CRC LEME OPEN FILE REPORT 232
VOL 1 AND VOL 11

Regolith Characterisation as an Aid to Exploration in the Wudinna north area, Central Gawler Province, South Australia.

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July 2007

ABSTRACT

Over much of the Gawler Province (nee Gawler Craton) deep weathering profiles and extensive transported cover combine to hide crystalline basement (protolith) from conventional surface exploration methods. Recently recognised, the Central Gawler Gold Province lies within South Australia's Gawler Province. Previous conventional geological mapping attests to a dearth of protolith outcrop south of the Gawler Ranges highlands (northern Eyre Peninsula). 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 ~20 km north of Wudinna and ~100 km WNW of Kimba. The Study Area covers ~445 km^2 and has corner grid coordinates of 528000-551447 E and 6358000-6377000 N (GDA 94, Zone 53 I). This area includes parts of Gawler Ranges National Park and Pinkawillinie Conservation Park; it also encompasses Barns and Baggy Green gold prospects.

Regolith profile recognition utilised methods and models established within CRC LEME. A modified RED Scheme (developed by CSIRO Exploration & Mining) was used for regolith mapping, in combination with geomorphology for landform description, and pedology for soil recognition. The aim being to highlight areas of *in situ* crystalline basement (protolith to pedolith) and thinly covered equivalents. Two adjoining 1:20,000 scale regolith landform map sheets resulted, where a Landscape Evolution Block Model with 12 Diagrammatic Regolith Profiles are key components. Forty six regolith landforms were identified, they include: 14 Relict + 9 Erosional + 20 Depositional and 3 Duricrusts. Regolith landform mapping increased the area of protolith derived regolith from <8% to ~35% and therefore has increased surface mineral prospectivity by a similar four fold factor.

Aeolian sand plain—dune systems form the major surficial transported cover. Sand cover is relatively thin (<1 to ~15 m) but forms a significant barrier to conventional surface exploration methods. Yaninee-Narlaby Palaeochannel complex and Corrobinnie Depression (Narlaby Palaeochannel) are buried fluvial valleys where sediment thickness may exceed 30 m. Areas of fluvial deposition have been partially defined by this study and exploration drilling. Inverted topography,
forming small mesas, reveals bog-iron overprinted palaeochannel sediment, evidence for swampy reducing conditions where acid groundwater input was once a significant factor in Fe-Mn mobility. These bog-iron capped mesas are also evidence for erosional landscape lowering of the area by 10-15 m since the late Palaeogene and illustrate significant profile truncation.

Mapping and petrography show that a previously widespread but thin Fe-rich pisolithic horizon (<1 m) developed on a deeply weathered profile has been substantially minimised by erosion. Most of the remaining Fe-pisolith bearing horizon (pedolith) occurs as scattered *in* situ remnants or forms lag accumulations in the transported cover. More commonly, a collapsed Fe-megamottle horizon (1-1.5 m) forms the regional duricrust as a conspicuous variably indurated pedolith. The collapsed Fe-megamottle horizon can display void and crack in fill of mixed transported and *in situ* character. Within or below that a arenose zone (lowest pedolith) of collapsed quartz grit (<1-3 m) may occur, where clays and other fines are absent to rare. Eroding escarpments provide windows onto the underlying saprolite (commonly megamottled, and pallid in the upper two thirds; thickness <50m). Saprock and protolith are restricted to a few small cropouts, of which two are named (Poondana Rocks and Little Pinbong Rockhole). Contacts between Tunkillia Suite and Hiltaba Suite lithotypes are not exposed and their similar petrophysical subsurface boundaries are quite difficult to define even from detailed aeromagnetic properties and gravity data.

Significant duricrusts include: gypcrete, calcrete, ferricrete and silcrete. Field and petrographic evidence from silcrete outcrop support the timing of megamottling in saprolite and palaeochannel sediment as both being prior to silicification. Silcrete typically caps collapsed arenose zones and may contain appreciable colluvium but may also extend into alluvium. Calcrete has been used by mineral explorers as a convenient geochemical sampling medium and forms massive sheets, accreted nodule aggregates, nodules, thin plates and earthy overprints within soils and substrates. No superior geochemical sampling medium to calcrete was identified but more use of the Fe-pedolith for such work may provide finer detail in areas of relict terrane. Gypcrete is abundant, especially around playas and associated lunettes, and gypsum can be a significant dilutant in surface geochemical samples.

PIMA infrared analysis of playa muds identified alunite at 9 locations in the western half of the Study Area (possibly derived from acid groundwater). Those in the NW quadrant this may relate to weathering of protolith hosted sulphides. Gypsum is a common evaporite mineral in most playa sediments. Kaolinite in exposed saprolite has a higher crystallinity index than kaolinite in playa sediments. Palaeochannel clays are commonly montmorillonitic and the (older) Orange Longitudinal Dunes (map symbol De-4) also have clayey cores containing montmorillonite.

Gold-in-calcrete geochemistry overlaid on the regolith map demonstrates that most Au anomalism is associated with exposed or very thinly covered *in situ* weathered basement. However, there is one significant Au anomaly developed over a palaeochannel tributary, where exploration drilling has confirmed Au in high ppb to low ppm concentrations within the channel sediment. Gold grains can be panned from palaeochannel sand and gravel samples from those drillholes. The bedrock sources of this sediment hosted Au remains elusive.

Reliable interpretations of surface geochemical signatures are not possible without an adequate comprehension of the regolith profile, its degree of profile loss by erosion, and whether or not any remnant mineral signatures are laterally displaced via erosion or mass wasting (debris flows) or sheet flow alluvial dispersion. Identification of host provenance is essential for interpreting the significance of trace element data. Confidence in the trueness of surface geochemistry is significantly improved when any anomalism is known to be either: *in situ*, displaced, diluted, or missing through profile erosion. Results of the landscape evolution study, especially with respect to contemporary and palaeodispersion mechanisms, indicate that both an understanding of landscape position and landforms are crucial when selecting appropriate geochemical sample media and for interpreting their trace element assay values.

Key Recommendation

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