reddish siliceous dune sand with paler podsol horizonation developed, loose, medium-grained sand, frosted sub-rounded grains + nodular calcrete. |
| 2-<4 | Red hardpan and calcrete, bulk is non calcareous but peds and blocks are carbonate dusted at 2-3 m. Unconformity just above 4 m. |
| <4-6 | Pedolith (waste mantle) capping to saprolite, multicoloured and gypseous (well crystallised). |
| 6-8 | Pallid upper saprolite with bright yellow mottling & staining, mostly kaolinite + quartz grit, abundant grey vein quartz. [down hole contamination from red hardpan as well rounded quartz gravel and pebbles]. |
| 8-11 | Pallid interval, greasy feel to cuttings (?talc) + kaolinite and quartz grit. |
| 11-13 | As above interval, but with greenish tint to saprolite, kaolinite + talc + quartz grit, red mottling at 12-13 m. |
| 13-17 | Greenish saprolite, quartz + kaolinite + micas + chlorite. |
| 17-18 | Yellowish saprolite, quartz + kaolinite + micas. |
| 18-32 | Greyish saprolite, with olive-green tint, quartz + kaolinite + micas + chlorite. |
| 32-37 | Saprolite, strong yellow hue, quartz + kaolinite + micas. |
| 37->50 | Greyish saprolite, greyish with abundant grey vein quartz; more competent than above interval. |
| E.O.H. | **Note:** depths have not been corrected for hole angle, to obtain true depths multiply by 0.86. |

## *In situ* Regolith

Bedrock wasn't penetrated by any drillholes on this prospect, but remnant corestones within the saprock indicate it has components typical of the Archaean Christie Gneiss. Generally saprolite and most of the weathered *in situ* regolith at this site follow descriptions for this prospect set out earlier. Pedolith however, appears to be truncated, probably by erosion (the site is on a buried escarpment where the silcrete roughly follows the palaeotopography). What remaining pedolith there is, is partly encapsulated by the silcrete horizon, and the remainder is difficult to be certain about (cuttings alone don't provide large enough fragments for complex weathering fabrics to be properly observed-described).

## *Transported Regolith*

Aeolian dune sand forms the primary transported cover (~3 m thick) with an additional <1 m of primarily fluvial sediment (sand + gravel + pebbles +?colluvium) encapsulated by the silcrete duricrust. That silcrete possibly forms a major barrier or impediment to the upward migration of weathering associated solutions derived from buried mineralization.

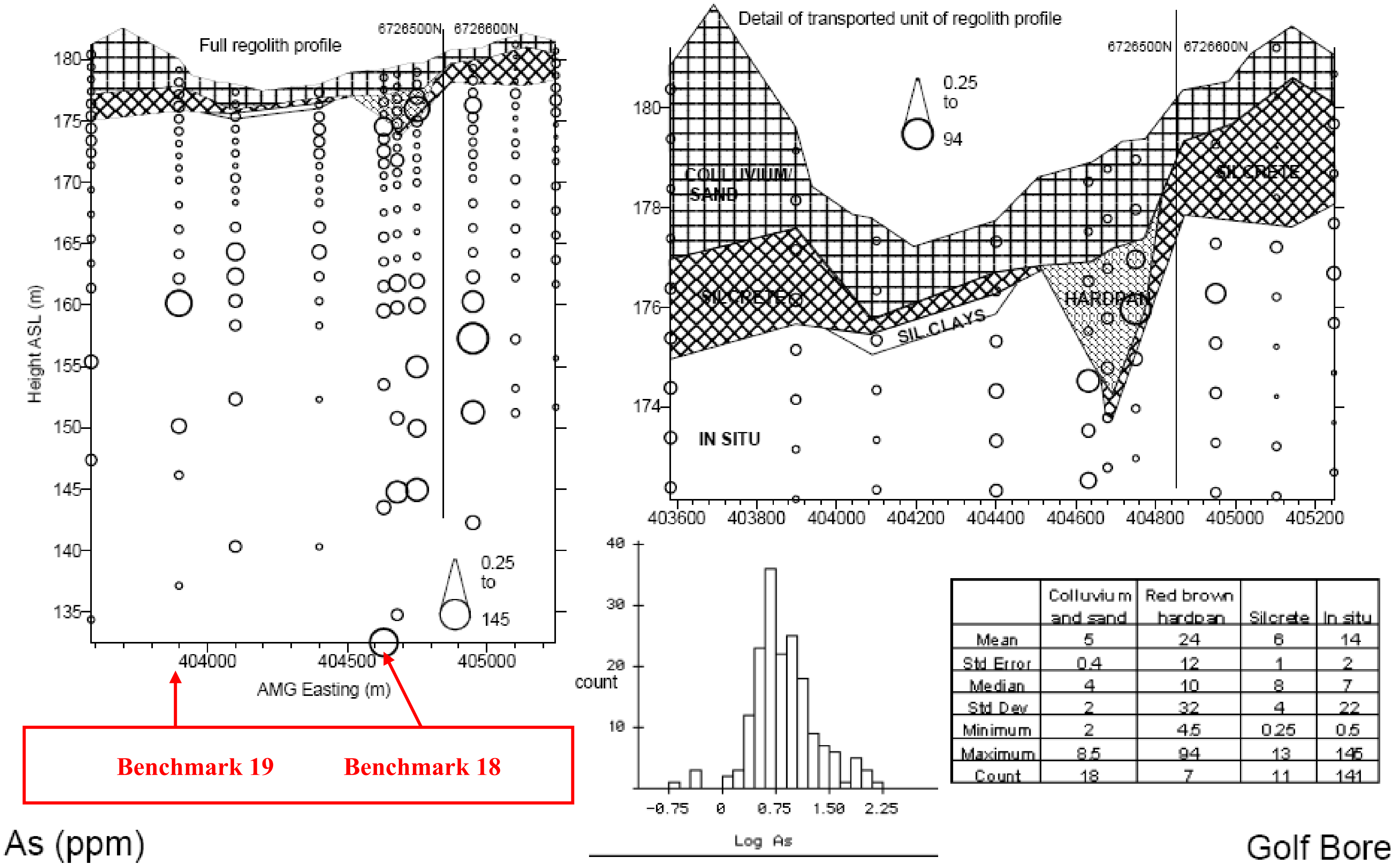
It is worth noting here that well rounded fluvial pebbles were shaken loose during drilling, from the silcrete and associated sediments, and similarly for nodular calcrete in the dune sands. These together formed significant down-hole contaminants in the RAB samples (to sample depths of ~30 m) and could mislead unwary sample loggers.

### Geochemistry

Significant Au concentrations in the regolith are listed in Tables 63, 64. Gold concentrations above background (>1 ppb) were measured in both the transported cover and upper weathered *in situ* regolith at Golf Bore prospect (Figure 150). This Benchmark has the highest Au concentrations (Au 284 ppb at 35-36 m & 483 ppb at 46-47 m) in saprolite and those correspond with high Au concentrations found in the deeper regolith. Near surface, the highest Au concentration were located in and around a palaeochannel where sediment may be sourcing Au from the underlying-silcrete. The relationship between Au and Ca in the upper regolith is displayed under Benchmark 27 Geochemistry (Figure 157). That relationship is more tenuous within the heavily gypcreted zone due to metal signature dilution by gypsum. More general comments on associated elemental abundances and dispersion are made under the Golf Bore gold prospect Geochemistry heading.

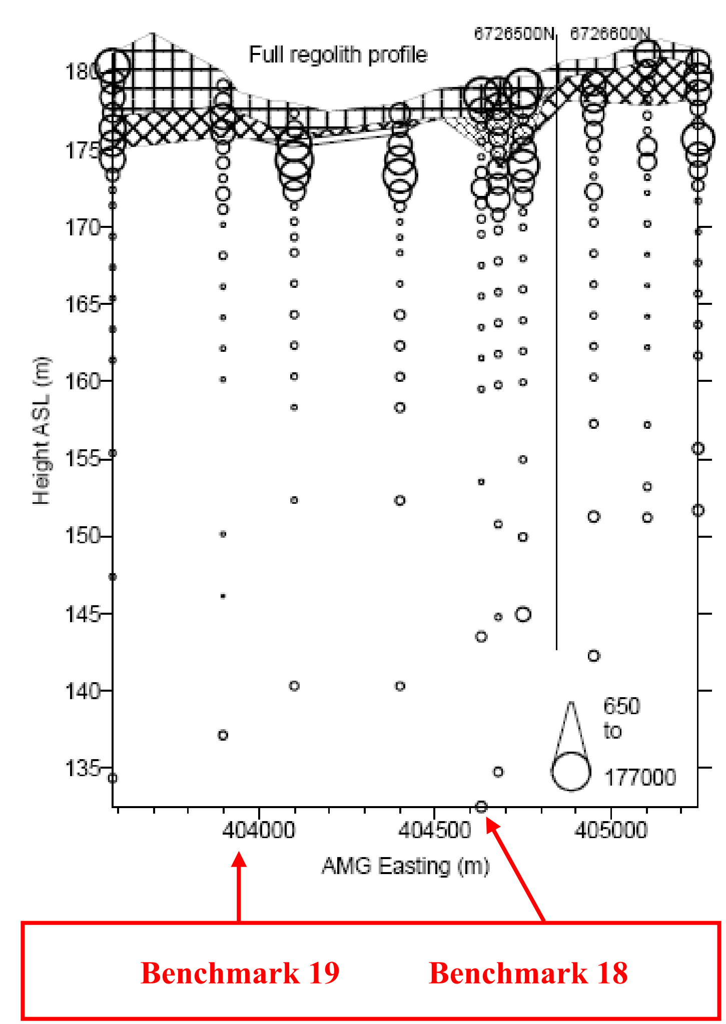
A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including As, Ca, S and W appear in Figures 152-155. Plots of Ca and S (Figures 153, 154), when compared, demonstrate the presence of both calcrete and abundant gypsum in the upper regolith. Arsenic is anomalous within the mineralized zone, its weathered equivalent, and also in the transported regolith. It therefore may serve as a regional pathfinder element to more cryptic mineralization in this area – particularly where Au signatures are weak. Tungsten here may serve as a deeper level secondary pathfinder element, although it is very low level in the upper regolith, and Au provides a much stronger signal on its own.

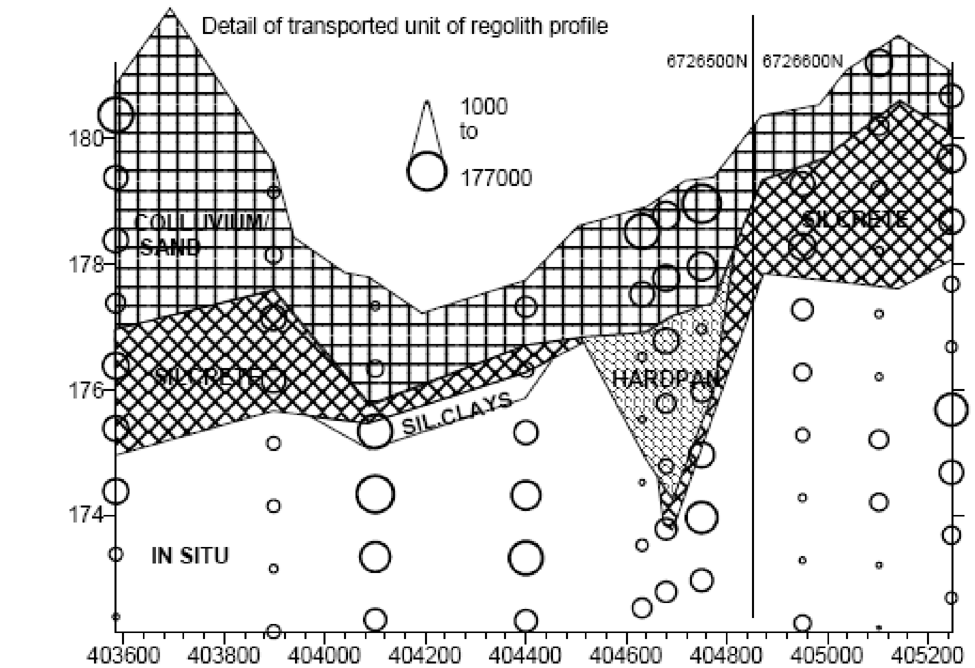
Compare this geochemical expression with that of Benchmark 27 set away from the defined Au mineralization and where the aeolian transported cover is thicker than for Benchmark 26.

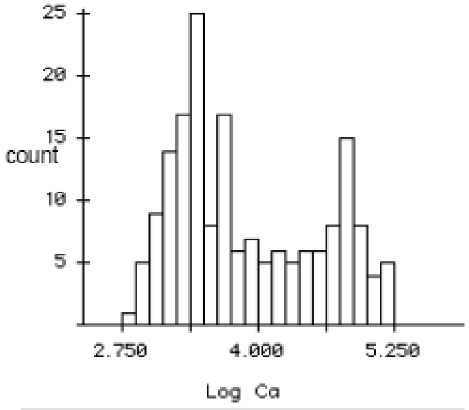



| | Colluvium and sand | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 5 | 24 | 6 | 14 |
| Std Error | 0.4 | 12 | 1 | 2 |
| Median | 4 | 10 | 8 | 7 |
| Std Dev | 2 | 32 | 4 | 22 |
| Minimum | 2 | 4.5 | 0.25 | 0.5 |
| Maximum | 8.5 | 94 | 13 | 145 |
| Count | 18 | 7 | 11 | 141 |

**Figure 152:** Golf Bore gold prospect regolith section, regolith architecture and As geochemical expression (*c.f.* Figures 150, 153-155). Lintern *et al*. (2002).



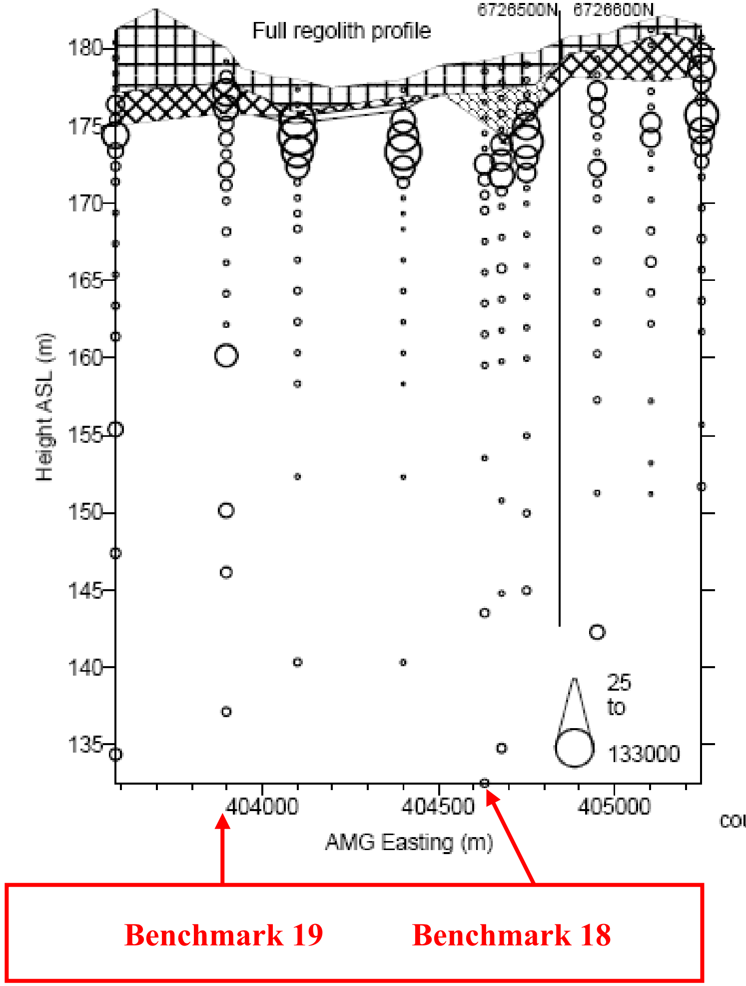



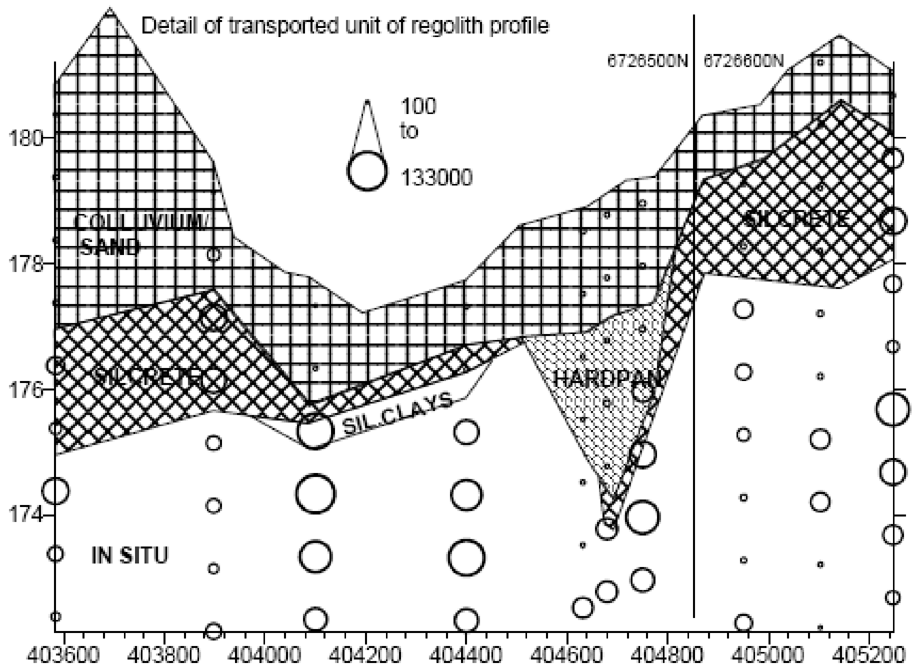



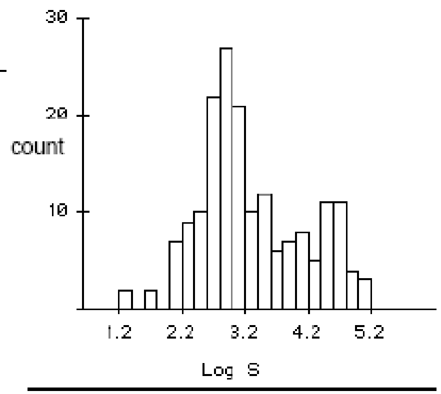

| | Colluvium and sand | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 70431 | 26729 | 57064 | 15512 |
| Std Error | 10863 | 9286 | 7803 | 2479 |
| Median | 64700 | 19700 | 69900 | 3350 |
| Std Dev | 46087 | 24570 | 25879 | 29441 |
| Minimum | 5450 | 3050 | 5300 | 650 |
| Maximum | 177000 | 70000 | 86900 | 164000 |
| Count | 18 | 7 | 11 | 141 |

Golf Bore

**Figure 153:** Golf Bore gold prospect regolith section, regolith architecture and Ca geochemistry (calcrete + gypsum; *c.f.* Figures 150, 152, 154, 155). Lintern *et al.* (2002).



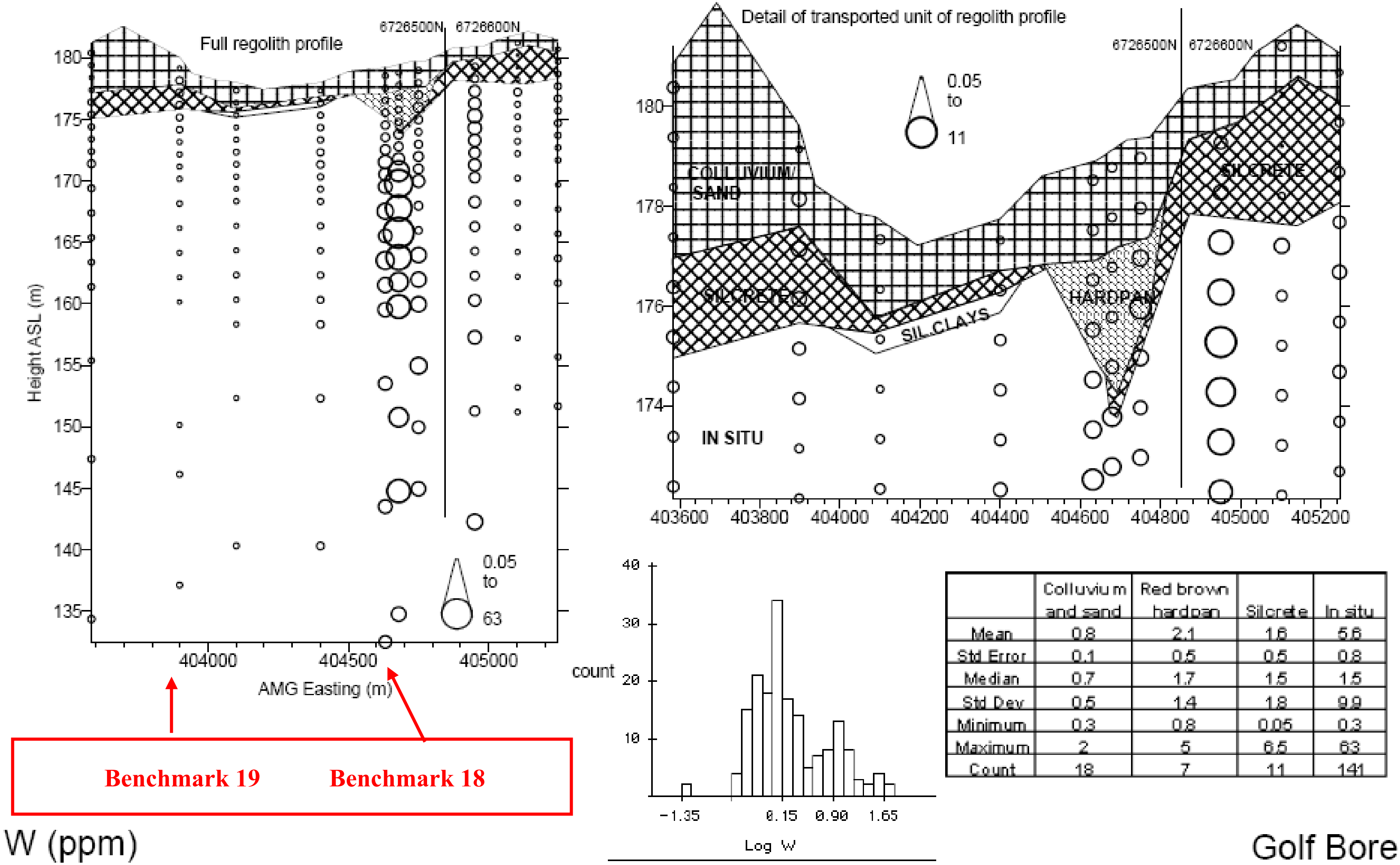




| | Colluvium and sand | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 1094 | 5107 | 23518 | 12206 |
| Std Error | 528 | 4452 | 7206 | 2082 |
| Median | 625 | 650 | 22600 | 1450 |
| Std Dev | 2240 | 11780 | 23898 | 24720 |
| Minimum | 100 | 200 | 250 | 25 |
| Maximum | 10000 | 31800 | 60000 | 133000 |
| Count | 18 | 7 | 11 | 141 |

S (ppm)

Golf Bore

**Figure 154:** Golf Bore gold prospect regolith section, regolith architecture and S geochemistry (gypsum; *c.f.* Figures 150, 152, 153, 155). Lintern *et al*. (2002).




| | Colluvium and sand | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 0.8 | 2.1 | 1.6 | 5.6 |
| Std Error | 0.1 | 0.5 | 0.5 | 0.8 |
| Median | 0.7 | 1.7 | 1.5 | 1.5 |
| Std Dev | 0.5 | 1.4 | 1.8 | 9.9 |
| Minimum | 0.3 | 0.8 | 0.05 | 0.3 |
| Maximum | 2 | 5 | 6.5 | 63 |
| Count | 18 | 7 | 11 | 141 |

**Figure 155:** Golf Bore gold prospect regolith section, regolith architecture and W geochemistry (*c.f.* Figures 150, 152-154). Lintern *et al*. (2002).

## Benchmark 27: drillhole 96GBAR249

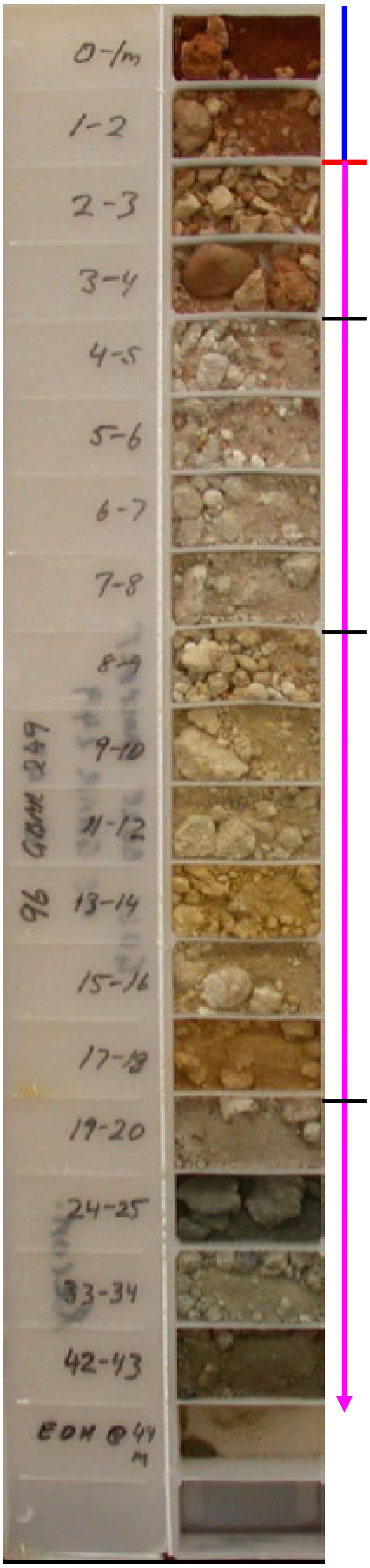
Quick reference items are set out in Table 67; detailed descriptions, figures and data tables follow on below. Golf Bore prospect lies about 36 km NE of the Challenger Gold Mine and can be accessed via a pastoral lease track running NW to Sandstone Bore from Commonwealth Hill Pastoral Station Homestead (Figures 110-112, 136, 147). Drilling for this RAB hole was vertical, while all RC holes were angular ($60^o$ dip → $090^o$). A summary of this profile is provided in Table 68 and chiptray photograph with regolith zonation is in Figure 156. Geochemical data are presented in Figures 150, 152-155, 157 and Tables 63, 64.

**Table 67:** Benchmark 27 reference data; drillhole 96GBAR249 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-112, 136. |
| Local-site location map | Figures 147-149. |
| GPS coordinates, attitude & elevation | RAB drillhole 96GBAR249: Zone 53, 404026 E, 6726683 N, GDA 94. Vertical. **AHD:** 179.650 m (differential GPS data.). |
| Site access, owner | About 36 km NE of the Challenger Gold Mine (Figure 136) and can be accessed via a pastoral lease track running NW to Sandstone Bore from Commonwealth Hill Pastoral Station Homestead. Site Lease holder: Commonwealth Hill Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 156, Table 68. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 150, 152-155, 157 and Tables 63, 64. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite crystallinity indices for unconformity picks. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | ?As. |
| Useful sampling media | Calcrete & ? silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 96GBAR249 is selected to form this benchmark because it has a thin (2 m) transported cover and is sited away from the defined Au mineralization. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 26 and the regolith cross-sections of Figures 148, 149. Exploration grid drilling on this prospect mostly involved RAB (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have terminated in saprock or lower saprolite rather than within fresh gneiss. Moreover, the same is true for all infill RC drilling, in that those mineralization targeted drillholes also terminated in saprolite-saprock due to the weathering front dropping to well below 55 m around mineralization. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




96GBAR249

**0-<2 m** **Transported**: aeolian sand, reddish, siliceous uniformly sorted fine to medium grains, + nodular calcrete + minor silcrete with rounded quartz clasts & vein quartz (?lag).

**>2-4 m** ***In situ***: pedolith, silcrete with enclosed rounded quartz clasts & grey vein quartz.
**Unconformity** >2 m.

**<4-8 m** Lower pedolith (waste mantle) plasmic (clay-rich) pallid & yellow mottled.

**8-19 m** Saprolite, yellowish to strong yellow, kaolinite + quartz, chalky.

**19-44 m** Saprolite, greys with olive-green chlorite-rich zones, some FeOH staining & abundant grey quartz; quartz + kaolinite + chlorite, more competent than above interval.

**NOTE: saprock and bedrock not penetrated.**
**E.O.H. at 44 m.**

Regolith logged by M.J. Sheard

**Figure 156:** Benchmark 27, Golf Bore gold prospect drillhole 96GBAR249, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). Drilling penetrated to 44 m but regolith chiptray sampling stopped at 43 m. In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work.

**Table 68:** Benchmark 27, regolith log to RAB drillhole 96GBAR249 (after Lintern *et al*., 2002).

**Hole:** 96GBAR249. **Regolith Line**, Golf Bore gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 404026 E, 6726683 N, GDA 94. **AHD:** 179.650 m (near drillhole 98ORAR001; differential GPS data)

**Attitude:** vertical

**Site:** on dune-silcrete rise.

**Vegetation:** *Acacia aneura* as Tall Open Shrubland over Shrubland over *Maireana georgei* and *Maireana integra* Low Open Shrubland over *Eragrostis eriopoda* Very Open Grassland (many dead *Acacia aneura* trees). (Botanical log by S. Lintern).

**Soil:** Um (sand, loose, medium grained throughout).

**Calcrete:** nodular.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-1 | Reddish siliceous dune sand, loose, medium-grained, frosted sub-rounded grains + nodular calcrete. |
| 1-2 | Reddish siliceous dune sand, loose, medium-grained, frosted sub-rounded grains + calcrete + some silcrete & grey vein quartz. |
| 2-4 | Pedolith, silcrete with enclosed rounded quartz clasts & grey vein quartz. Unconformity >2 m. |
| 4-6 | Pedolith, cream clay zone (plasmic zone), yellow mottles, waste mantle. |
| 6-8 | Pallid interval, kaolinite and quartz grit. |
| 8-9 | Saprolite, yellow to off-white & grey, predominantly kaolinite. |
| 9-13 | Saprolite, yellowish, weak greasy feel, kaolinite + quartz +?talc. |
| 13-14 | Saprolite, bright yellow, kaolinite + quartz. |
| 14-17 | Saprolite, pale yellow, kaolinite + quartz. |
| 17-19 | Saprolite, strong yellow hue, kaolinite + quartz. |
| 19->44 | Saprolite, grey with olive-green chlorite-rich zones & abundant grey quartz; more competent than above interval. |
| E.O.H. | |

## *In situ Regolith*

Bedrock was not penetrated by drilling on this prospect, but remnant corestones within the saprock indicate it has components typical of the Christie Gneiss. Generally saprolite and most of the regolith at this site follow descriptions for this prospect set out earlier. A thick saprolite is present here and drilling may have come close to penetrating saprock. The pedolith appears to be truncated, probably by erosion (the site is on a buried escarpment where the silcrete roughly follows the palaeotopography). Some of the upper basement derived pedolith is partly encapsulated by the silcrete horizon, and the remainder is plasmic zone ± arenose zone (cuttings don't provide enough textural information to be certain).

## *Transported Regolith*

Aeolian dune sand forms the primary transported cover (~2 m) with an additional <1 m of primarily fluvial-colluvial sediment (sand + gravel) encapsulated by the silcrete duricrust. That silcrete possibly forms a major barrier or impediment to the upward migration of weathering associated solutions derived from buried mineralization.

## *Geochemistry*

Significant Au concentrations in the regolith on this prospect are listed in Tables 63, 64. Gold concentrations above background (>1 ppb) were measured in both the transported cover and upper weathered *in situ* regolith at Golf Bore prospect (Figure 150). However. this Benchmark is set well back from any defined Au mineralization and so its Au-in-regolith signatures are very low (1-3 ppb, Figures 150, 157. More general comments on associated elemental abundances and dispersion are made under the Golf Bore gold prospect Geochemistry section.

A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including As, Ca, S and W appear in Figures 152-155. Plots of Ca and S (Figures 153, 154) when compared demonstrate the presence of both calcrete and abundant gypsum in the upper regolith. Arsenic is anomalous within the mineralized zone, its weathered *in situ* equivalent, and also in the transported regolith. It therefore may serve as a regional pathfinder element to more cryptic mineralization in this area – particularly where Au signatures are weak. Tungsten may serve as a deeper level secondary pathfinder element, although it is very low level in the upper regolith here, and Au provides a much stronger signal on its own.

Compare this geochemical expression with that of Benchmark 26 over the defined Au mineralization and where the aeolian transported cover is marginally thicker than for Benchmark 26.

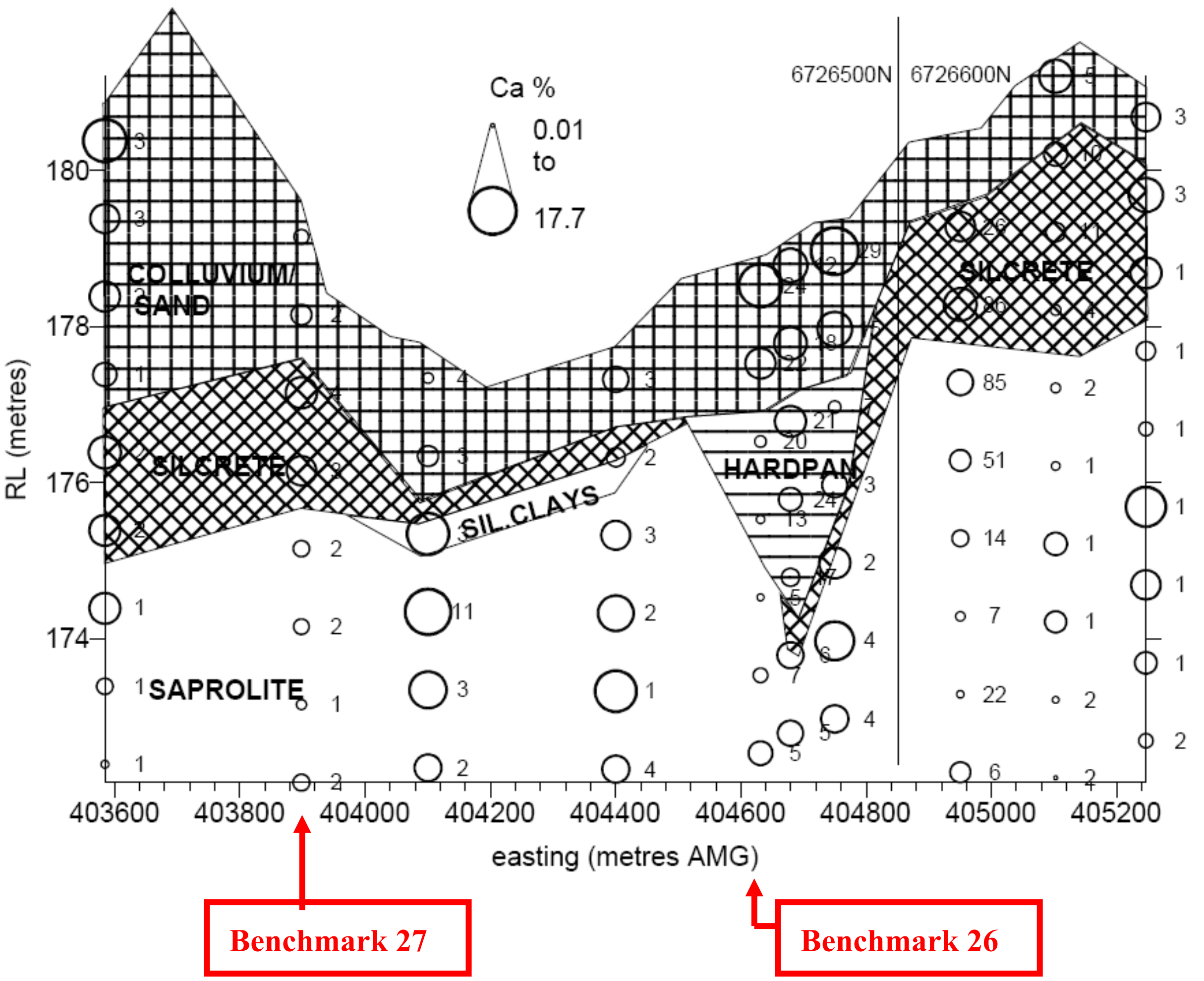



**Figure 157:** Golf Bore gold prospect. Distribution of Au (numerical data in ppb) and Ca (circular symbols) in the upper regolith section. Calcium is present principally as calcrete and gypsum.

## *South Hilga gold prospect*

### *Background*

South Hilga gold prospect lies about 130 km NW of Tarcoola and about 32 km ~W of Mulgathing Pastoral Station Homestead (Figure 136). It can be accessed via pastoral lease tracks and gazetted unsealed roads. The area is very flat and forms the lower ground between two silcrete capped relict mesa-plateaus (S and N of prospect). Reconnaissance bedrock drilling by SA Mines and Energy Department in 1991, included drill samples from this location. Gold was reported as being anomalous from the adjacent Woomera Tank drilling (~5 km NW of the South Hilga site) and from the South Hilga site (MIQ, 1991). Dominion Mining NL quickly assessed those drill samples, and applied the AMIRA developed Au-in-calcrete methodology (from W. Australia) to the near surface calcrete recovered by drilling. Their assay results demonstrated that Au was detectable in the pedogenic calcrete horizon. Thereby this technique became applicable to South Australian regolith. Dominion then acquired the relevant exploration tenements, leading eventually to their Challenger Gold Deposit discovery in 1994 (Edgecombe, 1997).

The South Hilga geochemically anomalous area (Figure 158) consists of Archaean basement (Christie Gneiss), typically deeply weathered, beneath relatively thin Cainozoic alluvial deposits and exposed calcrete. That weathered *in situ* Archaean basement generally has a 1-1.5 m thick silcrete duricrust capping. Most of the palaeotopography locally has been completely infilled with Cainozoic alluvial sediment, yielding the near flat surface exposed today. That terrain supports *Acacia* woodland with numerous shrubs (*Eremophila, Senna, Sclerolaena* and bluebush *Maireana*; after Lintern *et al*., 2002).

South Hilga gold prospect formed part of the larger Gawler Joint Venture tenement coverage, occupying most of the area in Figure 136. This Au anomaly has a calcrete maximum of ~100 ppb Au; Figure 158). It was extensively drill tested in 1996, mineralization appears to be restricted to numerous thin veinlets within a complex pattern–stockwork across the prospect (Lintern *et al*., 2002).

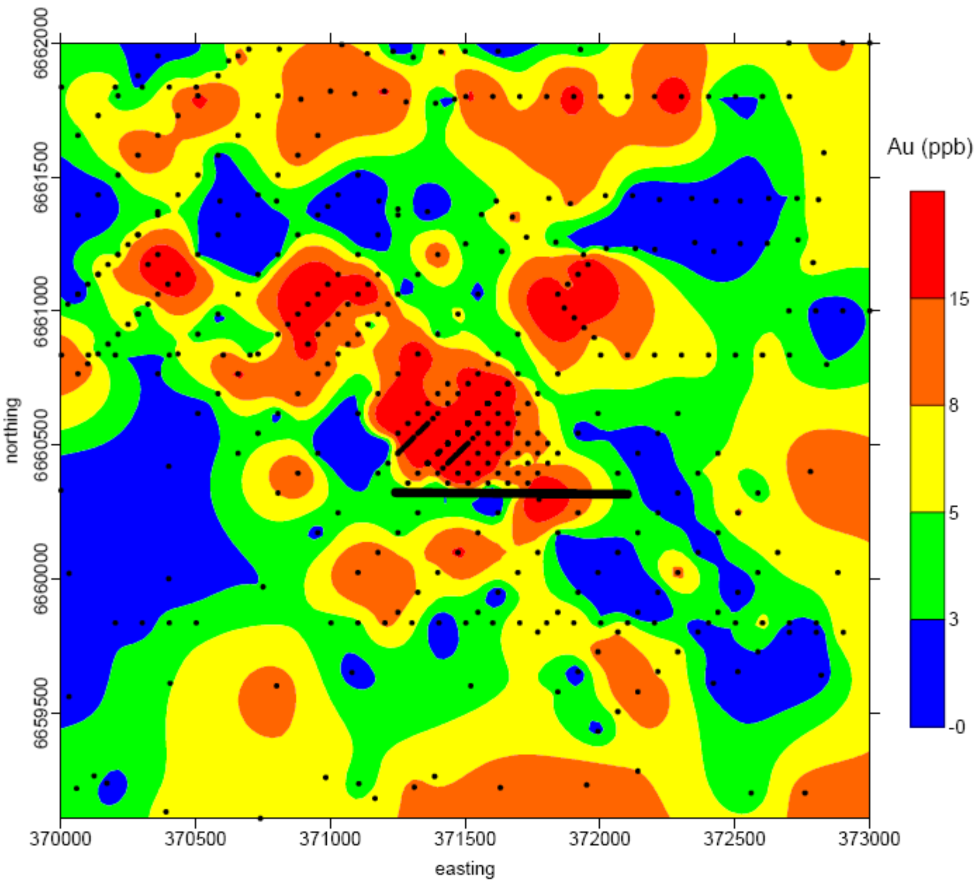



**Figure 158:** South Hilga gold prospect in plan, showing Au-in-calcrete anomaly. Black dots are sample points; black line is the Regolith Line of Lintern *et al*. (2002). No detailed DEM is available for this area. Original data supplied by the Gawler Joint Venture. **Note:** grid projection is in AGD66.

Regolith investigations by Lintern *et al*. (2002) began in 1998 as part of a broader regional study examining Au-in-calcrete anomalism. Complex gridded company RAB and RC drilling, many drill lines were oriented ~NE-SW but others were oriented E-W; they provided samples for regolith logging, characterisation and assay. Field inspection of drillhole spoil piles aided selection of a suitable study line (on local grid 6660305 m N, AGD66 [ = 6660477 m N, GDA94]) on Figure 158, to investigate the surface geochemical anomalism and mineralization identified by drilling.

## *In situ* Regolith

Bedrock (<5% weathered) was not penetrated by any of the exploration drilling on this prospect, however, remnant corestone fragments in lower saprolite to saprock indicate bedrock to be a garnet-bearing quartz-feldspar-mica gneiss, a granulite of fine- to medium-grain size and typically dark grey (Christie Gneiss). A more mafic character occurs between drillholes 96SHAR079 and 96SHAR145, as two distinct zones or bands, steeply dipping to the east (Figure 159), (Lintern *et al*., 2002).

Saprolith (saprock + saprolite) was the dominant weathered material encountered by drilling and its complex nature is displayed in the cross-sections of Figure 159. The more mafic bands penetrated yielded chloritic greens, and where further weathered, yielded FeOx and/or FeOH hues of brown to strong yellow (dominated by kaolinite + quartz ± smectite). Upper saprolite is commonly leached and has hues in pale yellows to pinks, where some mottling may also occur, however, within the mafic bands strong colours persist in the upper saprolite (Lintern *et al*., 2002).

Pedolith (extremely weathered) is remnant at best over this prospect but is commonly hard to pick from cuttings. PIMA Kaolinite Crystallinity Indices provide some assistance, although if the unconformity occurs within silcrete, its position may be indeterminate (too little kaolinite for reliable spectra), see red line on Figures 159, 160. A recognisable plasmic zone occurs below the silcrete capping horizon in a number of drill intersections but its fragile nature means its samples do not survive the drilling process well. Silcrete (0.5-1.5 m thick) occurs across the whole section near surface – even within the palaeochannel incisions. Within the silcrete are two separately sourced components: the lower part is silicified weathered *in situ* pedolith containing angular quartz grit and relict graphite flakes; while the upper portion is silicified colluvium containing subangular to subrounded quartz-rich gravel and an alluvium of well rounded quartz gravel with pebbles. Silcrete here is pedogenic in origin, is pale grey to cream and yellowish, and contains wisps of titania plus some Fe-staining (Lintern *et al*., 2002).

## Transported Regolith

Red-brown alluvium-colluvium these materials cover the site to a depth of 2-3 m and also infill two distinct channels at the centre of the section, to depths of 6 m (Figures 159, 160). Much of the upper part is probably related to Quaternary alluvial fans flanking nearby higher ground, but the lower parts are significantly older, darker coloured and are partly indurated (hardpanized). Generally, these materials consist of rounded to subrounded quartz and lithics (fine sand to cobble sized) but is dominantly a gravel-rich clast to matrix supported sediment. These materials have a distinctly reddish to brown colour, with strongly developed ferruginous staining. Poor clast sorting suggests dominantly a short transport history (colluvial). The upper parts of this material are calcrete impregnated (Lintern *et al*., 2002).

Calcrete occurs throughout the upper regolith within the soil profile and upper colluvium-alluvium, as distinct near-white horizons. Forms include nodules, earthy powders, coatings and irregular low density sheets (0.5 m thick), some displaying karstic features (Lintern *et al*., 2002).

Soils range from uniform silty to sandy (Um, Uc) to gradational calcareous (Gc) lithosols in gravelly lag areas. These soils are generally poorly structured and with little organic matter present in the A horizons. All are strongly alkaline and are probably sodic (AS3) where clay-rich (Northcote and Skene, 1972; Northcote, 1979; Lintern *et al*., 2002).

## PIMA Mineralogy

PIMA spectrometry of the upper regolith indicates poorly crystalline kaolinite and smectite in the colluvium and a sharp boundary with more crystalline kaolinite in the saprolite. The PIMA derived, plus the microscope and field studies derived, unconformity boundary are in general agreement. PIMA spectroscopy also indicates the presence of Mg-chlorite (371530 m E at 43-63 m), K-alunite (371880 m E at 24-25 m) and possibly, remnant diopside in the Fe-rich (probably goethitic) saprolite in drillhole MHP080b (Benchmark 28), (Lintern *et al*., 2002).

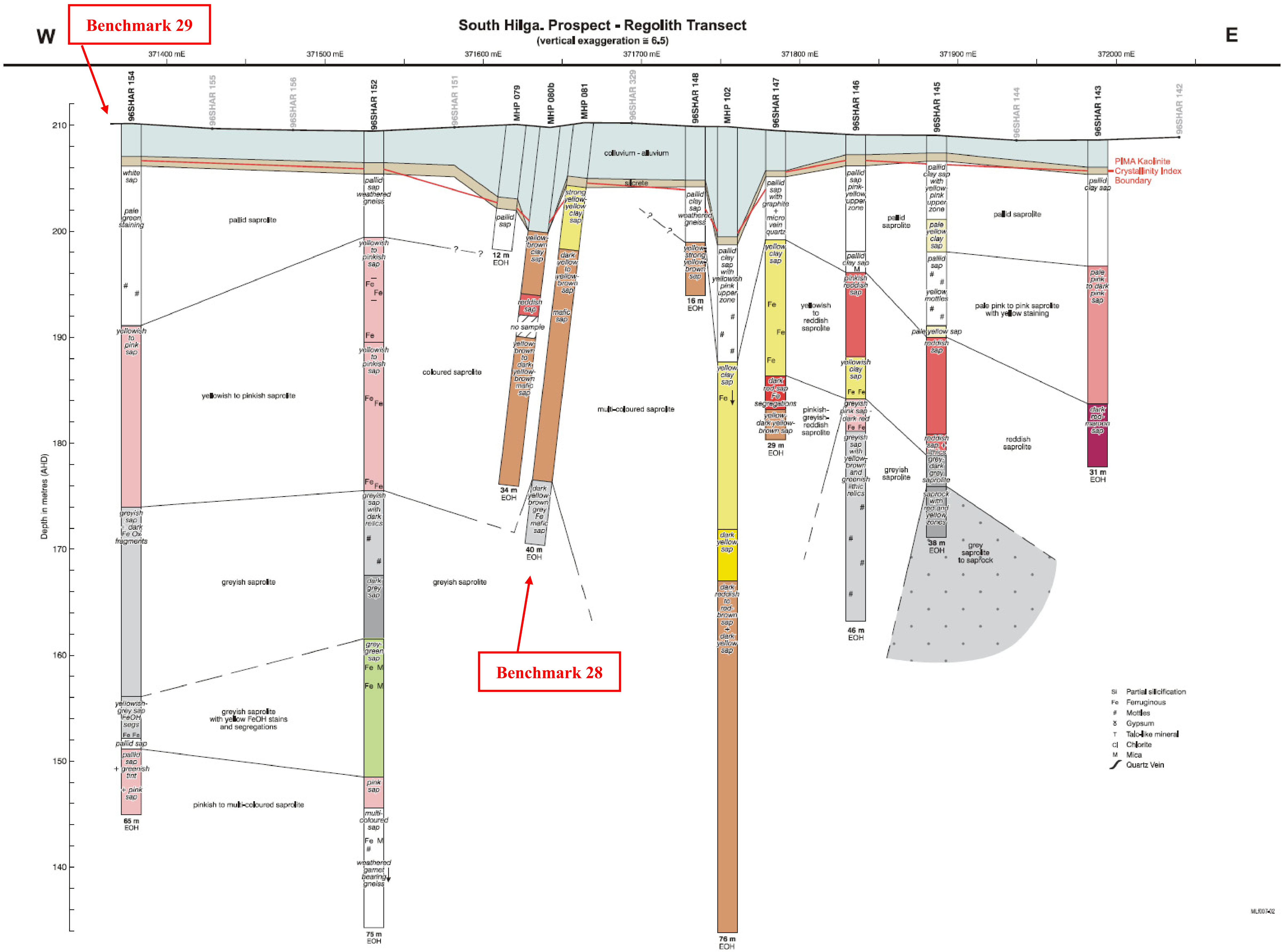



**Figure 159:** South Hilga gold prospect, full regolith section along line displayed in Figure 158 (Lintern *et al.*, 2002). Benchmarks 28 and 29 are indicated.

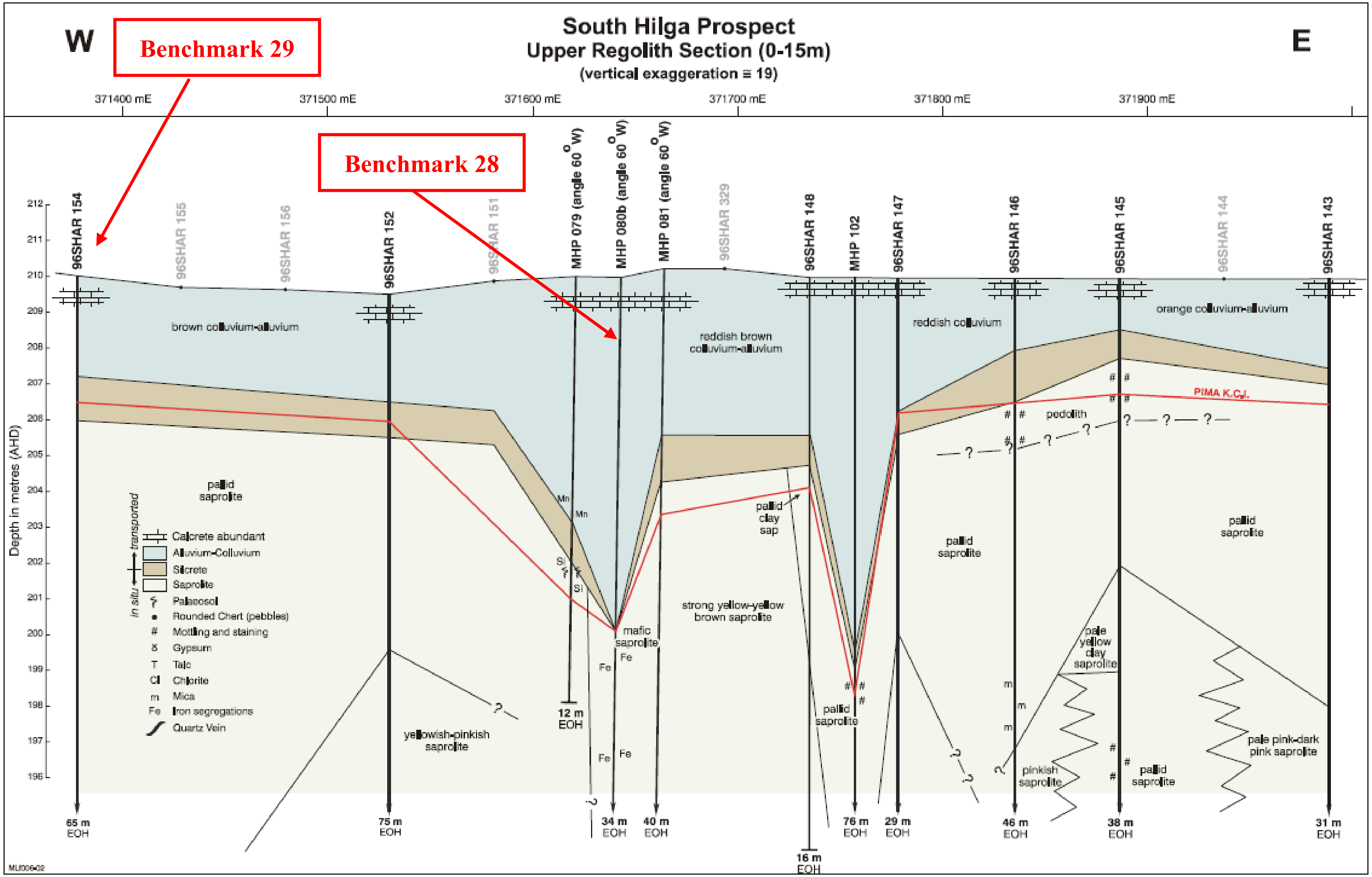



**Figure 160:** South Hilga gold prospect, upper regolith section along line displayed in Figure 158 (Lintern *et al*., 2002). Benchmarks 28 and 29 are indicated.

### *Geochemical expression*

Iron concentrations associated with the weathered mafic rocks are particularly high in Fe but low in Mg (Figure 161). Iron is moderately associated with As, Co, Mn, Ni and Zn, probably due to adsorption on Fe oxyhydroxides.

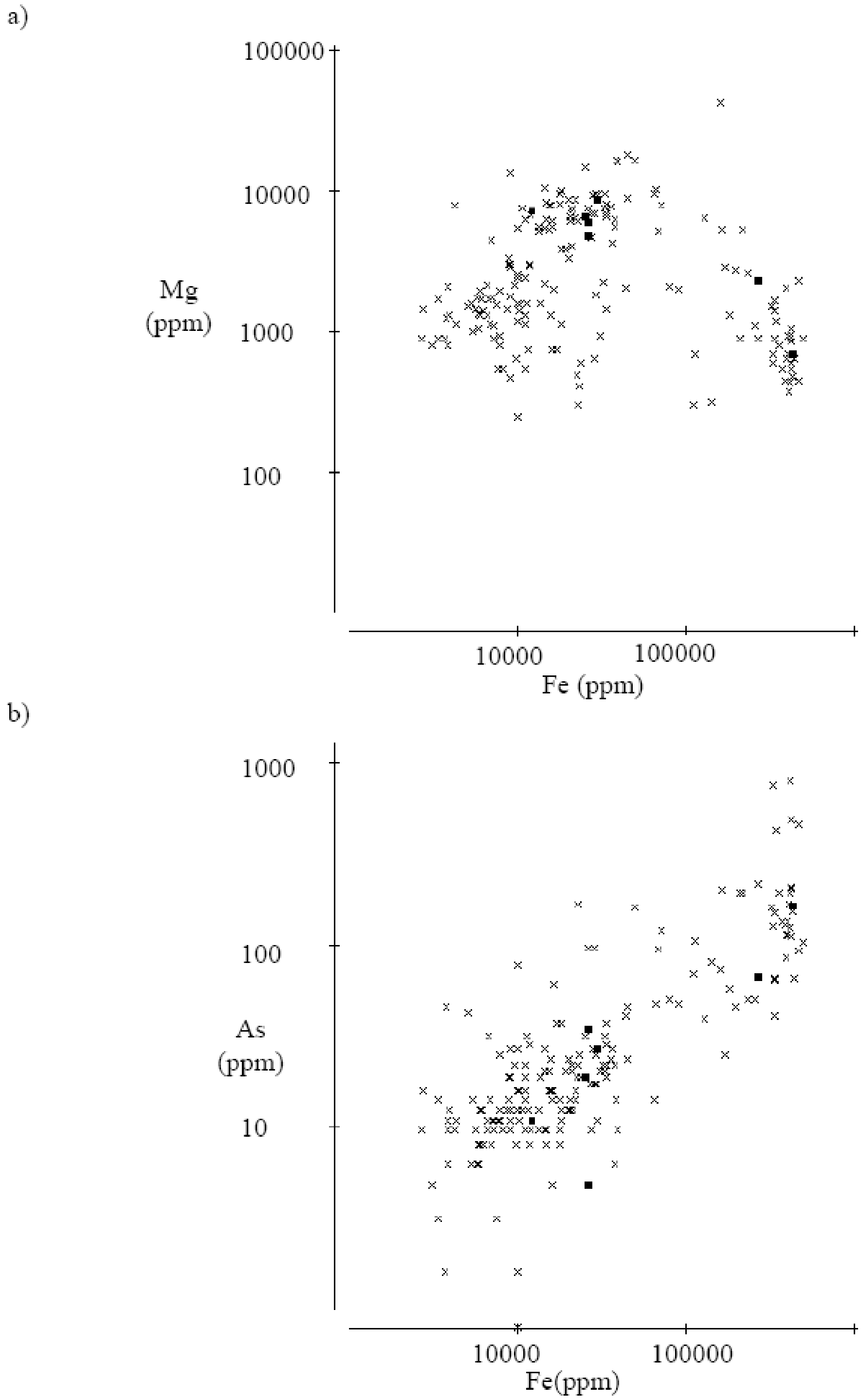



**Figure 161:** South Hilga gold prospect, scatter plots for selected elements. Box symbols indicate samples with the higher Au concentrations, (Lintern *et al*., 2002).

**Plot a:** Fe *v* Mg. Note the cluster of high Fe and relatively low Mg (lower right) indicating highly ferruginous saprolite (derived from a mafic parent).

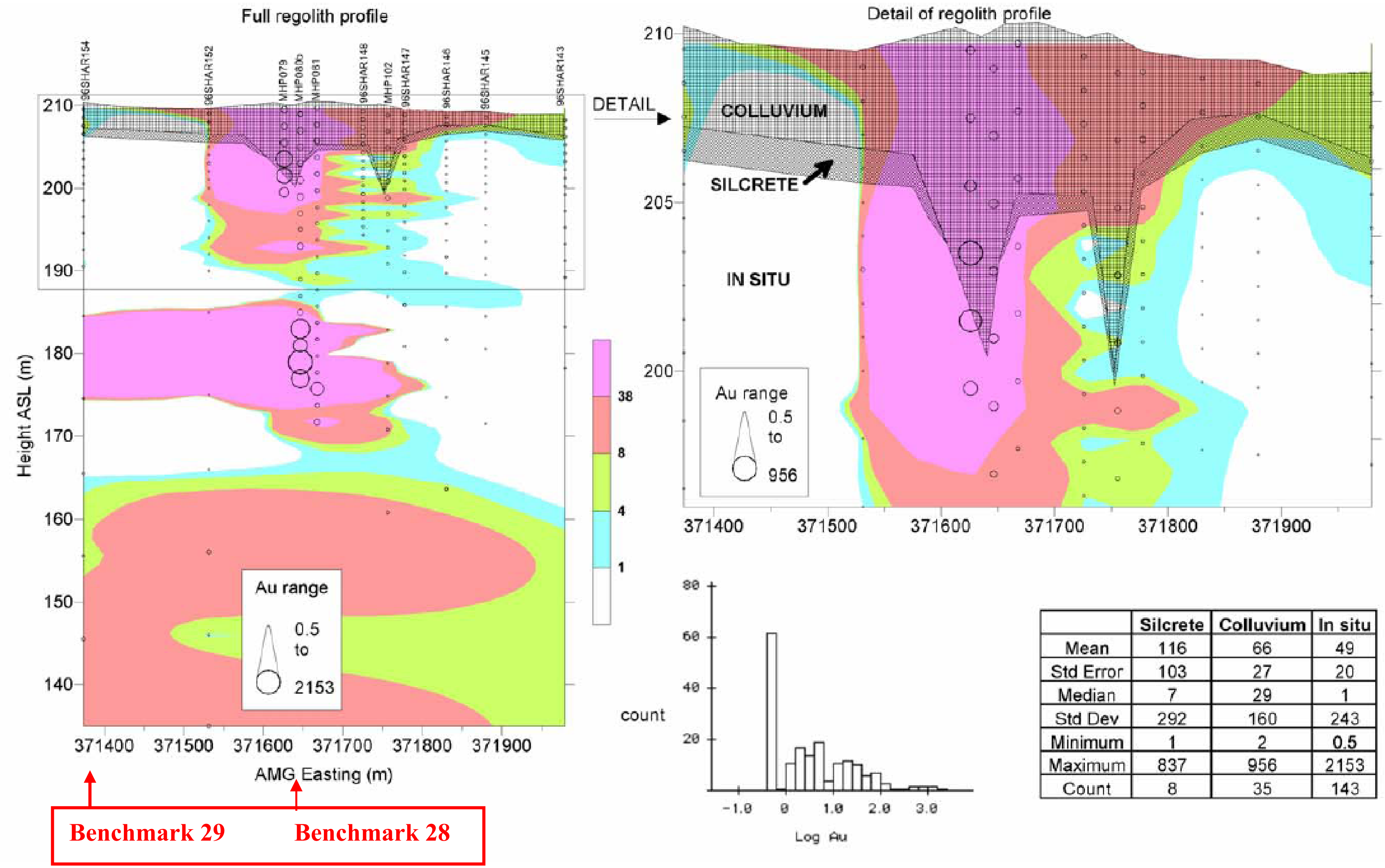
**Plot b:** Fe *v* As. Some pathfinders, e.g. As, are adsorbed by Fe oxyhydroxides (goethite).

The greatest Au concentration (2.2 ppm max.) is in the section about 30 m below surface in strongly ferruginous , yellow-brown, mafic saprolite and forms part of a mineralized interval averaging 8 m at 1.3 g/t. It is associated with moderate concentrations of Cu (mean 120 ppm; Table 69). As adjacent drillholes are relatively poor in Au, mineralization is probably confined to narrow veinlets. Above mineralization, however, anomalous Au is continuous through the 10 m deep transported material to the surface (Figure 162). Maximum concentrations in the transported regolith (960 ppb) at 6-8 m) are associated with slightly calcareous samples in a buried channel close to the interface between transported and weathered *in situ* units adjacent to mineralization. In calcrete, samples reach up to 100 ppb Au above mineralization. However, all these samples are down slope of mineralization to the north and so the origin of the anomalous concentrations is equivocal (Lintern *et al*., 2002).

**Table 69:** South Hilga gold prospect, highest Au concentrations and other anomalous drillhole intervals (Lintern, 2004b).

| Drillhole | Interval (m) | Analyses (ppm, Au ppb) | Regolith type |
|---|---|---|---|
| MHP080b | 26-34 | Au 1340 ppb, Cu 120 | saprolite |
| MHP079 | 4-12 | Au 560 ppb | colluvium/alluvium and saprolite |
| MHP081 | 34-36 | Au 530 ppb | saprolite |
| 96SHAR147 | 13-14 | Au <1 ppb, As 250, Sb 14 | saprolite |
| 96SHAR132 | 63-64 | Au 3 ppb, Zn 3700, Ni 1150 | saprolite |
| 96SHAR145 | 24-25 | Au <1 ppb, Pb 340 | saprolite |

<u>In Summary</u>; the South Hilga case study indicates that weathering has led to a 20 m thick saprolite zone depleted in Au. The old land surface and samples immediately beneath it still retain significant concentrations of Au, particularly in the silcrete. Calcrete in the transported overburden is also highly anomalous but, as stated above, due to the topographic effects on sediment dispersal, an origin for that Au is equivocal and may only be explained through a detailed 3D study (Lintern, 2004b).




| | Silcrete | Colluvium | In situ |
|---|---|---|---|
| Mean | 116 | 66 | 49 |
| Std Error | 103 | 27 | 20 |
| Median | 7 | 29 | 1 |
| Std Dev | 292 | 160 | 243 |
| Minimum | 1 | 2 | 0.5 |
| Maximum | 837 | 956 | 2153 |
| Count | 8 | 35 | 143 |

**Figure 162:** South Hilga gold prospect, regolith section, regolith architecture and Au geochemical expression (*c.f.* Figures 159, 160). All data are in ppb (Lintern, 2004b). Benchmarks 28 and 29 are indicated.

## Benchmark 28: drillhole MHP080b

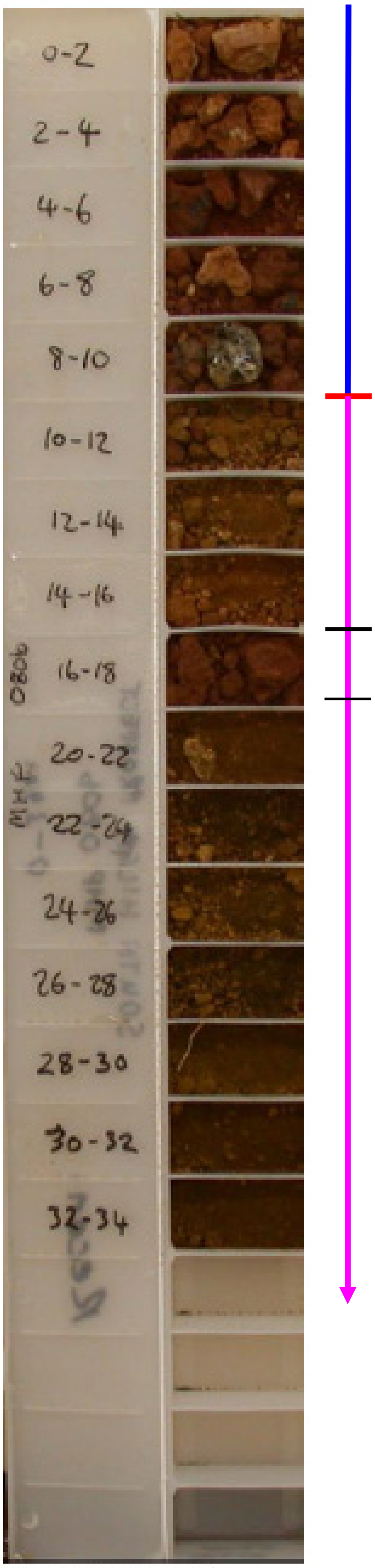
Quick reference items are set out in Table 70; detailed descriptions, figures and data tables follow on below. South Hilga prospect lies about 130 km NW of Tarcoola and about 32 km ~W of Mulgathing Pastoral Station Homestead (Figures 110-112, 136, 158). It can be accessed via pastoral lease tracks W of Mulgathing Pastoral Station Homestead. Drilling for this Rotary hole was angular (60$^o$ dip → ~270$^o$), while all RAB holes were vertical. A summary of this profile is provided in Table 71 and chiptray photograph with regolith zonation is in Figure 163. Geochemical data are presented in Figures 161, 162, 164-167 and Table 69.

**Table 70:** Benchmark 28 reference data; drillhole MHP080b (Type 2, drill cuttings profile).

| **Items** | **Figures, Data, Sources** |
|---|---|
| Regional location map | Figures 110-112, 136. |
| Local-site location map | Figures 158, 159. |
| GPS coordinates, attitude & elevation | Rotary drillhole MHP080b: Zone 53, 371775 E, 6660503 N, GDA 94. **Attitude**: angled (60$^o$ dip → ~270$^o$). **AHD:** 209.971 (differential GPS data). |
| Site access, owner | About 130 km NW of Tarcoola and about 32 km ~W of Mulgathing Pastoral Station Homestead (Figure 136). Site can be accessed via pastoral lease tracks W of the main Homestead. Site Lease holder: Mulgathing Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 163, Table 71. |
| Sample types | Drill chips in chiptrays + ~1 kg bags |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 161, 162, 164-167, and Table 69. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite Crystallinity Indices for unconformity picks & some mineral identification. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | ?As, Cu, Zn. |
| Useful sampling media | Calcrete, soil, sediment & silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole MHP080b is selected to form this benchmark because it includes a moderate thickness of transported cover and is located within the defined Au mineralization. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 29 and the regolith cross-sections of Figures 159, 160. Exploration grid drilling on this prospect mostly involved RAB (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have terminated in lower saprolite to saprock rather than within fresh gneiss. Moreover, the same is true for all infill RC and rotary drilling, in that those mineralization targeted drillholes also terminated in saprolite or saprock for a variety of reasons. Cuttings were sampled from the drilled 2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




MHP080b

**0-10 m** — **Transported**: reddish colluvium-alluvium (deepest channel infill), poorly sorted silt + sand + gravel + pebbles of quartz & lithics; prominent carbonate at ~1 m. ~3-10 m is more indurated and possibly much older (?hardpanized).

**10 m** — **Unconformity**

**10-16 m** — ***In situ***: saprolite, yellow-brown clay-rich, ferruginous, crumbly.

**16-18 m** — Saprolite, reddish, quite ferruginous, clay-rich.

**20->34 m** — Saprolite, yellowish brown to dark yellowish brown, more competent than above interval.

**NOTE: saprock and bedrock not penetrated.**
**E.O.H. at 34 m.**

Regolith logged by M.J. Sheard

**Figure 163:** Benchmark 28, South Hilga gold prospect drillhole MHP080b, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work. **Note:** no depth correction has been made for the 60° angled drilling; to obtain true depths x 0.86.

**Table 71:** Benchmark 28, regolith log to Rotary drillhole MHP080b (after Lintern *et al*., 2002).

**Hole:** MHP080b. **Regolith Line**, South Hilga gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 371775 E, 6660503 N, GDA 94. **AHD:** 209.971 (differential GPS data)

**Attitude:** angled (60$^o$ dip → ~270$^o$)

**Site:** flat and generally denuded.

**Vegetation:** Very Open Grassland with many dead *Acacia aneura*. (Botanical log by S. Lintern).

**Soil:** Um (sand, loose, medium grained throughout).

**Calcrete:** ? nodular to earthy.

**Logged by:** M.J. Sheard, 1999. **Note:** only 2 m interval drill spoil piles available.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-10 | Reddish colluvium-alluvium (deepest channel infill here), silt + sand + gravel + pebbles of quartz & lithics; prominent carbonate at ~1 m. ~3-10 m is more indurated and possibly much older (?hardpanized). Unconformity below 10 m. |
| 10-16 | Saprolite, yellow-brown clay-rich, ferruginous. [**Not** Algebuckina Sandstone as indicated by exploration company logging]. |
| 16-18 | Saprolite, reddish, quite ferruginous, clay-rich. |
| 18-20 | No sample. |
| 20->34 | Saprolite, yellowish brown to dark yellowish brown, predominantly kaolinite + goethitic staining; mafic saprolite. |
| E.O.H. | **Note:** no depth correction has been made for the 60$^o$ angled drilling; to obtain true depths x 0.86. |

## *In situ Regolith*

Bedrock was not penetrated by drilling on this prospect, but remnant corestones within the saprock indicate it has components typical of the Christie Gneiss. At this location the bedrock is mafic (from PIMA identified remnant diopside in the goethitic saprolite). Generally saprolite at this site follows the earlier descriptions for the prospect. Saprolite was not fully penetrated here, its total thickness can be inferred by reference to the regolith section of Figure 159. All evidence for pedolith appears to be missing from the samples, that zone most likely eroded by channel incision; but silcrete too seems to be absent, however, the 2 m bulk sampling may have inadvertently obscured evidence for silcrete and clayey pedolith (bulked cuttings are a poor substitute for core or outcrop).

## *Transported Regolith*

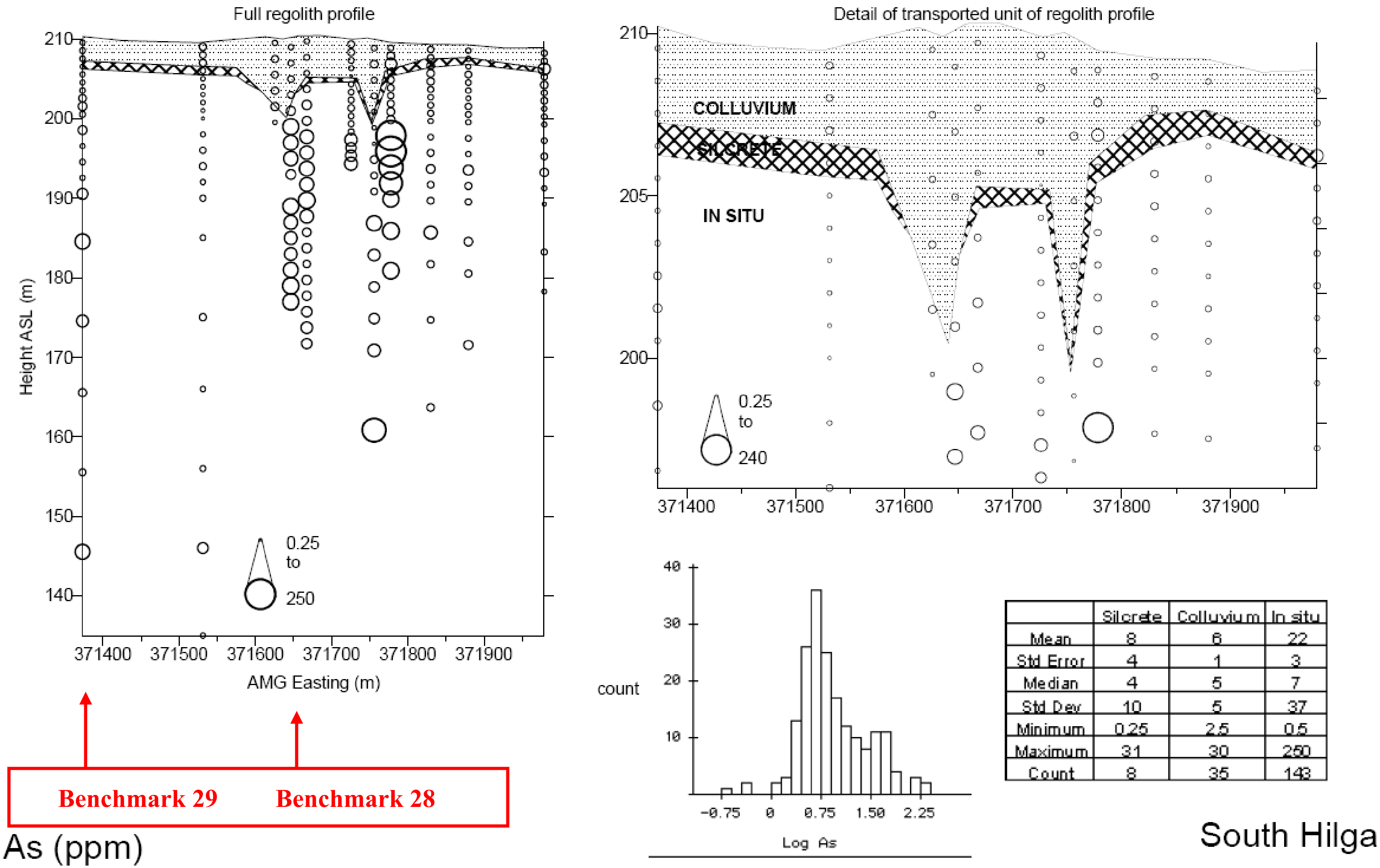
Colluvium and alluvium (mostly sand + gravel) forms the primary transported cover, as palaeochannel infill in this drillhole (~10 m). Clast rounding, the presence of lithics and the broad range of clast size indicate immature sediment with a local provenance. This site is currently deflating and eroding (partly due to stock grazing pressures) leading to extensive exposure of calcrete horizons and the basal soil horizon.

## *Geochemistry*

Geochemical expression for South Hilga gold prospect has been outlined above and presented via Figures 161, 162 (Au) and Table 69 (As, Cu, Ni, Pb, Sb, Zn).

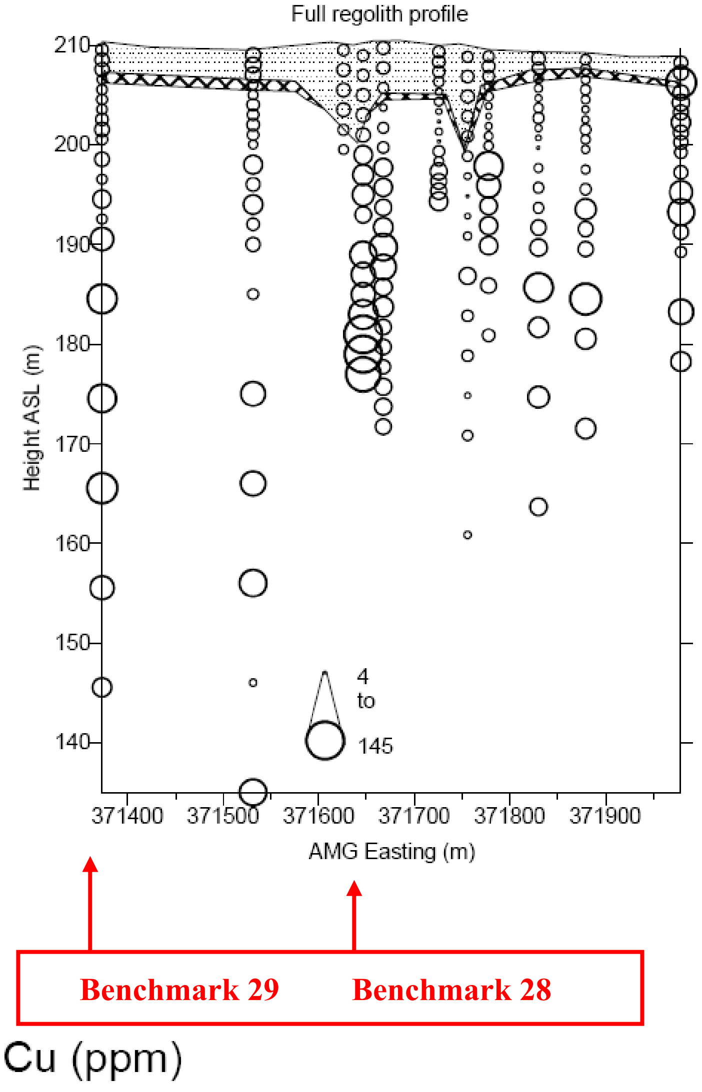
A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including: As, Cu, Fe and Zn appear in Figures 164-167. Copper and Zn may serve as pathfinder elements in this area but the Au values alone provide a far stronger signal.

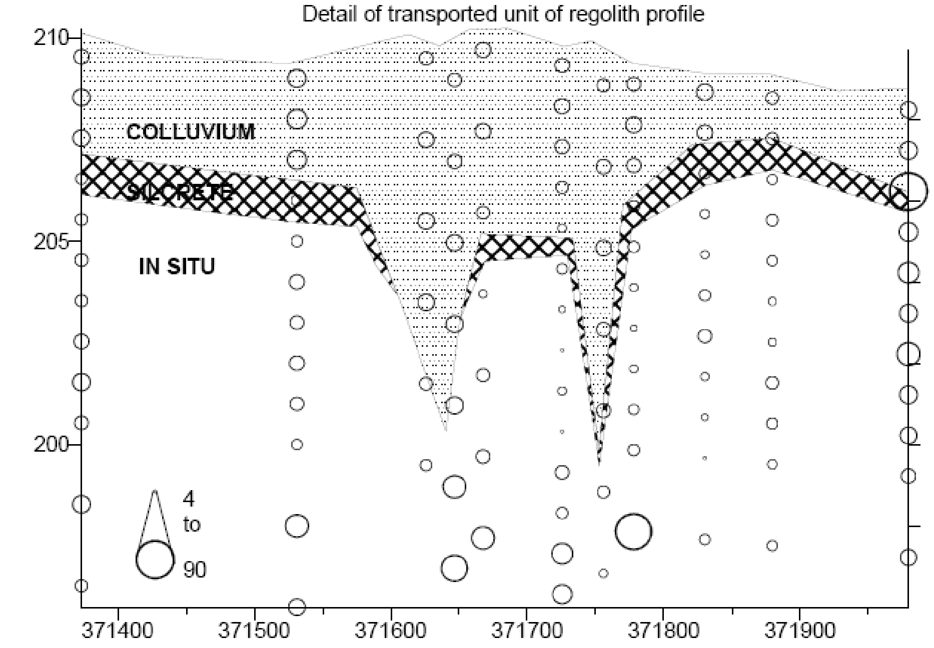
Compare this geochemical expression over defined Au mineralization with that of Benchmark 29 (in unmineralized ground) and where the transported cover is thicker than for Benchmark 29.

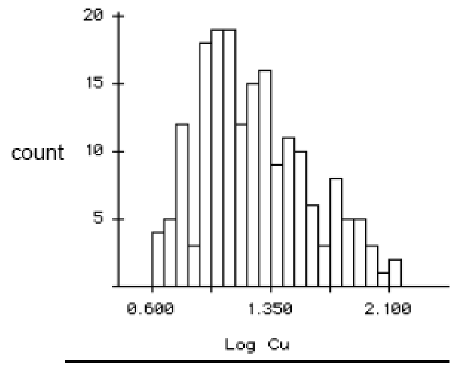



| | Silcrete | Colluvium | In situ |
|---|---|---|---|
| Mean | 8 | 6 | 22 |
| Std Error | 4 | 1 | 3 |
| Median | 4 | 5 | 7 |
| Std Dev | 10 | 5 | 37 |
| Minimum | 0.25 | 2.5 | 0.5 |
| Maximum | 31 | 30 | 250 |
| Count | 8 | 35 | 143 |

**Figure 164:** South Hilga gold prospect regolith section, regolith architecture & As geochemistry (*c.f.* Figures 165-167). Lintern *et al*. (2002). Benchmarks 28, 29 indicated.



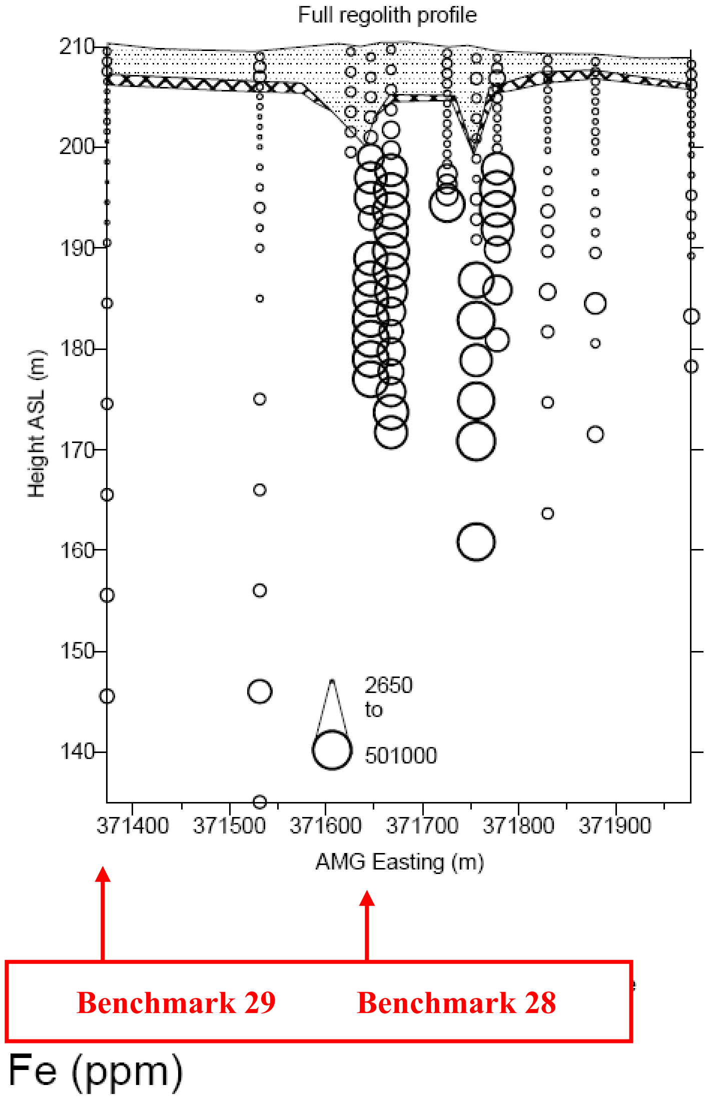



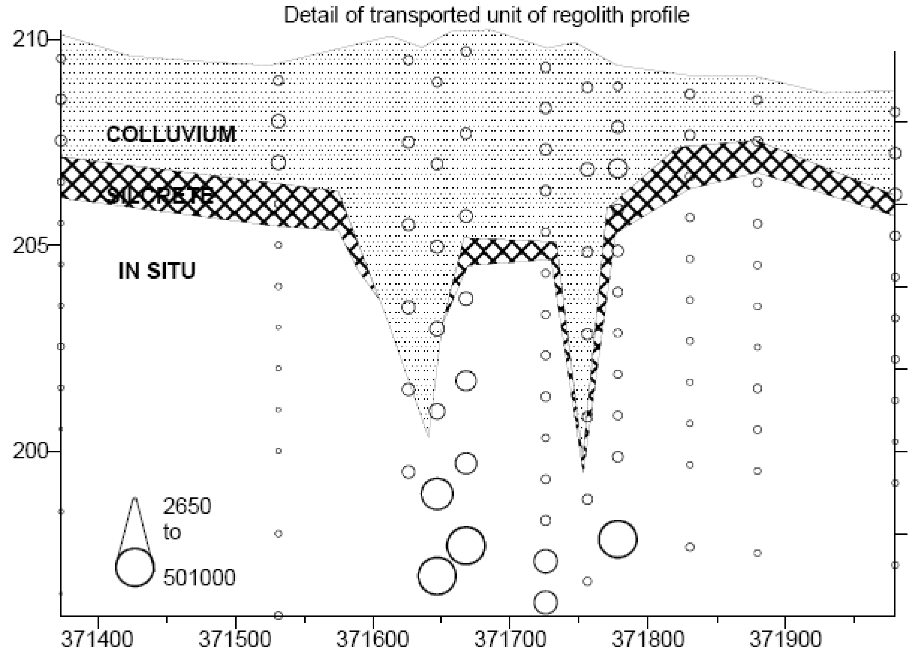



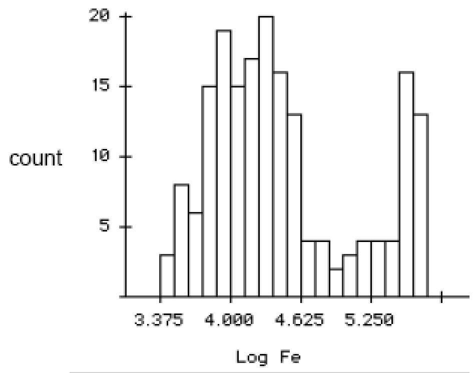

| | Silcrete | Colluvium | In situ |
|---|---|---|---|
| Mean | 20 | 15 | 28 |
| Std Error | 10 | 1 | 2 |
| Median | 10 | 15 | 19 |
| Std Dev | 29 | 3 | 27 |
| Minimum | 6 | 9 | 4 |
| Maximum | 90 | 23 | 145 |
| Count | 8 | 35 | 143 |

South Hilga

**Figure 165:** South Hilga gold prospect regolith section, regolith architecture & Cu geochemistry (*c.f.* Figures 164, 166, 167). Lintern *et al*. (2002). Benchmarks 28, 29 are indicated.



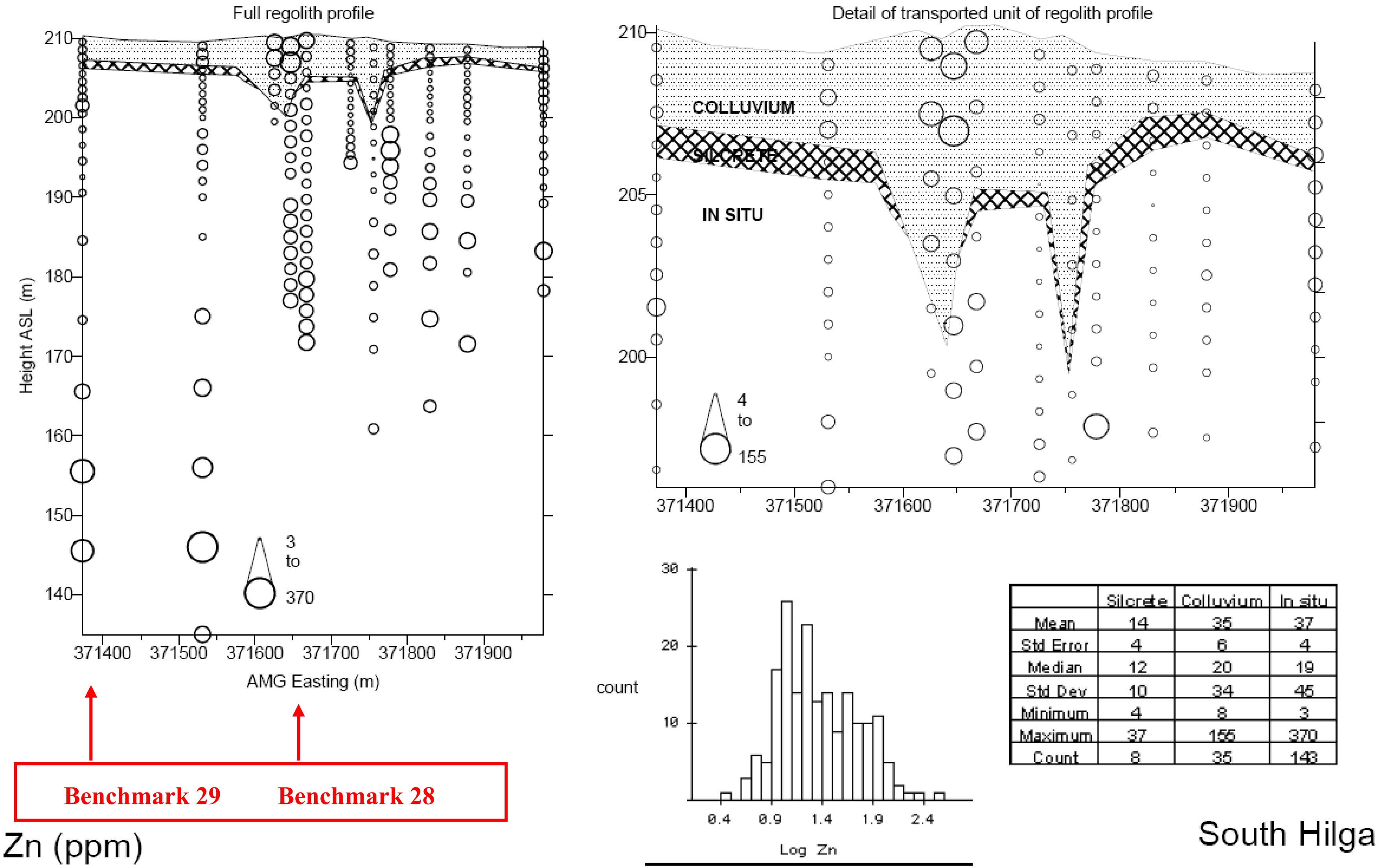




| | Silcrete | Colluvium | In situ |
|---|---|---|---|
| Mean | 16744 | 22929 | 113588 |
| Std Error | 3132 | 1934 | 13160 |
| Median | 13400 | 20300 | 23100 |
| Std Dev | 8857 | 11439 | 157372 |
| Minimum | 6900 | 10800 | 2650 |
| Maximum | 27800 | 69300 | 501000 |
| Count | 8 | 35 | 143 |

South Hilga

**Figure 166:** South Hilga gold prospect regolith section, regolith architecture & Fe geochemistry (*c.f.* Figures 164, 165, 167). Lintern *et al*. (2002). Benchmarks 28, 29 are indicated.




| | Silcrete | Colluvium | In situ |
|---|---|---|---|
| Mean | 14 | 35 | 37 |
| Std Error | 4 | 6 | 4 |
| Median | 12 | 20 | 19 |
| Std Dev | 10 | 34 | 45 |
| Minimum | 4 | 8 | 3 |
| Maximum | 37 | 155 | 370 |
| Count | 8 | 35 | 143 |

**Figure 167:** South Hilga gold prospect regolith section, regolith architecture & Zn geochemistry (*c.f.* Figures 164-166). Lintern *et al*. (2002). Benchmarks 28, 29 are indicated.

## Benchmark 29: drillhole 96SHAR154

Quick reference items are set out in Table 72; detailed descriptions, figures and data tables follow on below. South Hilga prospect lies about 130 km NW of Tarcoola and about 32 km ~W of Mulgathing Pastoral Station Homestead (Figures 110-112, 136, 158). It can be accessed via pastoral lease tracks W of Mulgathing Pastoral Station Homestead. Drilling for this RAB hole was vertical while most of the Rotary holes were angular ($60^o$ dip → ~$270^o$). A summary of this profile is provided in Table 73 and chiptray photograph with regolith zonation is in Figure 168. Geochemical data are presented in Figures 161, 162, 164-167 and Table 69.

**Table 72:** Benchmark 29 reference data; drillhole 96SHAR154 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figures 110-112, 136. |
| Local-site location map | Figures 158, 159. |
| GPS coordinates, attitude & elevation | RAB drillhole 96SHAR154: Zone 53, 371502 E, 6660477 N, GDA 94. **Attitude**: Vertical. **AHD:** 210.054 (differential GPS data) |
| Site access, owner | About 130 km NW of Tarcoola and about 32 km ~W of Mulgathing Pastoral Station Homestead (Figure 136). Site can be accessed via pastoral lease tracks W of the main Homestead. Site Lease holder: Mulgathing Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 168, Table 73. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 161, 162, 164-167, and Table 69. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite Crystallinity Indices for unconformity picks & some mineral identification. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | ?As, Cu, Zn. |
| Useful sampling media | Calcrete, soil, sediment & silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 96SHAR154 is selected to form this benchmark because it includes a 3.5 m thickness of transported cover and is located away from the defined Au mineralization. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 28 and the regolith cross-sections of Figures 159, 160. Exploration grid drilling on this prospect mostly involved RAB (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have terminated in lower saprolite to saprock rather than within fresh gneiss. Moreover, the same is true for all infill RC and rotary drilling, in that those mineralization targeted drillholes also terminated in saprolite or saprock for a variety of reasons. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).


**0-~3 m** **Transported**: brown colluvium-alluvium (silt + sand + gravel + pebbles of quartz & lithics); prominent carbonate in ~1$^{st}$ m.

**~3-4 m** **Unconformity.** Silcreted sediment & *in situ* weathered pedolith.

**4-19 m** ***In situ***: saprolite, white, clay-rich, has greenish staining (?fuchsite or ?Mg-chlorite) lithic relicts at 15-16 m, crumbly.

**19-36 m** Saprolite, yellowish to pinkish, clay-rich.

**36-54 m** Saprolite, greyish with dark coloured Fe oxide-rich fragments, more competent than above interval.

**54-64 m** Saprolite, yellowish grey and pallid, clay-rich, + brown Fe sesquioxide nodules and fragments.

**64->65 m** Saprolite, yellowish grey with greenish tint (?chloritic) clay-rich, + pinkish saprolite.

**NOTE: chiptray sampling is irregular below 20 m, saprock and bedrock not penetrated.**

**E.O.H. at 65 m.**

Regolith logged by M.J. Sheard

**Figure 168:** Benchmark 29, South Hilga gold prospect drillhole 96SHAR154, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work.

**Table 73:** Benchmark 29, regolith log to RAB drillhole 96SHAR154 (after Lintern *et al*., 2002).

**Hole:** 96SHAR154. **Regolith Line**, South Hilga gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 371502 E, 6660477 N, GDA 94. **Attitude**: Vertical.
**AHD:** 210.054 (differential GPS data)

**Attitude:** vertical

**Site:** near edge of N-S access track, flat and generally denuded.

**Vegetation:** *Acacia aneura* Low Open Woodland over *Acacia aneura* Tall Open Shrubland over Shrubland over mixed Chenopodaceae Low Shrubland. (Botanical log by S. Lintern).

**Soil:** Um (sand, loose, medium grained throughout).

**Calcrete:** ? Sheet-like to earthy.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-~3 | Brown colluvium-alluvium (silt + sand + gravel + pebbles of quartz & lithics; prominent carbonate within 1st m. |
| ~3-4 | Pedolith – silcrete, ~1 m thick, developed partly in sediment & partly in white saprolite. Unconformity ≅ silcrete mid point. |
| 4-19 | Saprolite, white clay-rich, has greenish staining ?fuchsite or ?Mg-chlorite, lithic relicts at 15-16 m. |
| 19-36 | Saprolite, yellowish to pinkish clay-rich. |
| 36-54 | Saprolite, greyish, with dark coloured Fe oxide-rich fragments, clay-rich. |
| 54-58 | Saprolite, yellowish grey, with brown Fe sesquioxide nodules and fragments, clay-rich. |
| 58-59 | Saprolite, pallid, clay-rich. |
| 59->65 | Saprolite, yellowish grey with greenish tint (?chloritic) + pink saprolite. |
| E.O.H. | |

## *In situ Regolith*

Bedrock was not penetrated by drilling on this prospect, but remnant corestones within the saprolith indicate it has components typical of the Christie Gneiss. Generally saprolite at this site follows descriptions for this prospect set out earlier. Saprolite was not fully penetrated here. Evidence for pedolith is scant and limited to the silcrete horizon.

## *Transported Regolith*

Colluvium and alluvium (mostly sand + gravel) forms the transported cover, as palaeo-fan material (~3 m thick) emanating from nearby higher ground. Clast rounding, the presence of lithics and the broad range of clast size indicate immature sediment. This site is currently deflating and eroding (partly due to stock grazing pressures and track erosion by rain run-off) leading to extensive exposure of calcrete horizons and the basal soil horizon.

## *Geochemistry*

Geochemical expression for South Hilga gold prospect has been outlined earlier and presented via Figures 161, 162 (Au) and Table 69 (As, Cu, Ni, Pb, Sb, Zn).

A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including: As, Cu, Fe and Zn appear in Figures 164-167. Copper and Zn may serve as pathfinder elements in this area but the Au values alone provide a far stronger signal.

Compare this geochemical expression away from the defined Au mineralization with that of Benchmark 28 (over mineralization) and where the transported cover is thinner than for Benchmark 28.

## *Monsoon gold prospect*

### *Background*

Monsoon gold prospect and its associated geochemical anomaly lie on flat to weakly undulating terrain about 150 km WNW of Tarcoola and about ~53 km W of Mulgathing Pastoral Station Homestead (Figure 136). It can be accessed via pastoral lease tracks and gazetted unsealed roads.

The Monsoon geochemically anomalous area (Figure 169) consists of outcropping and subcropping weathered Archaean Christie Gneiss, and is partly on-lapped by a wedge of Cainozoic alluvial sediment with silcrete and calcrete horizons. All weathered basement outcrop generally has a 1-2 m thick silcrete duricrust capping. Low points of the palaeotopography (>8 m depth) have been filled with Quaternary alluvium and the modern drainage lines follow the palaeodrainage. This terrain supports sparse *Acacia* woodland and numerous woody shrubs (*Eremophila, Senna* and bluebush *Maireana*) but the vegetation is more substantial just north of the geochemical anomaly (after Lintern *et al*., 2002 & Lintern 2004b).

Monson gold prospect formed part of the larger Gawler Joint Venture tenement coverage, occupying most of the area in Figure 136. The Au anomaly has a calcrete maximum of ~30 ppb Au; Figure 169). It was extensively drill tested in 1997; mineralization is patchily developed with the best interval averaging 1.22 ppm over 6 m at 30 m depth (Lintern *et al*., 2002; Lintern 2004b).

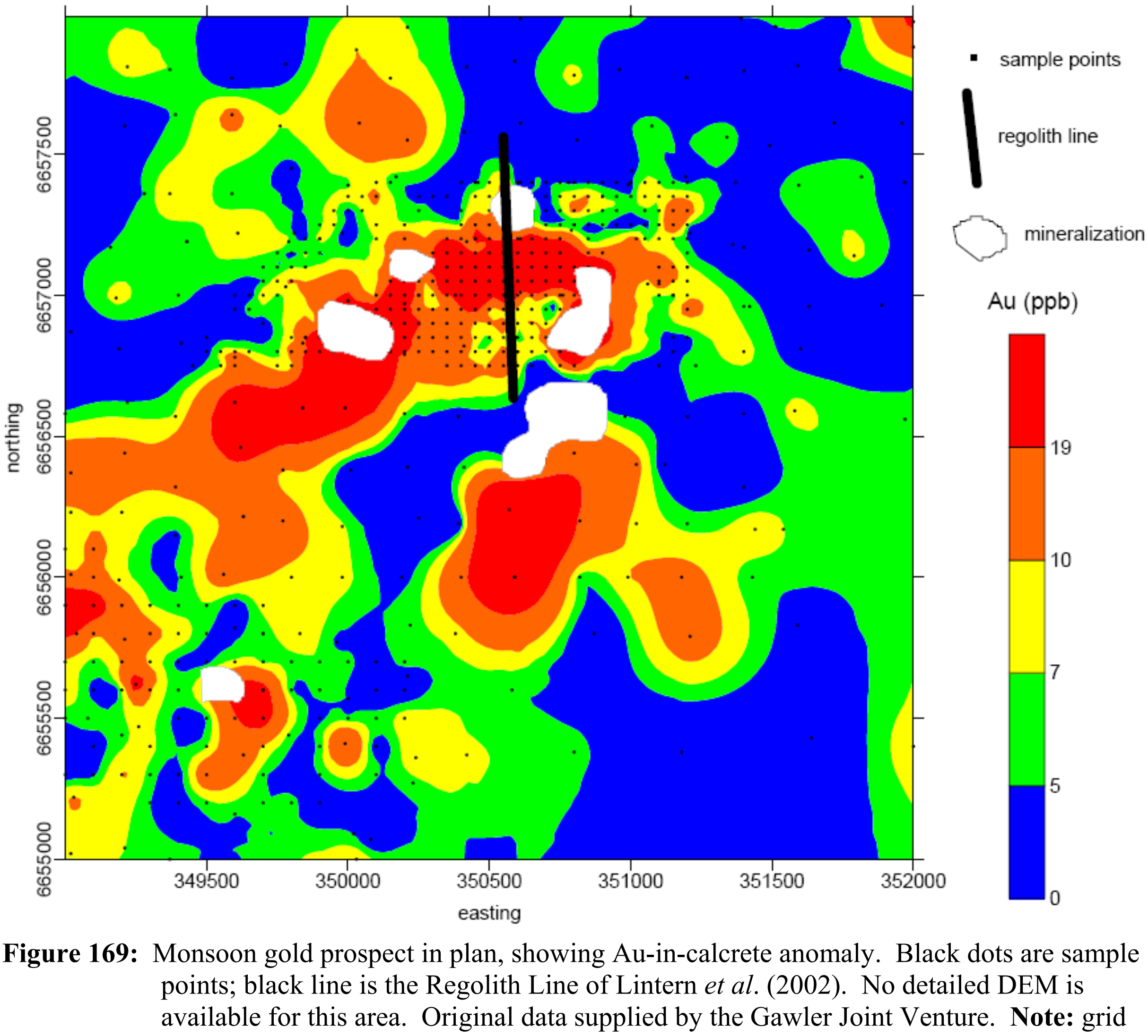



**Figure 169:** Monsoon gold prospect in plan, showing Au-in-calcrete anomaly. Black dots are sample points; black line is the Regolith Line of Lintern *et al*. (2002). No detailed DEM is available for this area. Original data supplied by the Gawler Joint Venture. **Note:** grid projection is in AGD66.

Regolith investigations by Lintern *et al*. (2002) began in 1998 as part of a broader regional study examining Au-in-calcrete anomalism. Gridded company RAB and RC drilling provided samples for regolith logging, characterisation and assay. Field inspection of drillhole spoil piles aided selection of a suitable NS oriented study line (along local grid ~350500 m E, AGD66 [ = 350628 m E, GDA94]) on Figure 169, to investigate the surface geochemical anomalism and mineralization identified by drilling.

## *In situ Regolith*

Bedrock (<5% weathered) was not penetrated by any of the exploration drilling on this prospect, however, remnant corestone fragments in saprock indicate bedrock to be Christie Gneiss – a quartz-feldspar-mica gneiss of granulite grade. It is typically dark grey and fine- to medium-grained. The northern two thirds of the Regolith Study Line has lithotypes richer in Fe, Mg and Mn (chloritic alteration) while the southern end appears to be more felsic (Figure 170). Quartz veins occur randomly throughout the weathered basement (Lintern *et al*., 2002; Lintern, 2004b).

Saprolith (saprock + saprolite) was the dominant weathered material encountered by drilling and its complex nature is displayed in the cross-section of Figure 170. The more mafic bands penetrated yield chloritic greens, and where further weathered, yields FeOx and/or FeOH hues of brown to strong yellow (dominated by kaolinite + quartz ± smectite). Grey saprock is thicker where rock grain size is finest. Total saprolite is >50 m thick in many places. Upper saprolite is commonly leached and has hues in pale yellows to pinks to browns or is white to cream coloured, within the mafic lithotype strong colours persist into the upper saprolite (Lintern *et al*., 2002; Lintern, 2004b).

Pedolith (extremely weathered) is best preserved along the northern two thirds of the Regolith Study Line and is hard to pick from cuttings at the southern end. The PIMA Kaolinite Crystallinity Index provided assistance, although where the pick is within silcrete, its location is questionable (too little kaolinite to provide a reliable spectra), see red line on Figures 170, 171. A recognisable clay-rich plasmic zone occurs below the silcrete capping horizon in a number of drill intersections and this has been in part silicified to porcellanite. Silcrete (0.5-2 m thick) occurs across the whole section and outcrops where weathered basement reaches the surface. Within the silcrete are two separately sourced components: the lower part is silicified pedolith containing angular quartz grit and relict quartz veins; while the upper portion is silicified colluvium containing subangular to subrounded quartz-rich gravel and an alluvium of well rounded quartz gravel with pebbles. Silcrete here is pedogenic in origin, is pale grey, cream or yellowish, and contains wisps of titania, some Fe-staining, and in the lower portions has relict *in situ* weathered minerals like graphite persisting (Lintern *et al*., 2002; Lintern, 2004b).

## *Transported Regolith*

Hardpan, at Monsoon is 0-2 m thick (Figure 171), underlies the sand-rich modern creek alluvium and overlies the silcreted alluvium horizon. A strong brown colour and indurated clay-rich texture makes this sediment easily identifiable from all the others in the Monsoon regolith profile. It contains dark brown to black Mn-Fe sesquioxide and hydroxide cements and/or segregations, the matrix clay may also be partly silicified. In places this clay-rich material is carbonate coated or fracture impregnated (Lintern *et al*., 2002; Lintern, 2004b).

Dark reddish alluvium-colluvium, is restricted to the main sediment wedge (Figure 171), filling the lower portion of a distinct channel and consists of loose rounded to subrounded quartz plus lithic clasts; it ranges from fine sand to cobbles in clast size. This sediment is dominantly a gravel-rich unit with a distinct brown colour, ferruginous staining and calcrete coatings to clasts and/or cementation in distinct bands. Clast rounding and sorting variability suggests both local and distal sources. Drill sample evidence suggests there may be thin layers of reddish silty clay as lenses or localised low-flow regime stringers. An irregular upper boundary to this alluvium indicates later incision by the coincidental modern drainage regime (Lintern *et al*., 2002; Lintern, 2004b).

Modern alluvium, is also restricted to the main sediment wedge, this material fills the upper portion of a distinct channel and consists of loose rounded to subrounded quartz plus lithic clasts; in the fine sand to cobble size range, it is though predominantly sandy (Figure 171). This sediment is much paler in colour than the underlying alluvial unit, and contains calcrete as clast cementation within part of its overall thickness. Clast rounding and sorting variability suggests both local and distal sources, most of this sediment relates to modern creek activity (Lintern *et al*., 2002; Lintern, 2004b).

Colluvium: between drillholes 97MNAR118 and 052 (Figure 171) is a subsoil colluvium (<1 m thick) overlying the silcrete. This is essentially a weathering-erosional lag accumulation deposit, locally derived from exposed materials. Most clasts are angular to subrounded, range from blocks to fine gravel, and have a clast to fines ratio of >2:1. Calcrete has impregnated and stabilised this deposit, thus minimising later erosive affects (Lintern *et al*., 2002; Lintern, 2004b).

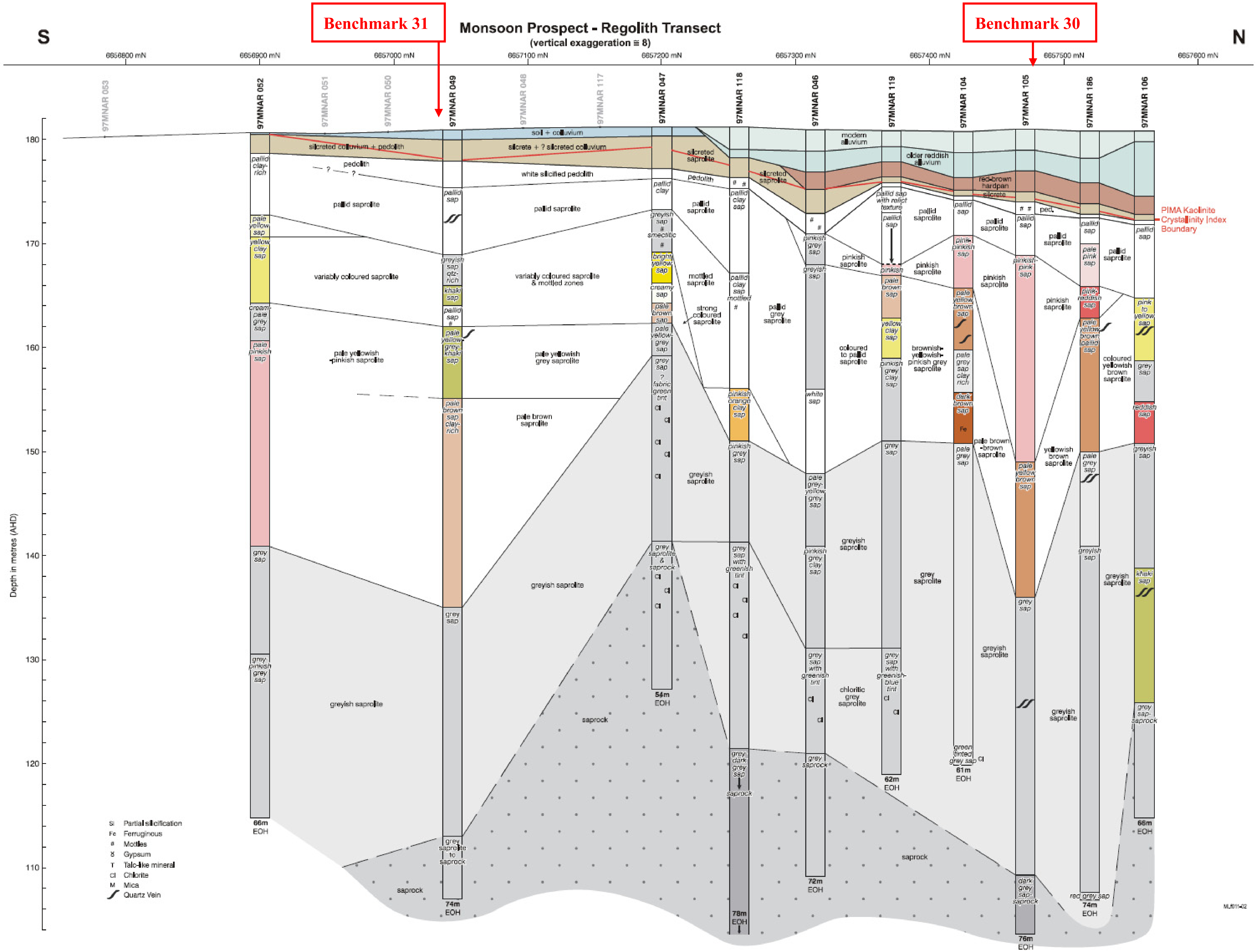



**Figure 170:** Monsoon gold prospect, full regolith section along line displayed in Figure 169 (Lintern *et al*., 2002). Benchmarks 30 and 31 are indicated.

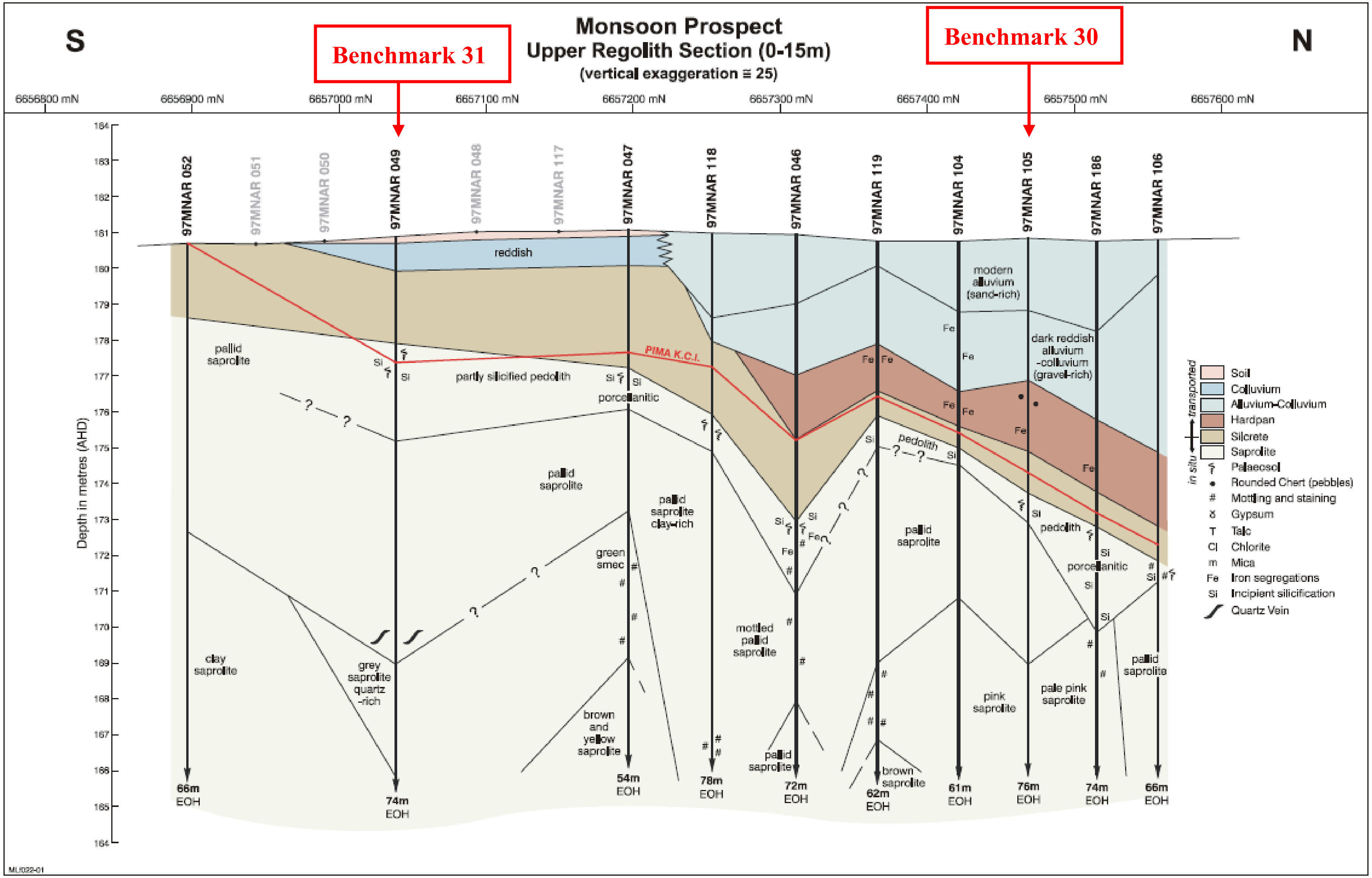



**Figure 171:** Monsoon gold prospect, upper regolith section along line displayed in Figure 169 (Lintern *et al*., 2002). Benchmarks 30 and 31 are indicated.

Calcrete occurs across the upper regolith within the soil profile and colluvium. It coats the silcrete and penetrates several metres into the alluvium wedge. Forms include: nodules, earthy powders, coatings, irregular sheets and as irregular low density sheets (0.5 m thick) to thick horizons of very porous material (Lintern *et al*., 2002).

Soils range from uniform silty to sandy (Um, Uc) to gradational calcareous (Gc) to lithosols in gravelly lag areas. These soils are generally poorly structured and with little organic matter present in the A horizons. All are strongly alkaline and are probably sodic (AS3) where clay-rich (Northcote and Skene, 1972; Northcote, 1979; Lintern *et al*., 2002).

## PIMA Mineralogy

PIMA spectrometry indicates crystalline kaolinite and smectite, with intermediate chlorite (Fe-Mg) and muscovite recorded in a few samples from the lower regolith. Poorly crystalline kaolinite and smectite characterise the alluvium and hardpan. There is a sharp boundary to well crystalline kaolinite in the weathered *in situ* regolith *versus* the transported regolith. Kaolinite crystallinity within the silcrete varies markedly from low to high but silcrete usually has a low abundance of kaolinite and this may yield spurious results. The field evidence is for silcrete at Monsoon enclosing both weathered *in situ* regolith and transported regolith (Lintern *et al*., 2002).

## Geochemical expression

Iron at Monsoon correlates with As, Co, Cu and Ni, but unlike at Golf Bore prospect, not Mg, and not as strongly as at Jumbuck and Golf Bore prospects. Some samples relatively rich in S (up to 2.1%) and Fe are also relatively rich in Cd, Zn and Au suggesting some association with sulphide mineralization (Figure 172). The co-presence of S and Fe potentially provides a larger drilling target. Gold mineralization is also associated with elevated As, Cu, Ni, and Tl (Table 74), (Lintern *et al*., 2002; Lintern, 2004b).

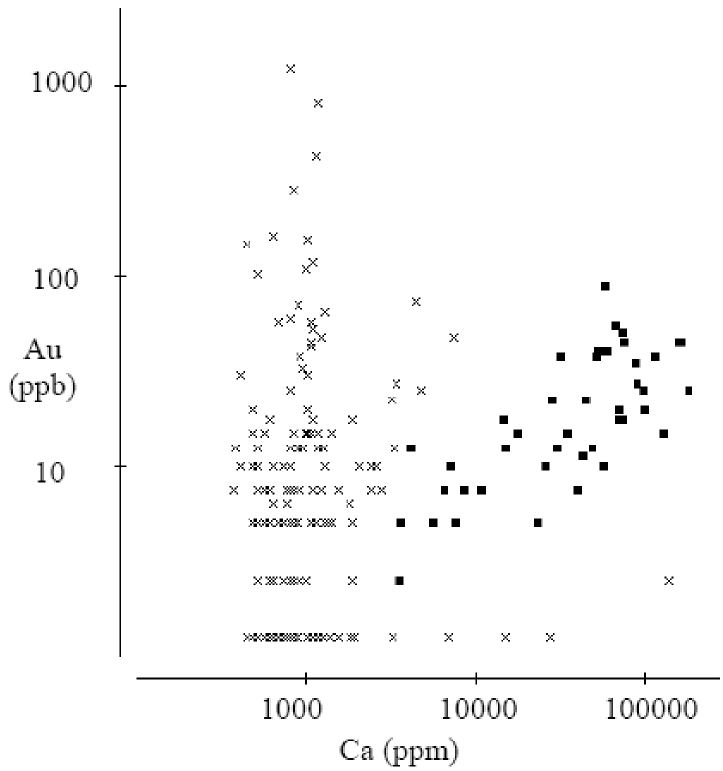
For the upper regolith, the highest Au concentrations (10-30 ppb) occur in the southern part of the section and are associated with Ca in the siliceous upper saprolite and thin colluvial units. Anomalous but lower Au concentrations (10-20 ppb) continue into calcareous facies of the adjacent alluvium. Gold is only weakly anomalous above mineralization in the siliceous units below the alluvium in the central part of the section (Figure 173). The dominant factor in the distribution of Au appears to be lateral dispersion related to known subcropping mineralization occurring to the west, and the presence of calcrete (Ca) with which it is strongly associated. The Ca versus Au scatter plot is particularly interesting since the strong correlation with surficial Ca suggests that the Au is probably mostly chemically derived since detrital Au would cause spikes in the data (Figure 172). There is no evidence of vertical migration of Au to the surface from mineralization located beneath 5 m of transported overburden (and ~30 m of leached saprolite) in the north of the section (Figure 173), (Lintern *et al*., 2002; Lintern, 2004b).

**Table 74:** Monsoon gold prospect, highest Au concentrations and other anomalous intervals in drillholes (Lintern, 2004b).

| Drillhole | Interval (m) | Analyses (ppm unless stated) | Regolith type |
|---|---|---|---|
| 97MNAR105 | 43-44 | Au 495 ppb | saprolite |
| 97MNAR104 | 44-45 | Au 170 ppb | saprolite |
| 97MNAR105 | 45-46 | Au 320 ppb, Cu 550, Ag 2 | saprolite |
| 97MNAR105 | 55-56 | Au 115 ppb, As 450, Zn 950, Ni 1050, Tl 15 | saprock |
| 97MNAR105 | 19-20 | Au 2 ppb Se 20 | saprolite |
| 97MNAR119 | 31-32 | Au 23 ppb Se 13, Cu 500 | saprolite |
| 97MNAR49 | 24-25 | Au 4 ppb As 550 | saprolite |
| 97MNAR47 | 29-30 | Au 65 ppb Ni 1350 | saprolite |

Conclusions: This case study is typical of a number from the Western Gawler Craton. It demonstrates how calcrete can be sampled to show the presence of underlying mineralization within basement derived regolith. For transported overburden, the buried mineralization is not reflected in hardpan or saprolite at the unconformity, and any surface expression in calcrete is obscured by lateral dispersion from the stronger anomaly associated with the basement derived regolith to the south (Lintern, 2004b).

a)




b)

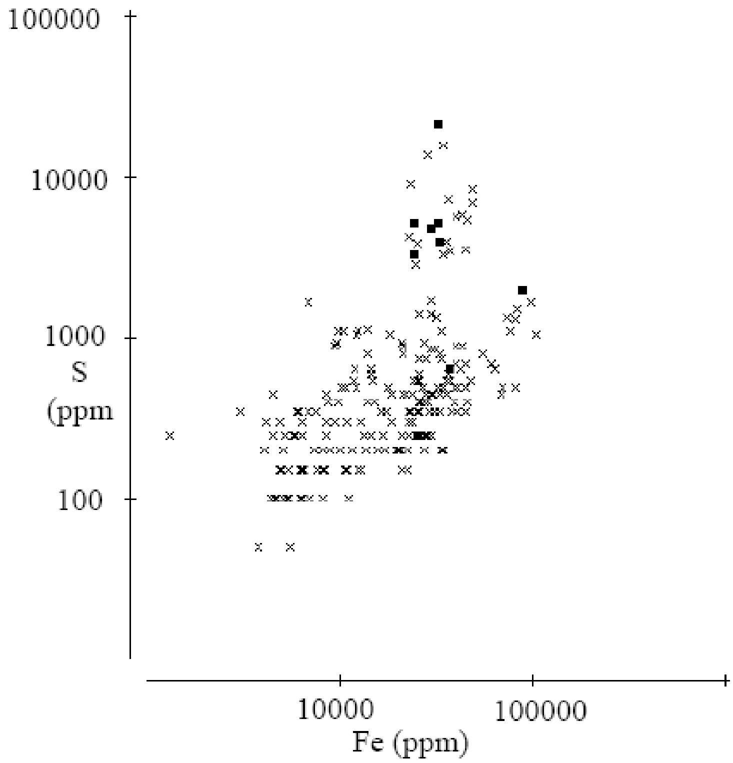
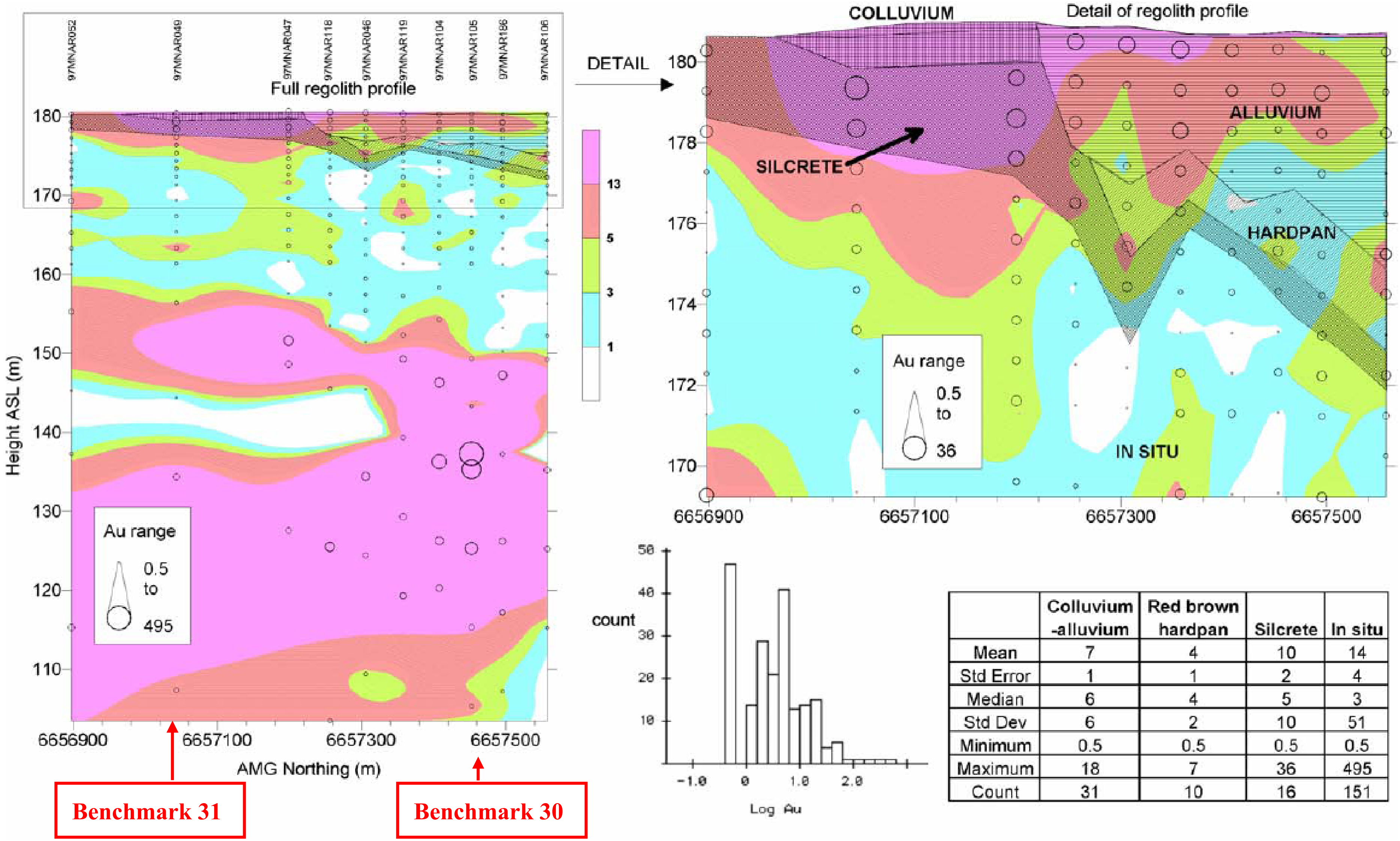



**Figure 172:** Monsoon gold prospect, scatter plots for selected elements.

**Plot a.** Ca *v* Au; large box symbols indicate highly calcareous surficial samples showing strong association between Ca and Au.

**Plot b.** Fe *v* S; large box symbols in top right of plot indicate samples with high Au contents.




| | Colluvium -alluvium | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 7 | 4 | 10 | 14 |
| Std Error | 1 | 1 | 2 | 4 |
| Median | 6 | 4 | 5 | 3 |
| Std Dev | 6 | 2 | 10 | 51 |
| Minimum | 0.5 | 0.5 | 0.5 | 0.5 |
| Maximum | 18 | 7 | 36 | 495 |
| Count | 31 | 10 | 16 | 151 |

**73129:** Monsoon gold prospect, regolith section, regolith architecture and Au geochemical expression (*c.f.* Figures 170, 171), (Lintern, 2004b). Benchmarks 30 and 31 are indicated.

## Benchmark 30: drillhole 97MNAR105

Quick reference items are set out in Table 75; detailed descriptions, figures and data tables follow on below. Monsoon prospect lies about 150 km WNW of Tarcoola and about ~53 km W of Mulgathing Pastoral Station Homestead (Figures 110-112, 136, 169). It can be accessed via pastoral lease tracks and gazetted unsealed roads. Drilling for this RAB hole was vertical. A summary of this profile is provided in Table 76 and chiptray photograph with regolith zonation is in Figure 174. Geochemical data are presented in Figures 172, 173, 175-179 and Table 74.

**Table 75:** Benchmark 30 reference data; drillhole 97MNAR105 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figure 110-112, 136. |
| Local-site location map | Figures 169, 170. |
| GPS coordinates, attitude & elevation | RAB drillhole 97MNAR105: Zone 53, 350688 E, 6657625 N, GDA 94. **Attitude**: vertical. **AHD:** 180.823 (differential GPS data). |
| Site access, owner | About 150 km WNW of Tarcoola and about 53 km ~W of Mulgathing Pastoral Station Homestead (Figure 136). Site can be accessed via pastoral lease tracks and gazetted unsealed roads. Site Lease holder: Mulgathing Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 174, Table 76. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 172, 173, 175-179 and Table 74. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite Crystallinity Indices for unconformity picks & some mineral identification. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | ?As, Bi, ?Cu, Ni. |
| Useful sampling media | Calcrete & silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 97MNAR105 is selected to form this benchmark because it includes a moderate thickness of transported cover and is located within the defined Au mineralization. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 31 and the regolith cross-sections of Figures 170, 171. Exploration grid drilling on this prospect involved RAB (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have terminated in lower saprolite to saprock rather than within fresh gneiss. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).


**0-2 m** **Transported**: siliceous <u>alluvium</u>, pale pinkish, sand to pebbles, loose to cemented by calcrete.

**2-4 m** **Transported**: <u>colluvium</u>-<u>alluvium</u>, dark reddish brown, calcareous in part, carbonate coatings on clasts, Fe-oxide staining.

**4-6 m** **Transported**: red-brown <u>hardpan</u>, palaeosol, partly Fe-oxide cemented.

**~6 m** **Unconformity**, base of palaeochannel.

**6-8 m** ***In situ***: <u>pedolith</u>, silcrete on/in incipiently silicified pallid plasmic zone.

**8-12 m** <u>Upper saprolite</u>, pallid, kaolinite + quartz grit.

**12-32 m** <u>Upper saprolite</u>, pinkish to pink, kaolinite + quartz grit.

**32-45 m** <u>Upper saprolite</u>, pale yellow-brown, kaolinite + quartz grit.

**45-72 m** <u>Lower saprolite</u>, grey, clays + quartz grit, bluish grey vein quartz at 55-56 m.

**NOTE: saprock and bedrock not penetrated; irregular sampling below 20 m. E.O.H. at 76 m but chiptray image is only to 56 m.**

Regolith logged by M.J. Sheard

**Figure 174:** Benchmark 30, Monsoon gold prospect drillhole 97MNAR105, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work.

**Table 76:** Benchmark 30, regolith log to RAB drillhole 97MNAR105 (after Lintern *et al*., 2002).

**Hole:** 97MNAR105. **Regolith Line**, Monsoon gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 350688 E, 6657625 N, GDA 94. **AHD:** 180.823 (differential GPS data).

**Attitude:** vertical.

**Site:** within a shallow creek gully.

**Vegetation:** *Acacia aneura* Low Open Woodland over *Maireana sedifolia, Senna cardiosperma* subsp. *microphylla* and *Eremophila latrobei* Low Open Heath. (Botanical log by S. Lintern).

**Soil:** Uc (gravelly alluvium).

**Calcrete:** massive to platy.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-2 | Siliceous alluvium, pale pinkish, sand to pebbles, loose to cemented by calcrete. |
| 2-4 | Colluvium-alluvium, dark reddish brown, calcareous in part as carbonate coatings to clasts, Fe-oxide staining. Older than unit above but still related to the modern creek channel. |
| 4-6 | Red-brown hardpan, palaeosol, partly Fe-oxide cemented. |
| 6-8 | Pedolith, silcrete on/in incipiently silicified pallid plasmic zone. |
| 8-12 | Upper saprolite, pallid, kaolinite + quartz grit. |
| 12-32 | Upper saprolite, pinkish to pink, kaolinite + quartz grit. |
| 32-45 | Upper saprolite, pale yellow-brown, kaolinite + quartz grit. |
| 45-72 | Lower saprolite, grey, clays + quartz grit, bluish grey vein quartz at 55-56 m. |
| 72->76 | Lower saprolite, dark grey, kaolinite + quartz grit. |
| E.O.H. | |

## *In situ Regolith*

Bedrock was not penetrated by drilling on this prospect, but remnant saprock corestones within the saprolite indicate it has components typical of the Christie Gneiss. Generally saprolite at this site follows descriptions for this prospect set out earlier. Saprolite was not fully penetrated here, its total thickness in adjacent drillholes can be inferred by reference to the regolith section of Figure 170. Pedolith is thinned at this site in comparison with that intersected in Benchmark 31, similarly for silcrete, it too is thinned – possibly by fluvial erosion.

## *Transported Regolith*

Colluvium and alluvium (mostly sand + gravel) forms the thickest transported cover, as palaeochannel infill in this benchmark (~6 m thick). Clast rounding, the presence of lithics and the broad range of clast size indicate immature sediment with a local and some distal provenances. The underlying red-brown hardpan forms a readily identifiable stratum, having colluvial + minor alluvial and pedogenic character (~2 m thick). Red-brown hardpan is an extensively deposited unit in this region and can serve as a key stratigraphic marker bed. PIMA spectral data, as a derived Kaolinite Crystallinity Index, places the main unconformity within the silcrete, where it may well be here. However, the low levels of preserved kaolinite in silcrete and the 1 m drill chip sample bias may also be skewing the pick. Drillcore or an excavation would provide a more absolute answer.

## *Geochemistry*

Geochemical expression for Monsoon gold prospect has been outlined earlier and presented via Figures 172, 173 (Au) and Table 74 (As, Cu, Ni, Se, Tl, Zn).

A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including: Ca *v* Au, Bi, Ni, S and V appear in Figures 175-179. The sulphur plot serves to demonstrate the presence of some gypsum in the palaeochannel sediments and sulphides at depth; compare with the

Ca *v* Au plot of Figure 175 where the high Ca includes both calcrete and minor gypsum. Bismuth, ?Cu and Ni may serve as limited pathfinder elements in this area, but all have weak near surface signals. Compare the geochemical expression over defined Au mineralization with that of Benchmark 31 (in unmineralized ground) and where the transported cover is thinner than for Benchmark 30.

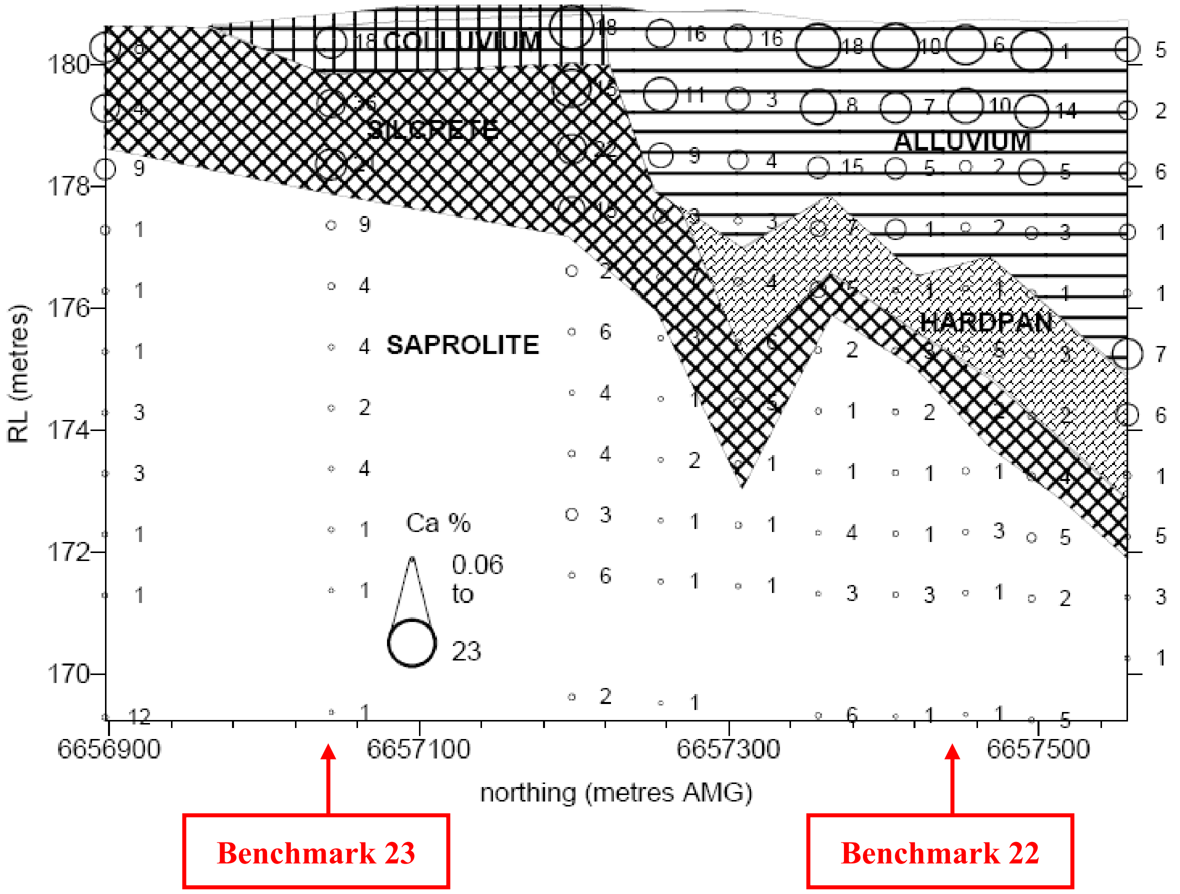
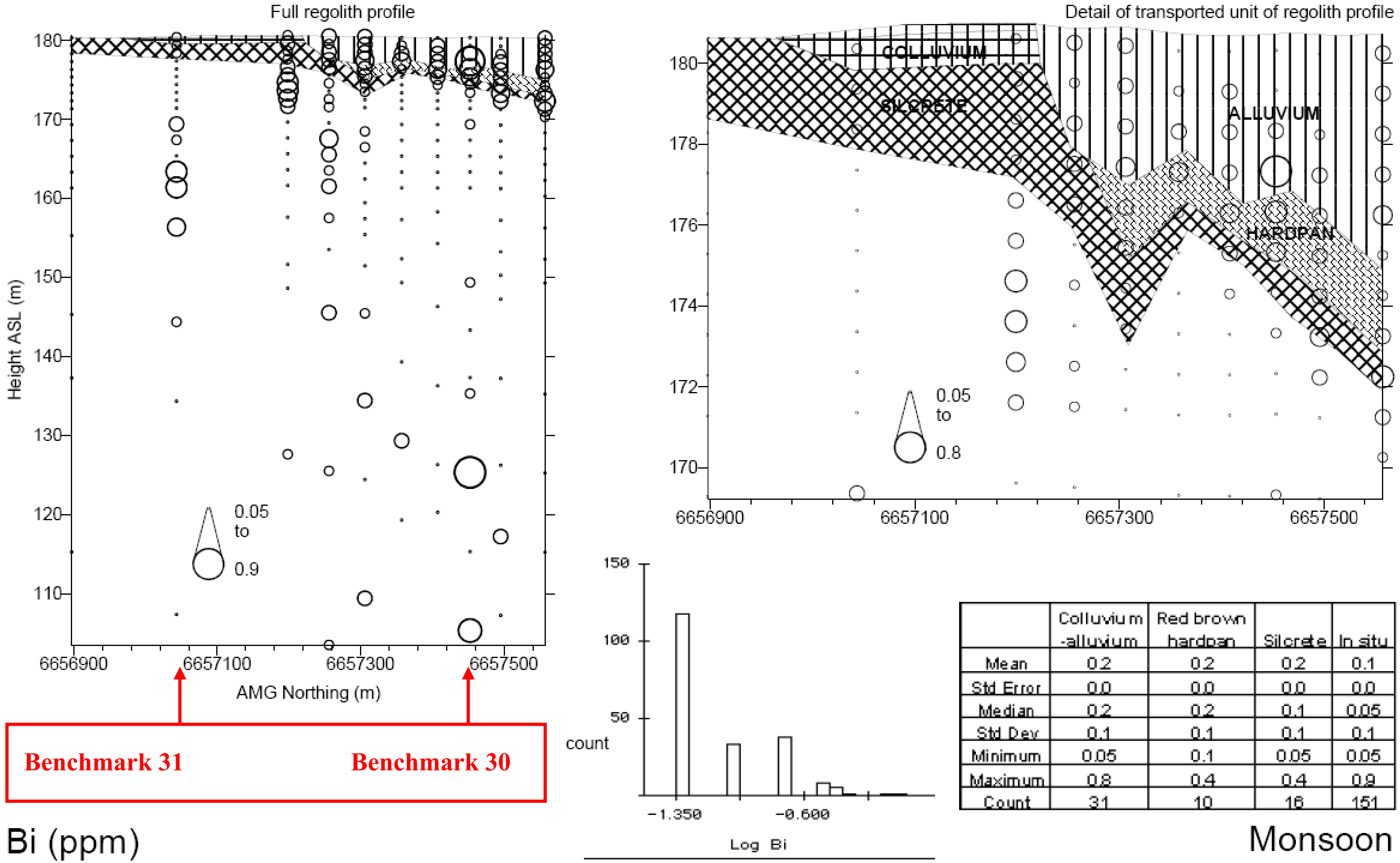
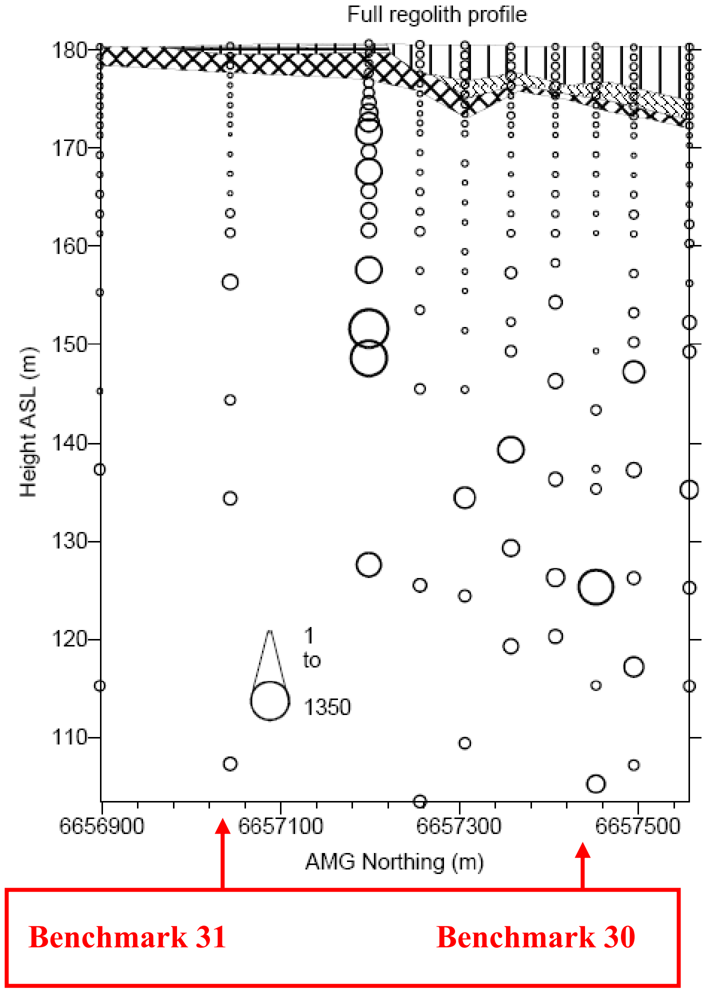


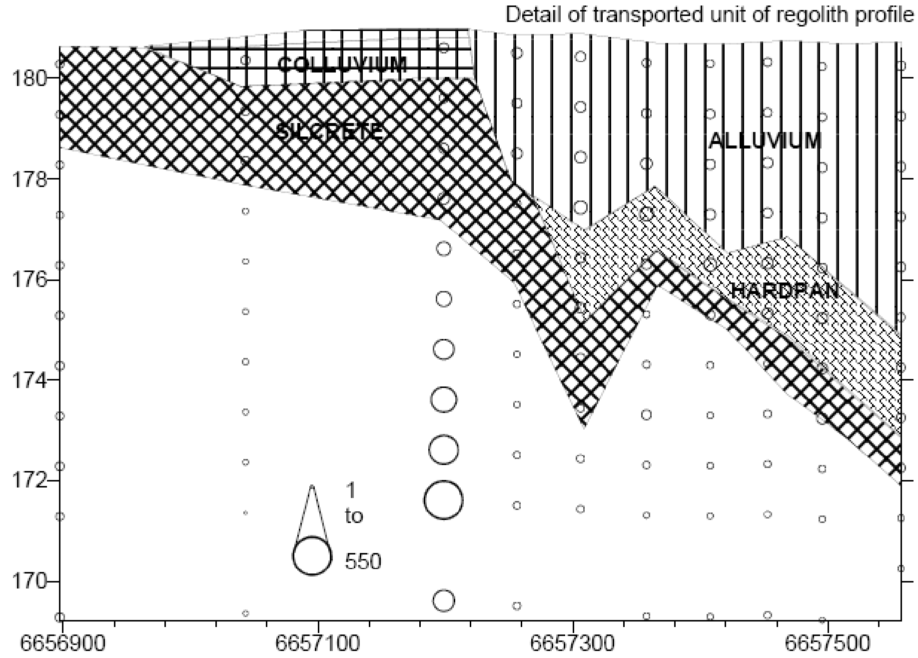

**Figure 175:** Monsoon gold prospect, distribution of Au (numerical data in ppb) and Ca (circular symbols) in the upper regolith. Calcium is present principally as calcrete but some gypsum is also present (*c.f.* S plot in Figure 178).

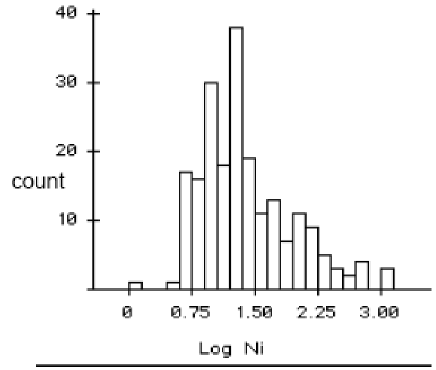



| | Colluvium -alluvium | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 0.2 | 0.2 | 0.2 | 0.1 |
| Std Error | 0.0 | 0.0 | 0.0 | 0.0 |
| Median | 0.2 | 0.2 | 0.1 | 0.05 |
| Std Dev | 0.1 | 0.1 | 0.1 | 0.1 |
| Minimum | 0.05 | 0.1 | 0.05 | 0.05 |
| Maximum | 0.8 | 0.4 | 0.4 | 0.9 |
| Count | 31 | 10 | 16 | 151 |

**Figure 176:** Monsoon gold prospect regolith section, regolith architecture & Bi geochemistry (*c.f.* Figures 177-179). Lintern *et al*. (2002). Benchmarks 30, 31 indicated.



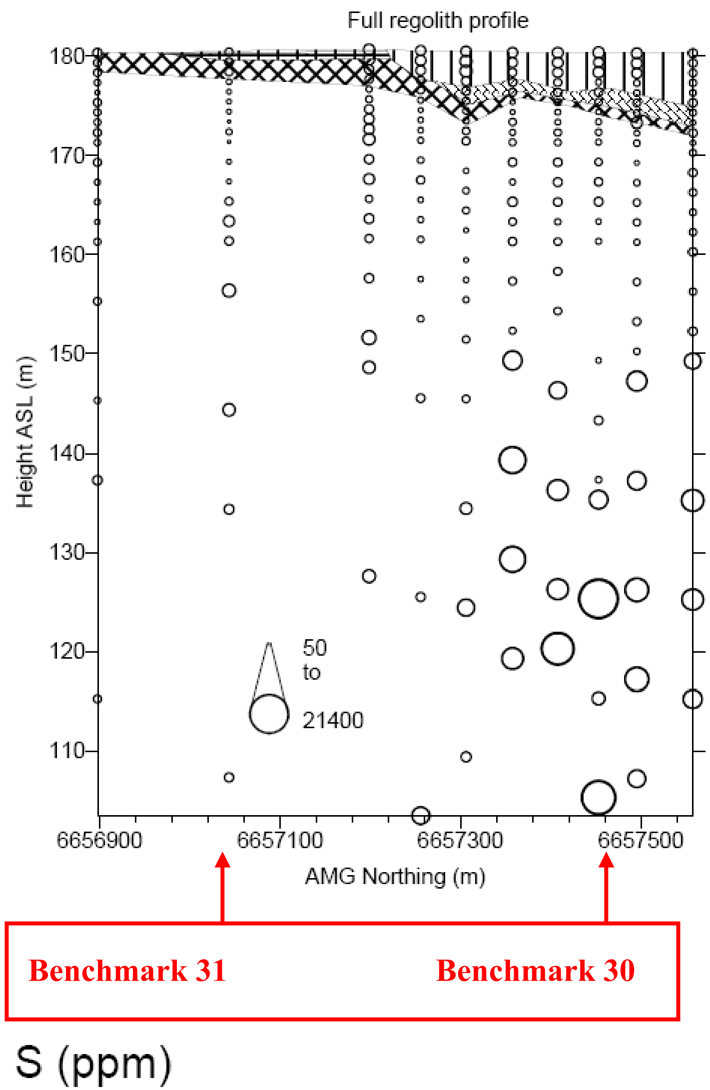



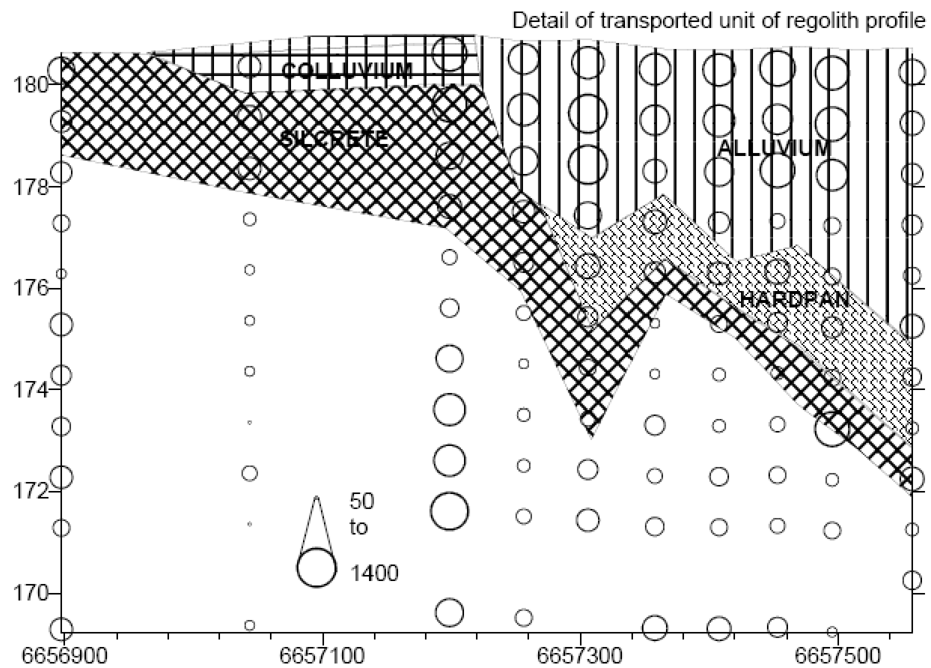

| | Colluvium -alluvium | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 22 | 29 | 17 | 89 |
| Std Error | 1 | 3 | 2 | 16 |
| Median | 21 | 26 | 18 | 17 |
| Std Dev | 7 | 11 | 7 | 193 |
| Minimum | 11 | 17 | 9 | 1 |
| Maximum | 46 | 51 | 32 | 1350 |
| Count | 31 | 10 | 16 | 151 |

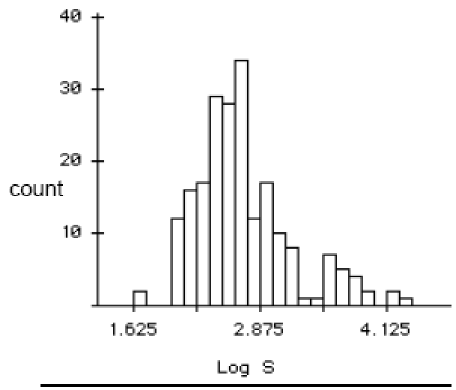
Ni (ppm)

Monsoon

**Figure 177:** Monsoon gold prospect regolith section, regolith architecture & Ni geochemistry (*c.f.* Figures 176, 178, 179). Lintern *et al*. (2002). Benchmarks 30, 31 are indicated.



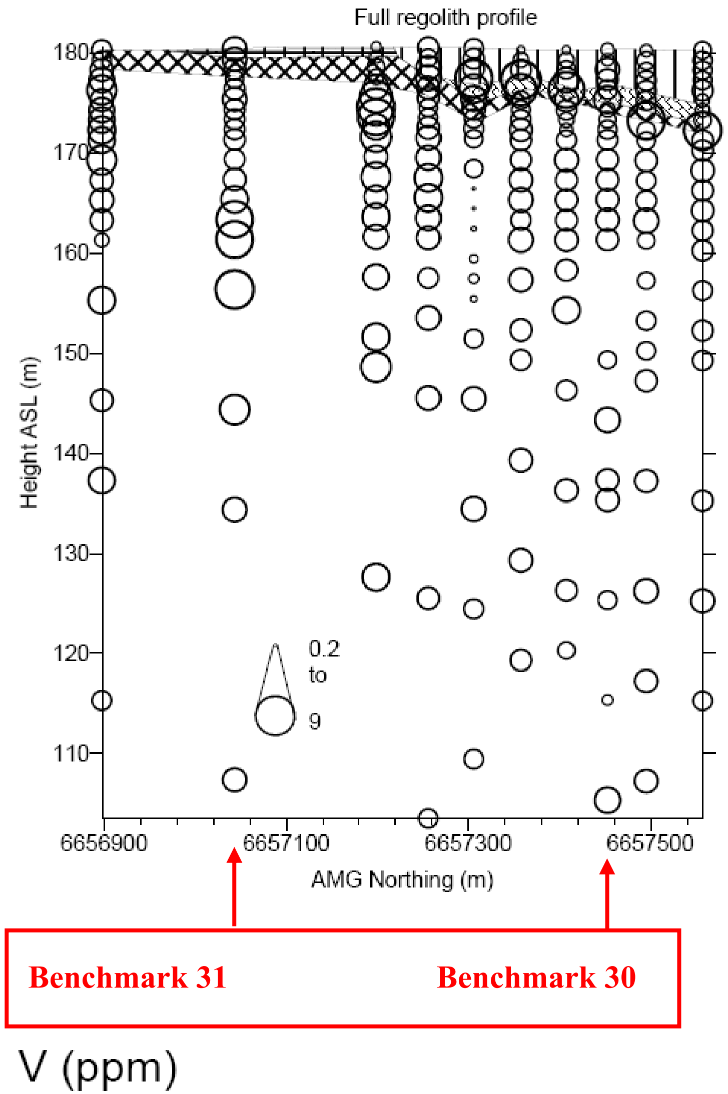



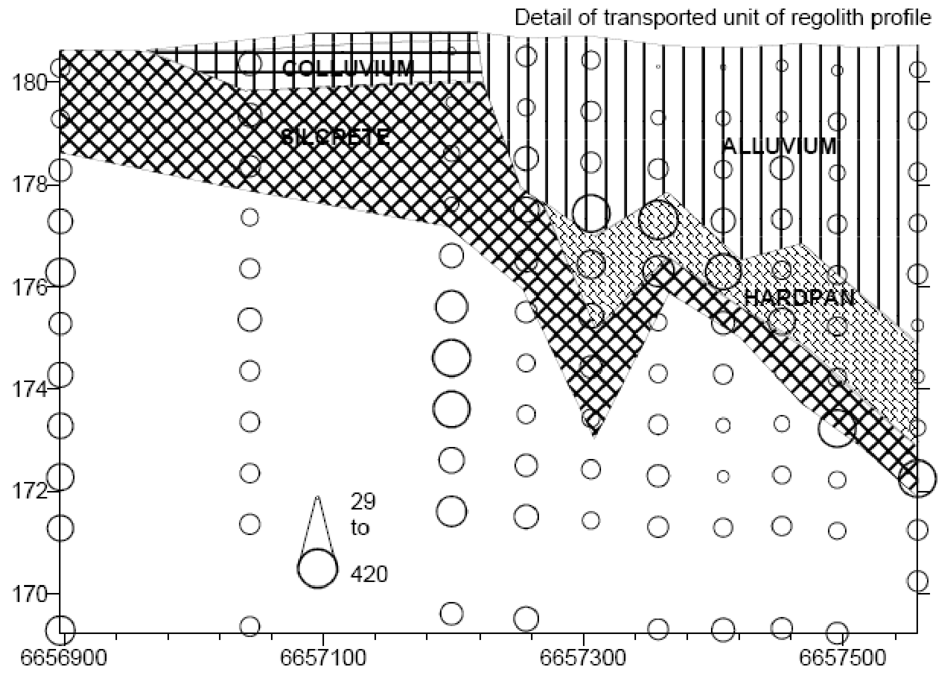



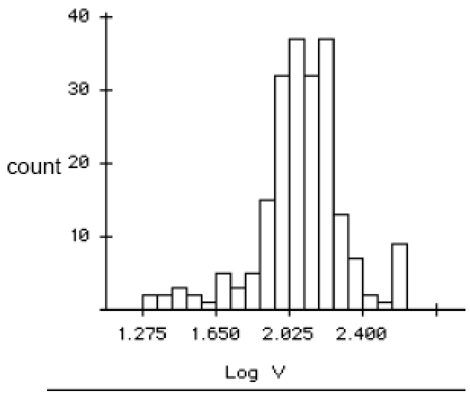

| | Colluvium -alluvium | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 742 | 385 | 494 | 1341 |
| Std Error | 60 | 42 | 69 | 232 |
| Median | 800 | 375 | 450 | 350 |
| Std Dev | 333 | 131 | 277 | 2852 |
| Minimum | 200 | 150 | 150 | 50 |
| Maximum | 1400 | 550 | 1100 | 21400 |
| Count | 31 | 10 | 16 | 151 |

Monsoon

**Figure 178:** Monsoon gold prospect regolith section, regolith architecture & S geochemistry (*c.f.* Figures 176, 177, 179). Lintern *et al*. (2002). Benchmarks 30, 31 are indicated.




| | Colluvium -alluvium | Red brown hardpan | Silcrete | In situ |
|---|---|---|---|---|
| Mean | 102 | 181 | 154 | 140 |
| Std Error | 11 | 38 | 26 | 5 |
| Median | 96 | 140 | 133 | 130 |
| Std Dev | 63 | 121 | 103 | 63 |
| Minimum | 29 | 59 | 49 | 22 |
| Maximum | 380 | 420 | 380 | 400 |
| Count | 31 | 10 | 16 | 151 |

Monsoon

**Figure 179:** Monsoon gold prospect regolith section, regolith architecture & V geochemistry (*c.f.* Figures 176-178). Lintern *et al*. (2002). Benchmarks 30, 31 are indicated.

## Benchmark 31: drillhole 97MNAR049

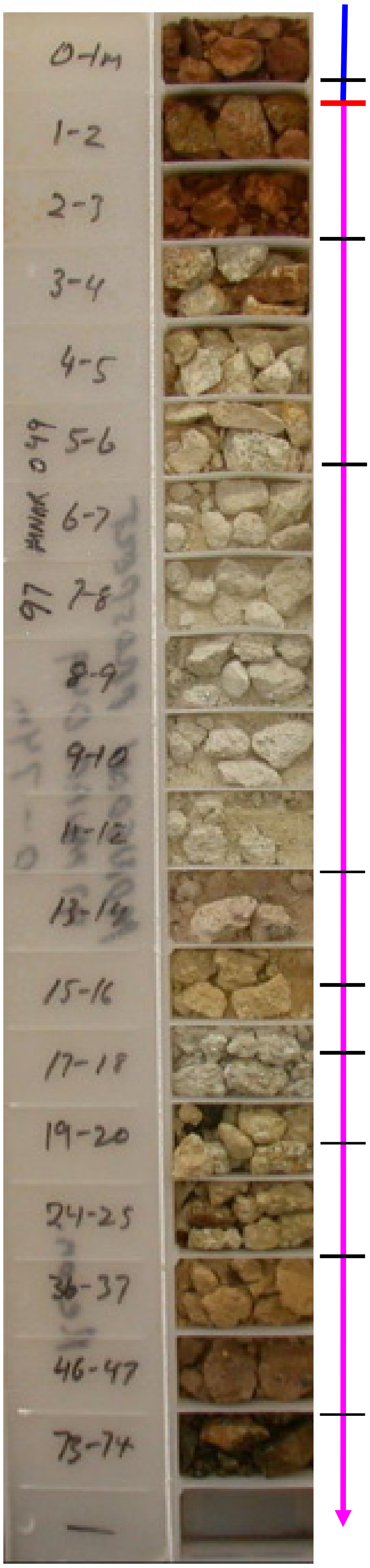
Quick reference items are set out in Table 77; detailed descriptions, figures and data tables follow on below. Monsoon prospect lies about 150 km WNW of Tarcoola and about ~53 km W of Mulgathing Pastoral Station Homestead (Figures 110-112, 136, 169). It can be accessed via pastoral lease tracks and gazetted unsealed roads. Drilling for this RAB hole was vertical. A summary of this profile is provided in Table 78 and chiptray photograph with regolith zonation is in Figure 180. Geochemical data are presented in Figures 172, 173, 175-179 and Table 74.

**Table 77:** Benchmark 31 reference data; drillhole 97MNAR049 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figure 110-112, 136. |
| Local-site location map | Figures 169, 170. |
| GPS coordinates, attitude & elevation | RAB drillhole 97MNAR049: Zone 53, 350787 E, 6657214 N, GDA 94. **Attitude**: vertical. **AHD:** 180.859 (differential GPS data). |
| Site access, owner | About 150 km WNW of Tarcoola and about 53 km ~W of Mulgathing Pastoral Station Homestead (Figure 136). Site can be accessed via pastoral lease tracks and gazetted unsealed roads. Site Lease holder: Mulgathing Pastoral Station. |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 180, Table 78. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 172, 173, 175-179 and Table 74. |
| XRD mineralogy | No. |
| PIMA spectral data | Yes, unpublished data only, used by Lintern *et al*. (2002) to produce kaolinite Crystallinity Indices for unconformity picks & some mineral identification. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | ?As, Bi, ?Cu, Ni. |
| Useful sampling media | Calcrete & silcrete. |
| Key reference sources | Lintern *et al*. (2002); Lintern (2004b). |

### *Background*

Drillhole 97MNAR049 is selected to form this benchmark because it includes very thin transported cover and is located away from the defined Au mineralization. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 30 and the regolith cross-sections of Figures 170, 171. Exploration grid drilling on this prospect involved RAB (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have terminated in lower saprolite to saprock rather than within fresh gneiss. Cuttings were sampled from the drilled 1-2 m composites (not ideal for regolith investigations). These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




97MNAR049

**0-1 m** **Transported**: Surficial lag + colluvium + thin lithosol, pale brown, calcreted.

**>1 m, <2 m** **Unconformity**, within silcrete horizon.

**1-3 m** **Transported/*in situ***: pedolith, silcrete: silicified brownish colluvium + pallid plasmic zone.

**3-<6 m** ***In situ***: pedolith, partly silicified pallid plasmic zone.

**<6-12 m** Upper saprolite, pallid, kaolinite + quartz grit, bluish vein quartz at 8-9 m.

**12-15 m** Upper saprolite, grey, quartz grit + less kaolinite

**15-17 m** Saprolite, khaki, kaolinite + quartz grit.

**17-19 m** Saprolite, pallid + brown micro-flecking, kaolinite + quartz grit.

**19-30 m** Saprolite, pale yellowish to grey to khaki, kaolinite + quartz grit, bluish vein quartz at 19-20 m.

**30-50 m** Lower saprolite, pale brown, dominantly clay.

**50->74 m** Lower saprolite to saprock, greyish with dark grey lithics (saprock corestones) increasing towards 70 m.

**NOTE: bedrock not penetrated; irregularly sampled below 20 m**

Regolith logged by M.J. Sheard

**Figure 180:** Benchmark 31, Monsoon gold prospect drillhole 97MNAR049, chiptray and regolith zonation (image extracted from Lintern *et al*., 2002). In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work.

**Table 78:** Benchmark 31, regolith log to RAB drillhole 97MNAR049 (after Lintern *et al*., 2002).

**Hole:** 97MNAR049. **Regolith Line**, Monsoon gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 350787 E, 6657214 N, GDA 94. **AHD:** 180.859 (differential GPS data).

**Attitude:** vertical.

**Site:** on the upper part of a low flat outcrop area.

**Vegetation:** *Maireana sedifolia, Senna cardiosperma* subsp. *microphylla* and *Eremophila latrobei* Low Shrubland. (Botanical log by S. Lintern).

**Soil:** Uc (lithosol, gravelly colluvium).

**Calcrete:** massive to platy.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-1 | Surficial lag + colluvium + thin lithosol pale brown, calcreted. |
| 1-3 | Pedolith, silcrete: silicified brownish colluvium + pallid plasmic zone. |
| 3-<6 | Pedolith, partly silicified pallid plasmic zone. |
| <6-12 | Upper saprolite, pallid, kaolinite + quartz grit, bluish vein quartz at 8-9 m. |
| 12-15 | Upper saprolite, grey, quartz grit + less kaolinite. |
| 15-17 | Saprolite, khaki, kaolinite + quartz grit. |
| 17-19 | Saprolite, pallid + brown micro-flecking, kaolinite + quartz grit. |
| 19-30 | Saprolite, pale yellowish to grey to khaki, kaolinite + quartz grit, bluish vein quartz at 19-20 m. |
| 30-50 | Lower saprolite, pale brown, dominantly clay. |
| 50->74 | Lower saprolite to saprock, greyish with dark grey lithics (saprock corestones) increasing towards 70 m. |
| E.O.H. | |

## *In situ Regolith*

Bedrock was not penetrated by drilling on this prospect. Saprock was encountered in a some drillholes, samples indicate it has components typical of the Christie Gneiss. Generally saprolite at this site follows descriptions for this prospect set out earlier. Saprolite thickness is quite variable, refer to the regolith section of Figure 170 (Lintern *et al*., 2002). Pedolith is thicker at this site but it may still reflect significant erosion pre and post silcrete formation (ferruginous capping is not present and overall the total pedolith thickness is less than might be expected).

## *Transported Regolith*

Colluvium and lags (mostly gravel to blocks) forms the residual transported cover (<2 m thick). Clast angularity, the presence of lithics and the broad range of clast size indicate a very immature sediment with a local provenance. The silcrete horizon enclosing the unconformity, contains colluvium in its upper portion. PIMA spectral data, as a derived Kaolinite Crystallinity Index, places the main unconformity within the silcrete too, confirming the visual observations (Lintern *et al*., 2002).

## *Geochemistry*

Geochemical expression for Monsoon gold prospect has been outlined earlier and presented via Figures 172, 173 (Au) and Table 74 (As, Cu, Ni, Se, Tl, Zn).

A 51 element assay package was applied to all samples and Lintern *et al*. (2002) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including: Ca *v* Au, Bi, Ni, S and V appear in Figures 175-179. Bismuth, ?Cu and Ni may serve as limited pathfinder elements in this area, but all have weak near surface signals.

Compare the geochemical expression away from the defined Au mineralization with that of Benchmark 30 (over mineralized ground) where the transported cover is much thicker than for Benchmark 31.

## *Edoldeh Tank (ET) gold prospect*

### *Background*

ET gold prospect and its associated geochemical anomaly occupy sand dune dominated undulating terrain (relief <35 m) about 150 km W of Tarcoola and about 67 km WSW of Mulgathing Pastoral Station Homestead (Figures 136, 181, 182). The prospect is also ~16 km W of the Dog Fence, 21 km W of Mt Christie, and is outside the State's designated Pastoral Leases region. ET can be accessed via gazetted unsealed roads, the Dog Fence maintenance track and more recently made exploration access tracks (Figure 181). The name 'ET' is an acronym contraction derived from the nearby abandoned Edoldeh Tank (Lintern *et al.*, 2002, 2003).

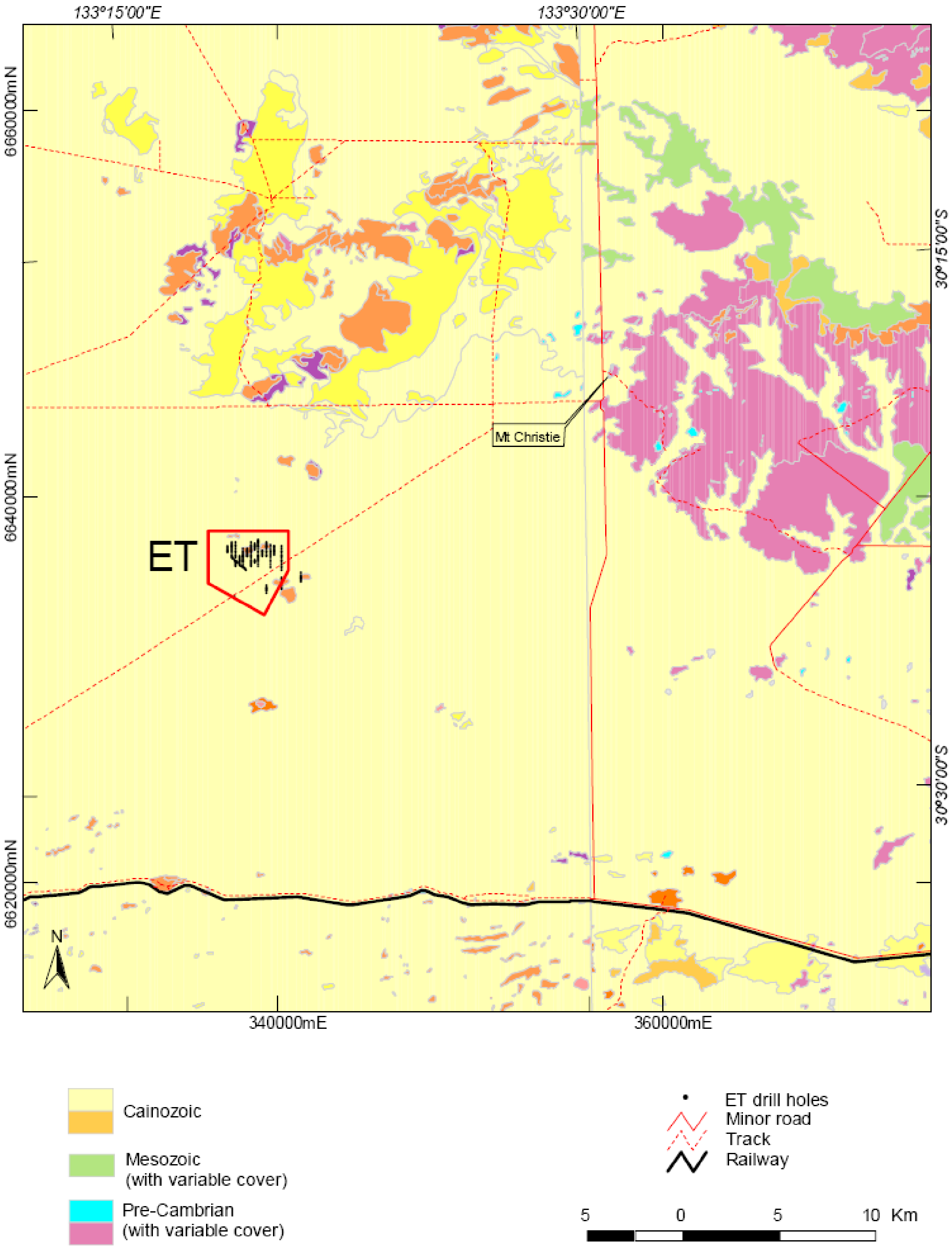



**Figure 181:** ET gold prospect (boxed) and drill lines in relation to Mt Christie, local roads and tracks, and regional geology (BARTON 250k sheet), (Lintern *et al.*, 2003).

The ET geochemically anomalous area (Figure 182) consists of ubiquitous ~E-W trending sand dunes (Great Victoria Desert E fringe) and limited outcrop to subcrop of weathered Archaean Christie Gneiss, where silcrete and calcrete form duricrust cappings. Orange dunes generally mantle palaeotopography (Figures 183, 184), where siliceous sand can reach thicknesses of ~15 m and hosts substantial vegetative cover. Low points of the palaeotopography have been partly infilled with indurated Quaternary colluvium-alluvium in the form of red-brown hardpan (<1-<4 m thick; Lintern *et al*., 2003).

Climatically this region is arid with hot dry summers and cool winters, average rainfall is ~150 mm but annual evaporation exceeds 3500 mm. Pleistocene climate in general appears to have been drier, windier, and possibly cooler than present, leading to extensive desert dunefield development (Callen and Benbow, 1995; Sheard *et al*., 2006). The ET-local terrain and arid climate support woodlands, open woodlands, mallee over shrublands, dominated by large trees and woody shrubs (*Acacia, Eucalyptus, Casuarina, Cratystylis, Scleroleana* and *Senna*). Areas of thin sand cover support woodlands and open woodlands over open shrublands of woody shrubs and trees (*Casuarina, Senna, Eremophila, Santalum, etc*). Vegetation of this type and density impedes vehicle access and exploration but has stabilised the dune system (Lintern *et al*., 2002, 2003; Sheard *et al*., 2006).

ET gold prospect formed part of the larger Gawler Joint Venture tenement coverage, occupying most of the area in Figure 136. The Au anomaly covers an area of ~3 x 4 km$^2$ (an area larger than for the Challenger Gold Deposit), and has a calcrete maximum of ~115 ppb Au located atop a silcrete breakaway, Figure 182). ET prospect was extensively drill tested in 1996 (>200 RAB drillholes); mineralization below the anomaly pattern yielded best assays of 0.670 to 0.755 ppm over intersections of 2-6 m at depths of 40-50 m. However, evidence from the regolith studies of Lintern *et al*. (2002, 2003) suggest the geochemical anomaly is not necessarily directly over mineralization. Their findings indicate that the main source mineralization to the ET Au anomaly probably lies further west; furthermore, that supposition remains untested by drilling (to mid 2008).

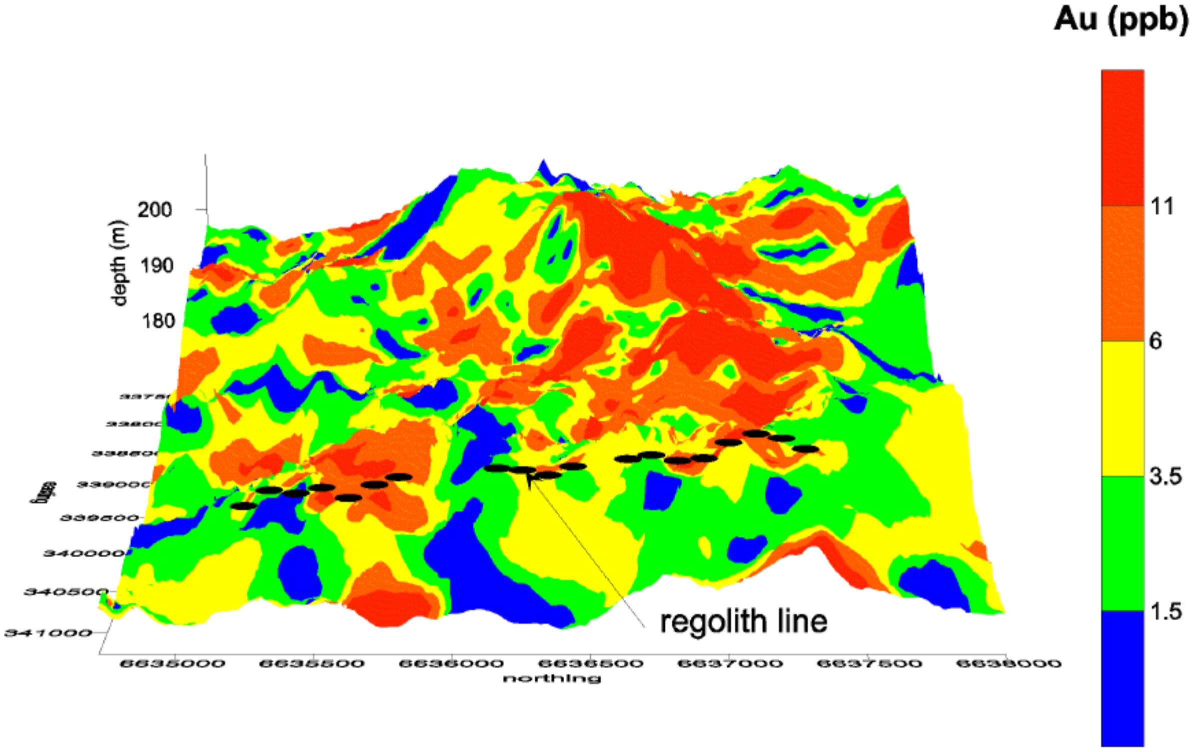



**Figure 182:** ET gold prospect showing Au-in-calcrete anomaly and drilled regolith study line overlaid on the DEM. Viewed from the east (Lintern *et al*., 2002). Original data supplied by the Gawler Joint Venture.

Regolith studies over the ET prospect by CRC LEME and PIRSA involved a two stage approach. Firstly, an initial N-S oriented section (340200 m N local grid) was selected in the east of the prospect, to investigate dispersion in the transported regolith (~11 m thick there; Lintern *et al*., 2002). In the second phase, the rest of the prospect was investigated in detail, including: i) 3D visualisation of the regolith volume and Au distribution; ii) construction of a detailed regolith landform map (1:10,000 scale; Craig, 2001); iii) use of remote sensing technologies to identify regolith materials (Tapley and

Cornelius, 2003); and iv) extensive regolith logging + geochemical assay + PIMA analysis of weathered minerals + XRD mineralogy (Lintern *et al*., 2003). The following summary derives from those studies.

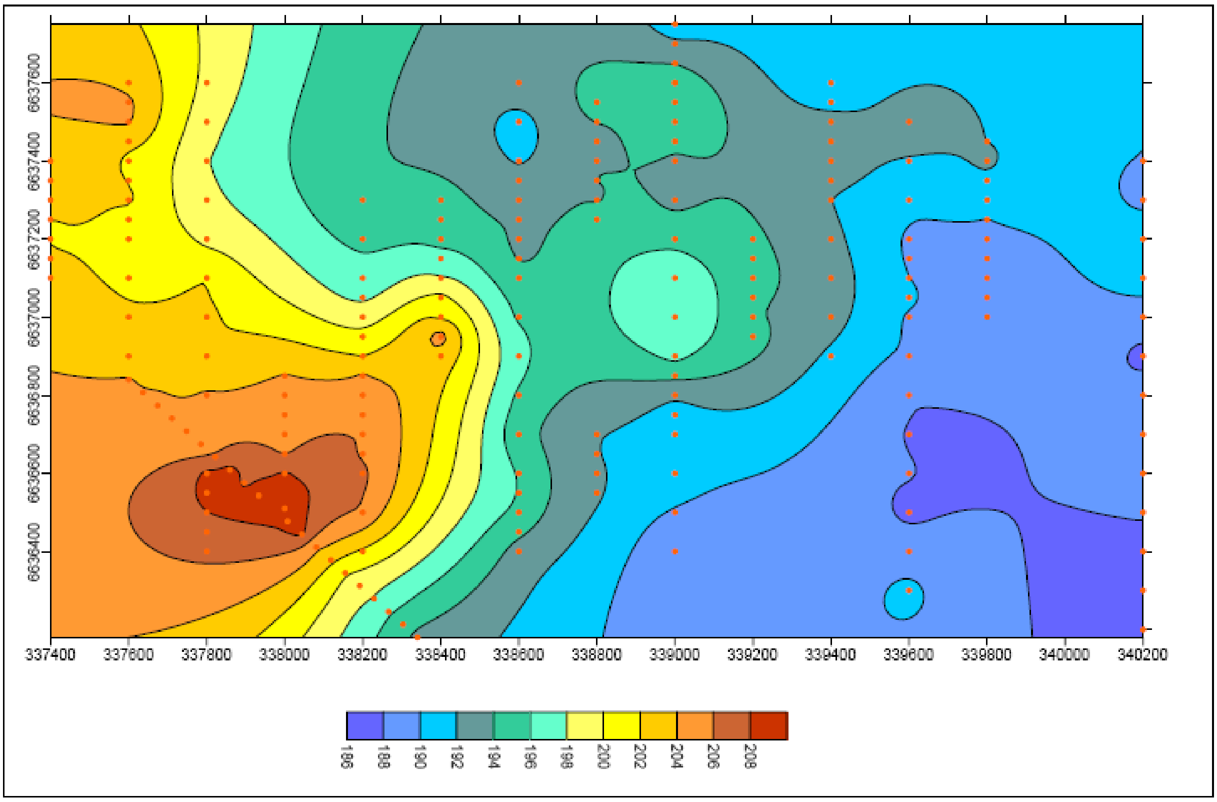



**Figure 183:** ET gold prospect DEM, derived from aerial photographs. It displays the westerly high ground and associated ridge trending SW. Drillholes are marked by red dots. (Lintern *et al*., 2003).

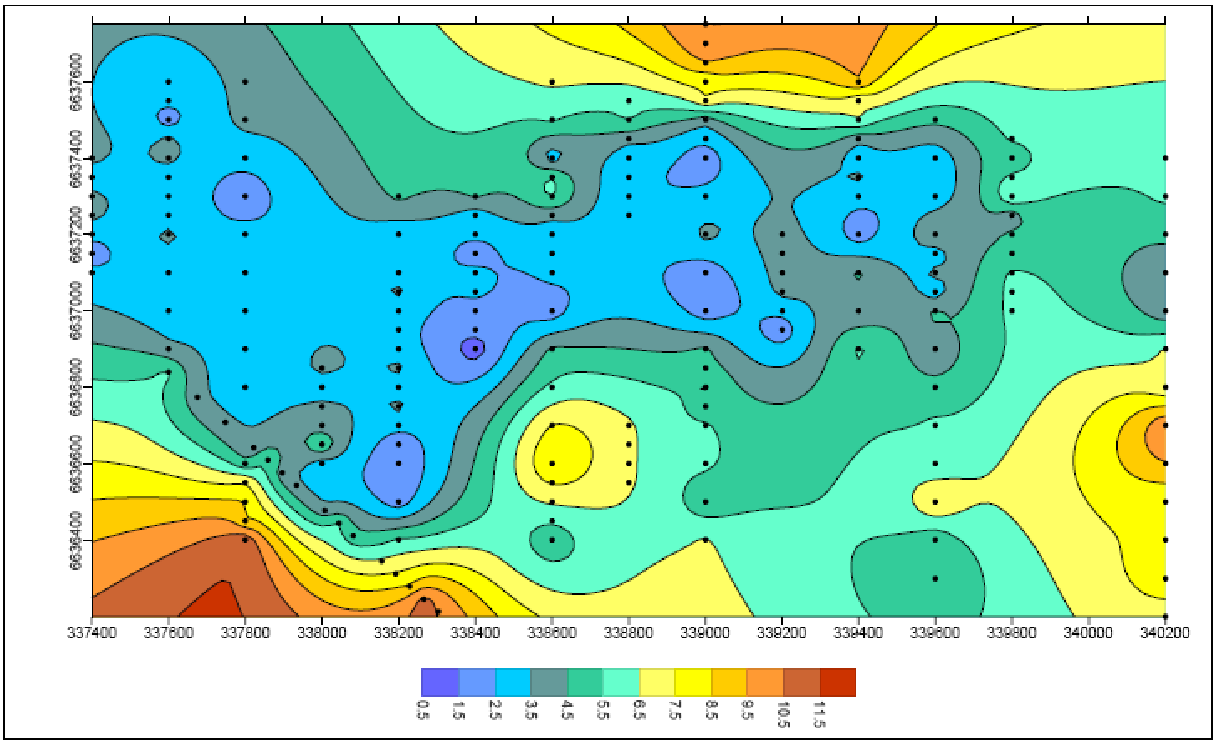



**Figure 184:** ET gold prospect, isopachs to transported cover. Comparison with the DEM (Figure 183) reveals that the sediments are infilling a palaeolandscape and that there is no significant topographic inversion. Sediment thins over the palaeo-ridgeline and most of the drillholes are sited within the area enclosed by the 4.5 m isopach. (Lintern *et al*., 2003).

## *In situ Regolith*

All basement outcrop and subcrop is deeply weathered (~50-70 m) and is generally capped by 1-2 m of silcrete duricrust onto and into which has developed calcrete. A breakaway ridge, comprised of abundant silcrete lag, scarce massive silcrete and rare saprolite, provides a window through the sand cover (Figure 185). The 3D and cross-sectional views of ET regolith are presented in Figures 186-188).

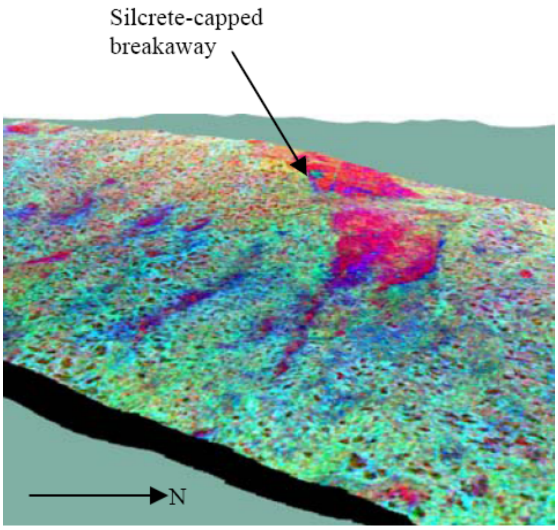



**Figure 185:** ET gold prospect, a 3D perspective view of colour composite image of HYMAP endmembers 6:5:4, overlaid on the TOPSAR DEM and viewed from the E, looking W across a 2.5 km swath of the prospect. Adapted from Tapley and Cornelius (2003).

Bedrock (<5% weathered), was intersected in only 14 of the >200 RAB drillholes. It is granulitic Christie Gneiss, compositionally layered, strongly foliated and of two distinct types. A felsic gneiss where the white mica is generally muscovite, and a basic-mafic to possibly ultramafic gneiss where biotite is the typical mica and amphibole after pyroxene is also present. Both forms have accessory garnet, cordierite and trace graphite These gneisses give rise to two distinctly different weathering profiles, the former is pale hued and poorer in Fe-minerals, while the latter is dark hued throughout and richer in Fe-minerals (Lintern *et al*., 2003) (Figure 187).

Saprock (>5-<20% weathered), was penetrated by ~ 60% of the RAB drilling, its thickness ranges from ~2->10 m. The felsic gneiss derived form is typically greyish in hue; but the mafic gneiss derived form is very dark grey to dark olive grey or dark olive, where chlorite and nontronite are typical alteration minerals (Lintern *et al*., 2002, 2003) (Figure 187).

Saprolite (>20% weathered) is the dominant weathering zone at ET prospect and generally has a darker coloured lower portion with a more leached upper portion. Its overall thickness ranges from ~25 m to >60 m, and like the bedrock, has two broad types: felsic gneiss derived and mafic gneiss derived. The felsic derived saprolite typically has a coloured lower portion and a pallid (kaolinite + quartz) upper portion; the mafic derived saprolite can be near equally darkly coloured in both upper and lower portions (Figure 186-188). Fe-oxide or Fe-hydroxide coloured mottles (?after garnets) may occur in the upper saprolite (*c.f.* earlier descriptions of a similar occurrence reported for the Challenger Gold Deposit saprolite). Weathering resistate mineral preservation in saprolite is highly variable between drillholes and may include graphite, ilmenite and some biotite. However, garnet, amphibole, pyroxene and muscovite do not persist into the upper saprolite.

An unusual alteration mineral observed within saprolite at ET prospect involves bright yellow-green to bright green clay (PIMA spectra suggest nontronite – a form of smectite) these are more common in the strongly coloured saprolite at depths of 14-26 + >32 m. SEM analysis indicated: Fe, K, Mn, Si, Al, O, Ni & Cr, where Cr = 2.5%. Spatial occurrence of these appear partly related to broad compositional mafic bands in the Christie Gneiss, while others are random occurrences (Lintern *et al*., 2002, 2003).

Pedolith (all weatherable minerals altered, new pedogenic fabric and texture). In this area the unconformity lies within a siliceous duricrust and in a few locations it lies at the silcrete top (see Silcrete below). Locating the pedolith base from drill cuttings alone has been very difficult at ET prospect because the plasmic zone in drill chips resembles the underlying saprolite, that stated, pedolith thickness ranges from <4 to perhaps as much as 20 m. Pedolith commonly includes a clay-rich plasmic zone ± an arenose zone + silcrete, and presents in two distinctly coloured forms: one derived from felsic basement (pale coloured), and a strongly coloured form derived from mafic basement (Fe-stained) (Figures 186-188). Neither form displays an Fe-rich pisolith horizon or remnant; whether Fe-rich pisoliths developed here was impossible to demonstrate from drill samples or outcrop. However, erosional evidence preserved within the silcrete exposures suggests 2-3 m of profile stripping occurred prior to silicification. Pedolith parallels the palaeotopography and grit-rich arenose zones indicate profile collapse has occurred during formation. Megamottling was not observed in outcrop in this area, and RAB sampling does not preserve such macroscopic features (Lintern *et al*., 2002, 2003).

Unusual minerals observed within pedolith at ET prospect include: bright yellow-green to bright green clay (confirmed as nontronite by PIMA), these are more common in the strongly coloured pedolith and deeper within saprolite (Lintern *et al*., 2002, 2003).

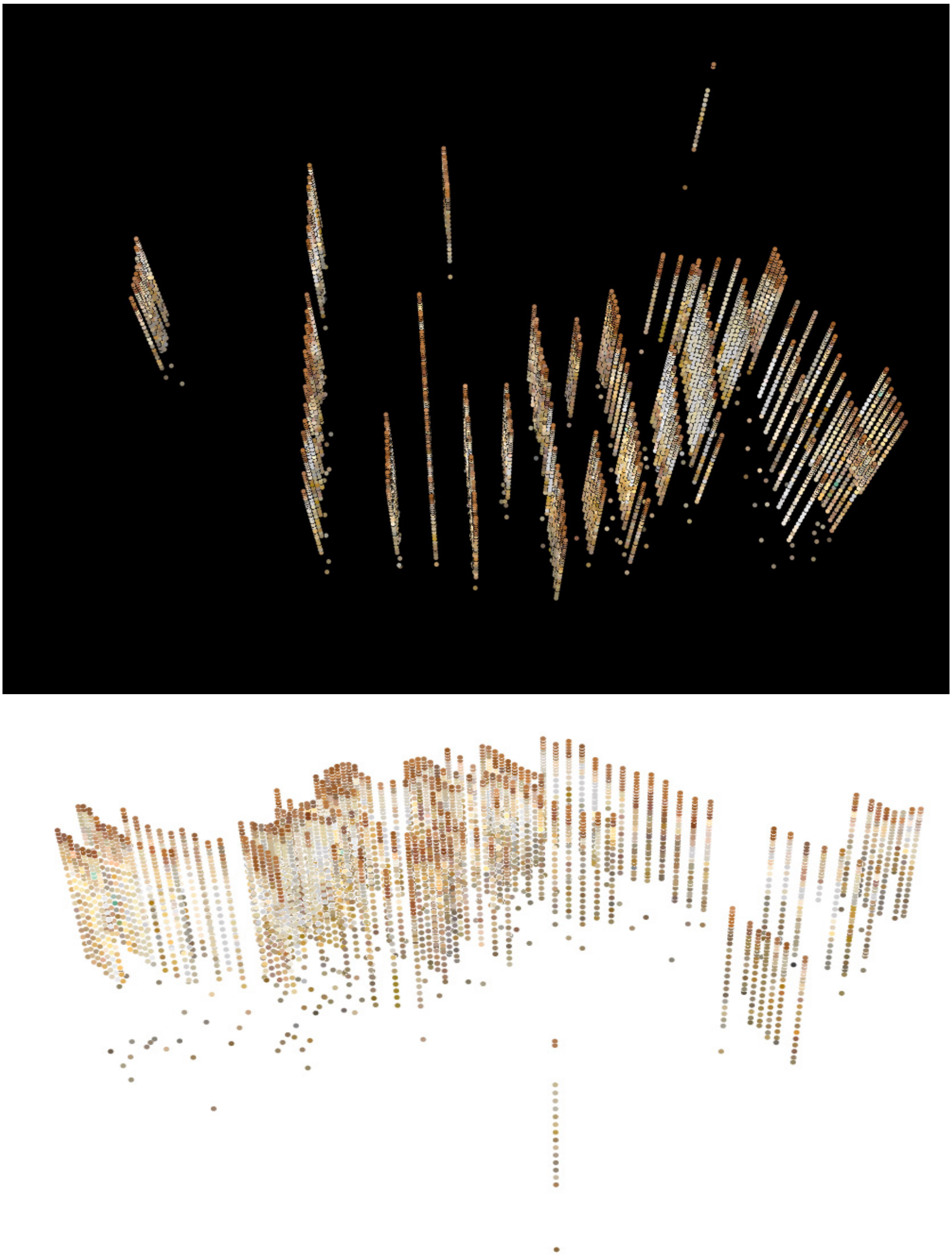


**Figure 186:** ET gold prospect. Munsell Colours (dominant) for samples from 200 RAB drillholes. Drillholes have been plotted in 3D using small circles for each 2 m sample, where the assigned Munsell colour has been converted from its original notational form to an equivalent digital RGB form. Two contrasting backdrops amply highlight the pallid zones, mafic lithotypes and weathering variations across this area. These view perspectives are not identical (Lintern *et al*., 2003).

Silcrete, forms a significant duricrust on the palaeolandscape at ET prospect and is a later pedogenic process to that which formed most of the deeply weathered basement. Silicification of the remnant earlier formed pedolith and an overlying colluvium-alluvium has occurred, forming a silcrete horizon with associated incipiently silicified profile below. Where the host was clay-rich then porcellanite has developed rather than the more ubiquitous "grey billy" form so common in sandier hosts. Outcrop displays well rounded to angular quartz gravel and pebbles suspended in a sandy to silty matrix, all silicified – forming the colluvial-alluvial upper component. Below the unconformity remnant collapsed quartz veins in a silicified grit-rich collapse fabric forms the lower massive silcrete portion. Graphite, remnant micro-mottles, delicate 3D MnOx dendrites have been encapsulated by the silicification process. PIMA spectral analysis and Kaolinite Crystallinity Indices also place the unconformity within the silcrete horizon (Figures 187, 188). As described above for saprolith and pedolith, silcrete at ET prospect has two distinct colour forms, a pale greyish type usually developed in/on pallid pedolith; and a darker hued Fe-stained form developed in/on ferruginous pedolith, although this colour association with strongly coloured pedolith is not consistent at every site. Thickness ranges from ~1-2 m, but siliceous fronts below the silcrete duricrust may increase the overall thickness to >6 m (Lintern *et al.*, 2002, 2003).

Quartz veining, seems to occur randomly throughout the crystalline basement, although the 2 m RAB sampling precludes a more definitive structural description. Quartz in veins is usually semitranslucent and colours range from white to greys to bluish to dark bluish and zoned variants thereof. Vein mineralogy is typically unaffected by the weathering process and any entrapped minerals (micas, feldspar, amphibole, *etc*) remain in pristine condition even within the upper saprolith. Vein thickness ranges from sub-millimetre to tens of centimetres.

## ***Transported Regolith***

Colluvium-alluvium, mentioned above in the silcrete description, is consistent with sheet flow, gravity assisted clast movement and deflation of a slowly eroding landscape. Transport distance is generally short, clasts are dominated by gravel and pebbles derived from vein quartz fragments, the finer material derives from surface liberated quartz grit. This sediment in outcrop is poorly sorted and channelling is not obvious, there is commonly a gradational zone between pure colluvium and pure alluvium. Silicification of this sediment occurred well before deposition of the overlying hardpan sediment (Figure 188) (Lintern *et al.*, 2002, 2003).

Red-brown hardpan, forms the next youngest sediment and is strongly coloured red-brown to brown by FeOx and FeOH cements. Hardpan forms a reliable marker unit in this area, and is of late Cainozoic age. Primarily a clay-rich, matrix supported sediment, containing rounded to angular quartz clasts of sand to gravel sizes. Clast morphology and distribution indicate a colluvial provenance dominating for this unit but alluvium is also present, therefore some sheet and minor channel flow was operating during deposition. Cementation includes ferruginous materials and hyaline silica. Younger calcrete may infill cracks or form surface coatings. Hardpan ranges from <1 to ~4 m thick and is located in topographic lows. Its upper surface forms another unconformity with overlying aeolian materials (Figure 188) (Lintern *et al.*, 2002, 2003).

Dune sand, blankets a large portion of this prospect. These aeolian sands form an eastern fringe to the Great Victoria Desert stretching NW to skirt the Nullarbor Plain. Sand grains are siliceous, dominantly quartz (>80%) but includes feldspar (<20%), fines (<1%) and trace lithic grains. Grain size is fine to medium, grain sorting is uniform, and most sand is mostly free running when dry, except where cemented by calcrete. Colours are: moderate orange (5YR 6/7) to brownish orange (5YR 5/7) to light brown (5YR 5/6) to strong brown (5YR 4/6 and 4/8) and less commonly moderate reddish brown (2.5YR 4/5). In some instances, illuviated fines have established clayey sand dune cores that are more strongly coloured than the surrounding sand. Dune thicknesses range from ~4 to 11 m, and surrounding sand plains have thicknesses of <1-3 m (Figure 188) (Lintern *et al.*, 2002, 2003). Luminescent dating of dune sand ~55 and 105 km W of ET prospect yielded dune core ages of ~200-220 ka and dune crest sands ages of 100-20 ka (Sheard *et al.*, 2006). It is expected that the dunes on ET prospect have similar age characteristics.

Calcrete, occurs throughout the upper regolith in aeolian sand, impregnating near surface hardpan, silcrete and pedolith. Within dunes there are typically more than one calcrete horizon, these range from earthy powders to nodules and extensive sheets (Figure 188). Where developed into exposed silcrete, pedolith and saprolith, calcrete tends to be massive or of laminated sheets in form. Karstic weathering has developed into the more massive sheets yielding sizeable pot holes and rillen (Lintern *et al*., 2002, 2003) (Plate 34).

**Plate 34:** ET gold prospect, dune sand soil pit (~1 m deep) exposing a sheet calcrete $B_{Ca}$ horizon (>50 cm thick) into which pipe karst has developed. Soil water dissolution and perhaps the activity of tree roots on the $CaCO_3$ have yielded this solution feature. Scale bar in pothole is 100 mm long (Lintern *et al*., 2003).

Lags, are a minor residual component of this landscape, consisting mostly of silcrete and vein quartz clasts. Lags range from fine gravel to blocks of up to 100 mm and various rounded pebbles (Lintern *et al*., 2002, 2003).

Soils, range from uniformly sandy (Uc) to poorly structured lithosols, especially surrounding silcrete and saprolith outcrop. They all have weakly developed horizonation with little organic component in the A horizon. All soils in this region have a strong alkaline reaction trend due to the presence of calcrete in the $B_{Ca}$ horizon. Fines-rich soil types and those developed in exposed dune clayey sand cores, are probably sodic (type AS2; Northcote and Skene, 1972; Northcote, 1979). Soils like these are prone to gully erosion if their surfaces are disturbed because sodic clays are very dispersive in rain run-off waters (Lintern *et al*., 2002, 2003; Northcote and Skene, 1972).

## *PIMA Mineralogy*

The major minerals identified in drill samples by PIMA in the weathered zone are kaolinite and smectite (PIMA does not detect quartz). Small amounts of poorly crystalline kaolinite and smectite occur in the dune sand with a sharp boundary to well crystallized kaolinite of the basement derived saprolite. Kaolinite in the silcrete horizon beneath dune sand and hardpan is mainly poorly crystalline, suggesting a large transported component. However, kaolinite in silcrete is typically in low abundance and may have undergone changes during silicification; whereas evidence from outcrop places the unconformity in the silcrete horizon's lower half (Lintern *et al*., 2002, 2003).

Selected samples were also analysed by XRD and SEM to identify or confirm unusual minerals and weathering products (see earlier information under *In situ* Regolith); also refer to Lintern *et al*. (2003) for specific particulars.

## *Geochemical expression*

Elemental concentrations are primarily governed by regolith type. Element abundances in transported material (dune sand) are: i) generally lower than for the other regolith materials, except for Ca, Sr and, to a lesser extent, Au (Figure 189a), ii) correlated with one another and iii) restricted in their concentration ranges due to sediment mixing *e.g*. Fe and Ga (Figure 189b). Concentrations of pathfinder elements, commonly associated with Au, are generally low *e.g*. As, Cu and Ni (Table 79).

Along the study line (340200 m E; Lintern *et al*., 2002) Au concentrations in the dune sand are surprisingly high (Maximum 21 ppb; Figure 190) considering that the dunes are only a few hundred thousand years old according to Sheard *et al*. (2006). One Au concentration (drillhole 96ETAR189, 33 ppb) occurs close to the interface between the weathered *in situ* and transported regolith units and may be attributable to detrital Au in silicified alluvium at the base of a palaeo-gully. Another very high Au concentration of 755 ppb Au, was subsequently re-analysed at 0.1 ppb, and was also located at the unconformity, and is suggestive of either detrital Au or analytical contamination. Higher Au concentrations in the dunes appear to be not necessarily related to the calcrete but can also be relatively high in the carbonate poor surrounding material. Gold concentrations in the dune sand do not necessarily reflect higher Au in the upper saprolite or mineralization in the lower saprolite.

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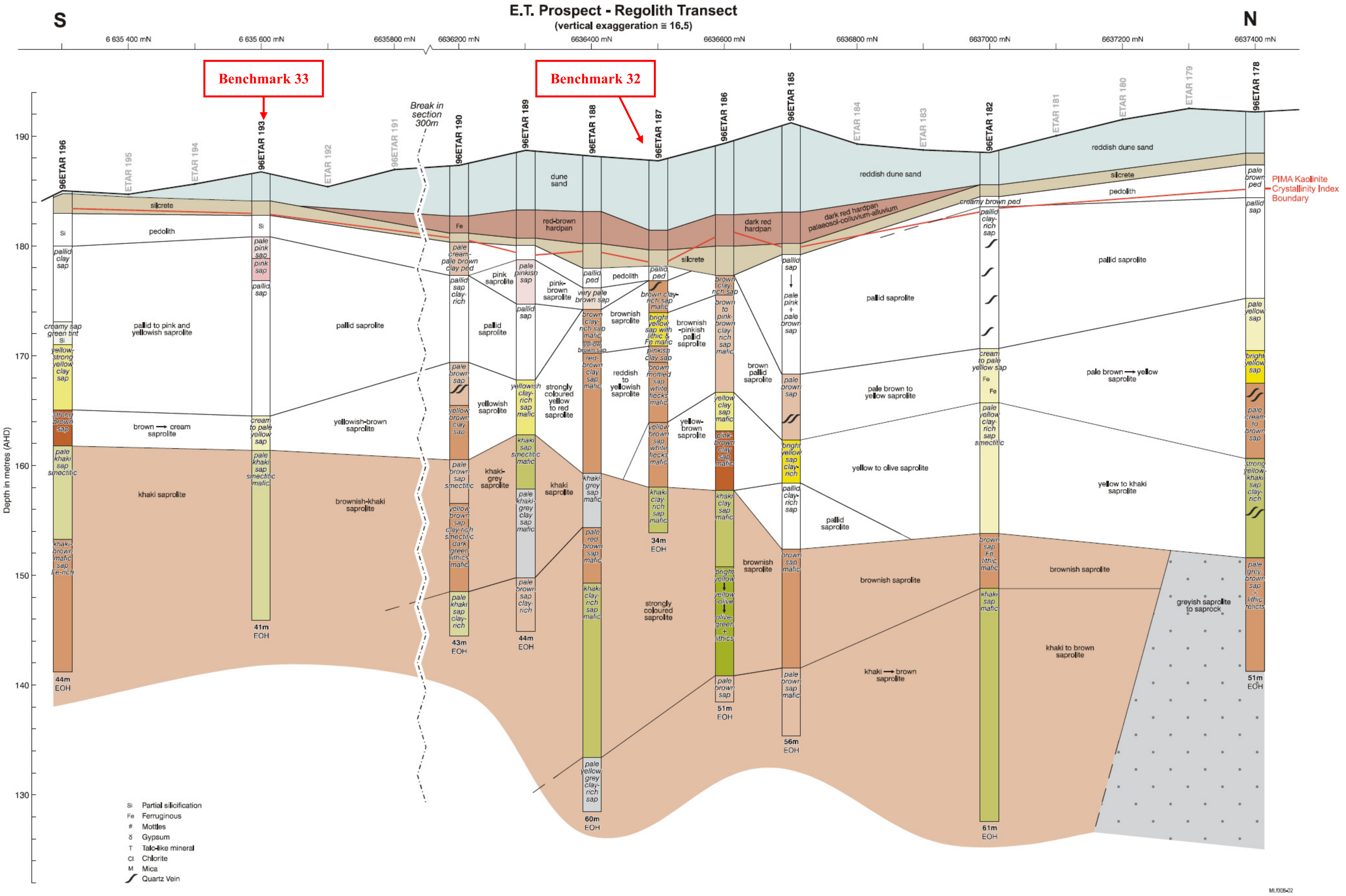



**Figure 187:** ET gold prospect full depth section along 340200 m E (local grid) the study line displayed in Figure 182 (Lintern *et al*., 2002). Benchmarks 32 and 33 are indicated.

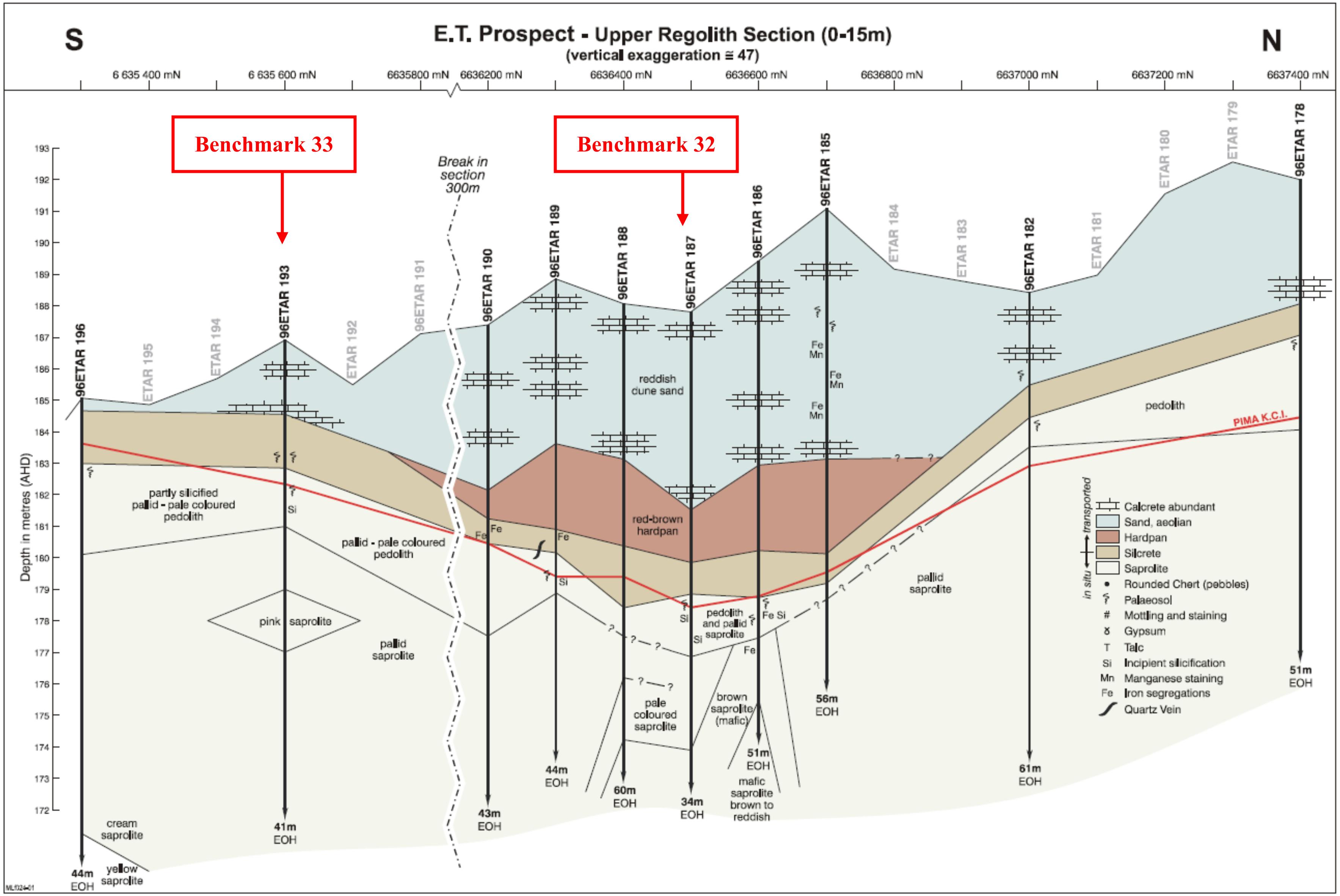
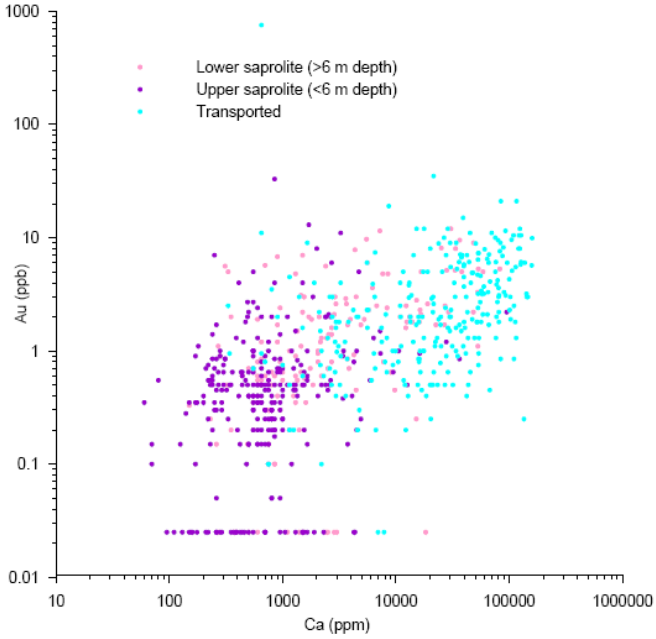



**Figure 188:** ET gold prospect, upper regolith section along study line (340200 m E local grid) displayed in Figures 182, 187 (Lintern *et al.*, 2002). Benchmarks 32 and 33 are indicated.

a)




b)

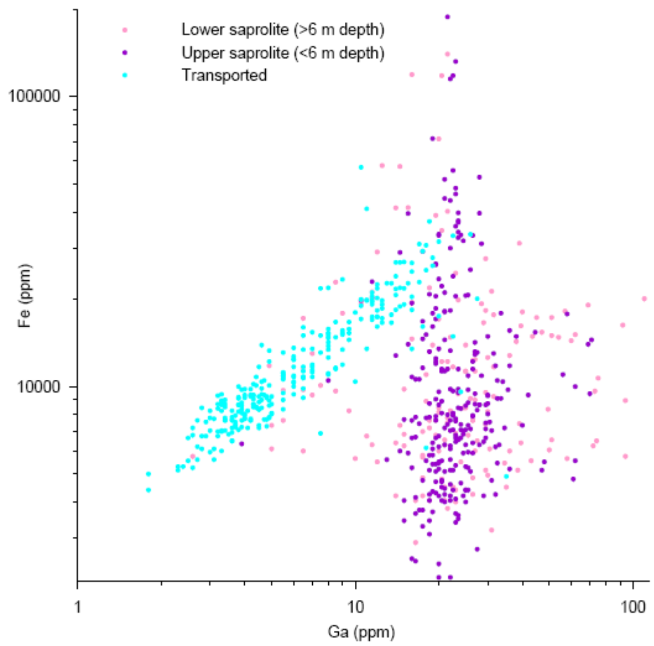



**Figure 189:** ET gold prospect, scatter plots (logarithmic axies) for: a) Ca *v* Au, and b) Fe *v* Ga.

**Table 79:** ET gold prospect, highest Au concentrations and other anomalous drillhole intervals for drilled section 340200 m E (local grid).

| Drillhole | Interval (m) | Analyses (ppm unless stated) | Regolith type |
|---|---|---|---|
| 96ETAR185 | 47-48 | Au 390 ppb | saprolite |
| 96ETAR187 | 33-34 | Au 101 ppb | saprolite |
| 96ETAR196 | 17-18 | Au <1 ppb Cu 320 | saprolite |
| 96ETAR188 | 42-43 | Au 30 ppb Ni 1400 | saprolite |

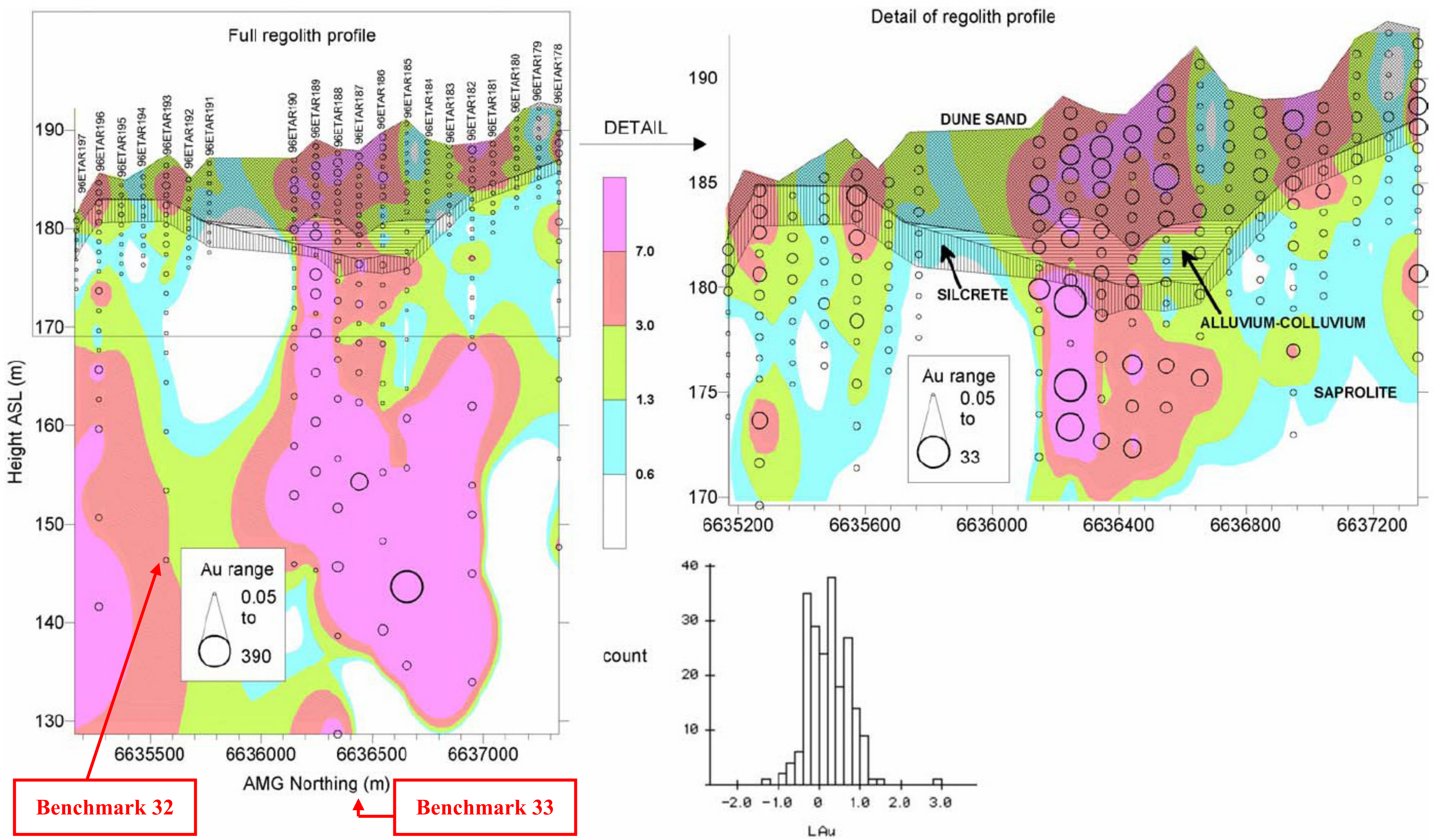



**Figure 190:** ET gold prospect, regolith section, regolith architecture and Au geochemical expression (*c.f.* Figures 187, 188, 193), (Lintern, 2004b). Benchmarks 32, and 33 are indicated.

From the second phase of study (Lintern *et al*., 2003) it was concluded that:

1. The main Au anomaly in calcrete is associated with a thinly covered, topographic high of weathered *in situ* (residual) regolith flanked by lower lying deeper sand. It is not directly coincident with the main Au anomaly found in the upper regolith, which is further E along the ridge. The reasons for this are unclear since there is a strong association with Au and carbonate in the drill cuttings.
2. Drilling data suggests that neither the main anomaly (upper regolith) nor that in calcrete is fully explained by the current understanding of the mineralization extent. Further drilling is required.
3. Multi-element geochemistry has limited value in delineating new anomalies but can support the Au data. For example, Ag (cyanide-soluble) is anomalous over the Au anomalies occurring in calcrete and the 0-1 m drill cuttings. However, Cu (cyanide-soluble) is much more related to lithotype than mineralization. Arsenic from lower saprolite appears to be following a structural trend and may be related to mineralization.
4. Whereas many anomalies within weathered *in situ* regolith are directly related to mineralization, there are several examples where the surficial data are not easily explained by the drilling data. The Au has either been displaced from its source and seemingly concentrated, or the drilling has been inadequate.
5. The best evidence for an anomaly occurring in transported regolith is drillhole 96ETAR070 (Figure 191). Gold concentrations in drill cuttings reach 35 ppb in calcareous sand over weak mineralization at 25 m. A nearby calcrete sample has an Au concentration of 30 ppb. In section there is no mineralization on the upslope ridge and Au in calcrete on the ridge attains a maximum of 10 ppb.
6. In some locations there are no surficial Au anomalies over concealed mineralization. This suggests surficial regolith materials cannot be relied upon to detect all mineralization at the prospect scale. Alternatively, the mineralization may be so weak that it does not form an anomaly or be discontinuous, in which case the data reflect the real situation and there is no surficial dispersion.
7. Vegetation Au data (0.5 km x 0.5 km grid) can potentially provide additional exploration targets, but their failure to substantiate existing anomalies in calcrete reduces the confidence in their use. The highest Au concentrations appear to be more related to transported regolith, suggesting that vegetation may be responding more to run-off from sub-crop on the ridge.
8. Soil sampling (0.5 km x 0.5 km grid) appears to delineate the main Au anomaly but is probably responding more to the presence of thin transported regolith above underlying anomalous calcrete.
9. The multi-disciplinary approach at ET prospect proved to be especially useful in interpreting geochemical anomalies and establishing regolith controls. Regolith mapping greatly benefited from Landsat TM data and digital elevation models. Regolith architecture and mapping of regolith materials is important for any exploration program since different sampling media give different responses.
10. Calcrete appears to be the best sampling medium at ET prospect.

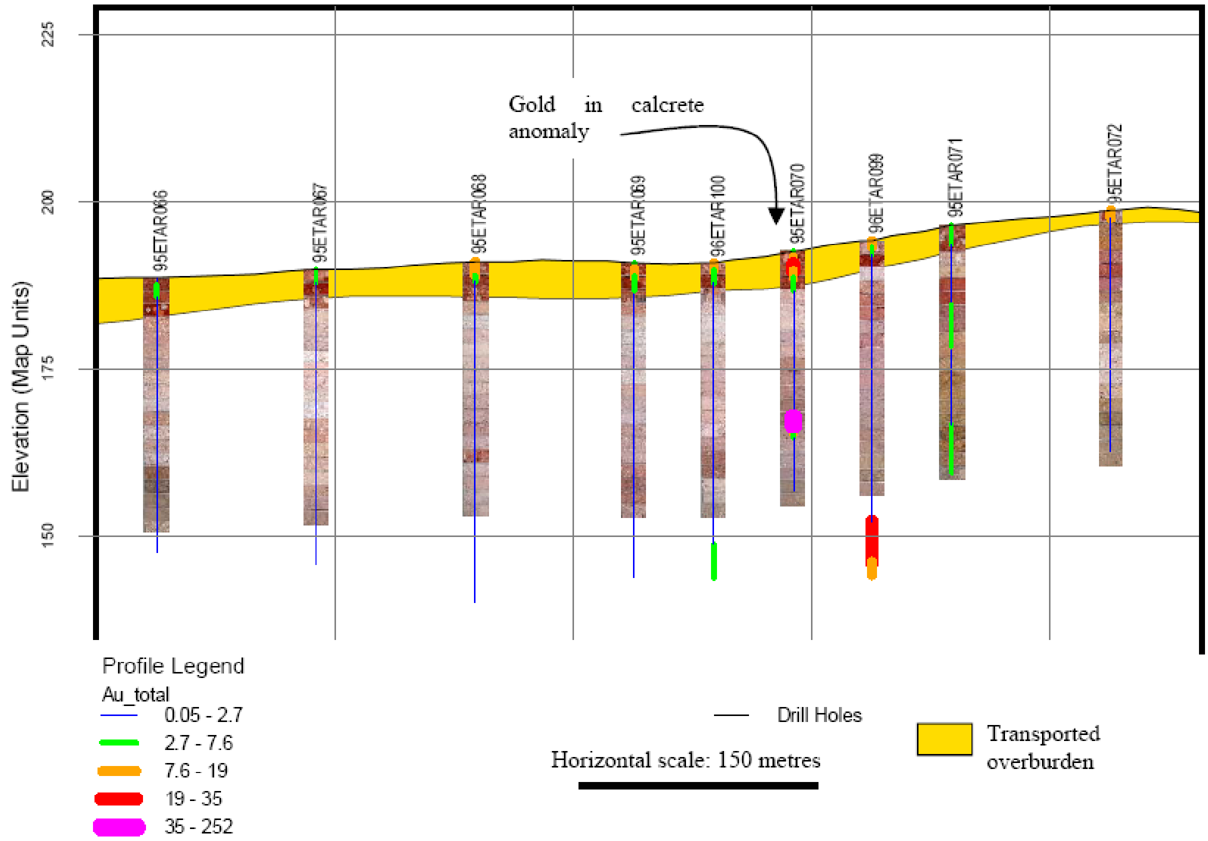



**Figure 191:** Gold-in-calcrete anomaly in transported regolith over mineralization along the southern portion of drilled section 339000 m E (local grid). Chiptray photos are behind the down hole Au traces, they display regolith colours (Lintern *et al*., 2003, 2004).

## Benchmark 32: drillhole 96ETAR187

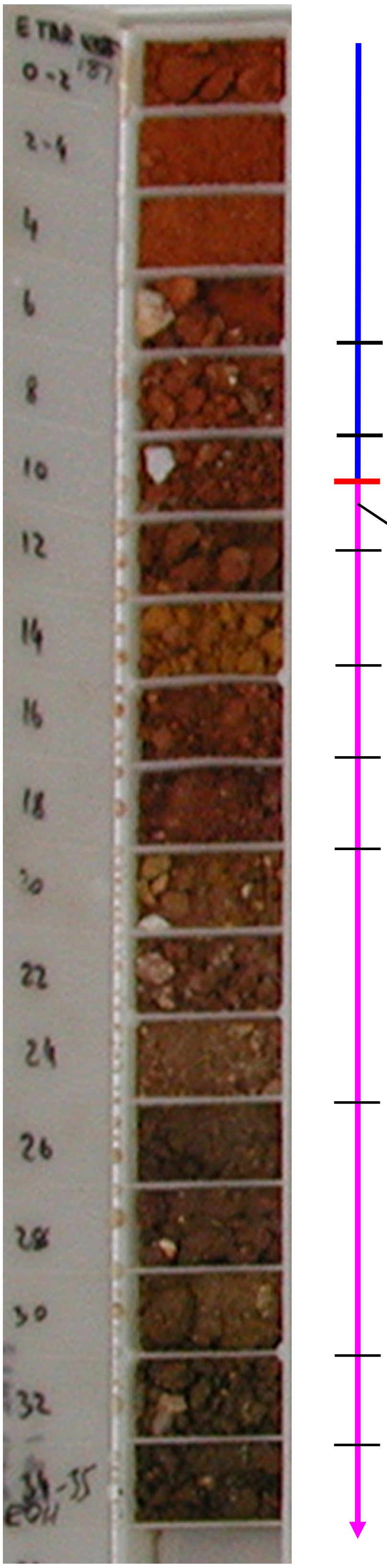
Quick reference items are set out in Table 80; detailed descriptions, figures and data tables follow on below. ET prospect lies about 150 km W of Tarcoola and about 67 km WSW of Mulgathing Pastoral Station Homestead (Figures 110-112, 136, 181-184). The prospect is also ~16 km W of the Dog Fence, 21 km W of Mt Christie, and is outside the State's designated Pastoral Lease western edge. ET can be accessed via gazetted unsealed roads, the Dog Fence maintenance track and more recently made exploration access tracks (Figure 181). Drilling for this RAB hole was vertical. A summary of this profile is provided in Table 81 and chiptray photograph with regolith zonation is in Figure 192. Geochemical data are presented in Figures 189, 190, 191, 193, 194 and Table 79.

**Table 80:** Benchmark 32 reference data; drillhole 96ETAR187 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figure 110-112, 136. |
| Local-site location map | Figures 181, 182-184, 187, 188. |
| GPS coordinates, attitude & elevation | RAB drillhole 96ETAR187: Zone 53, 340366 E, 6636613 N, GDA 94. **Attitude**: vertical. **AHD:** 187.830 (differential GPS data). |
| Site access, owner | ET prospect is ~150 km W of Tarcoola, ~67 km WSW of Mulgathing Pastoral Station Homestead. It is also ~16 km W of the Dog Fence, 21 km W of Mt Christie. ET prospect is outside the designated Pastoral Lease area. The site is accessed via gazetted unsealed roads, the Dog Fence maintenance track and exploration tracks (Figure 181). |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 192, Table 81. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 189, 190, 191, 193, 194 and Table 79. |
| XRD mineralogy | Yes, selected data in Lintern *et al*. (2003). |
| PIMA spectral data | Yes, selected data, used by Lintern *et al*. (2002, 2003) to produce kaolinite Crystallinity Indices for unconformity picks & some mineral identification. |
| Dating | Yes, for Christie Gneiss bedrock, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | Ag, ?As, ?Cu. |
| Useful sampling media | Calcrete, soil & ?silcrete. |
| Key reference sources | Lintern *et al*. (2002, 2003); Lintern (2004b). |

### *Background*

Drillhole 96ETAR187 is selected to form this benchmark because it includes a thick zone of transported cover, is located within defined Au mineralization and has a mafic profile. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 33 (thinner cover and a felsic profile) and the regolith cross-sections of Figures 187, 188. Exploration grid drilling on this prospect involved only RAB method (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have mostly terminated in lower saprolite to saprock but a rare few terminate in bedrock. Cuttings were sampled from the drilled 1-2 m composites. These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).




96ETAR187

**0->6 m** **Transported**: aeolian sand (dune) siliceous, loose free running except where cemented by calcrete at ~1 & ~6 m.

**>6-8 m** **Transported**: hardpan, strong red hue colluvium (clay-rich) & palaeosol, partly Fe-oxide cemented.

**8-9 m** **Transported** & ***In situ***: Pedolith, silcrete horizon, incorporating alluvium-colluvium + *in situ* weathered plasmic zone. **Unconformity** at base of alluvium.

**9-11 m** ***In situ***: pedolith, incipiently silicified plasmic zone.

**11-14 m** Upper saprolite, brown, clay-rich, FeOH stained, grey quartz veins at 11-12 m.

**14-17** Upper saprolite, bright yellow, clay-rich, relict granulite texture & fabric, FeOH stained.

**17-18** Upper saprolite, pale reddish brown, clays + quartz grit.

**18-24 m** Saprolite, browns with white flecks, clays + quartz.

**24-30 m** Saprolite, yellow-brown with white flecks, clay-rich, mafic derived material.

**30-34 m** Lower saprolite, khaki + darker hued relicts (marginal saprock remnants), clay-rich, mafic gneiss was parent lithotype.

**30-34 m** Lower saprolite to saprock, grey-brown, clay-rich, weathered mafic gneiss.

**NOTE: saprock barely penetrated.**

Regolith logged by M.J. Sheard

**Figure 192:** Benchmark 32, ET gold prospect drillhole 96ETAR187, chiptray and regolith zonation. In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work.

**Table 81:** Benchmark 32, regolith log to RAB drillhole 96ETAR187 (after Lintern *et al*., 2002, 2003).

**Hole:** 96ETAR187. **Regolith Line**, ET gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 340366 E, 6636613 N, GDA 94. **AHD:** 187.830 (differential GPS data).

**Attitude:** vertical.

**Site:** on aeolian dune, sandy & vegetated..

**Vegetation:** *Acacia aneura* and *Alectryon oleifolius* subsp. *canescens* Tall Shrubland over *Senna artemisioides* subsp. *petiolaris* and *Acacia aneura* Open Shrubland over *Acacia aneura* and *Scerolaena* Low Open Shrubland (vehicle track disturbance. (Botanical log by S. Lintern).

**Soil:** Um (sand).

**Calcrete:** nodular.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0->6 | Aeolian sand, dune, siliceous, loose free running except where cemented by calcrete at ~1 & ~6 m. Colour: 5YR 5/8, brownish orange. CO3 acid value = 2. |
| >6-8 | Hardpan, colluvium, clay matrix+ gravel + silcrete + white vein quartz, palaeosol, strong red hue, partly Fe-oxide cemented. Colour: 2.5YR 5/6, greyish reddish orange. CO3 acid value = 1. Transported then weathered *in situ*. |
| 8-9 | Pedolith, silcrete horizon, incorporating alluvium-colluvium + weathered *in situ* plasmic zone. Colour: 5YR 4/8, strong brown. CO3 acid value = 1 (down hole contamination) |
| 9-11 | Pedolith, incipiently silicified plasmic zone. Colour: 5YR 4/8, strong brown. |
| 11-14 | Upper saprolite, brown, clay-rich, FeOH stained, grey quartz veins at 11-12 m. Colour: 7.5YR 4/5, moderate brown. |
| 14-17 | Upper saprolite, bright yellow, clay-rich, relict granulite texture & fabric, FeOH stained. Colour: 10YR 5/7, strong yellowish brown. |
| 17->18 | Upper saprolite, pale reddish brown, clays + quartz grit. Colour: 5YR 5/5, light brown. |
| >18-24 | Saprolite, browns with white flecks, clays + quartz. Colours: (18-20 m) 10R 4/3, moderate reddish brown, (20-22 m) 10YR 4/4, moderate yellowish brown; (22-24 m) 2.5YR 4/3, greyish reddish brown. |
| 24-30 | Saprolite, yellow-brown with white flecks, clay-rich, mafic derived material. Colours: (24-26 m) 10YR 5/3, greyish yellowish brown; (26-28 m) 10YR 4/2, greyish yellowish brown; (28-30 m) 7.5YR 5/3, light brown. |
| 30-34 | Lower saprolite, khaki + darker hued relicts (marginal saprock remnants), clay-rich, mafic gneiss was parent lithotype. Colours: (30-32 m) 10YR 5/4, moderate yellowish brown, (32-34 m) 10YR 4/2, greyish yellowish brown. |
| 34-35 | Lower saprolite to saprock, grey-brown relict gneiss (marginal saprock remnants), clay-rich, weathered mafic gneiss. Colour: 10YR 4/1.5, greyish yellowish brown |
| E.O.H. | |

## *In situ Regolith*

Bedrock was only penetrated by 14 of the >200 drillholes on this prospect, they confirm that unweathered crystalline basement in this area is typical of the Christie Gneiss. Benchmark 32 barely penetrates the lower saprolite-saprock boundary at 35 m. Saprolite at this site is similar to descriptions set out earlier for material deriving from more mafic versions of Christie Gneiss. Saprolite was barely intersected here, its total thickness is ~24 m (Figures 187, 192). Pedolith has an eroded top at this site, see also for Benchmark 33, its thickness is ~5 m (including the overlying hardpan).

## *Transported Regolith*

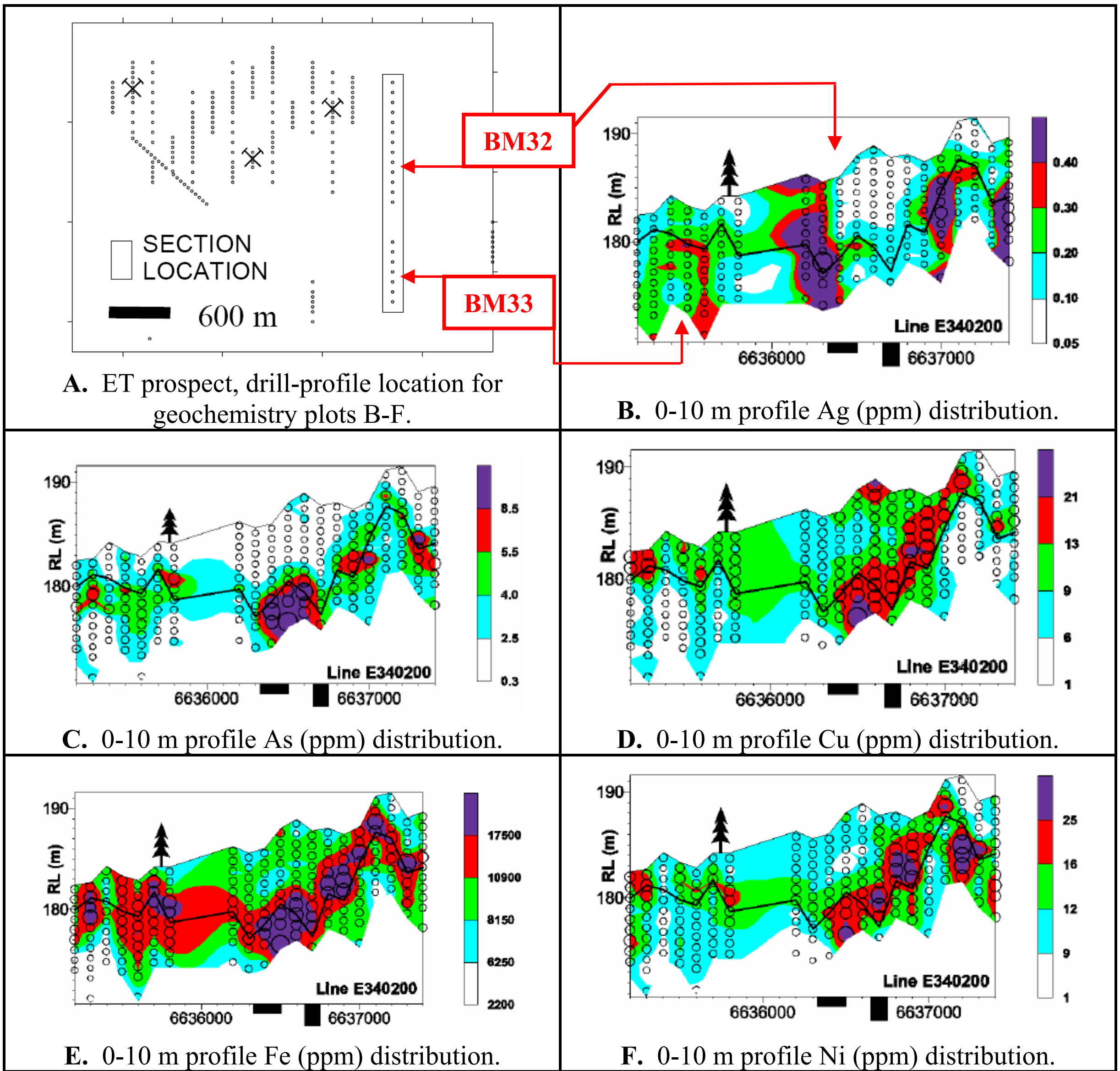
Aeolian dune sand forms the thickest transported cover unit at ET prospect. Underlying the dune sand is a ~2 m thick hardpanized colluvium-alluvium, with strong ferruginous colours (a readily identifiable bed) + some cementation and palaeosol-pedolith pedogenic modifications. Underlying the hardpan, within the silcrete horizon is colluvium and alluvium, mostly sand + gravel and here is <1 m thick. Clast rounding, the presence of lithics and the broad size range indicate immature sediment with partly local and some distal provenance. PIMA spectral data, as a derived Kaolinite Crystallinity Index, places the main unconformity just within the silcrete. However, the low levels of preserved kaolinite in silcrete and the 2 m drill chip sample bias may also be skewing the pick. Drillcore or an excavation would provide a more absolute depth.

## *Geochemistry*

Geochemical expression for ET gold prospect has been outlined earlier and presented via Figures 189-191 (Au, Ca, Fe, Ga ) and Table 79 (Au, Cu, Ni).

A 51 element assay package was applied to all samples and Lintern *et al.* (2003) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including: Ag, As, Ca, Cu, Fe, Ni & Mg appear in Figures 193, 194. Silver, Cu and Ni may serve as limited pathfinder elements in this area, but all have low to weak near surface signals and Cu seems to relate more to lithotype than mineralization.

Compare the geochemical expression over defined Au mineralization with that of Benchmark 33 (in unmineralized ground) and where the transported cover is thinner than for Benchmark 32.




**A.** ET prospect, drill-profile location for geochemistry plots B-F.

**B.** 0-10 m profile Ag (ppm) distribution.

**C.** 0-10 m profile As (ppm) distribution.

**D.** 0-10 m profile Cu (ppm) distribution.

**E.** 0-10 m profile Fe (ppm) distribution.

**F.** 0-10 m profile Ni (ppm) distribution.

**Figure 193:** ET gold prospect, geochemical expression along drill line 340200 m E (AMG grid) for selected elements Ag, As, Cu, Fe & Ni (Lintern *et al.*, 2003). Benchmarks 32 and 33 are indicated in top panels. Compare these with Au plot in Figure 190.

Calcrete at ET is calcic near the surface but becomes more dolomitic with depth; however, at Benchmark 32 Mg is highest between 2-6 m (Figure 194).

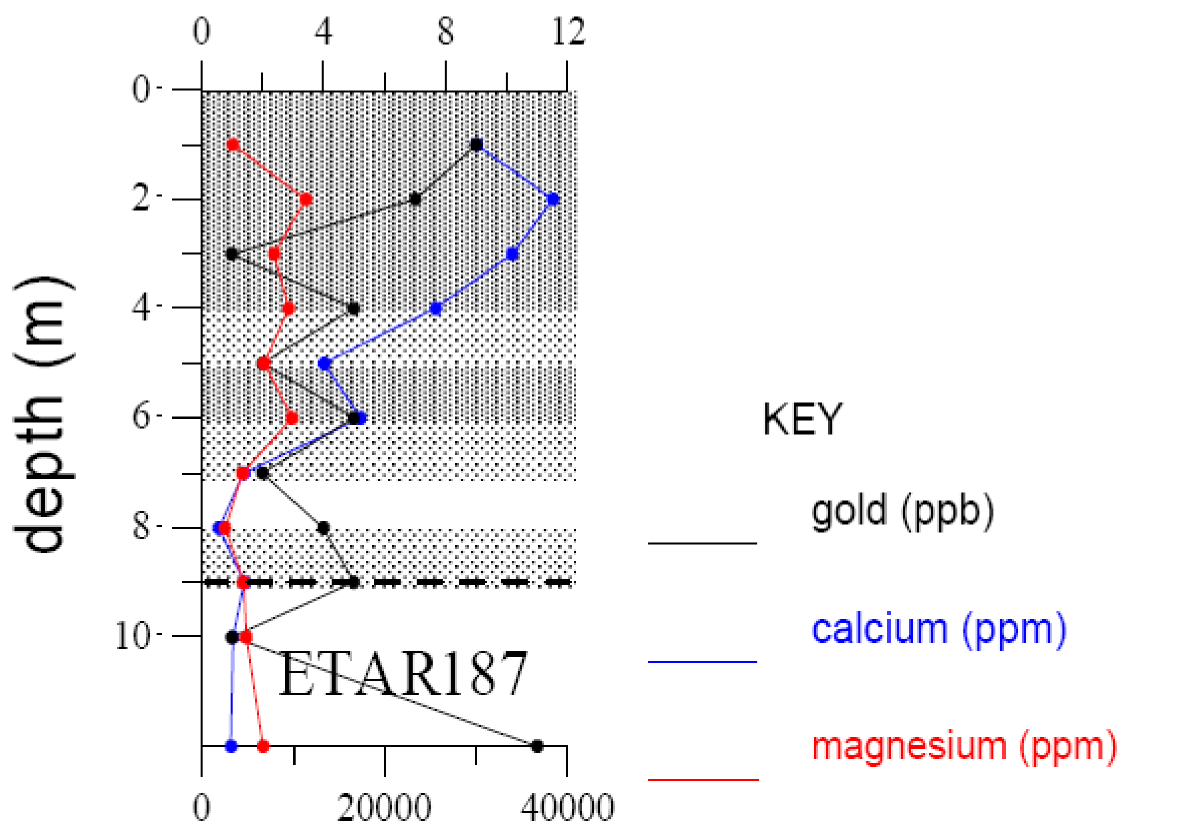



**Figure 194:** ET gold prospect, relationships between Au, Ca & Mg *versus* depth (0-12 m) for Benchmark 32 (Lintern *et al*., 2003).

## Benchmark 33: drillhole 96ETAR193

Quick reference items are set out in Table 82; detailed descriptions, figures and data tables follow on below. ET prospect lies about 150 km W of Tarcoola and about 67 km WSW of Mulgathing Pastoral Station Homestead (Figures 110-112, 136, 181-184). The prospect is also ~16 km W of the Dog Fence, 21 km W of Mt Christie, and is outside the State's designated Pastoral Lease western edge. ET can be accessed via gazetted unsealed roads, the Dog Fence maintenance track and more recently made exploration access tracks (Figure 181). Drilling for this RAB hole was vertical. A summary of this profile is provided in Table 83 and chiptray photograph with regolith zonation is in Figure 195. Geochemical data are presented in Figures 189, 190, 191, 193, 196 and Table 79.

**Table 82:** Benchmark 33 reference data; drillhole 96ETAR193 (Type 2, drill cuttings profile).

| Items | Figures, Data, Sources |
|---|---|
| Regional location map | Figure 110-112, 136. |
| Local-site location map | Figures 181, 182-184, 187, 188. |
| GPS coordinates, attitude & elevation | RAB drillhole 96ETAR193: Zone 53, 340388 E, 6635744 N, GDA 94. **Attitude**: vertical. **AHD:** 186.895 (differential GPS data). |
| Site access, owner | ET prospect is ~150 km W of Tarcoola, ~67 km WSW of Mulgathing Pastoral Station Homestead. It is also ~16 km W of the Dog Fence, 21 km W of Mt Christie. ET prospect is outside the designated Pastoral Lease area. The site is accessed via gazetted unsealed roads, the Dog Fence maintenance track and exploration tracks (Figure 181). |
| Related drillholes | Part of the Gawler Joint Venture exploration multiple drillhole grid. |
| Drill sample photo / log | Yes, Figure 195, Table 83. |
| Sample types | Drill chips in chiptrays + ~1 kg bags. |
| Sample storage | PIRSA Drillcore Storage Facility, 23 Conyngham St, GLENSIDE. |
| Lithotypes | Weathered Christie Gneiss. |
| Petrology | Not from thin-sections, only from binocular microscope observations. |
| Geochemistry | Yes, Figures 189, 190, 191, 193, 196 and Table 79. |
| XRD mineralogy | Yes, selected data in Lintern *et al*. (2003). |
| PIMA spectral data | Yes, selected data, used by Lintern *et al*. (2002, 2003) to produce kaolinite Crystallinity Indices for unconformity picks & some mineral identification. |
| Dating | Yes, for Christie Gneiss, U-Pb zircon age of ~2440 Ma (Fanning, 2002), and peak metamorphic age of ~1710 Ma (Tomkins and Mavrogenes, 2002). |
| Target elements | Au. |
| Potential Pathfinder Elements | Ag, ?As, ?Cu. |
| Useful sampling media | Calcrete, soil & ?silcrete. |
| Key reference sources | Lintern *et al*. (2002, 2003); Lintern (2004b). |

### *Background*

Drillhole 96ETAR193 is selected to form this benchmark because it includes a thin zone of transported cover, is located away from the main Au mineralization, has a felsic profile, and fresh bedrock was penetrated. The weathered *in situ* regolith is relatively straight forward regarding its interpretation. A comparison is provided through Benchmark 32 (thicker cover and a mafic profile) and the regolith cross-sections of Figures 187, 188. Exploration grid drilling on this prospect involved only RAB method (typically without hammer) and so drillholes commonly terminated at or near blade refusal. Therefore drillholes have mostly terminated in lower saprolite to saprock but in this case it terminates in bedrock. Cuttings were sampled from the drilled 1-2 m composites. These drillholes were not originally intended for use as benchmarks; they were later sampled and analysed as part of regional regolith and chemical dispersion studies (Lintern *et al*., 2002, 2003).


**0-2 m** **Transported**: aeolian sand, dune flank, siliceous, strongly coloured, loose free running. Calcrete: nodular at ~1 m / massive on silcrete at ~2 m..

**2-4 m** **Transported** & ***In situ***: Pedolith, silcrete horizon, alluvium-colluvium + *in situ* plasmic zone. **Unconformity** at base of colluvium.

**4-6 m** ***In situ***: pedolith, incipiently silicified plasmic zone, pallid, + white vein quartz.

**6-10 m** Upper saprolite, pale pink (6-8 m) to stronger pink (8-10 m), kaolinite + quartz grit.

**10-25 m** Upper saprolite, dominantly pallid, clays + quartz grit.

**25-38 m** Saprolite, multi hued, relict granulite-gneiss texture & fabric, clay-rich (?smectitic near base).

**38-40 m** (not sampled here) Lower saprolite to saprock; clay + biotite-rich felsic gneiss, granulite, medium- to course-grained.

**40-41 m** Bedrock, dominantly biotite-rich felsic gneiss, granulite, medium- to course-grained.

**NOTE: bedrock barely penetrated.**

Regolith logged by M.J. Sheard

**Figure 195:** Benchmark 33, ET gold prospect drillhole 96ETAR193, chiptray and regolith zonation. In-field logging and selective bulk sampling (for assay) utilised drill spoil piles prior to prospect rehabilitation work.

**Table 83:** Benchmark 33, regolith log to RAB drillhole 96ETAR193 (after Lintern *et al*., 2002, 2003).

**Hole:** 96ETAR193. **Regolith Line**, ET gold prospect. Regolith descriptions (combined in-field + laboratory observations).

**Location:** Zone 53, 340388 E, 6635744 N, GDA 94. **AHD:** 186.895 (differential GPS data).

**Attitude:** vertical.

**Site:** on lower flank of aeolian dune, sandy & vegetated..

**Vegetation:** *Casuarina pauper* Woodland over *Acacia aneura* and *Acacia* sp. Tall Open Shrubland over *Senna cardiosperma* subsp. *gawlerensis* Shrubland over Low Open Shrubland. (Botanical log by S. Lintern).

**Soil:** Um (sand).

**Calcrete:** massive.

**Logged by:** M.J. Sheard, 1999.

| Depth (m) | Description of RAB cuttings |
|---|---|
| 0-2 | Aeolian sand, dune, siliceous, strongly coloured, loose free running except where cemented by calcrete: nodular at ~1 m / massive on silcrete at ~2 m. CO3 acid value = 2. Colour: 5YR 4/4, moderate brown. |
| 2-3 | Pedolith, massive calcrete on silcrete, incorporating minor alluvium-colluvium + weathered *in situ* plasmic zone. Colours: 2.5YR 4/4, moderate reddish brown + 10YR 7/3, light greyish yellowish brown. CO3 acid value = 1. |
| 3-4 | Pedolith, silcrete horizon, incorporating weathered *in situ* plasmic zone. Colour: 10YR 7/3, light greyish yellowish brown. CO3 acid value = 0. |
| 4-6 | Pedolith, incipiently silicified plasmic zone, pallid, + white vein quartz. Colour: 10YR 7/3, light greyish yellowish brown. |
| 6-10 | Upper saprolite, pale pink (6-8 m) to stronger pink (8-10 m), kaolinite + quartz grit. Colours: (6-8 m) 5YR 7/4, moderate yellowish pink; (8-10 m) 2.5YR 6/5, light reddish brown. |
| 10->22 | Upper saprolite, pallid, clays + quartz grit. Colours: (10-12 m) 2.5YR 6/5, light reddish brown; (12-14 m) 10YR 8/3, pale orange yellow; (14-18 m) N 8/-, light grey; (18-20 m) 10YR 9/2, yellowish white; (20-22 m) 2.5Y 8/5, light yellow. |
| >22->25 | Upper saprolite, pallid, clays + quartz grit. Colour: 2.5Y 8/3, greyish yellow. |
| >25-38 | Saprolite, multi hued, relict granulite-gneiss texture & fabric, clay-rich (?smectitic near base). Colours: (25-26 m) 10YR 6/3, lt.gr.y.Br + 10YR 5/6, st.y.Br; (26-28 m) 2.5Y 7/2, y.Gr; (28-30 m) 2.5Y 6/3, lt.ol.Br + 10YR 5/6, st.y.Br; (30-32 m) 2.5Y 6/2, lt.ol.Br; (32-34 m) 5Y 6/2, lt.ol.Gr; & (34-36 m) 5Y 7/2, y.Gr; (36-38 m) 5Y 6/1, lt.y.Gr. |
| 38-40 | Lower saprolite to saprock; clay + biotite-rich felsic gneiss, granulite, medium- to course-grained. Colours: 5Y 7/2, yellowish grey. |
| 40-41 | Bedrock, dominantly biotite-rich felsic gneiss, granulite, medium- to course-grained. Colours: N 2/-, black + 5Y 7/2, yellowish grey. |
| E.O.H. | |

## *In situ* Regolith

This Benchmark is one of the few drillholes at ET prospect that seems to penetrate bedrock (fresh Christie Gneiss), however, the ~1 m intersection may also be a large corestone surrounded by saprolite. Saprock is quite thin here (~1 m, see previous comment), in adjacent drillholes this material is much deeper. Saprolite at this site is similar to descriptions set out earlier for material deriving from more felsic versions of Christie Gneiss. Saprolite total thickness is at least 33 m (Figures 189, 192). Pedolith has an eroded top at this site, see also for Benchmark 32, its thickness is ~4 m.

## *Transported Regolith*

Aeolian dune sand forms the thickest transported cover unit at ET prospect. Underlying the thin dune sand, within the silcrete horizon is colluvium and alluvium, mostly sand + gravel and here is <0.5 m thick. Clast rounding, the presence of lithics and the broad size range indicate immature sediment with partly local and some distal provenance. PIMA spectral data, as a derived Kaolinite Crystallinity Index, places the main unconformity just below the silcrete. However, the low levels of preserved kaolinite in silcrete and the 2 m drill chip sample bias may also be skewing that pick. Drillcore or an excavation would provide a more absolute depth.

## *Geochemistry*

Geochemical expression for ET gold prospect has been outlined above and presented via Figures 189-191 (Au, Ca, Fe, Ga ) and Table 79 (Au, Cu, Ni).

A 51 element assay package was applied to all samples and Lintern *et al*. (2003) have plotted elemental abundances for all of those on a cross-sectional backdrop. From those abundance plots a selected set, including: Ag, As, Ca, Cu, Fe, Ni & Mg appear in Figures 193, 194. Silver, Cu and Ni may serve as limited pathfinder elements in this area, but al have low to weak near surface signals and Cu seems to relate more to lithotype than mineralization.

Calcrete at ET is generally calcic near the surface but becomes more dolomitic with depth, as indicated here, Mg does loosely follow that trend (Figure 196); but at Benchmark 32 that regional trend is much less obvious (*c.f.* Figure 194).

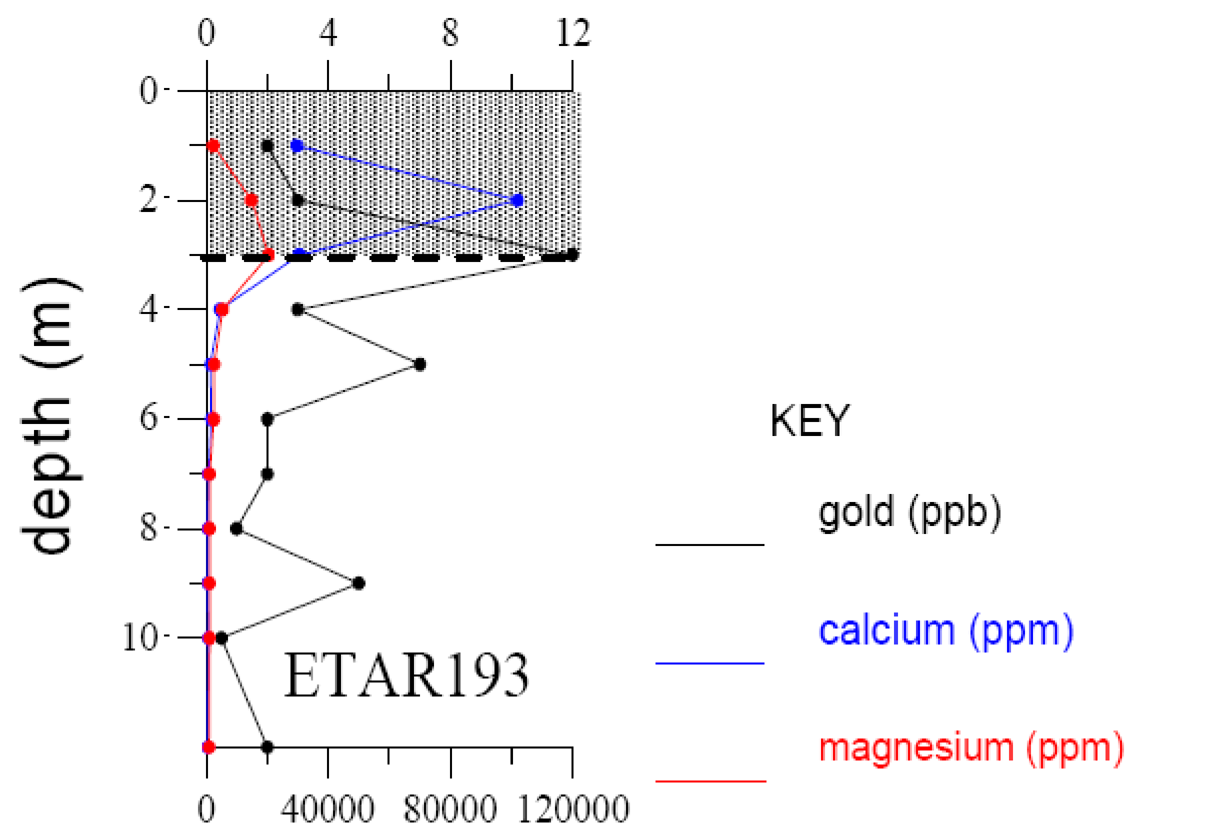



**Figure 196:** ET gold prospect, relationships between Au, Ca & Mg *versus* depth (0-12 m) for Benchmark 33 (Lintern *et al*., 2003).

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