BAIGENT GEOSCIENCES

KUTh Energy Limited
Central East Tasmania
Geophysical Survey
Processing Report

April 2009

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1. Datum Specification

The survey was based in Launceston in Tasmania.

The output survey coordinates are based on the Geocentric Datum of Australia 1994 (GDA94), zone 55.

It has the following parameters:

Projection name:	Map Grid of Australia
Datum:	Geocentric Datum of Australia (GDA94)
Reference Frame:	ITRF92 (International Terrestrial Reference 1992)
Epoch:	1994.0
Ellipsoid:	GRS80
Semi-major axis:	6.378.137.0 metres
Inverse flattening:	298,257222101
False Northing:	10,000,000 m N
False Easting:	500,000 m E
Scale Factor:	0.9996

2. Parallax

Parallax corrections were applied as follows:

1. 0 seconds for magnetics and elevation data.

3. Magnetic processing

3.1 Processing Flow

The diurnal base station data was checked for spikes and steps, and suitably filtered prior to the removal of diurnal variations from the aircraft magnetic data.

The diurnal data was filtered with a second difference filter to identify and remove spikes of less than 0.05nT. A second smoothing filter, a 13 point moving average filter is used to reduce noise levels.

The filtered diurnal are then applied to the survey data by synchronising the diurnal data time with the aircraft survey time. The average diurnal base station value was added to the survey data.

An eighth difference filter was run on the raw magnetic survey data in order to identify any remaining spikes in the data, which were manually edited from the data.

The X and Y positioning of the data was then checked for spikes before applying the IGRF correction. Any spikes in the positions were manually edited.

The IGRF 2005 (updated to 2009.28) correction was calculated at each data point taking into account the height above sea level using the gps altitude. This regional magnetic gradient was subtracted from the survey data points.

The data was then tie-line levelled and micro-levelled.

3.2 Compensation

The data was compensated post flight using a 16 term model based on the work done by C.D. Hardwick.

Magnetic compensation sequences were flown before acquisition commenced and after routine maintenance was performed, as required. The resulting coefficients were used for post flight magnetic compensation:

Aircraft	Date	Flight	StDev (UnC)	StDev (Cmp)	IR
VH-AQS	11/3/09	56	0.291	0.051	5.72
VH-JFH	10/3/09	5	0.260	0.062	4.22

UNC: Standard deviation of uncompensated TMI (nT)
CMP: Standard deviation of compensated TMI (nT)
IR: Improvement ratio (UNC/CMP)

3.3 Magnetic Model

IGRF was removed using the gps altitude.

The magnetic model for the centre of the area is detailed below:

Model	IGRF 2005 updated to 2009.28
Declination	14.66965 degrees
Inclination	-72.02355 degrees
Field strength	61684.06 nT
Grid zone	55
Grid central meridian	147.00000 degrees
Input latitude	-42.16729 degrees
Input longitude	147.59958 degrees
Grid convergence	0.40250 degrees
Grid magnetic angle	15.07214 degrees
Secular variation	0.01965 degrees

3.4 Diurnal Base Value

The average diurnal base value was 61,499.34 nT

3.5 Tie Line levelling Method

Tie line levelling was applied to the data by least squares minimisation, using a polynomial fit of order 0, of the differences in magnetic values at the crossover points of the survey traverse and tie line data.

The least squares tie line levelling process employs a two pass Gauss-Seidel iterative scheme. The essential steps in this process are:

In the first pass the tie lines were first adjusted to minimise, in the least squares sense, the crossover values with the traverse line values being held constant.

The second pass held the levelled tied line values constant, and minimised in the least squares sense, the crossover values with traverses.

The DC correction values to be applied to the traverse lines and tie lines were then applied to the magnetic data.

Tie line levelling was not applied.

3.6 Micro-levelling Method

Micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensity Selective micro-levelling was applied in order to leave unaffected any data having no residual levelling artefacts. Selective micro-levelling proceeds using the following steps:

Areas of interest that required micro-levelling were identified through the use of image processing visualisation.

Polygons were used to define areas requiring micro-levelling.

“Pseudo-ties” were constructed from the gridded data by extracting traverses from the grid normal to the flight direction.

Line dependent artefacts were removed from the pseudo lines using custom filters.

Crossover values were calculated between traverse lines and pseudo tie lines.

The traverse lines were adjusted in the pre-defined sections to minimise the crossover values.

This process was repeated in order to remove various wavelength line dependent artefacts from the pseudo-ties. The object of each micro-levelling iteration was to produce a smooth control surface to which the traverse lines are levelled. This control surface was provided through the use of “pseudo-ties”.

3.7 Interpolation Method

The interpolation used is a minimum curvature algorithm. The algorithm is based on the worked published by Briggs 1974, Briggs I. C.: Machine contouring using minimum curvature. *Geophysics*. Vol. 39, No. 1. February 1974. pp. 39-48.

The algorithm has been modified to include a tension parameter based on the work published by Smith and Wessel Smith, W. H. F, and P. Wessel, 1990, Gridding with continuous curvature splines in tension, Geophysics 55, 293-305.

A tension factor of 0 was used to interpolate the magnetics

The mesh size for data interpolation was 50 x 50 metres

4. Elevation Processing

4.1 Processing Flow

The processing steps for digital elevation data were as follows:

1. Application of necessary parallax corrections to data
2. Calculation of raw digital elevation data by subtracting the radar altimeter from the gps altitude
3. Tie line levelling
4. Micro-levelling
5. Adjust to AHD

4.2 Tie Line levelling Method

Tie line levelling was applied to the data by least squares minimisation, using a polynomial fit of order 0, of the differences in elevation values at the crossover points of the survey traverse and tie line data.

The least squares tie line levelling process employs a two pass Gauss-Seidel iterative scheme. The essential steps in this process are:

In the first pass the tie lines were first adjusted to minimise, in the least squares sense, the crossover values with the traverse line values being held constant.

The second pass held the levelled tied line values constant, and minimised in the least squares sense, the crossover values with traverses.

The DC correction values to be applied to the traverse lines and tie lines were then applied to the magnetic data.

To reduce the effects of radar altimeter and gps errors on the recorded elevation data at the crossover points, data having a radar altimeter difference greater than 15 metres in a radius of 50 metres on the traverse or tie lines were excluded from the tying process.

4.3 Micro-levelling Method

Micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensity Selective micro-levelling was applied in order to leave unaffected any data having no residual levelling artefacts. Selective micro-levelling proceeds using the following steps:

Areas of interest that required micro-levelling were identified through the use of image processing visualisation.

Polygons were used to define areas requiring micro-levelling.

“Pseudo-ties” were constructed from the gridded data by extracting traverses from the grid normal to the flight direction.

Line dependent artefacts were removed from the pseudo lines using custom filters.

Crossover values were calculated between traverse lines and pseudo tie lines.

The traverse lines were adjusted in the pre-defined sections to minimise the crossover values.

This process was repeated in order to remove various wavelength line dependent artefacts from the pseudo-ties. The object of each micro-levelling iteration was to produce a smooth control surface to which the traverse lines are levelled. This control surface was provided through the use of "pseudo-ties".

4.4 Adjust to AHD

N values were removed in real time in the GPS receiver.

After the data was levelled to image processing quality, the data were then adjusted to AHD.

This was achieved by using the published AUSLIG 9 second dtm data. This data was re-interpolated to the same cell size as the survey data. An area with low topographic relief, was used to mathematically get the difference between the AUSLIG data and the survey data. The difference between the two datasets was 0.66 metres. This was then added to the survey data and then interpolated to form the final data set.

4.5 Interpolation Method

The interpolation used is a minimum curvature algorithm. The algorithm is based on the worked published by Briggs 1974, Briggs I. C.: Machine contouring using minimum curvature. *Geophysics*. Vol. 39, No. 1. February 1974. pp. 39-48..

The algorithm has been modified to include a tension parameter based on the work published by Smith and Wessel Smith, W. H. F, and P. Wessel, 1990, Gridding with continuous curvature splines in tension, Geophysics 55, 293-305.

A tension factor of 0 was used to interpolate the elevation data.

The mesh size for data interpolation was 50 x 50 metres

5. Deliverable Items

The deliverable items included all digital data. The located data conformed to ASEG-GDF format and the gridded data was suppled in ERMapper format. The description of the located data is below:

Located data supplied in ASEG GDF

File name	Definition
Block1_magdtm	Final magnetics and elevation data

Gridded data supplied in ER Mapper format

File name	Definition	Units
TMI	Final magnetic gridded data	nT
Elev	Final dtm gridded data	m
TerrainClearance	Radara altimeter data	m

5.1 Final Located Data file

```
COMM
COMM  Baigent Geosciences Pty. Ltd.
COMM  -----------------------------
COMM
COMM  LOCATED DATA
COMM  -------------
COMM Area  : Bloack 1 Central East Tasmania
COMM Company Flown by:   Thomson Aviation Pty. Ltd.
COMM Company Flown for:  KUTh Energy Ltd
COMM Company Processed:  Baigent Geosciences Pty. Ltd.
COMM
COMM AIRBORNE SURVEY EQUIPMENT:
COMM -------------------------
COMM
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COMM Aircraft                          : Cessna 210 VH-AQS & JHF
COMM Magnetometer                      : Geometrics G822 Cesium  Vapour
COMM Magnetometer Resolution           : 0.001 nT
COMM Magnetometer Compensation         : Picodas, Post Flight
COMM Magnetometer Sample Interval      : 20 Hz, Approx 3.75 metres
COMM Data Acquisition                  : GeoOZ Model 2007
COMM Spectrometer                      : Radiation Solutions RS 500
COMM Crystal Size                      : 33 lt downward array
COMM Spectrometer Sample Interval      : 1.0 Seconds (approx 70 metres)
COMM GPS Navigation System             : Novatel 951R GPS Receiver
COMM
COMM
COMM
COMM
COMM AIRBORNE SURVEY SPECIFICATIONS
COMM
COMM Flight Line Direction             :    090 - 270  degrees
COMM Flight Line Separation            :          200  metres
COMM Tie Line Direction                :    000 - 180  degrees
COMM Tie Line Separation               :          2000 metres
COMM Terrain Clearance                 :       90 metres (MTC)
COMM
COMM
COMM Survey flown                      :       March 2009
COMM
COMM
COMM Flight path calculated from differentially
COMM corrected GPS Data using a Novatel 951R GPS Receiver.
COMM
COMM
COMM Grid notation refers to GDA/MGA Zone  55
COMM
COMM
COMM MAGNETIC DATA CORRECTIONS:
COMM ------------------------
COMM Diurnal variations removed
COMM IGRF(2005) updated to 200 removed
COMM Average survey base station value added to datum
COMM
COMM  Field Name                     Format         Units     Null Value
COMM
COMM  BGS Job No                    a5
COMM  Line number                   a8
COMM  Flight number                 i4
COMM  Flight date                   a8
COMM  fiducial                       f12.1                         -999999.0
COMM  mga_east                       f10.2          METRES         -99999.00
COMM  mga_north                      f11.2          METRES         -99999.00
COMM  wgs84_lat                      f12.7          DEGREES        -99.000000
COMM  wgs84_long                     f13.7          DEGREES        -999.00000
COMM  mag_gammas                     f10.3          nT             -9999.000
COMM  diurnal_gammas                 f10.3          nT             -9999.000
COMM  igrf_gammas                    f10.3          nT             -9999.000
COMM  mag_level                      f10.3          nT             -9999.000
COMM  rad_alt                        f8.2           METRES         -999.00
COMM  gps_height                     f8.2           METRES         -999.00
COMM  dtm                            f8.2           METRES         -999.00
COMM
```
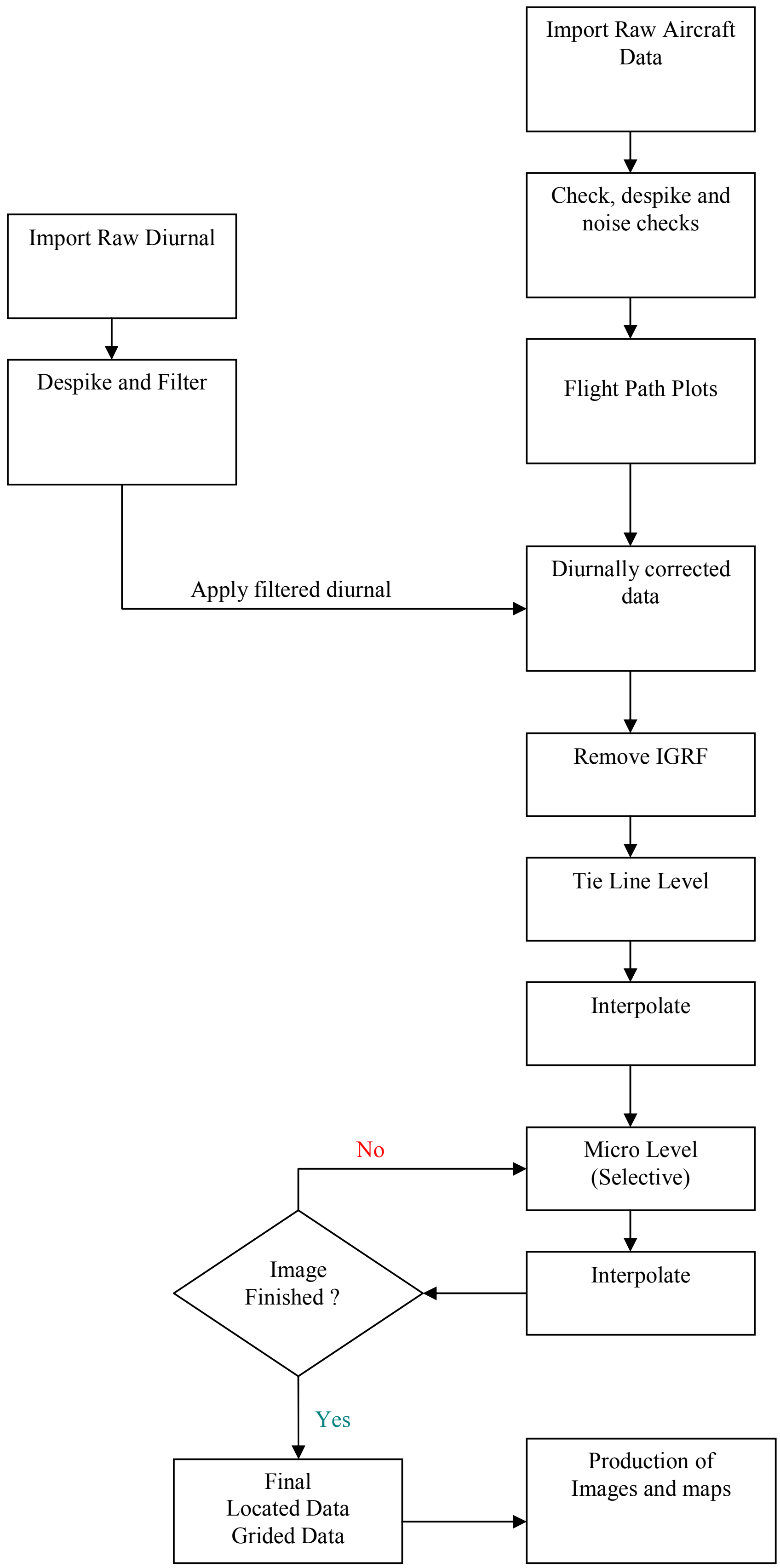

6. Magnetic Data Processing Flow Chart



7. Elevation Data Processing Flow Chart