GEOPHYSICAL PROPERTIES OF THE REGOLITH NEAR THE VICTORY GOLD MINE, KAMBALDA, WESTERN AUSTRALIA

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The Kambalda St. Ives Gold Mine is located in the southern part of the Norseman-Wiluna Greenstone Belt that lies within the Archaean Yilgan Craton. This area is rich in mesothermal gold mineralisation, and forms a corridor of mafic-ultramafic rocks and porphyry intrusions, which is bounded by two major NNW trending regional fault structures. These are the Boulder-Lefroy Fault to the east and the Merougil Fault to the west (Nguyen *et al*. 1998). Smaller offshoots of these large-scale features are the principle structures hosting gold mineralisation. The Sub-Audio Magnetics (SAM) response represents conductivity at depth from current channelling in the subsurface. The purpose of this study is to explain the SAM response along a single transect, while also investigating the geophysical response of the regolith using a number of different geophysical methods.

Gravity, SAM, Electrical Resistivity Imaging (ERI), seismic refraction surveying and downhole geological and geophysical logging have been used to study the geophysical response of the regolith along a key, two kilometre long transect that lies to the east of the Victory Mine. Each geophysical method has mapped the regolith to a varying degree of accuracy, and each targeted different properties of the regolith. Combined, these methods have provided quality regolith knowledge and explained the sources of the SAM responses in the East Victory area of St Ives.

ERI of the regolith was carried out using the IRIS Syscal Pro data acquisition system. The data collected provided an inverted section of apparent resistivity that proved to be an accurate representation of depth of regolith. The depths provided by the inversion were confirmed by drilling at 6 locations. The resistive, fresh bedrock depth was found to be consistent with the inversion results.

Gravity data was collected along the transect at 10 metre station spacing and was used to model the response of the lower density regolith. A gravity residual was also created in order to highlight the near-surface density anomalies. A basic regolith depth model was created from the resistivity inversion, and then the regolith response was modelled from the gravity data. The modelling was done successfully with basement and without the basement by removing a regional field.

The SAM Total Field Magnetometric Resistivity (TFMMR) current density response along the transect was modelled in ModelVision using the same polygons used to model the gravity. This achieved a good current density fit, with higher current densities being assigned in the centre of the transect and smaller densities along the edge conductors. The TFMMR data in the East Victory area was also inverted using the Grav3D program. A cut-away through the transect shows that the central conductor was successfully inverted to a depth in agreement with drilling information. The smaller amplitude edge conductors were not able to be inverted, possibly due to their smaller amplitude response, narrow width, and wider model cell size.

The SAM TFMMR response is an approximate inverse of the gravity residual along the same transect, highlighting that the SAM response is predominantly controlled by depth of weathering. This is also highlighted in the comparison of the SAM response with the ERI section. Figure 1 shows the SAM EQMMR 1VD response with a gravity residual response as it relates to the ERI apparent resistivity inversion and drilled depths of regolith. SAM highs predominantly correspond to deep regolith sections, and SAM lows predominantly correspond to shallow regolith sections.

The six holes drilled along the transect were all logged for downhole conductivity. All holes were found to be highly conductive, with peak conductivities ranging from 1,200-2,700 mS/m. From the conductivity logging, it is noted that the conductivity in this area is not the main control on the SAM response, where as depth of weathering and width of deep weathering zones have a greater influence on current density.

Collection of seismic refraction data was previously carried out to image features in the basement, with only a 2 km section of the collected data used in this study. The refraction data from static corrections was incorporated into a tomographic velocity inversion. The tomographic velocity inversion did not define the regolith as well as the other geophysical methods used in this study. It was found to provide more of an average depth of weathering, and also to have over estimated the depth of weathering by a factor of approximately 2. The seismic acquisition parameters were low frequency and not optimal for resolving the regolith.

Integration of all the methods used in the study provided a detailed knowledge about the geophysical responses of the regolith along the transect. The SAM response in the East Victory hypersaline area was found to be primarily controlled by depth of weathering, with changes in conductivity being a lesser control. It is shown for the first time that SAM maps out geological structures primarily coincident to deep weathering.

SAM 1VD, Gravity residual, ERI inversion with drilled depth of regolith

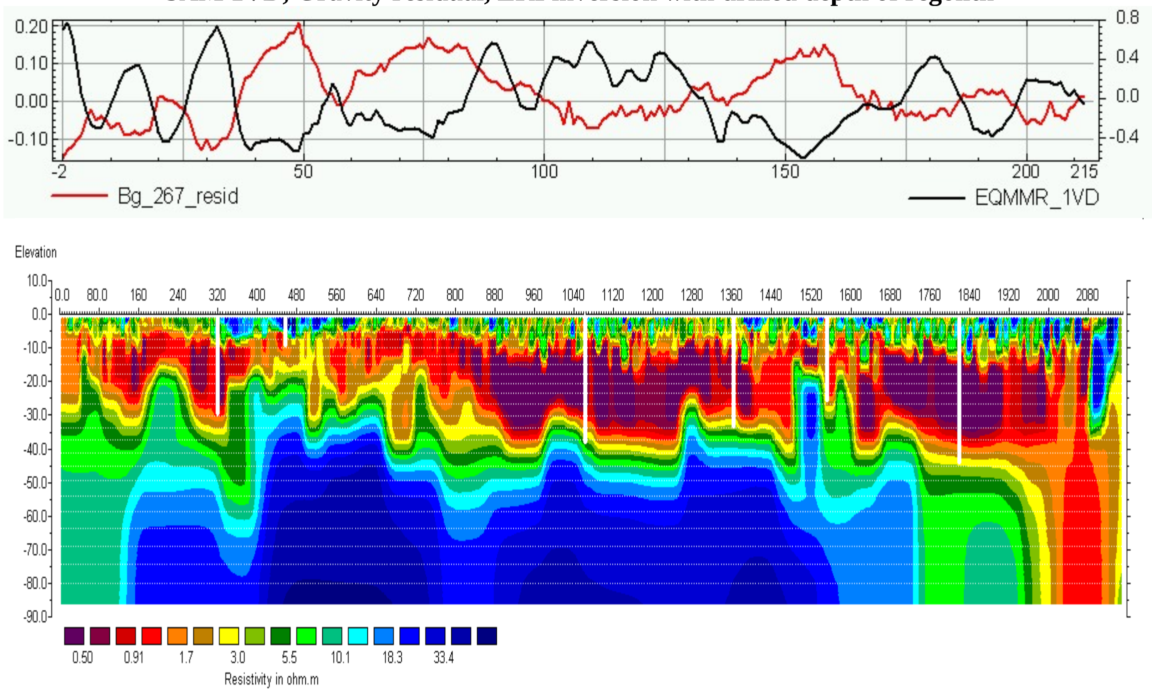

Figure 1: Profiles of SAM TFMMR 1VD and residual gravity (top), and ERI resistivity depth inversion (bottom) with drillhole locations to fresh bedrock (white bars).

REFERENCES

NGUYEN P.T., DONALDSON J.S. & ELLERY S.G. 1998. Revenge gold deposit, Kambalda. *In:* BERKMAN D.A. & MACKENZIE D.H. eds. *Geology of Australian and Papua New Guinean Mineral Deposits*. The Australasian Institute of Mining and Metallurgy **Monograph 22**, pp.233-238.