REGOLITH-LANDFORM MAPS ARE AN ESSENTIAL TOOL FOR INTERPRETING REGOLITH GEOCHEMISTRY: THE WHITE DAM, SA, EXPERIENCE

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INTRODUCTION

Results from an integrated study utilising regolith-landform (R-L) mapping, biogeochemical and geochemical sampling and surface dispersion vector mapping at the White Dam Au-Cu mineralisation has highlighted significant regolith and landform effects on the dispersion and residence of chemical elements in the landscape.

White Dam was chosen as the study site for the reasons that the mineralisation is poorly expressed in existing company assay results and that most of the mineralisation essentially occurs under transported cover. The techniques used in this study have been able to significantly improve the detection of Au and Cu with respect to mineralisation, especially in areas of transported cover.

The integration of the assay results within a detailed (1:2,000) R-L map provided the framework for the identification of landform effects on the assay results and allows for greater confidence in the interpretation of geochemical and biogeochemical data. It is disappointing that many exploration companies continue to explore in regolith-dominated terrains without the framework of a good quality regolith-landform map because, without one, the potential to interpret the geochemical survey data is not being fully realised.

BACKGROUND

Mineral Exploration History

Aberfoyle Resources’ discovery of relatively high Au contents in soils at the area now known as White Dam was the culmination of a regional airborne magnetic survey and reconnaissance soil survey of parts of the 300 km^2 of regolith-dominated terrain on the western margins of the Mundi Mundi Plains. Soil sampling was conducted on a 1 km spaced grid, using airphotos for location control, and samples were collected preferentially at sites at the base of slopes (McGeough & Anderson 1998). Subsequent 400 m grid sampling in the White Dam area generated a number of anomalous Au results, however, poor correlation with an adjacent magnetic target resulted in the postponement of follow up work on the site until 1994-95 when MIM entered into a joint venture agreement with Aberfoyle Resources and Newmont.

MIM embarked upon a more detailed exploration program at White Dam and other sites with 'anomalously' high Au assays obtained in the Aberfoyle reconnaissance soil surveys. MIM's geochemical sampling strategy at White Dam used 100 m line spacing and involved two main techniques:

1. in areas of subcrop or shallow outcrop on erosional rises, a –80 mesh sample was collected; and,
2. in depositional areas a 3 kg bulk sample was collected for Bulk Leach Extractable Gold (BLEG) analysis.

Based on promising geochemical results, MIM Exploration drilled five RC percussion holes in December 1996. Due to extensive flooding in the Olary area, further drilling was postponed until May 1997 when a further 6 RC holes and a number of HG cores were drilled. Subsequently a detailed drilling program was commenced and over 130 RC percussion holes and NQ diamond cores were drilled at White Dam.

Drilling delineated a substantially larger orebody than indicated by geochemical surveying. As little as 1 m of transported regolith was enough to mask significant underlying bedrock mineralisation. This was in part attributed to varying regolith conditions across the prospect (McGeough & Anderson 1998), and led to the question as to why White Dam does not have a better geochemical surface signature.

Recent drilling by Polymetals and EXCO Resources has led to the excavation of 6 costeans for the collection of metallurgical samples for column leach test work and has also provided excellent exposures of the mineralisation system (Cooke 2003) and overlying regolith profiles.

MINERALISATION SETTING

The mineralisation is hosted in biotite-quartzofeldspathic gneiss of the Wiperaminga Subgroup of the

Palaeoproterozoic Willyama Supergroup. The Au resource contained within an extensive stockwork of pyrite and chalcopyrite veins (Cooke 2003). Sulphide minerals are oxidised above an asymmetric weathering profile which extends up to 50 m deep towards a major N-S trending fault to the west of the mineralisation. Au is concentrated in the oxidised zone corresponding with biotite-rich selvedges and leucocratic bands and veins within the gneiss (Cordon 1998, Cooke 2003). Compared with other Au-Cu prospects in the district, White Dam has relatively low Fe contents and does not show elevated levels of As, Ag, Ni, Cd, Sb or Pb (Cordon 1998).

Although the transported regolith overlying mineralised saprock is less than 4 m deep, much of the mineralisation was not detectable by the previous soil geochemistry. As much as two thirds of the mineralisation is overlain by transported cover, however only one soil sample showed relatively high Cu and Au assays through the transported cover. Instead, high Au assays from soils were related to a sub-cropping weakly mineralised 'tail' of the mineralisation. Other high Cu and Au assays from soils within the area were also drilled however they were found to overlie unmineralised bedrock.

WHITE DAM REGOLITH-LANDFORM SETTING

The White Dam mineralisation occurs within a landscape with subdued topography and limited bedrock exposure. The area is within the upper Mingary Creek catchment, which is a part of the greater Lake Eyre Basin, but in this case flows into the Strzelecki Desert dunefield south of Lake Frome. Alluvial and sheetflow depositional plains and low rises occur across much of the mineralisation, which is bounded to the north and west by an alluvial channel flowing to the north and north-west. The transport of surface materials in the area is dominated by shallow overland flow (dominated by sheetflow), which occurs across much of the landscape. Alluvial sediments are most significant along the creek channel and associated alluvial plains, while aeolian sediments are at least a widespread component of most regolith materials. Limited exposures of weathered bedrock flanked by mixed sheetflow and aeolian sediments occur within low hills to the north and low erosional rises to the south

The vegetation at the site is mostly part of a chenopod shrubland, dominated by bladder saltbush (*Atriplex vesicaria)* and black bluebush (*Maireana pyramidata*), and some pearl bluebush (*Maireana sedifolia*). Rosewood trees (*Alectrylon oleofolius*) occur sporadically near bedrock exposures and regolith carbonate accumulations (RCAs), while belah (*Casuarina pauper*) occurs on some alluvial plains and fans.

EXPLORATION CHALLENGES

The previous exploration in this area raised several major concerns for further exploration programs in these landscapes:

1. Although transported cover is less than 4 m thick, the mineralisation signatures in the soil samples were only restricted to areas with sub-cropping mineralisation. The shallow transported regolith that obscured previous exploration expressions of buried mineralisation is widespread across the region, and has therefore potentially been a major impediment to previous exploration success;
2. A number of 'false anomalies' were obtained during the soil sampling program that later drilling showed were underlain by unmineralised bedrock; and,
3. The magnitude and dimensions of the area of relatively high Cu and Au assays did not correspond with the grade and extent of the mineralised zone within the underlying weathered bedrock.

METHODS

1:2,000 Regolith-Landform Mapping

The 1:2,000 regolith-landform map required field mapping to delineate subtle, yet significant, changes in the regolith and landforms over the known mineralisation and adjacent areas. The compilation of the 1:2,000 map was completed with the assistance of base maps produced from the colour digital ortho-imagery, however, due to the scale used and the 1.25 m pixel size of the ortho-imagery, only the most prominent features are actually observable on the basemaps. To counteract this problem the base maps included a coordinate grid, and a GPS was used to locate all field features and record them accurately on the grided base maps. The GPS units generally reported 4 m horizontal accuracy during the compilation of the 1:2,000 maps.

Field mapping at 1:2,000 requires careful attention to variations in the regolith materials, landscape position, vegetation present and changes in the nature of surface lags. Mapping of the landforms also required careful examination of the landscape, especially in the areas of low-lying topography in the centre of the mapping area. In some cases the change in elevation between units was in the order of tens of cms, and care had to be taken when assigning unit boundaries. Mapping of landforms was assisted by marker stakes from pre-drilling surveying by MIM, with differential GPS elevations recorded on the stakes in a 50 m grid over much of the mapping area. Due to the use of differential GPS, these elevations are accurate between mm to cm depending on survey procedure.

Although more time consuming, the level of detail (> 6 m wide polygons) gives improved confidence in defining the landscape context for existing geochemical data and the reinterpretation and subsequent ranking of surface geochemistry 'anomalies'.

Litter Dams

A new approach to measuring surface dispersion vectors has been developed at White Dam (Brown & Hill 2003). The use of 'litter dams' has allowed for the mapping of surface dispersion vectors to accompany detailed (1:2,000) regolith-landform mapping, and can be used as a tool in interpreting geochemical results in areas of shallow transported cover and subdued topography.

'Litter dams' are collections of surface organic fragments including leaves, twigs and macropod droppings that have been dispersed and accumulated due to shallow overland water flow (predominantly sheetflow). They mostly exhibit a curved, convex down-slope form, occur on a range of landforms and have previously been described from a variety of climatic settings ranging from tropical to arid zones, on steep to very gentle slopes and may be ephemeral or remain stable for more than a decade (Eddy *et al*. 1999, Koop 2001). The main controlling factors on 'litter dam' formation are slope gradient, litter supply and rainfall event intensity. The main control on the orientation of the convex down slope shape of the 'litter dams' is slope gradient and subsequent surface water flow direction. At White Dam, 'litter dams' are tens of cm to 1 m long. Litter dams are sensitive to subtle slope changes, and therefore to subtle variations in micro-topography. These changes are important to constrain when characterising surface dispersion vectors in areas of subdued relief, as they can have a significant effect on the physical dispersion of materials across the landscape, and thus on the geochemical assay results.

Biogeochemical Sampling

Atriplex vesicaria (bladder saltbush) was selected as the biogeochemical sampling media in the area, due to its widespread distribution. Samples were collected according to the protocol of Hill (2002) and, after low temperature drying, were analysed by Instrumental Neutron Activation Analysis (INAA), Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Inductively Coupled Plasma Mass Optical Emission Spectrometry (ICP-OES) at Becquerel Laboratories, Sydney. Twigs were selected as the sampling organ due to the recent drought conditions reducing leaf availability and to avoid the high Na contents typically in the leaves of bladder saltbush which can interfere with achieving low assay detection levels for many trace metals such as Au in INAA.

Geochemical Sampling

Geochemical sampling was carried out with an emphasis on sampling a consistent medium across the prospect. Based on the 1:2,000 R-L map, and further field investigation, the uppermost 2 cm of topsoil was selected as the most consistent medium. 70 topsoil samples were collected at White Dam, on a 50 x 50 m grid. At each site any loose vegetation and large lithic debris was scraped away, and a sample was collected using a plastic scoop to minimise metal contamination. Samples consisted of the top 2 cm of soil, and approximately 2.5 kg was collected for each site.

The –75 µm fraction was selected as the preferred fraction from topsoil samples, based on an orientation survey as part of this study, and on previous work in the Olary Domain (Skwarnecki *et al*. 2001).

RESULTS AND DISCUSSION

Geochemical assays

Au and Cu assay results from the topsoil samples show a considerable improvement from the existing company data and both highlight the effect of the subtle topography and regolith materials on the expression of mineralisation.

Au was detectable in 52 of the 70 topsoil samples, with anomalous values over subcropping mineralisation and a high grade zone in the mineralisation that is overlain by 4 m of transported cover. On the topographically lower landforms to the south-west of the mineralisation Au was below the detection limit of the assay method, with the exception of some samples along Bullo Creek and adjacent alluvial fans and plains. There is, however, detectable Au in all samples to the north-east of the mineralisation. This dilution/depletion to the southwest and presence of detectable Au assays to the northeast fits well with the predominantly north to northeast dispersion mapped across the prospect via the litter dam method.

Cu was detectable in all 70 samples, with the anomalous values largely restricted to the sub-cropping mineralisation. There is evidence of dispersion down onto the large depositional plain to the northeast of the prospect. Cu shows a distinct dilution/depletion zone in the southwest, extending across the mineralisation along the CHep and CHpd4 RLUs (Figure 1) in a similar way to the distribution pattern of Au assay results.

Biogeochemical assays

Au and Cu results from the bladder saltbush twig samples highlight a number of landform effects that should be considered if embarking on and interpreting a biogeochemical survey.

Au was detectable in just 9 of the 70 samples analysed, however, the regolith-landform context for those results is of great interest. Of the 9 samples with detectable Au assays, 7 are located over or immediately adjacent to mineralisation, which include 4 of these samples located adjacent to mineralisation in the south of the area, where the mineralisation is under approximately 1 m of transported regolith. The other 3 results are located over the high-grade zone of mineralisation which is overlain by 4 m of transported regolith. The remaining 2 results are located over an alluvial plain flanking Bullo Creek and 100 m north east of the high grade zone of mineralisation on a depositional plain (CHpd3; Figure1). These are both interpreted as transported and redeposited samples. The lack of detectable Au assays in the area of subcropping mineralisation could indicate a number of factors, such as the need for a certain depth of cover to allow for biological process to make the Au available for the plant, or else that because the soil here did not contain detectable Au then the plant was growing in an Au-poor substrate. The 3 detectable Au assay results from over the high grade mineralisation zone would indicate that even where the transported regolith is at its maximum thickness, if there is sufficient Au present then the plant will incorporate it into its tissue.

Cu was present in all 70 samples analysed, and all anomalous values are overlying or adjacent to the known mineralisation. As with the Cu and Au in topsoil results, the Cu results in the bladder saltbush show dilution/depletion to the south-west of the mineralisation, and over the mineralisation on the erosional plain (CHep; Figure 1) and depositional plain (CHpd4; Figure 1). This again fits well with the evidence of materials being transported in a northeast direction across the prospect, with non-mineralised material being carried in from the southwest. Cu results where also able to highlight the zone of higher grade mineralisation, through 4 m of transported cover.

CONCLUSIONS

Although much of the White Dam prospect occurs in an area of subdued topography, there are significant regolith-landform effects displayed in the expression of mineralisation in geochemical and biogeochemical assay results. The White Dam 1:2,000 Regolith-Landform map and the field notes collected provided an important framework for the interpretation of the assay results, and allowed for the easy identification of the landscape effects on the chemistry. This extra information allows for greater confidence in the interpretation of geochemical exploration assay results from regolith and plant materials and would make it possible to devise more targeted drilling programs.

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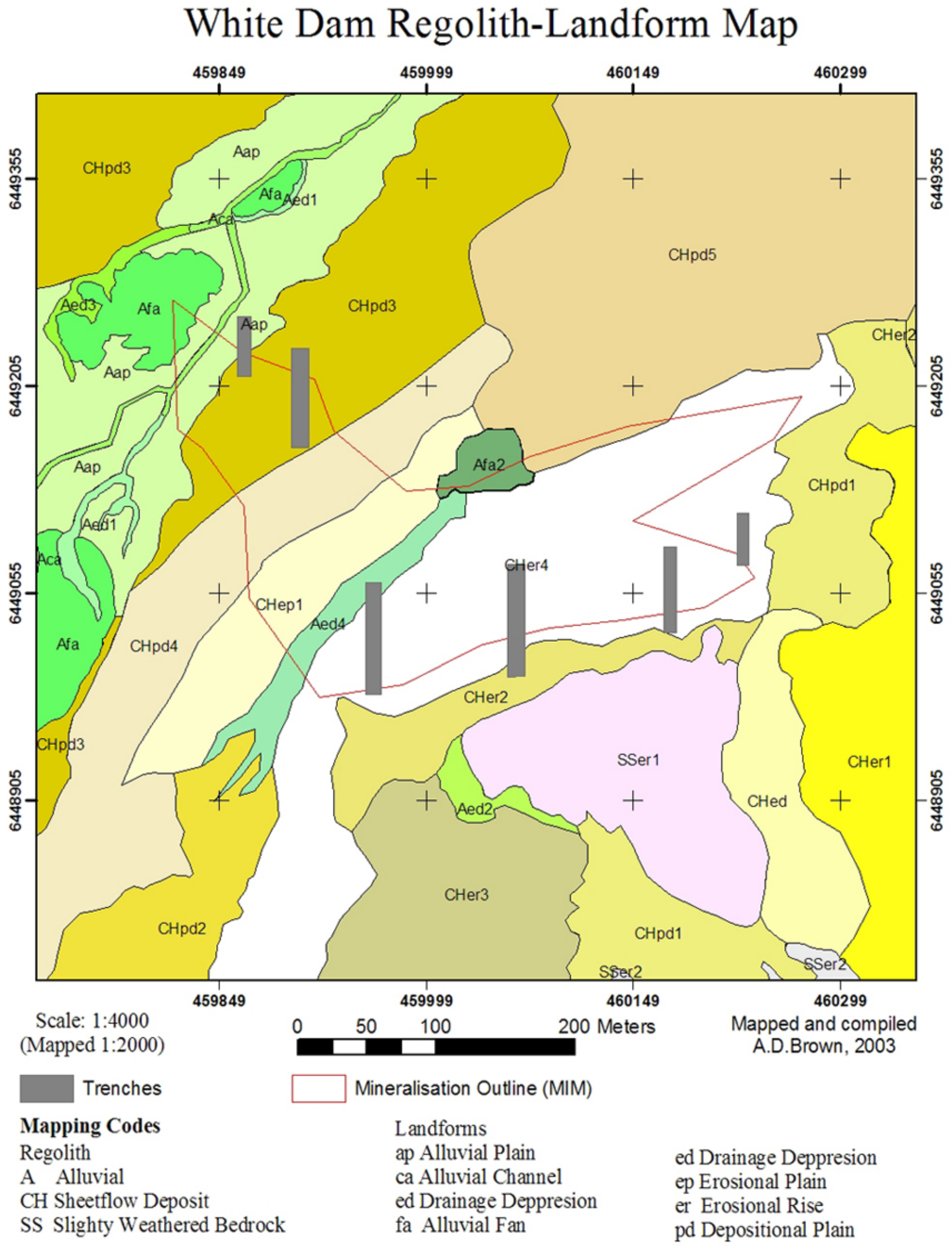

Figure 1: White Dam 1:2,000 regolith-landform map (not to scale).