The Geophysical Response of the Tusker Gold Deposit, Lake Victoria Gold Fields, Tanzania.

Karen Pittard
Barrick Gold Corporation
kpittard@barrick.com

Barry Bourne*
Barrick Gold Corporation
bbourne@barrick.com

SUMMARY

The Tusker gold deposit is located in the Lake Victoria Goldfields of Tanzania. The deposit contains total estimated resources of 123.27 Mt at 1.15g/t Au, as at 5th September, 2006. Geophysical techniques trialled over the deposit include down hole measurements, airborne time domain electromagnetics, dipole-dipole induced polarisation and resistivity and airborne magnetics.

Petrophysical measurements suggest the deposit is associated with a conductive and chargeable signature. This is confirmed by airborne EM and dipole-dipole IP and resistivity data. Magnetic data map the unmineralised magnetic mudstone package overlying the deposit, and show that stratigraphy is deformed.

Key words: down hole, geophysics, induced polarisation, Lake Victoria Goldfields, magnetics, resistivity, sulphides, Tanzania, time domain electromagnetics, Tusker, VTEM.

INTRODUCTION

The Tusker gold deposit is located in the Lake Victoria Goldfields of Tanzania, approximately 60km SSW of the town of Mwanza (Figure 1). The deposit has total estimated resources of 123.27 Mt at 1.15g/t Au for 4.54 million ounces of gold (ASX release, 5th September, 2006). Gold mineralisation within the deposit is closely associated with sulphides. Geophysical data acquired over the deposit has included petrophysics (down hole logs and core measurements), airborne time domain electromagnetics (EM), airborne magnetics and dipole-dipole induced polarisation (IP) / resistivity.

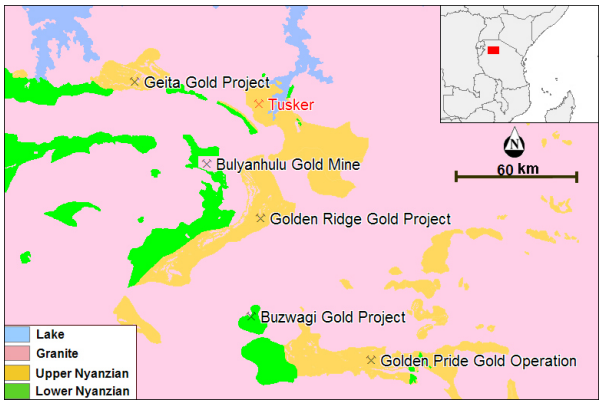

Figure 1 – Location of the Tusker Deposit, Tanzania

GEOLOGY AND MINERALISATION

The Tusker deposit is hosted within a package of Archaean east-dipping clastic metasedimentary rocks ranging from mudstones to conglomerates. Mineralisation is preferentially hosted in siltstones and fine-grained sandstones. The unmineralised stratigraphy covering mineralisation in the western part of the deposit comprises a sequence of finer grained mudstones and siltstones which are typically magnetic. The contact between unmineralised and mineralised stratigraphy is lithological. The main Tusker zone trends north-south and is sub-vertical in orientation. Sulphide stringers and replacements are dominated by pyrite-pyrrhotite. Arsenopyrite generally correlates with elevated gold grades (>1g/t Au). The system is dominated by broad low-grade mineralised zones, with minor intervals of >5g/t Au, and sporadic and isolated bonanza intercepts (>100g/t Au) associated with visible gold (Dobe, 2005).

LABORATORY MEASUREMENTS

Down-hole density, magnetic susceptibility, conductivity and gamma data were acquired on five holes within the Tusker project, including NYZRCD029 shown in Figure 2. Down hole logs for this hole are shown in Figure 3. In this hole, high conductivities at ~185m, 230m and 340m depth correlate with anomalous gold values. Density is also elevated in these zones suggesting the presence of sulphides. Conversely, elevated conductivity and density readings do not correlate with gold at 390m depth. This suggests that while conductivity may be used as a tool to locate sulphides, there may not always be gold present with sulphides. Further, high gold assays at 170m depth are not correlated with density or conductivity highs, suggesting gold may be present in the absence of abundant sulphides and a conductive signature.

Petrophysical measurements were performed by Systems Exploration on samples from drillholes NYZRCDD032 and 126. Table 1 contains results and Figure 2 shows the location of these drillholes. Sample 17 shows elevated conductivity (EM and galvanic), magnetic susceptibility, density and chargeability compared with other samples. Visual examination of this sample reveals abundant fine-grained pyrrhotite and minor cubic pyrite. Figure 4 shows the location of three petrophysical samples down hole against gold assays, lithology and magnetic susceptibility measurements. This figure shows that sample 17 was taken from within the mineralised zone.

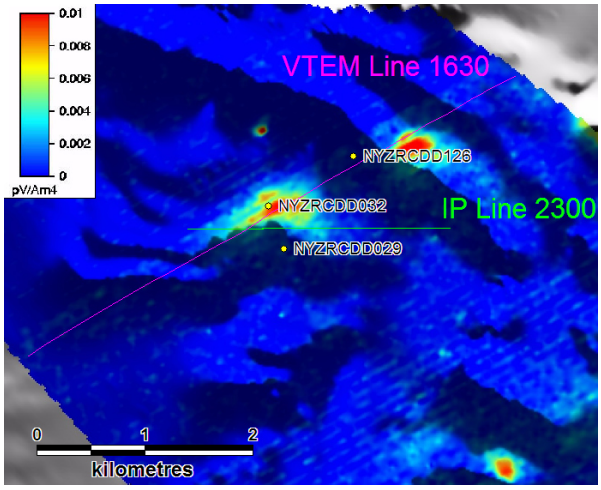

Figure 2 – Location of selected drill collars against VTEM late time channel data and the greyscale first vertical derivative (1VD) of Reduced to Pole (RTP) airborne magnetic data.

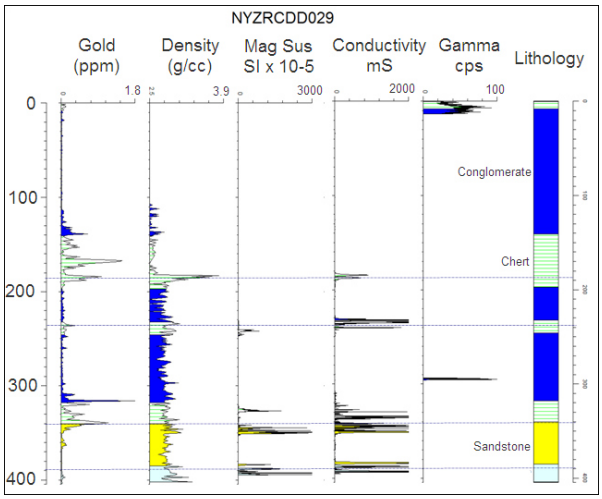

Figure 3 – Down hole geophysical logs for drill hole NYZRCDD029

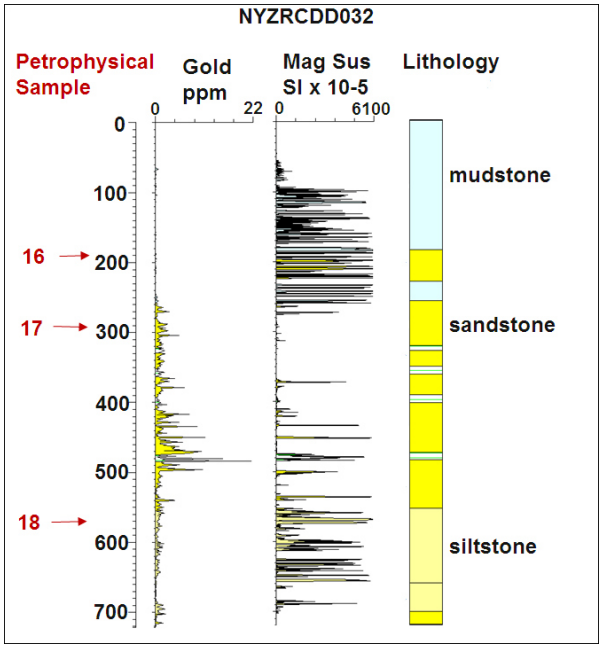

Figure 4 – Gold assays, magnetic susceptibility, and lithology logs for drill hole NYZRCDD032, showing the location of samples taken for petrophysics.

#	Drillhole NYZRCDD	Gold ppm	Depth m	Lithology	Mag Sus SIx 10^{-5}	WBD g/cm^3	apparent EM cond. S/m	Galvanic Res. ohm m	IP ms
16	32	0.005	189.75	Sandstone	89 263	2.90	→ 0	68323	66
17	32	0.75	290.0	Sandstone	2229 1122	2.93	23 - 200	2.3	221
18	32	0.42	569.9	Sandstone	189 128	2.77	→ 0	60044	34
22	126	0.005	176.35	Sandstone	8 3	2.70	→ 0	11053 12770	8 13
23	126	0.005	164.6	Mudstone	18 14	2.77	→ 0		

Table 1 – Petrophysical measurements performed by Systems Exploration.

GEOPHYSICAL SURVEYS

Airborne Time Domain EM

Geotech Airborne Limited acquired helicopter Versatile Time domain EM (VTEM) data over the Tusker deposit in August 2006. Data were acquired at 50m line spacing over an area of 44 km^2. Flight direction was 060˚, perpendicular to the dominant strike of geology, and the EM bird height was 32m. Thirty measurement gates were used in the range from 70us to 8900us (Geotech, 2006). Figure 5 shows late time channel data over the first vertical derivative of airborne magnetic data.

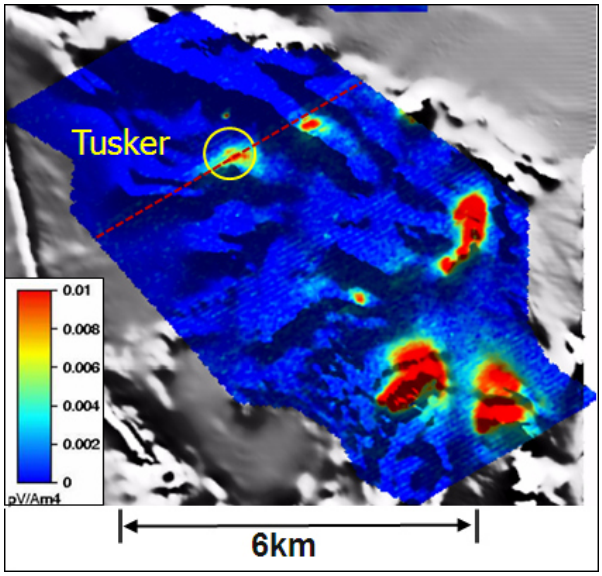

Figure 5 – VTEM late time channel data (channel 30: 8900us) displayed over the greyscale 1VD of RTP airborne magnetic data. The location of line 1630, on which an inverse model was run, is shown in red.

An inverse model was performed on line 1630 of the survey using University of British Columbia (UBC) software EM1dTM. A 28 layered earth model was used, increasing in thickness from surface to depth approximately logarithmically: the first layer was 5m thick and the deepest layer was 232m thick. A starting model of 0.04 S/m and a reference model of 0.0002 S/m was utilised.

Data were provided by Geotech in units of pV/Am^4. To convert to uV (required by the inversion software), data were multiplied by the dipole moment of the receiver by the dipole moment of the transmitter.

The inversion result is shown in Figure 6, along with gold plotted down hole. The inversion images the deposit geometry well, which is capped by a less conductive mudstone package.

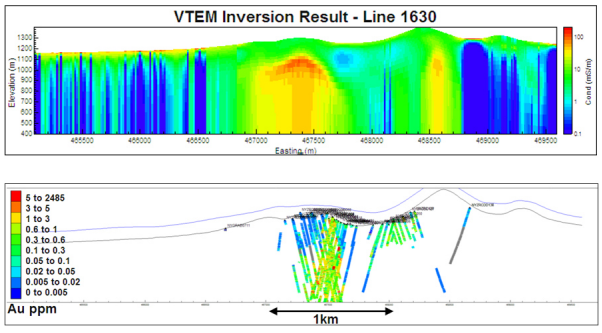

Figure 6 – UBC inversion result for line 1630 of VTEM data. The top pane shows the inverted model, and the bottom pane shows drill holes through the same section, with gold assays displayed in colour.

High conductivity values in the inversion which spatially correlate with mineralisation are supported by the high measured EM conductivity of sample 17 discussed previously. This sample contained fine grained pyrrhotite and was taken from within Tusker mineralisation

Airborne Magnetics

Airborne magnetic data were acquired over the project in March 2004 at 75m line spacing and 40m terrain clearance. The second vertical derivative of reduced to pole magnetic data is shown in Figure 7. The magnetic data map the magnetic mudstone / siltstone package, and show that stratigraphy has been deformed. The data also suggest that Tusker is at the intersection of a SE stratigraphic discontinuity, NS fault and NE fold and fault axis.

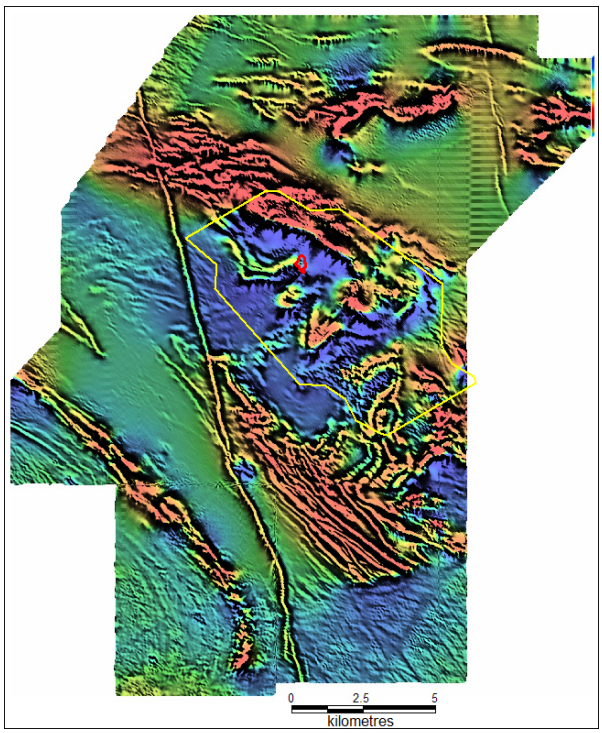

Figure 7 – RTP airborne magnetic data (colour) displayed over the second vertical derivative of RTP data (greyscale). The location of the VTEM survey is shown in yellow, and the location of Tusker mineralisation is shown in red, for reference.

Dipole-dipole Induced Polarisation and Resistivity

Approximately 60 line km of 50m dipole-dipole IP and resistivity data were acquired proximal to the Tusker deposit throughout 2001, 2005 and 2006. Figure 8 shows a depth slice of inverted IP and resistivity data and Figure 9 shows smooth model inversions of data for a line transecting the Tusker deposit. The Tusker deposit exhibits a high chargeability response in dipole-dipole data. This high chargeability response is consistent with the petrophysical measurements discussed previously.

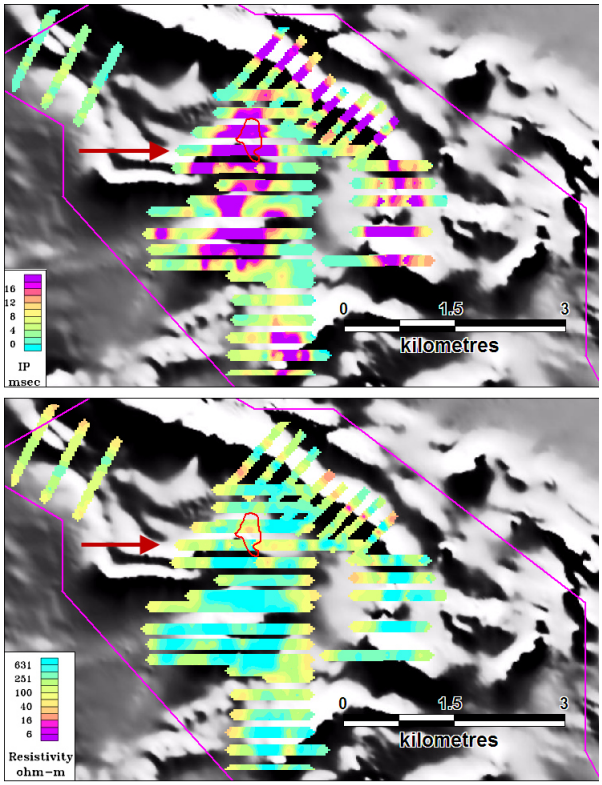

Figure 8 - Depth slices of inverted IP (top) and resistivity (bottom) data displayed against the first vertical derivative of RTP airborne magnetic data. The red arrow shows the location of the section shown in Figure 9.

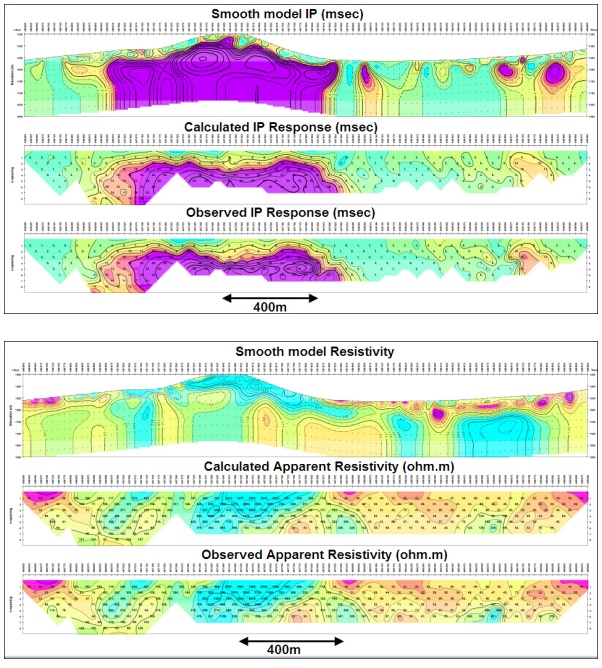

Figure 9 – Smooth model unconstrained inversions of IP (top) and resistivity (bottom) data. Both panes show, from top to bottom: inversion results, forward modelled data, and field data. Colour scales are the same as given in Figure 8.

DISCUSSION

A range of geophysical data have been acquired over the Tusker deposit in the Lake Victoria Goldfields in Tanzania, including petrophysical measurements, airborne time domain EM, airborne magnetics, and dipole-dipole IP and resistivity.

Down hole petrophysical data show conductive highs coincident with elevated densities (suggestive of sulphides) and anomalous gold values. Petrophysical measurements on core show elevated conductivity, density, and chargeability readings on a mineralised sample.

VTEM late time channel data show a conductive anomaly coincident with the Tusker deposit. An inversion of VTEM data through the deposit also shows a conductive anomaly coincident with mineralisation.

Airborne magnetic data map the magnetic mudstone package, show that stratigraphy has been deformed, and suggest the Tusker deposit lies at the intersection of a SE stratigraphic discontinuity, NS fault and NE fold and fault axis. Dipole-dipole IP and resistivity data map the mineralisation as chargeable, consistent with petrophysical measurements on core.

ACKNOWLEDGEMENTS

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