Geophysical Resources & Services Pty Ltd
A.B.N. 68 107 279 327

P.O. Box 549
Sumner Park, QLD, 4074
Australia

# Carpentaria Gold Pty. Ltd.
# 2D & 3D MIMDAS Surveys
# Welcome, Mt. Success and Mt. Douglas Grids
# North Queensland, Australia
# Acquisition & Modelling Report

**March 2012**

Prepared by

**Uthai Inthisaen**

## Disclaimer

This report has been prepared in good faith with all due care and attention – It is based on the data acquired and information supplied by Carpentaria Gold Pty. Ltd.. G.R.S. Pty. Ltd. accepts no responsibility for the conclusions drawn and any consequences arising from the conclusions in this report. Any use of this report or any reliance upon this report by any person, other than the use of the whole of this report by the client is outside of its intended purpose.

## TABLE OF CONTENTS

## 1. INTRODUCTION

Geophysical Resources and Services Pty Ltd. (G.R.S.) were commissioned by Carpentaria Gold Pty. Ltd. to run surveys of both 2D & 3D M.I.M. Distributed Acquisition System (MIMDAS) Induced Polarisation (IP) near Ravenswood in North Queensland. The Welcome, Mt. Success and Mt. Douglas surveys were located 40, 55 and 70 kms NE of Ravenswood. Ravenswood is approximately 100 kilometres to the South of the city of Townsville (Figure 1).

The following sections document the survey specifications and data processing employed and provides a brief discussion of the modelling undertaken. The attached appendices contain the Digital Data, Modelled Sections, Pseudosection Plots and 2D IP Data Variable Descriptions. A description of the Chargeability Standard used is also provided.


**Figure 1. Location Map. Welcome, Mt. Success and Mt. Douglas Grids. (Images courtesy of Google Earth.)**

## 2. SURVEY SPECIFICATIONS

### *Resistivity and Induced Polarisation (IP)*

The Welcome, Mt. Success and Mt. Douglas surveys consisted of 9 x 3-line 3D grids, 10 x 2D Lines and 6 x 2D lines respectively. For all the surveys the lines were acquired using a 100m a-spacing and a pole-dipole array. A map of transmitter and receiver layouts over the survey area is presented in Figures 2 A, B and C. A summary of the survey specifications are provided in Table 1 below.

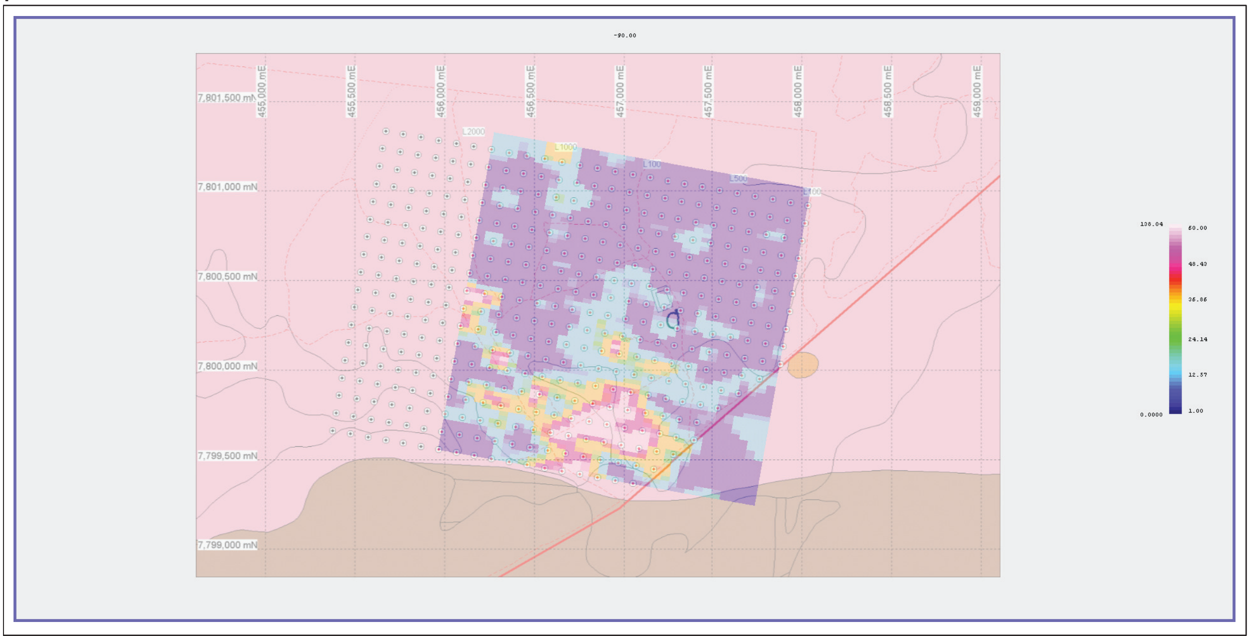

**Figure 2A: Welcome Grid with 3D Chargeability Plan (@90m depth)**

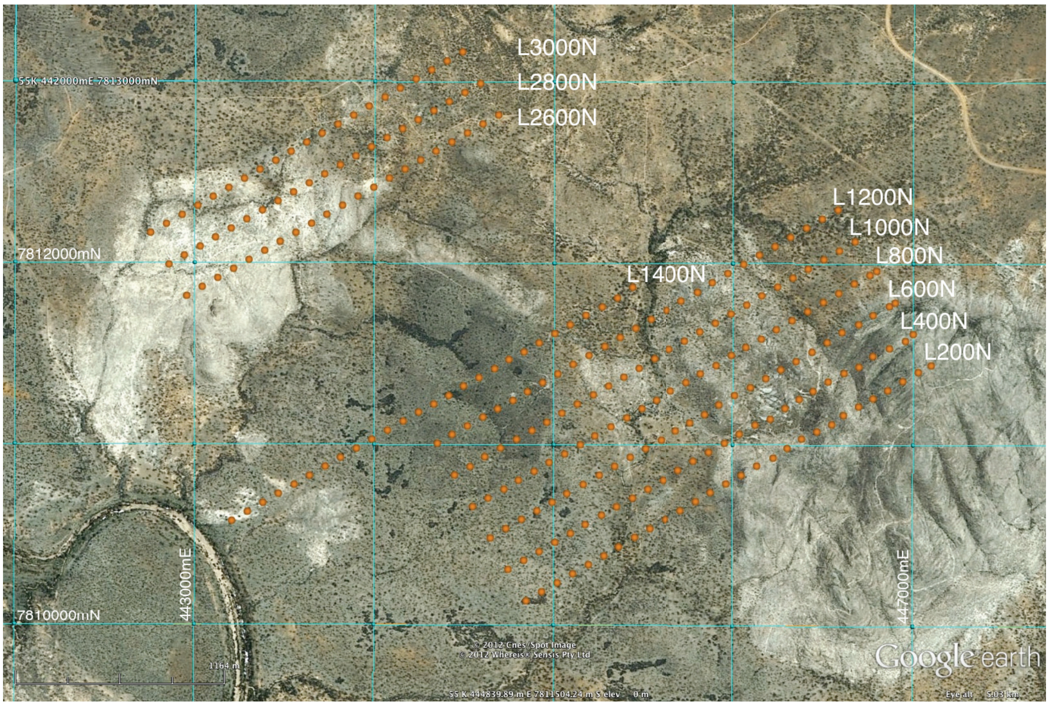


**Figure 2B: Mt. Success Lines, Golden Valley and Mt. Success. (Image Courtesy of Google Earth)**

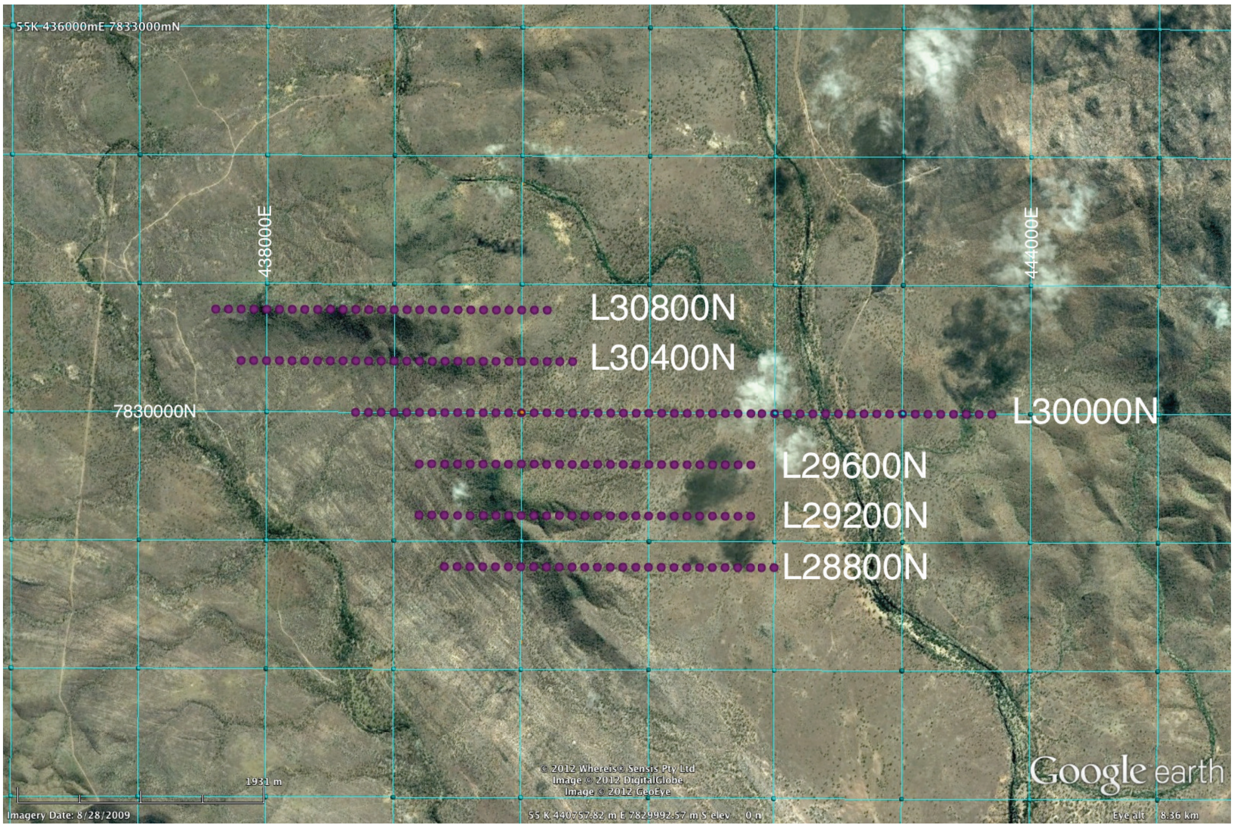


**Figure 2C: Mt. Douglas Lines (Image Courtesy of Google Earth)**

| ***I.P. Specifications*** | |
|---|---|
| Receiver (Rx) | M.I.M. Distributed Acquisition System |
| Transmitter (Tx) | Zonge GGT-10 |
| A-spacing | 100m |
| Tx Frequency | 25/128 Hz (for Welcome Grid) and 25/256 Hz (for Mt. Success and Mt. Douglas) |
| Rx Sampling | 400 samples per second |
| IP decay window | 0.25 - 1.25 seconds (Welcome)<br>0.50 - 2.50 seconds (Mt. Success)<br>0.50 - 2.50 seconds (Mt. Douglas) |

**Table 1: IP and Resistivity survey specifications.**

As is standard operating procedure for MIMDAS surveys, all potential dipoles were laid out and active for all transmitter sites along the line, resulting in readings taken synchronously on both sides of the transmitter site.[1]

For efficiency transmitter electrodes were placed midway between receiver dipoles resulting in non-integer 'n' values e.g. 0.5, 1.5, 2.5 etc.

For the 9 x 3-line 3D Grids surveyed at the Welcome Grid, all receivers were active during current transmission, resulting in a data package that consists of 1/3 co-linear and 2/3 broadside readings of primary and secondary potentials. This data can only effectively be evaluated by the use of 3D Inversion.

## 3. DATA PROCESSING & TREATMENT

The data was processed using the GRS proprietary 'Dirt-Burglar' software (note: a version of which is provided as a product of the survey with which to view or re-process the supplied time-series data). Brief descriptions of the various processing streams are provided below.

### *Resistivity and Induced Polarisation (IP)*

For the IP method, the MIMDAS system measures full waveform 'time-series' data for both the input excitation (current waveform) and received signal (voltage waveform). All 'raw' time-series data are recorded and then processed using the user controlled MIMDAS operating software 'Dirt-Burglar'. The IP processing stream applied is summarised in point form below.

*Time-Series Processing and Stacking*

- Collect time series of both the transmitted current waveform and the received voltage waveforms for all receiver sites in the array at the operator defined sampling rate and transmission frequency
- Note: In the case of the Welcome survey the current waveform was a 100% duty cycle square wave with a frequency of 25/128 Hz and for the Mt. Success and Mt. Douglas surveys the current waveform was a 100% duty cycle square wave with a frequency of 25/256 Hz, sampled at 400 samples per second
- Convert raw time series A/D counts into real units (i.e. Volts & Amps) via calibrations for sensors and individual receiver units (DAU's)
- Stack transmitted and received time series with a modified Halverson 'Linear Drift Removal' stacking algorithm. This algorithm removes DC and any linear drift.
- Note: 3 periods per stack were used at Welcome and 2 periods per stack were used at Mt. Success and Mt. Douglas.

[1] For the purposes of displaying the raw data as pseudo-sections, data collected on the western side of each transmitter site are usually displayed separately from the data acquired on the eastern side. The two data sets are referred to as the 'dipole-pole' and 'pole-dipole' data respectively

*Fourier Domain Operations*

- FFT the individual stacked data
- Calculate the frequency domain system response (i.e. received signal/transmitted signal) for individual stacks
- Optionally, selectively reject outliers
- Average the estimates, weighted by their observational errors
- Average any repeat readings, weighted by their observational errors
- Multiply the averaged system response with unit 50% duty cycle frequency response at fundamental period

*Parameter Estimation*

- Convert back to time domain, and
- Estimate the time domain normalised M.I.M. Chargeability estimation based upon a selected off-time window. (e.g. 0.25 – 1.25 seconds at Welcome, 0.5 - 2.5 seconds at Mt. Success and Mt. Douglas.

A more detailed description of the M.I.M. Chargeability Standard is provided in Appendix 4.

## 4. Data Quality

### *Resistivity / IP*

The overall data quality was high and this quality was obtained through a combination of MIMDAS selective stacking and by taking multiple readings (generally two but up to five repeats) combined with both automatic and judicious user selection of the cleanest data.

Final processed 2D pseudosections / 2D models and model fits for both 2D surveys are presented in Appendix 2. The 2D data are included on the hard disk provided in Appendix 1. The 2D data are in the standard geosoft IP format (dipole-pole and pole-dipole provided separately). At the client’s request, the data are also provided in UBC3D format. Description of the variables in the 2D data can be found in Appendix 3.

The unprocessed ‘time-series’ data are also provided. These data can be viewed and re-processed with the ‘DirtBurglar-Lite’ program. Assistance in these operations can be requested from GRS.

## 5. MODELLING

### *Smooth Model Inversion Models*

#### *2D Resistivity/IP Inversions*

The final Resistivity and IP data have been modelled using the 'UBC' 2D smooth model inversion algorithm – the details of which are provided in Oldenburg and Li (1994). Useful but less rigorous descriptions of the algorithm can also be found at the UBC 'Geophysical Inversion Facility' website at www.geop.ubc.ca/ubcgif/.

In brief the UBC algorithm defines the inversion using a typical 'smooth model' approach. That is the inversion scheme aims to produce a model minimising the misfit between the calculated and measured data whilst also minimising a second function (namely the model objective function) which contains terms describing the model structure and complexity (complexity being the opposite of smoothness). These terms can be set by the user and allows the inversion to favour an earth structure which approximates the user's knowledge of the geology. These constraints can bias horizontal or vertical structure i.e. layer cake stratigraphy or steeply dipping regimes and also can allow the user to specify a non-homogeneous seed model.

The 2D Inversions for Mt. Success and Mt. Douglas lines were run using all default options, which includes best-fitting, homogenous seed and reference models. The non-default option was the usage of a chi factor of 1.0. The final inverted sections generally fit the measured data to a level better than 5% of observed Primary Voltage (DC) and better than 0.25 mV/V on observed Chargeability. That is, the majority of 2D models converged within the assigned error floor. The 2D modelling output files are provided on the disks in Appendix 1.

#### *3D Resistivity/IP Inversions*

The final inverted Resistivity and I.P. Data for the Welcome Survey, the Southern Lines of Mt. Success ("Golden Valley" L200N - L1400N), the Northern Lines of Mt. Success ("Mt. Success" L2600N - L3000N) and the Mt. Douglas Survey was output to UBC 3D format and inverted using the UBC 3D smooth model inversion code. Details of the modelling algorithms are provided in Li and Oldenburg (2000).

Mostly all default parameters were employed for the four UBC3D models provided, except for the use of a weighting file to prevent 'spotting' of the surficial parameters, and individually chose model "length " weightings and chi factors. The weighting file increased the smoothing requirement in the East and North directions for the first 4 cell depths (diminishing with depth). Final fits to the observations of DC and IP were generally within 5% of Primary Voltage and to 0.5 mV/V of Chargeability.

The software to view the UBC model output is provided in Digital Appendix 1.
All modelling output files are provided on the Hard Disk provided as Digital Appendix 1.

## 6. REFERENCES


Oldenburg, D. W. and Li, Y., 1994, ‘Inversion of induced polarization data’, *Geophysics*, **59**, 1327-1341.

Li, Y. and Oldenburg, D. W., 2000, ‘3D inversion of induced polarization data’, *Geophysics*, **65**, 1931-1945.