KEY FINDINGS FROM THE SOUTH AUSTRALIAN REGOLITH PROJECT

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The principal aim of the South Australian Regolith Project was "to develop technically efficient procedures for mineral exploration in the major Cratons of South Australia through a comprehensive understanding of the processes of regolith development and landscape evolution and their effects on the surface expression of concealed mineralization". The Project involved scientific collaboration between CRC LEME, PIRSA, universities and the exploration industry from 1996 to 2003. Industry input was a key element throughout the project since many of the case studies were based on data provided by companies.

Studies were conducted at sixteen prospects and/or deposits in the Gawler Craton and Curnamona Province of South Australia. In addition, regional studies into dating and isotopes were undertaken. Research themes were regolith mapping, regolith geochemistry, surface geochemistry, biogeochemistry, and hydrogeochemistry. Not all of the themes were included for each study due to different sub-project objectives and resource limitations. A number of commodities were examined including Au, Cu, Ag and Pb, with the overwhelming proportion about Au. Similarities and differences between sites were developed, and models of geochemical dispersion produced (e.g., Figure 1). Some of the more important conclusions and recommendations are summarized below:

1. From the case studies, geochemical exploration models were constructed according to depth of overburden and commodity. At Challenger and Birthday, transported overburden is thin or absent and most upper regolith materials were found to be anomalous in Au (Figure 1). Other models will be presented for 1-5 m, 5-15 m and > 15 m thick transported overburden based on the case histories.

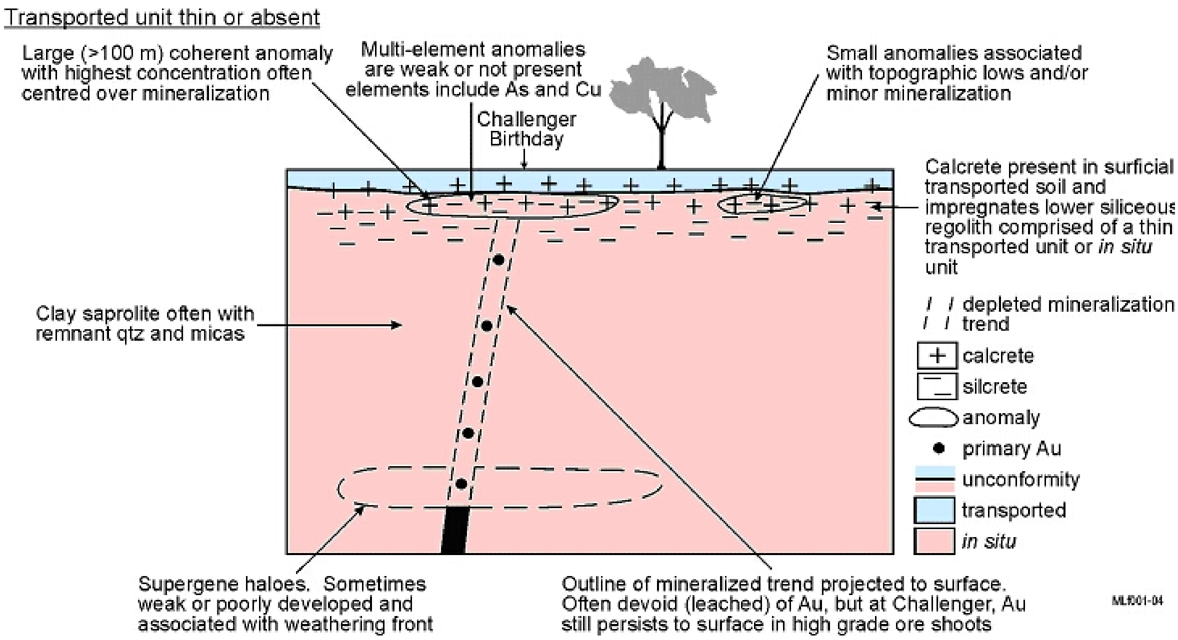


Figure 1: Geochemical exploration model for Au deposits which have thin or absent transported overburden (Lintern 2004).

2. The construction of large scale regolith-landform maps (preferably more detailed than 1:10,000) is recommended. These maps provide information on the distribution of regolith materials but should additionally provide some indication as to the extent of transported materials and thickness at the prospect scale. Small scale regolith maps (e.g. 1:100,000) provide an overview but have insufficient detail for any sampling programmes. The location of the maps and study sites is shown in Figure 2

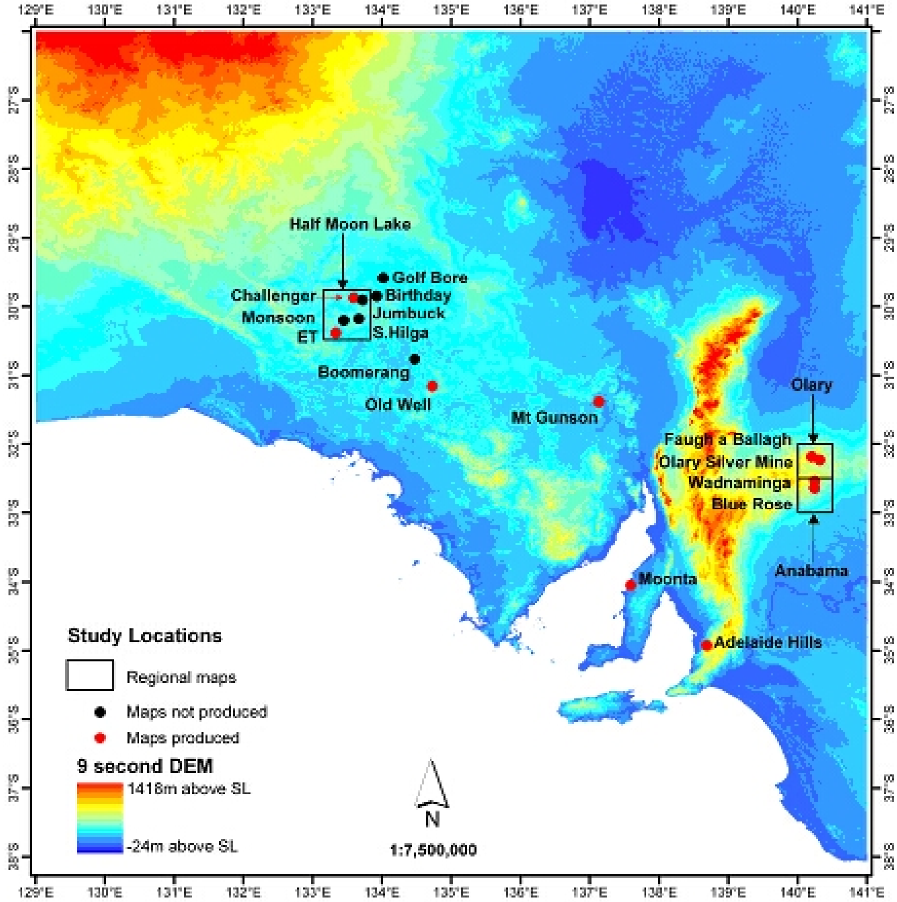


Figure 2: Plan of South Australia showing location of case studies, small scale (regional) regolith maps and large scale (prospect scale) regolith maps from Lintern (2004).

3. Just as in other regolith-dominated terrains, surficial geochemical sampling programs in South Australia are sensitive to the nature of regolith materials and depth of transported overburden and it is therefore important to establish the regolith stratigraphy and landforms for effective exploration. Remote sensing methods such as radiometrics, aerial photography, Landsat TM, ASTER and AIRSAR can give important information on the nature of the land surface and as an aid to mapping the distribution of surficial materials (Figure 3). Ground penetrating methods such as AEM may give sub-surface information such as the presence and depth of palaeochannels.

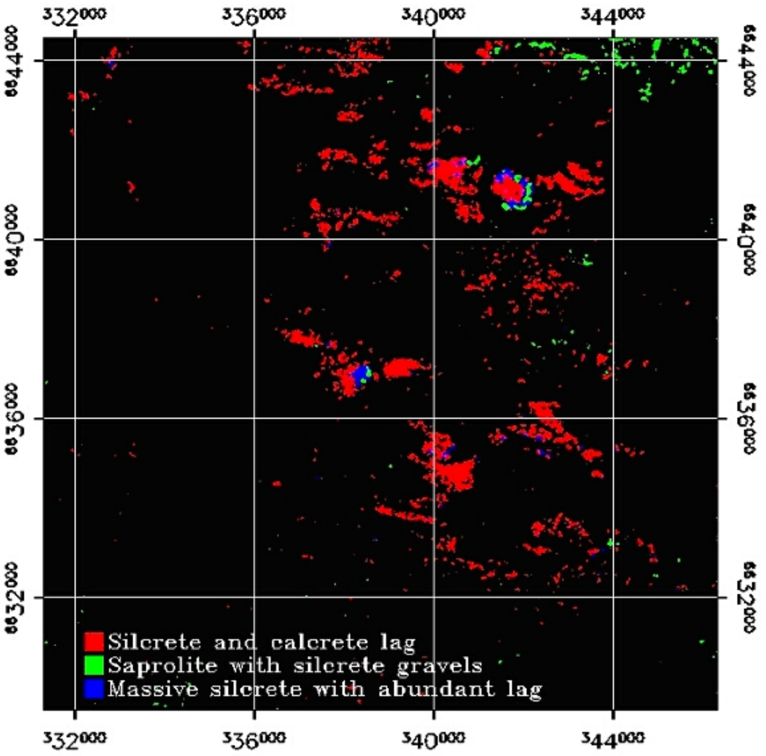


Figure 3: Classification of three principal regolith materials of interest at ET Gold Prospect, silcrete gravels (Red), saprolite (Green) and massive silcrete (Blue), using the Spectral Angle Mapping technique on LandsatTM data after Tapley & Cornelius (2003).

4. Distinguishing *in situ* from transported regolith is important for exploration as geochemical responses will differ depending on the depth of cover. The presence of cover may be inferred from field regolith-landform relationships, although drilling can provide definitive information. The use of PIMA spectra can in some cases establish transported-*in situ* boundaries. In some circumstances geochemistry can also discriminate between cover sequences and residual regolith (e.g., REE at Challenger, Figure 4).

5. Calcrete is the best near-surface sampling medium for Au and should be used as a first pass geochemical sampling technique. It occurs usually within a metre of the surface and is readily identifiable using dilute acid. It works best as a guide to mineralization where transported overburden is absent or thin (< 5 m), and when there is saprolite (weathering) rather than fresh bedrock in the residual regolith. Local topography may lead to the development of transported anomalies located away from their source mineralization. For Cu and some Au, specific environments (high water table, acidic groundwaters and < 5 m of transported material) may lead to upward dispersion of metal with a precipitation in alunite at the base of the calcrete horizon due to a pH change (Figure 5).

6. Hilly terrain is well-suited to stream sediment sampling, and orientation surveys investigating the most appropriate size fraction(s) are recommended at each site (e.g., < 2 mm at Faugh-a-Ballagh, Curnamona Province, Figure 6).

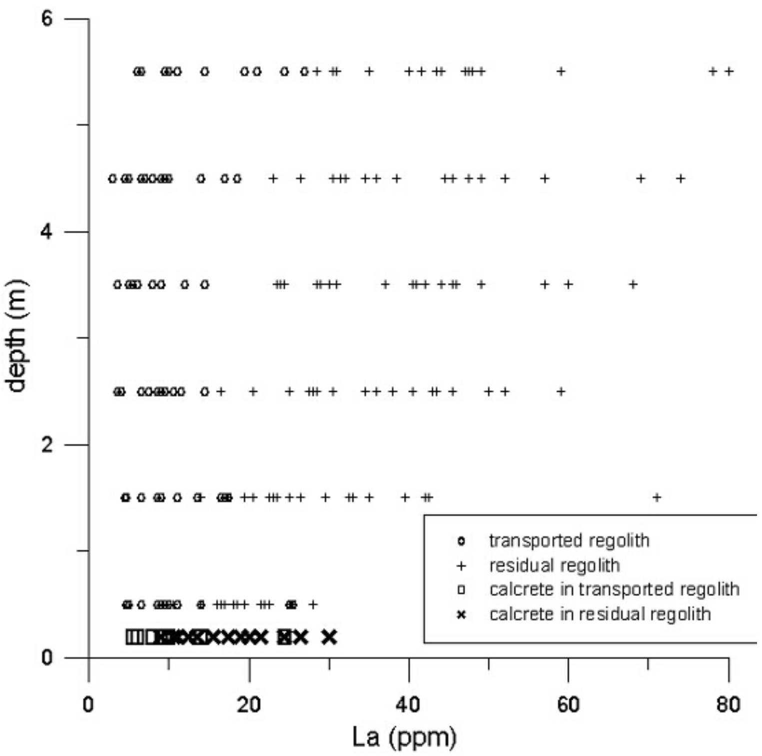


Figure 4: Lanthanum versus depth in calcretes and regolith (0-6 m) materials for transported and *in situ* (residual) regolith from Lintern & Sheard (1999).

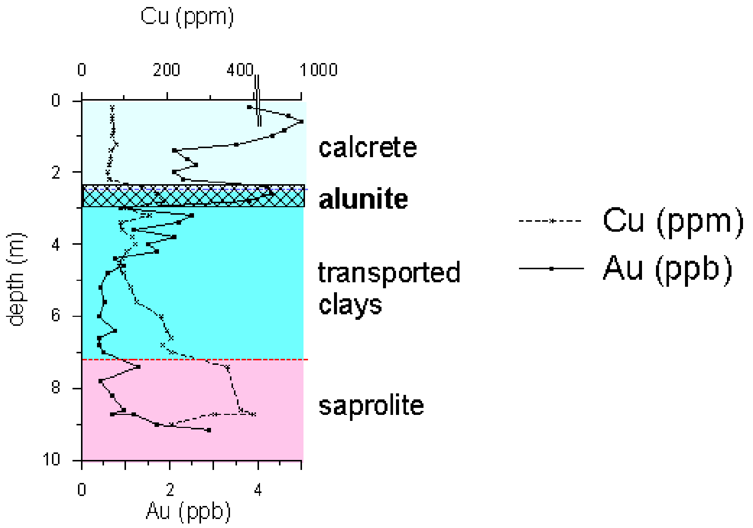
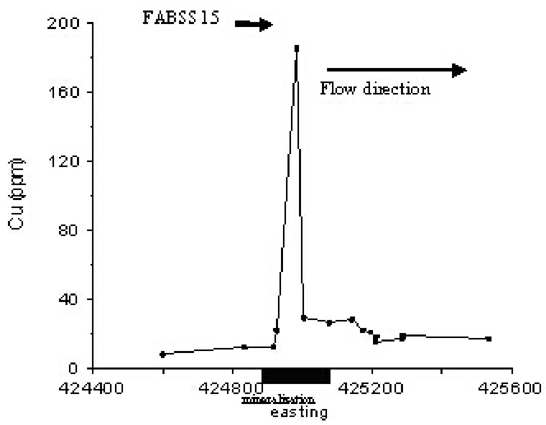


Figure 5: Copper and gold concentrations in profile at Poona Copper Mine after Hartley (2000).

Figure 6 (right): Distribution of Cu (ppm) in < 2 mm stream sediments, Faugh-a-Ballagh after Skwarnecki *et al.* (2001).



7. Biogeochemical methods for Au were shown to be of limited application in the Gawler Craton and are generally inferior to soil or calcrete sampling. Our understanding of the processes of metal accumulation in plants remains limited. There are several unexplained anomalies which require further testing. For Au deposit studies, associated base metals are often more reliable than Au itself, probably because they are present in higher concentrations (Figure 7).

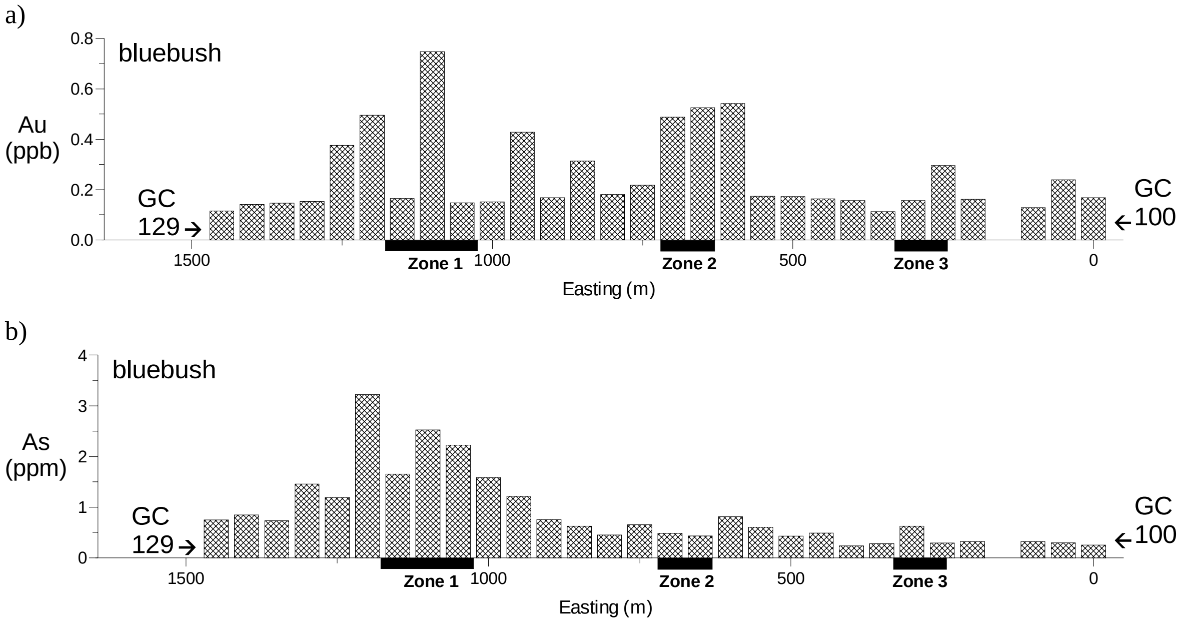


Figure 7: Gold (a) and As (b) in dry bluebush leaves and small branches over Challenger (Zone 1) (Lintern & Sheard 1999).

8. In the absence of calcrete, other sample media for geochemical exploration may be used but responses are weaker and/or more erratic. Silcrete can be used as a sample medium for Au exploration provided that it has developed within *in situ* materials (Figure 8). Soil commonly has an aeolian component, so the use of fine or coarse size fractions is recommended in order to remove its diluting effects to elements of interest. Groundwater as a sampling medium was not investigated to any great extent.

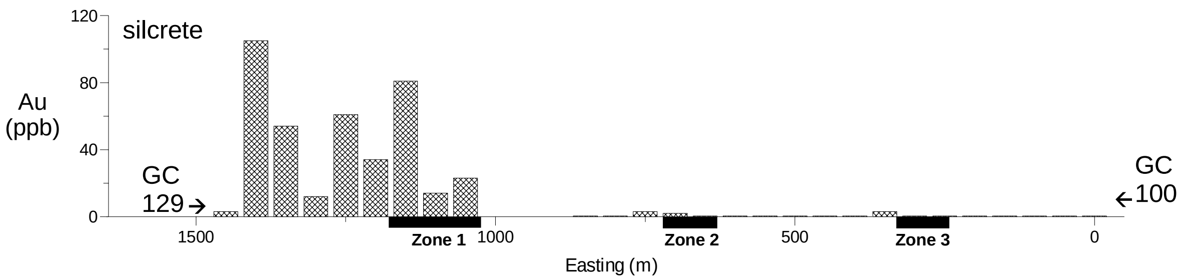


Figure 8: Gold concentration (ppb) in surficial silcrete over Challenger (Zone 1) (Lintern & Sheard 1999).

9. Although they may have some merit for investigating the nature of anomalies and how they form, partial extractions *per se* are not recommended, as conventional total extraction procedures were found to be equally satisfactory, easier to interpret and more cost-effective. However, selective extractions may indicate if it is worth targeting a particular mineral or size fraction in a sample. There are many different types of selective extraction procedures and a few were tested during the course of this project. Tests for utility in finding deeply buried Cu and Co mineralization were unsuccessful.

10. Multi-element geochemistry should be used in conjunction with an understanding of the nature of the targeted mineralization, pathfinders, and regolith sampling medium. Cost is an important consideration. For Au in the western Gawler Craton, multi-element geochemistry was of limited use since mineralization was not generally associated with high concentrations of pathfinder elements such as As or Cu. Furthermore, the paucity of Fe-rich regolith materials, such as lateritic duricrust or ferruginous lag, meant that these metal-scavenging materials cannot be used systematically in an exploration program.

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