REGOLITH LANDFORM MAPPING TO ENHANCE EXPLORATION THROUGH THIN TO MODERATE COVER: A CASE STUDY FROM WUDINNA NORTH, EYRE PENINSULA-GAWLER CRATON, SOUTH AUSTRALIA

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Over much of the Gawler Craton deep weathering profiles and extensive transported cover combine to hide protolith (crystalline basement) from conventional surface exploration methods. Recently recognised, the Central Gawler Gold Province lies within South Australia's Gawler Craton and includes northern Eyre Peninsula, where significant protolith obscuring factors abound. Previous conventional geological mapping attests to a dearth of protolith outcrop south of the Gawler Ranges highlands. Regolith landform mapping had never been tried or assessed for a large part of Central Gawler Gold Province, especially where demonstrated gold-in-calcrete anomalism occurs. To properly assess whether regolith characterisation, mapping and landscape evolution modelling could assist mineral exploration, a regolith landform study area was chosen, its centroid is ~25 km north of Wudinna and ~230 km W of Port Augusta (Figures 1, 2). It occupies an area of ~445 km^2 and has corner grid coordinates of 528000-551000mE and 6358000-6377000mN (GDA 94, Zone 53 I). This area partly covers the Gawler Ranges National Park and Pinkawillinie Conservation Park, it also encompasses Barns and Baggy Green gold prospects (Figure 2).

LOCALITY

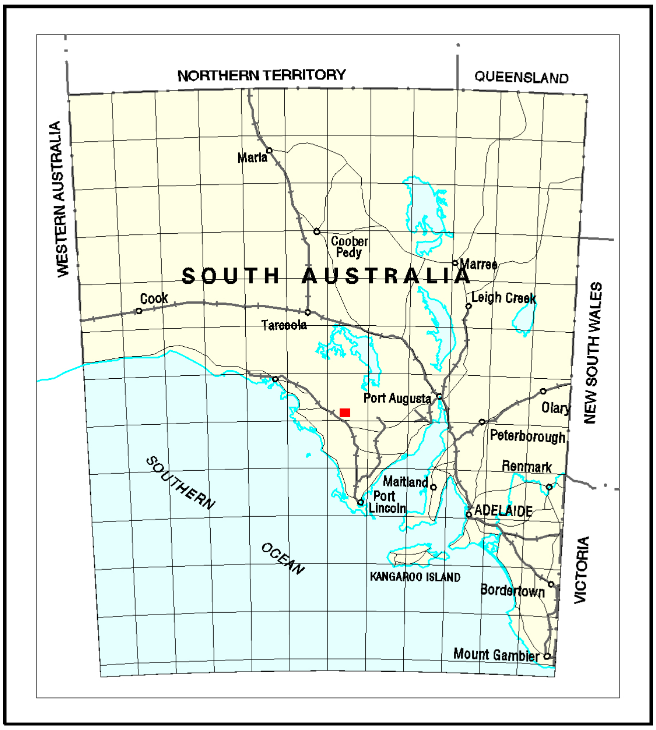

Figure 1: State Map, displays key geographic features, and the Study Area is marked by a small infilled square (red) west of Port Augusta.

Regolith profile recognition utilised methods and models established within CRC LEME. A modified RED scheme was used for regolith mapping (Table 1 & Figure 3) in combination with geomorphology for landform description and pedology for soil recognition. The aim being to highlight cropping out *in situ* crystalline basement (as protolith to pedolith) and thinly covered equivalents. Two adjoining 1:20,000 scale regolith landform map sheets resulted (Sheard, 2006), where a Landscape Evolution Block Model plus 12 Regolith Profile Models are key components. Forty six regolith units were identified, they include: 14 Relict + 9 Erosional + 20 Depositional + 3 Duricrust forms. Regolith landform mapping has increased the area of protolith derived regolith from <8% to ~35% and therefore must have increased its mineral prospectivity by a similar factor.

Thicknesses of transported cover are taken from exploration company drilling, natural outcrop or terrain incisions and various District Council borrow pit exposures. Two Regolith profile sections are depicted on the *Wudinna North Regolith Landform Map, Part B* (sections A–B and C–D; Figure 3), their construction involved vertical exaggerations of 10 times with appropriate dip and contact angle corrections applied (Sheard, 2006).

Aeolian sandplain-dune systems form the major transported cover. Their sands are relatively thin (<1-15 m) but form a significant barrier to conventional surface exploration methods. Yaninee Palaeochannel and Corrobinnie Depression (Narlaby Palaeochannel) are buried fluvial valleys where sediment thickness may reach more than 30 m. Areas affected by those have been partially defined by the intensive exploration drilling and by this study. Inverted topography, forming small mesas, exhibits bog-iron overprinted palaeochannel sediment, evidence for swampy reducing conditions where acid groundwater input was once a significant factor in Fe-Mn mobility. These cropouts also evidence substantial erosional landscape lowering in those locations (10-15 m) and serve as prime indicators of significant profile truncation.

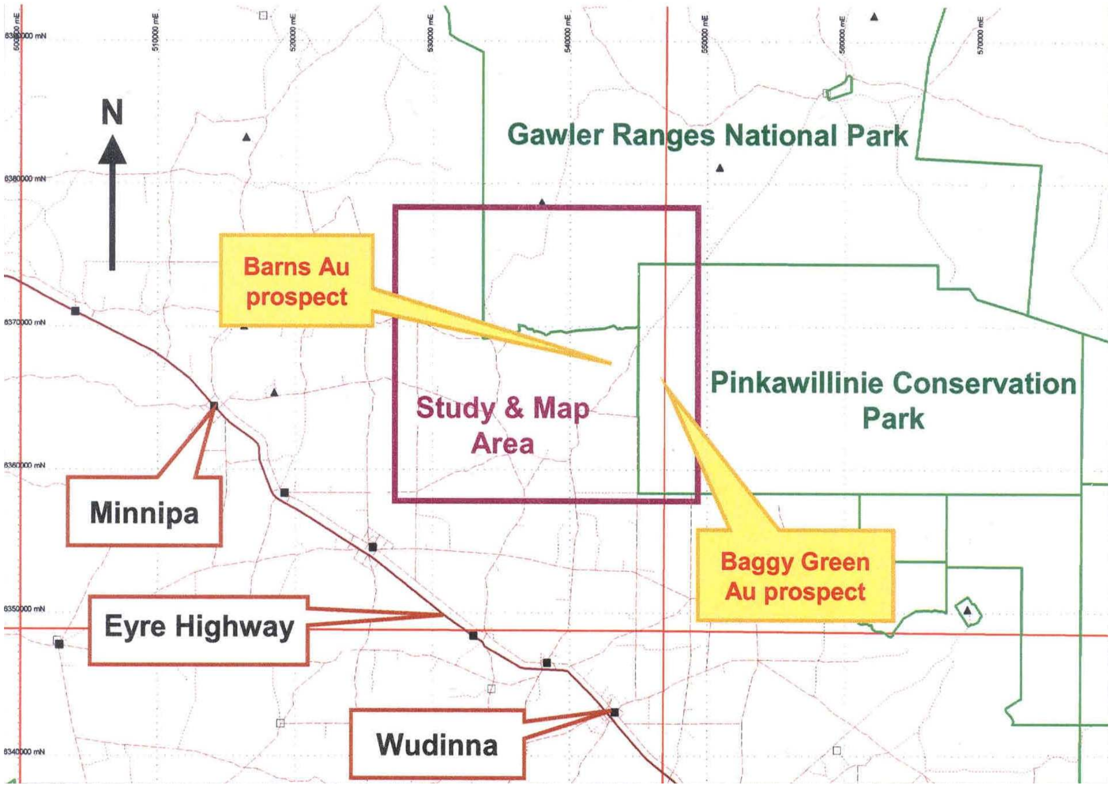

Figure 2: Principal boundaries and Towns. Regional Parks (green lines) cover ~40% of the Study Area (purple boundary; 19 x 23.5 km).

Mapping and petrography have indicated that a previously widespread lateritic profile has been substantially minimised by erosion, where most of the Fe-pisolith containing pedolith horizon (<1 m) now forms scattered remnants or lag accumulations. More typically, a collapsed Fe-megamottle sub-zone (1-1.5 m) forms the regional duricrust as a pseudo-pedolith – commonly displaying mixed transported and *in situ* characteristics. Within or below this is a collapsed arenose sub-zone consisting of quartz grit (<1-3 m) where clay fines are absent to rare. Eroding escarpments provide windows onto upper saprolite (megamottled or pallid, <50m thick) but saprock and protolith are restricted to rare small cropouts, only 2 are named (Poondana Rocks and Little Pinbong Rockhole). Intrusive contacts between Tunkillia Suite and Hiltaba Suite basement lithotypes are not exposed and their very similar petrophysics make any common subsurface boundaries quite difficult to properly define from even detailed aeromagnetics and gravity data.

Significant duricrusts include: gypcrete, calcrete, ferricrete and silcrete. Field and petrographic evidence from silcrete outcrop support the timing of saprolite + palaeochannel megamottling as both being prior to silicification. Silcrete typically caps collapsed arenose zones and may contain appreciable colluvium. Calcrete has been used by explorers as a convenient geochemical sampling medium, it forms massive sheets to accreted nodule aggregates to nodules to thin plates and earthy overprints within soils and substrates. Its host lithotype provenance is essential knowledge for interpreting any captured trace metal signatures. Gypcrete is abundant, especially around playas and their associated lunettes, it can be a significant trace metal dilutant in surface geochemical samples.

PIMA infrared analysis of playa muds has indicated alunite occurs at nine locations in the western half of the study area (potentially a result of acid groundwaters). Those in the map's NW quadrant may possibly relate to protolith hosted sulphides. Gypsum is a common evaporitic mineral in most playa sediments. Kaolinite within exposed saprolite has a higher crystallinity index than does kaolinite within playa sediments. Palaeochannel clays are commonly montmorillonite bearing and the older Orange Longitudinal Dunes (map unit De-4) also have clayey cores containing montmorillonite.

Gold-in-calcrete geochemistry in combination with the new regolith mapping demonstrates that most Au anomalies are indicating either exposed or very thinly covered *in situ* weathered regolith. However, there is also one significant Au anomaly developed over a defined palaeochannel tributary, where exploration drilling has demonstrated there to be Au in high ppb to low ppm concentrations within the channel sediment. Gold grains can be panned from those sands and gravel. Mineralized sources for this sediment hosted Au remain elusive and will require further work to define appropriate drill targets. Slightly anomalous Ag does outline buried palaeochannels but why this dispersive pattern occurs here remains to be explained because the mineralization defined so far is relatively low in Ag.

Reliable interpretations of surface geochemical signatures are not possible without an adequate comprehension of the regolith profile, the degree of erosional truncation, and whether or not any remnant mineral signatures are displaced by erosion or mass wasting (debris flows) or are modified by re-deposition. Confidence in the trueness of surface geochemistry is significantly improved when any anomalism is known to be: *in situ*, displaced, diluted, or is missing through profile truncation. An adequate local and regional regolith-landform understanding is therefore essential to that interpretive confidence.

Table 1: Wudinna North Area Regolith Landform Map unit symbol notation modified after Sheard and Robertson (2003).

Landscape Class	Brief Explanation and Notation
Relict	*In situ* fresh or weathered basement remnant as a resistive inlier within a broader area dominated by near surface younger transported cover or erosional terrain. **Landscape Class**: R = Relict. **RgSm** **Regolith Sub-zone**: m = collapsed megamottle capping, d = pisolithic Fe-pedolith, or sequential number. Soils: e = red earthy grit, g = brown earthy grit, h = sandy clay, or sequential number. **Regolith Zone**: P = Protolith, S = Saprolith, Q = Pedolith. **Lithotype**: v = felsic volcanic, g = granite, q = quartz vein, b = mafic volcanic/dyke.
Erosional	Terrain where erosion is the dominant landscape modifying component, can include currently eroding weathered *in situ* crystalline basement and/or transported cover deposits. **Landscape Class**: E = Erosional. **EgSm** **Regolith Sub-zone**: m = collapsed megamottle capping. Sediments: df = debris flow, ps = piedmont slope deposit, or sequential number. **Regolith Zone**: P = Protolith, S = Saprolith, Q = Pedolith, or sequential number. For eroding sediments no Zone is indicated. **Lithotype**: v = felsic volcanic/dyke, g = granite, b = mafic volcanic/dyke, c = colluvial, a = alluvial.
Depositional	Terrain where deposition dominates over other geological processes. **Landscape Class**: D = Depositional. **Dcdf** **Unit descriptor**: dash & sequential number, or name abbreviation; df = debris flow, ps = piedmont slope deposit, ta = talus. **Lithotype**: a = alluvial, c = colluvial, e = aeolian, l = lacustrine/paludal.

KEY RECOMMENDATION

Regolith landform mapping and profiling, in combination with landscape evolution modelling, are additional key components to a better understanding of areas where moderate to deep weathering and thin to moderately thick transported cover combine to obscure potentially mineralised protolith. Those key determinants are essential to surface geochemistry interpretive confidence in what is truly anomalous *vs* what is falsely anomalous.

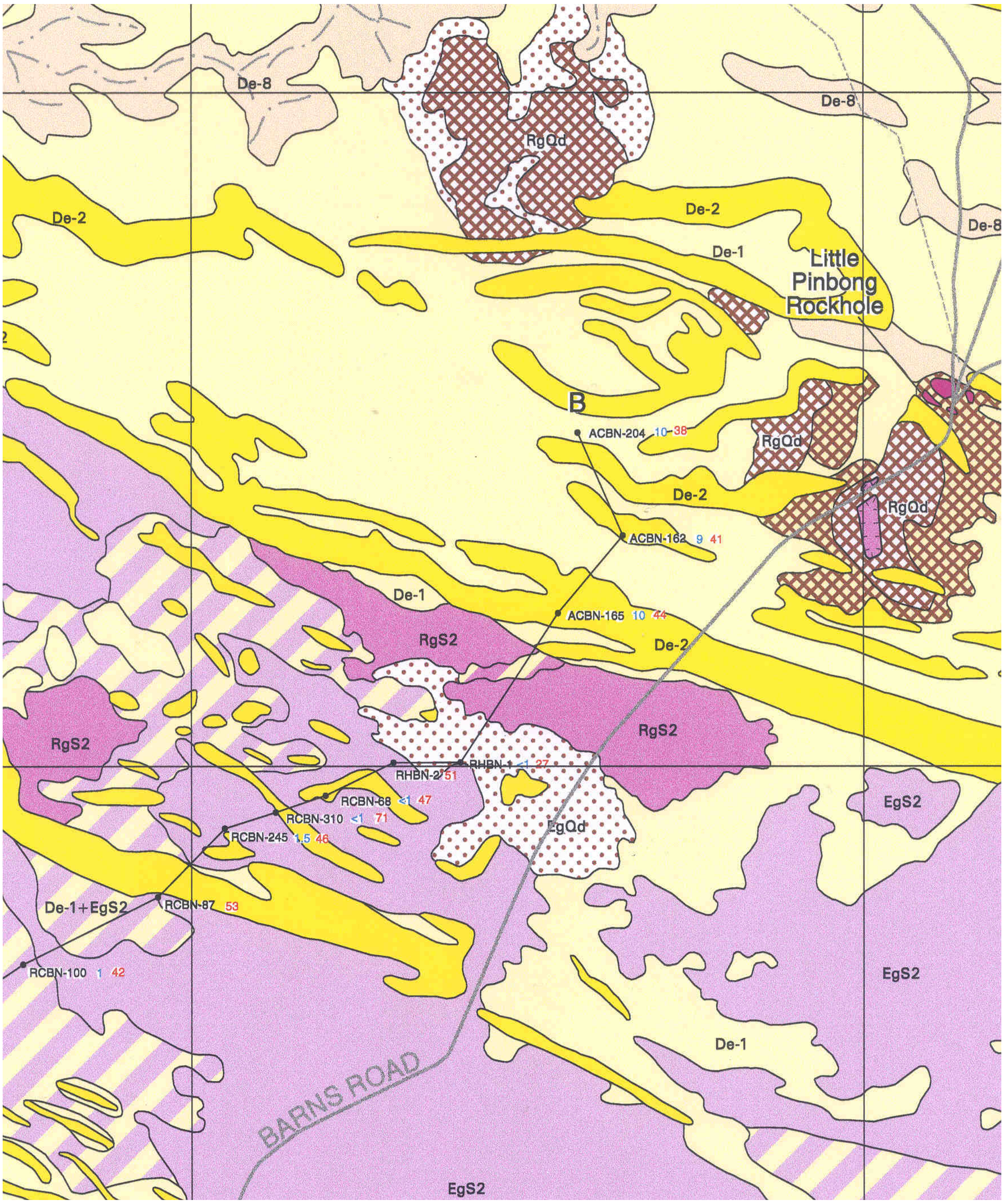

Figure 3: An extract from the *Wudinna North Area Regolith Landform Map A*, covering the Barns Au prospect and a variety of *in situ* weathered + transported cover regolith units. A segment of the Regolith Profile Section line A-B is also captured, this displays drillhole numbers followed by sediment thickness (blue numbers) and then depth to protolith (red numbers). Little Pinbong Rockhole (upper RHS) is outcropping Tunkillia Suite orthogneiss protolith. Map scale = 1:20,000. Map grid lines are at: 542000mE + 544000mE and 6366000mN + 6368000mN.

REFERENCES

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