REGOLITH CHARACTERISTICS AND GEOCHEMISTRY AS AIDS TO MINERAL EXPLORATION IN THE HARRIS GREENSTONE BELT, CENTRAL GAWLER CRATON, SOUTH AUSTRALIA.

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The Harris Greenstone Belt (HGB), southeast of Tarcoola in the Central Gawler Craton, is a newly outlined Archaean metakomatiitic greenstone province that has been the focus of recent drilling investigations (Figures 1 and 2). This determined the extent of the HGB and its mineral potential, in particular for Ni and Au. Over 95% of the greenstone belt, inferred from geophysical interpretation, is beneath regolith (Hoatson *et al.* 2002) that ranges from < 5 to > 80 m thick (Sheard & Robertson 2004, Hou 2004). Outcrop of highly weathered metakomatiite is limited to the northeast corner of Lake Harris, and greenstone-related basalts and relict pillow structures are exposed at Hopeful Hill.

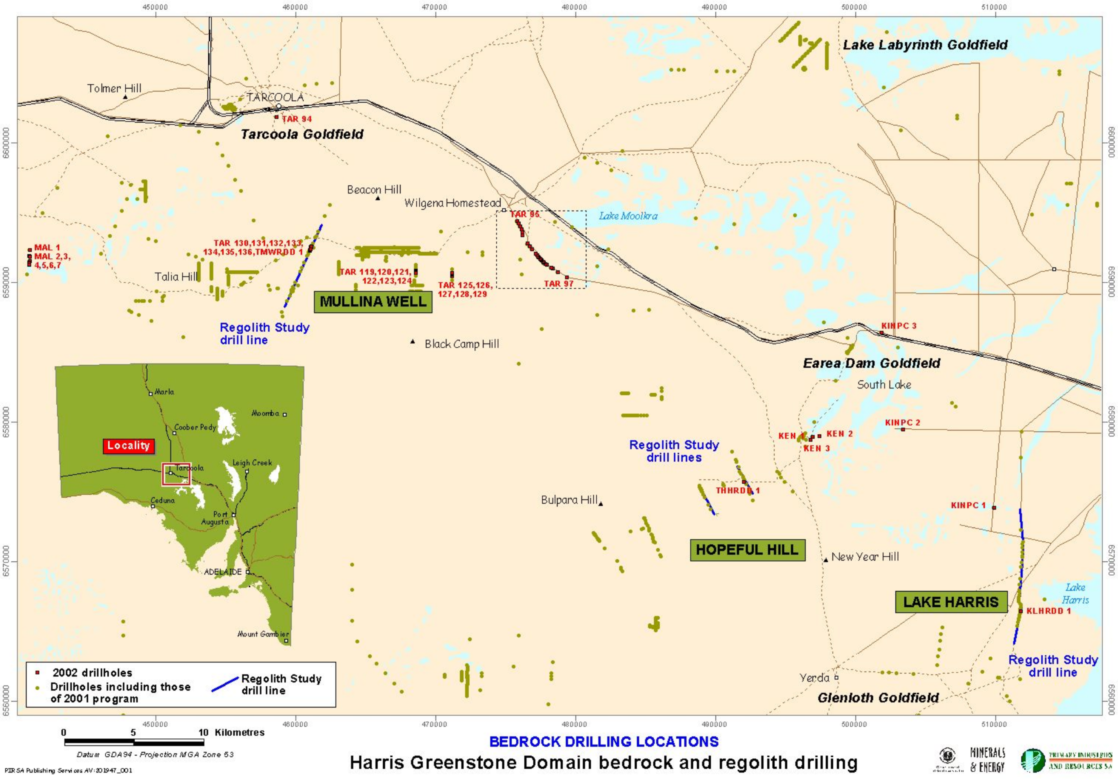

Figure 1: Locations to the PIRSA drilling program, 2001-2002 and the subset of regolith investigation sites.

Investigations by Sheard & Robertson (2004), summarised here, focus on the regolith and complements an earlier bedrock drilling program by Davies (2002a, b). The combined drilling programs were to confirm greenstone strike continuity, establish stratigraphy and contact relationships, elucidate details of the lava flows, establish the depth of cover, regolith assemblages, weathering history, element dispersion and landscape evolution. Over 130 aircore holes were drilled into regolith, unweathered greenstone and surrounding felsic basement.

OBJECTIVES

The objectives of this research were to:

- Evaluate the use of components from the transported cover and residual weathered profile to identify underlying fresh mafic and ultramafic greenstones; and,
- Evaluate surficial and shallow soil geochemistry to outline subsurface greenstones and to locate areas of anomalous metal concentration in the protolith.

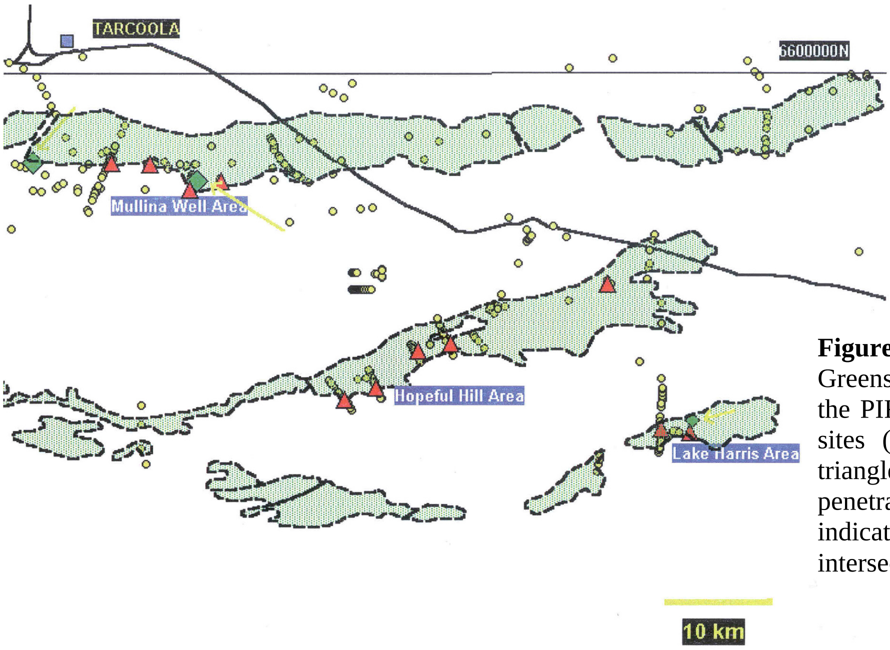

Figure 2: The Harris Greenstone Belt in relation to the PIRSA 2001 and 2002 drill sites (pale green circles), red triangles indicate metakomatiite penetration, green diamonds indicate anomalous gold intersected.

METHOD

The regolith was characterised over three key areas using drill cuttings from 56 selected aircore drillholes augmented by three purpose-drilled, fully-cored reference holes through the regolith, using visual logging, petrography and geochemistry. The regolith cores, one in each area, provided control for interpreting the more plentiful aircore drilling, helped to establish more precise boundaries in the regolith and refined interpretation of weathering-induced geochemical dispersion. The regolith cores also allowed detailed examination of weathering fabrics and overprints by duricrust cements (Table 1, Plates 1 and 2).

Table 1: Summary log of Lake Harris cored regolith, hole KLHRDD1 (Zone 53J, 0511863 mE, 6566452 mN). Diagrammatic and not to scale. Modified from Sheard & Robertson (2004).

Depth Range (m)	Graphic Log (not to scale)	Regolith Zone	Description
0-0.70		Soil-sand	Soil in loose red-brown aeolian sand with ~300 mm of calcrete.
0.70-10.50		Sediment	Alluvial clay + sand + gravel + cobbles, weakly bound to silicified. Upper 1-~5 m is red-brown hardpan colluvium–alluvium, the remainder is an older fluvial channel to overbank deposit with silcrete bands.
10.50-14.52		Colluvium	Pale clays plus rip-up pedolith clasts, quartz sand and grit with fragmentary Fe-pisoliths, locally deriving from eroded pedolith of both felsic and ultramafic terrains, red Fe-megamottled.
14.52-14.75	# # # #	*In situ* Pedolith (plasmic)	Extremely weathered greenstone; pedogenic clay-rich breccia, pale green to bluish and greyish, Fe-stained, top eroded, NO ferricrete cap.
14.75-41.60		Upper saprolite	Highly weathered greenstone; upper ~1 m displays weathering brecciation. Mostly a complex sub-zone with several enclaves of less + more highly weathered material. Clay-rich, soft to stiff and sticky-plastic clay (smectitic) light to bright greens + blue-greens + yellow-greens + blue-greys. Relict foliation and conjugate joint sets, red Fe-mega-mottling and yellow to brown Fe-staining, white to pale grey chalcedony veins, black MnOx flecks and dendrites. Some intervals have a distinctly greasy feel (talc). Sub-zone is smectite (dominant above 29 m), chlorite, talc + relict serpentine.
41.60-49.15		Lower saprolite	Weathered greenstone; complex sub-zone, has several enclaves of less or more highly weathered rock. Sub-zone is generally darker hued and more competent than the one above (less altered). Blue-green-grey weathered serpentinite + bright green and brown clay seams + talc + tremolite-actinolite and yellow Fe-staining, well jointed, relict foliation and texture.
49.15-51.25		Saprock–protolith	Partially weathered greenstone; serpentinite, dark green-grey, some clay fracture infill, progressively more competent with depth but still retains enclaves of more weathered material. Weathering Front probably just below end of drillhole.

The regolith was mapped over one key area at a scale of 1:10,000 at Lake Harris. This was selected for its metakomatiitic greenstone outcrop and diverse cover. Samples of the surface regolith and shallow soil were collected over a portion of the mapped area. A modified regolith mapping format was developed for the project using elements of both the CSIRO developed 'RED' scheme and the 'RTMAP' scheme of Geoscience

Australia. The thickness of cover and depth to protolith is shown at each drilled site, hand-dug pit or outcrop. A regolith cross-section along the main drill line provides further information on variability in depth of weathering. Map unit colours and tags were chosen to emphasise exposed greenstones and areas where transported cover was thin.

Plate 1: Part of a polished silcrete block from the Lake Harris greenstone outcrop. The greenstone-granite sheared contact lies only ca. 30 m from where this sample was collected. Angular laths of a translucent grey-brown to greenish grey chalcedony, consisting of banded comb-textured, unstrained quartz with line voids, are enclosed in a colluvial sand derived from both granitic and ultramafic source rocks. The matrix of angular strained metamorphic quartz grains is cemented by cream to pale brown cryptocrystalline quartz and anatase. Bulk assay of a portion from this specimen revealed: Cr = 63 ppm, Ni = 6 ppm, Ti = 1.83%, V = 39 ppm and Y = 11 ppm.

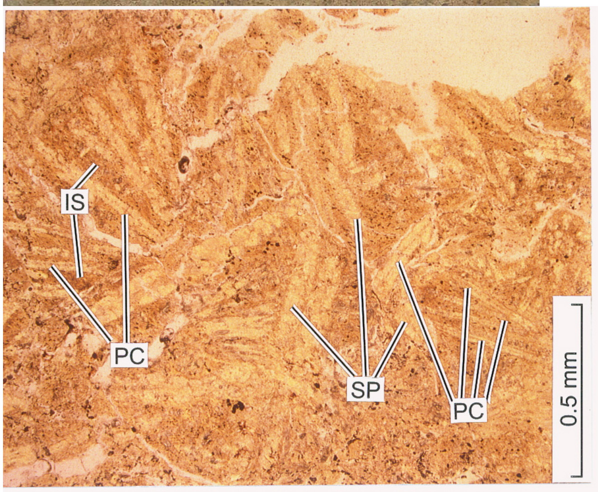

Plate 2: Bladed pyroxene spinifex structure (SP) now pseudomorphed by illitic clay, and the interstices (IS) and pyroxene cores (PC) are accentuated by dusty Fe-oxides. Photomicrograph of saprolite of ultramafic rock with a spinifex fabric under plane polarized transmitted light. Drillhole KLHRDD-1, depth 17.0-17.07 m.

A review of landscape evolution from previous work was completed and key sites were placed in context with this review. Recent palaeochannel modelling work for this area has also been included.

RESULTS

- Soil sampling revealed metakomatiite indicator elements (Mg, Cr, Ni, As, Co, Fe, Mn and V) are elevated over exposed weathered greenstones or where metakomatiites are mantled by thin cover (1-5 m, Figure 3). Mineralization-related elements (Au, Bi, Cu, Pb and W) are also elevated in places, indicating prospective ground.
- Analysis of stream sediments from a modern creek cross-cutting the covered HGB near Lake Harris was able to infer the presence of greenstones in the vicinity. However, as there are few active ephemeral streams over the HGB, this makes stream sediment sampling of limited value.
- Regolith mapping that indicates approximate cover thickness is an important aid to interpretation of geochemical data.
- Movement of greenstone-derived ferruginous resistate materials by bioturbation of the cover may provide a supplementary exploration sample medium and may make it possible to 'see through' 5-10 m of transported cover if these minerals are specifically sampled.
- Aircore drill cuttings provide a good orientation sample set within weathered greenstone terrain. Drill cuttings and core require revisiting and reinterpretation when assay, petrographic and other data became available. As regolith drillcore dries out, some important subtle regolith features become more apparent.
- Recognition of the unconformity between transported cover and in situ weathered bedrock proved

difficult at the Mullina Well cored site due to a debris flow deposit (about 5.5 m thick) of similar composition and degree of weathering to the underlying residual profile. The use of core was critical to recognise this unit. Debris flows may be more common than previously recognised and may pose interpretation hazards if unrecognised. Zirconium content may be helpful in defining the transported-*in situ* boundary on weathered greenstone.

- Greenstones are more deeply weathered and eroded than adjacent felsic rocks and the erosion channels are filled by younger sediments up to 80 m thick.
- Silcrete developed immediately above the greenstones proved to be silicified colluvium rather then silicified weathered meta-komatiite, with a resistate mineralogy drawn from the adjacent felsic and ultramafic terrains. However, inclusions of darker coloured chalcedony fragments, derived from the weathered metakomatiites are quite distinctive (Plate 1).
- Ferruginous cappings on the HGB are either very thin (< 1 m) or have been removed by erosion. They are commonly enriched in both Ni (up to 6,500 ppm) and Cr (> 2,000 ppm), but these concentrations are normal for ferruginous caps on weathered ultramafics. However, the value of ferruginous capping as a geochemical sample medium is limited by its variable and limited preservation here.
- The pedolith on greenstones is typically thinly developed or poorly preserved (commonly < 5 m). The generally thicker saprolite (up to 90 m) is readily identified as formed from greenstone protolith by its mineralogy (smectite), chemistry (elevated Cr, Ni, Cu, Mg, etc) and fabrics.
- Spinifex fabrics in the serpentinised komatiite are preserved in saprolite at Lake Harris to within 17 m of the surface and to within about 2.5 m of the unconformity beneath transported cover (Plate 2). This can be recognised from drill core but not readily from drill cuttings.
- Landscape evolution and palaeochannel modelling have revealed a strong coincidence between the Kingoonya Palaeochannel and the weathered greenstone subcrop, especially for the most northerly greenstone belt (>85% match; Hou 2004). The more readily eroded, weathered greenstones have directed palaeodrainage to preferentially carve out a significant valley system over some hundreds of kilometres, reaching up to ten kilometres wide in places. Sediment infill reaches thicknesses of about 15 to 80 m within the greenstone-linked palaeochannel segments but a gap in that overlap linkage occurs where the 2001 Mullina Well drill line cuts the greenstones, there HGB forms a palaeo-high ground.

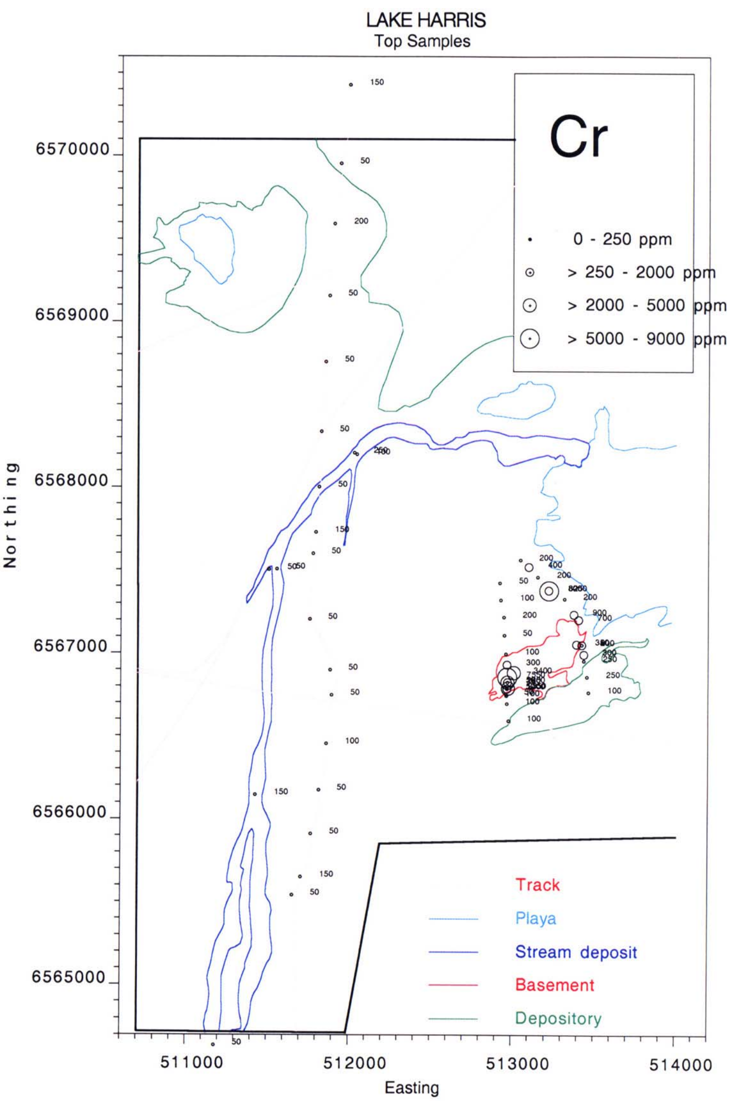

Figure 3: Chromium content of soil samples at Lake Harris showing only the top (20-150 mm) sample media in relation to major geomorphic units. Six stream sediment samples are also indicated.

KEY RECOMMENDATION

Our results demonstrate that thickness of transported cover is most significant in determining whether or not detrital or geochemical indicators of greenstone can be detected at the near surface. Difficulties encountered in accurately identifying the major unconformity between *in situ* and transported regolith in covered terrain, using aircore drill cuttings, are reduced markedly when compared with at least some fully cored regolith drilling. At least one carefully selected diamond drillcore per mineral prospect, passing through as complete a regolith profile as possible, aids regolith modelling, rationalises geochemical sampling and interpretation, and helps in planning follow-up drilling.

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