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## **SINOSTEEL AUSTRALIA PTY LTD**

### **New Zealand North Island Iron Sands Project: Data Processing and Target Generation of Aeromagnetic Survey Data**

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# CONTENTS

	Page
<b>1 EXECUTIVE SUMMARY.....</b>	<b>3</b>
<b>2 SCOPE OF STUDY .....</b>	<b>4</b>
<b>3 LOCATION.....</b>	<b>4</b>
<b>4 AEROMAGNETIC SURVEY SPECIFICATIONS .....</b>	<b>4</b>
<b>4 DATA PROCESSING AND IMAGE GENERATION .....</b>	<b>7</b>
4.1 MAGNETIC DATA PROCESSING.....	7
4.2 RADIOMETRIC AND DIGITAL TERRAIN MODEL DATA PROCESSING .....	8
<b>5 RESULTS AND TARGETS.....</b>	<b>8</b>
<b>6 CONCLUSIONS AND RECOMMENDATIONS.....</b>	<b>19</b>
<b>7 APPENDICES.....</b>	<b>20</b>

## FIGURES

Figure 1. Location of project area aeromagnetic survey outline.

Figure 2: Waikato North (A) and Taharoa (B) titanite-magnetite deposits magnetic responses.

Figure 3: Total magnetic intensity image of the entire project area.

Figure 4: Ternary radiometric image.

Figure 5: Target outlines (Blue) TMI image.

Figure 6: Target 1 and 2 outlines over Analytic Signal TMI image and 1:250K geology.

Figure 7: Target 3 to 7 and 23 outlines over Analytic Signal TMI image and 1:250K geology.

Figure 8: Targets 8 to 11 and 22 over Analytic Signal TMI image and 1:250K geology.

Figure 9: Targets 12 to 16 and 20 to 21 over Analytic Signal TMI image and 1:250K geology.

Figure 10: Target 15 to 18 and 19 to 20 over Analytic Signal TMI image and 1:250K geology.

## TABLES

Table 1: Survey and Equipment specifications.

Table 2: Target locations.

## APPENDICES

Appendix 1: List of processed imagery and data provided with this report.

Appendix 2 : UTS Geophysics logistics report.

# 1 EXECUTIVE SUMMARY

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Resource Potentials were engaged by Sinosteel Australia Pty Ltd (SSL) to carry out processing, imaging and targeting of newly acquired aeromagnetic data over the New Zealand North Island Iron Sands Project, located on the west coast of the north island of New Zealand.

The project area is bounded by prospecting permit 39 344 which covers approximately 9400 square km, and contains the Waikato North-Head and Taharoa, Titano-Magnetite Deposits operated by New Zealand Steel.

The aeromagnetic survey was conducted by UTS Geophysics from the 9<sup>th</sup> February to 26<sup>th</sup> March 2008, and flown with east-west traverses on 200m line spacings, for a total of 55,050 line km.

Processing and imaging of the aeromagnetic data has highlighted 23 target areas prospective for titano-magnetite iron sands, of which 7 are considered high priority. Further desktop and ground investigation of the target areas is highly recommended.

This report presents a summary of the aeromagnetic data processing, imaging and targeting within the New Zealand North Island Iron Sands project area.

## 2 SCOPE OF STUDY

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The scope of the work undertaken for this project incorporated:

- Briefly review and QC the aeromagnetic data supplied by UTS Geophysics;
- Compilation and processing of the aeromagnetic data to highlight titano-magnetite mineralisation and controlling structures;
- Generation of a suite of imagery to assist in the delineation and targeting of titano-magnetite mineralisation;
- Delineation and targeting of potential large deposits of titano-magnetite mineralization;
- Provide the processed imagery and targets in suitable digital format for incorporation by SSL into their GIS software package for interrogation and statutory reporting requirements.

## 3 LOCATION

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The project area is located on the west coast of the north island of New Zealand. It is bounded by the granted prospecting permit 39 244, which starts in the north at Manukau Harbour, follows the coast south to Mokau and extends east for approximately 60km, covering a total of approximately 9400sq.km, figure 1. The area consists a range of different environments including highly populated towns, villages and farmland, as well as moderate to densely forest. The terrain is variable across the survey area, rising from sea level to 940m at Mt Pirongia.

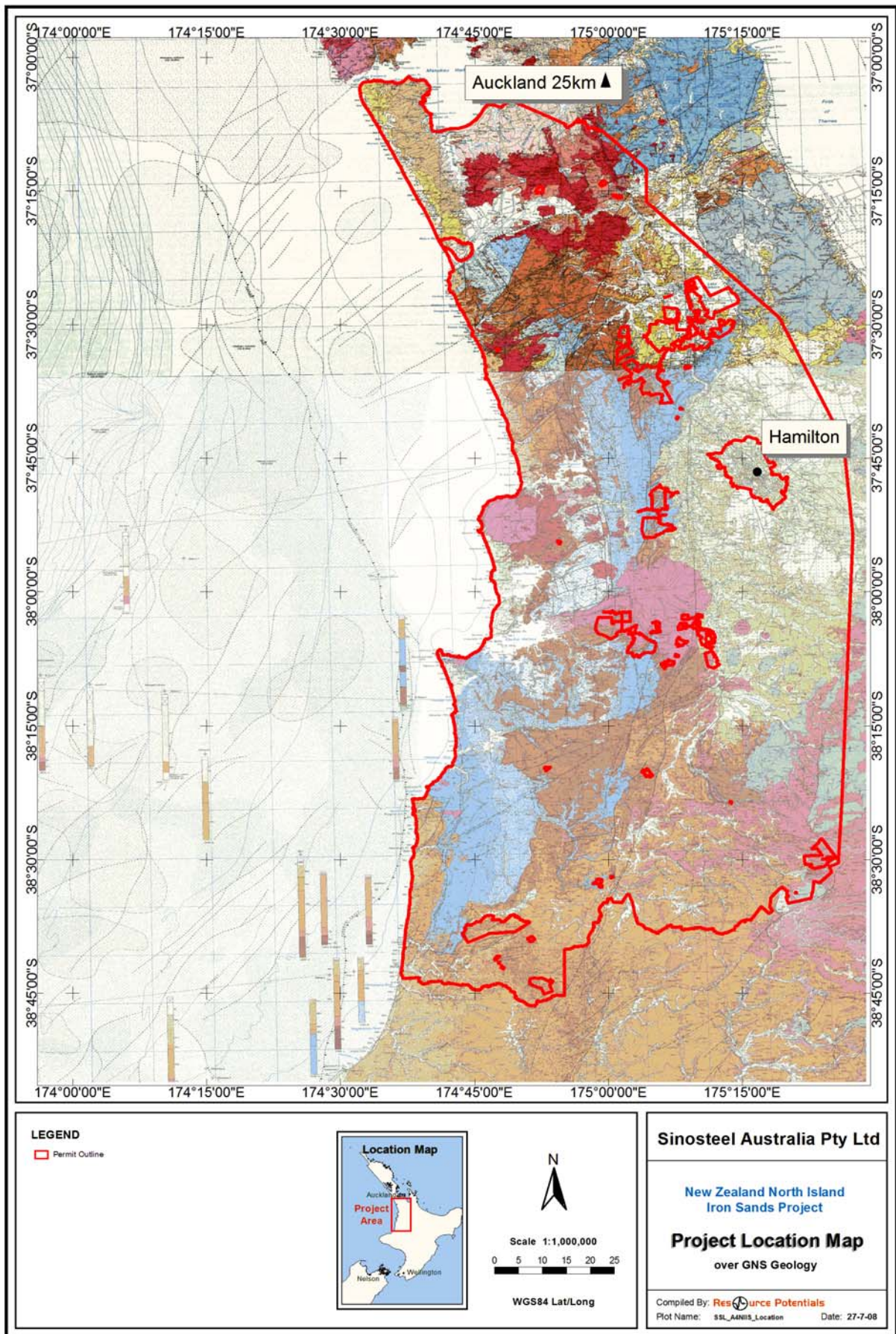
Figure 1 displays the project area location and the aeromagnetic survey outline.

## 4 AEROMAGNETIC SURVEY SPECIFICATIONS

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The aeromagnetic survey was flown by UTS Geophysics from the 9<sup>th</sup> February to 26<sup>th</sup> March 2008, using a Cresco-08-600 fixed wing aircraft. Magnetic, Radiometric and DTM data were acquired on east-west lines with 200m line spacings. Tie lines used for leveling the data were acquired on 2000m spacings, orientated north-south. A nominal survey altitude of 60m was employed for the entire survey, unless topographic relief, aviation laws or safety considerations required for variation. The survey was flown using the WGS84 coordinate system and was contained within the Universal Transverse Mercator (UTM) zone 60. A full list of the survey and equipment specifications are provided in Appendix 2.

Table 1 presents a summary of the specifications for all of the aeromagnetic surveys that fall within the project area, and highlights those used for this work.



**Figure 1. Location of project area aeromagnetic survey outline.**

**Job Details**

Flown By:	UTS Geophysics Australia
Flown For:	Sinosteel Australia Pty Ltd
Job No:	A964
Survey Type:	Magnetic, Radiometric and DTM
Survey Flown:	Feb-March 2008

**Survey Specifications**

Traverse Line Spacing:	200m
Traverse Line Direction:	090-270
Tie Line Spacing:	2000m
Tie Line Direction:	000-180
Nominal Terrain Clearance:	60m
Line Kilometres:	55050km

**Coordinates**

Datum:	WGS84
Projection:	UTM
Zone:	60S

**Survey Equipment**

Aircraft:	Cresco-08-600 (ZK-LTP)
Magnetometer:	Scintrex Cesium Vapour CS-2
Installation:	Tail Stinger
Resolution:	0.001nT
Recording Interval:	0.1sec
Spectrometer:	Exploranium GR820
Detector Volume:	32litres
Recording Interval:	1sec
Radar Altimeter:	King KRA-10
Accuracy:	0.3m
Recording Interval:	0.1sec
Navigation:	UTS Proprietary
Location:	Real Time GPS
GPS:	Novatel 3951R

**Table 1: Survey and Equipment specifications.****Cresco Survey Aircraft**



The aeromagnetic survey data consisting of magnetic, radiometric and digital terrain, were supplied by UTS Geophysics in both located and gridded data formats. The located data were imported into geophysical processing software for the purpose of quality control, verification and processing. The data was of good quality considering the terrain variation and restrictions due to cultural features such as towns and villages. The only point of note is that the final digital terrain model data included negative values.

The data included both latitude and longitude (WGS84) coordinates and projected eastings and northings (SUTM60). The data were gridded using both coordinate sets to allow for translation to the New Zealand National Grid within GIS software packages. The gridded data was then further processed to highlight and better define titanite-magnetite mineralisation, controlling structures and local lithological variations.

### 4.1 Magnetic Data Processing

Magnetic data processing included calculation of the first vertical and second vertical derivatives, automatic gain control filtering, analytic signal and reduction to the pole.

The first vertical derivative (1VD) is theoretically the rate of change of the magnetic field with increasing height. In practice it has two desirable effects. Firstly it tends to sharpen and separate magnetic anomalies. Secondly it makes the mean background level of the data equal to zero. The second vertical derivative (2VD) is essentially completing the first vertical derivative on the data twice, and is the rate of change of the rate of change of the magnetic field with increasing height. It sharpens and separates anomalies even further and is also symmetric about zero.

Automatic gain control (AGC) was performed on the vertical derivatives in order to enhance magnetic features within the dataset. It is a process whereby magnetic anomalies or features within a dataset are all reduced to similar amplitudes. This is very useful for extracting fine detail from datasets that are otherwise dominated by one or two high amplitude features, as is sometimes the case where magnetite bodies are present.

Analytic signal (AS) processing converts negative portions of magnetic response to be positive, which can be helpful where remnant magnetization is present. Mathematically it is the square root of the sum of the square of each derivative of the magnetic field in its three principal directions (X,Y,Z).

Reduction to the pole (RTP) is the correcting of the magnetic field for the inclination of the earth's magnetising field in the survey area. It theoretically removes dipolar lows in strongly magnetic bodies and places the positive highs directly over the magnetic bodies. In practice it can result in artifacts, particularly if remnant magnetization is present, however it is recommended that it is always performed on all datasets as it assists in more accurately locating drill targets.

The subsequent processed grid files were then imported into ERMMapper to generate final georeferenced imagery including sun shaded, grey scale and layered images. In addition to the imagery, contours files of the magnetic data were generated to refine the extents of magnetic responses and provide actual magnetic intensity values.

## 4.2 Radiometric and Digital Terrain Model Data Processing

Full 256 channel radiometric data was collected during the survey. This data was processed using the Noise Adjusted Singular Variable Decomposition NASVD method and corrected radon, dead time, temperature, pressure and height, as outlined in the UTS Geophysics survey report (Appendix B). The final radiometric data consisted of the windowed radioelements Potassium (K), Thorium (Th), Uranium (Ur) and Total Counts (TC). The Digital Terrain Model (DTM) was calculated by removing the corrected radar altimeter from the GPS height of the aircraft.

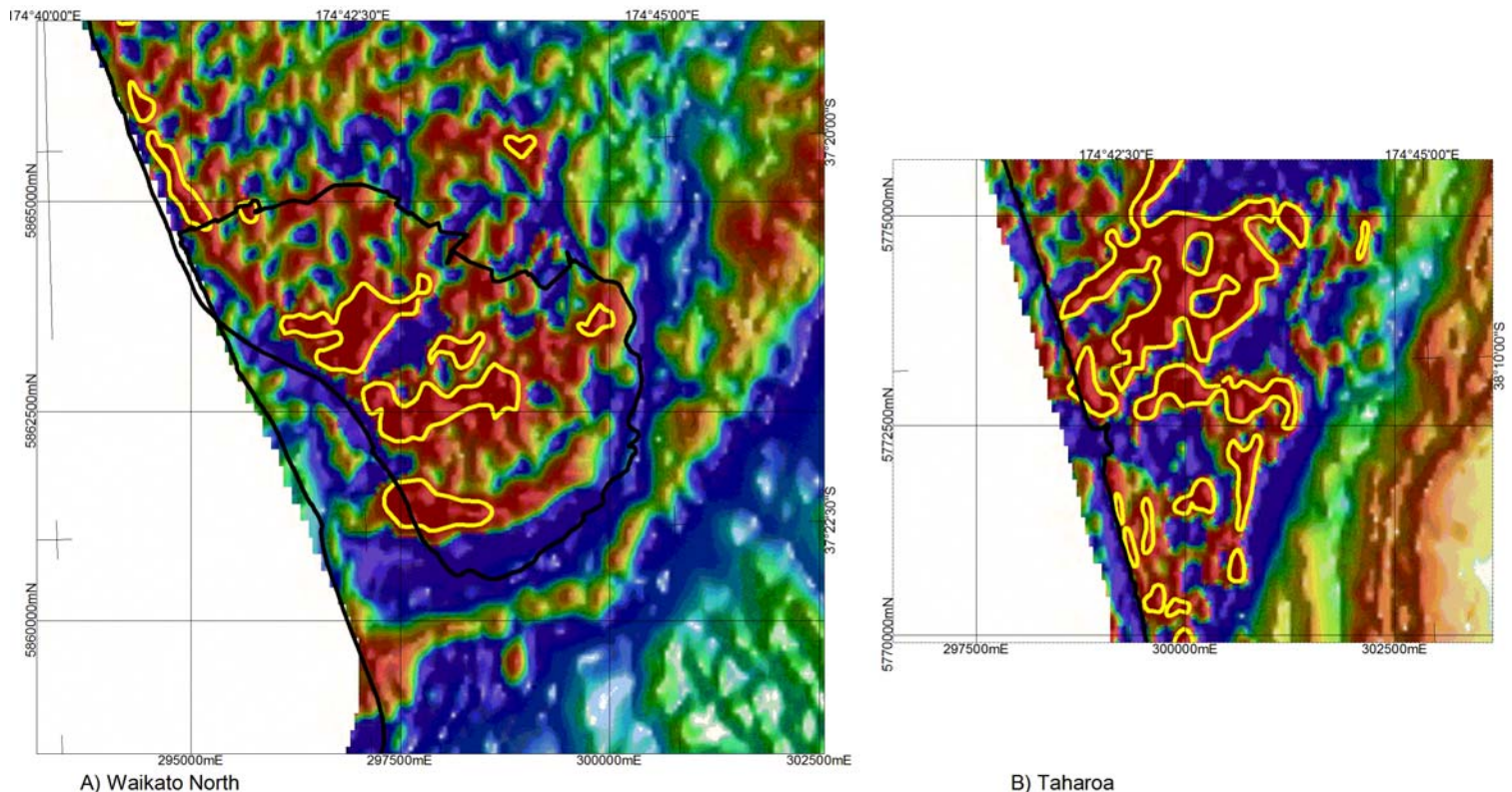
Processing and imaging of the radiometric and DTM data included generation of sun shaded, layered and pseudo coloured imagery, plus contours for every 10m height interval.

*A full list of the generated imagery and vector products have been included in the appendices.*

## 5 RESULTS AND TARGETS

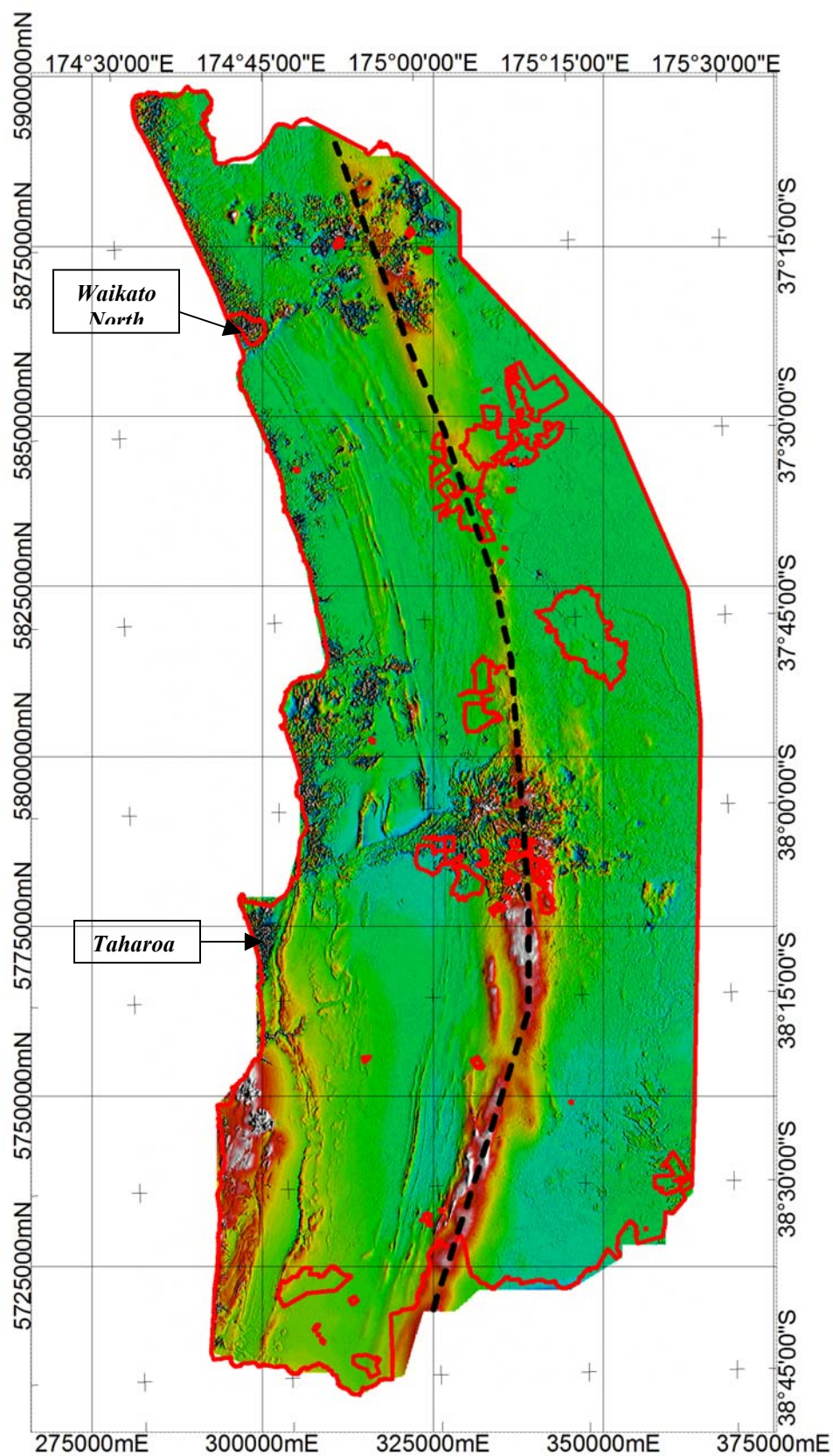
The magnetic data shows a dynamic range of approximately 6400nT, with the volcanics, iron sands and cultural features generating the majority of the highly magnetic responses within the project area including various volcanoes. The most prominent regional magnetic feature extends from south to north through the centre of the project area, figure 3. This may represent a major basement structure that controlled recent volcanic activity.

The known titanite-magnetite deposits at Waikato North and Taharoa appear as clusters of variably magnetized responses up to 3500nT but average approximately 500nT, figure 2.



**Figure 2: Waikato North (A) and Taharoa (B) titanite-magnetite deposits magnetic responses. Yellow outlines represent 500nT contours. Both images are at the same scale. SUTM60 Coordinates.**





**Figure 3: Total magnetic intensity image of the entire project area. Permit boundary displayed in red. Major magnetic structure as dashed black line. SUTM60 and WGS84 Coordinates.**

The processed magnetic data highlight a number of clusters of strongly magnetic features, which have similar magnetic signatures to Waikato North and Taharoa, and likely represent titano-magnetite mineralisation. These are located primarily along the coast, but several magnetic anomalies that may represent palaeo strandlines have been interpreted inland.

The radiometric data is restricted to imaging responses from the top 30cm of the ground and can be useful for mapping outcropping geology. A robust geological discriminator is the ternary radiometric image, figure 4, which displays Potassium rich rocks (e.g. granites, porphyry, clays) in shades of red, Thorium rich rocks (e.g. laterites, basalts) in shades of green, and Uranium rich rocks in shades of blue. Geological interpretation can be made according to the combination of the three primary colours, with white areas being strong in all three radioelements and black/dark areas due to water (i.e. no radiometric response). The northern portion of the project area is dominated by strong thorium responses interpreted to be due to volcanics and basalt flows, and water responses. Some recent volcanic eruptions have associated uranium responses as seen at Mt Karioi and Mt Piongia. The south and south western portions of the project area display a variety of responses but generally shades of red/pink, brown and blue. This depicts an area of sandstone/siltstones, drainages, recent alluvium/colluvium and reduced responses due to vegetation cover. The eastern side of the project area is dominated by drainage, alluvial plains and recent colluvium, as depicted by the pattern responses and colour responses. The known titano-magnetite deposits do not have a distinct signature and display mixed red/blue at Waikato North and black at Taharoa.

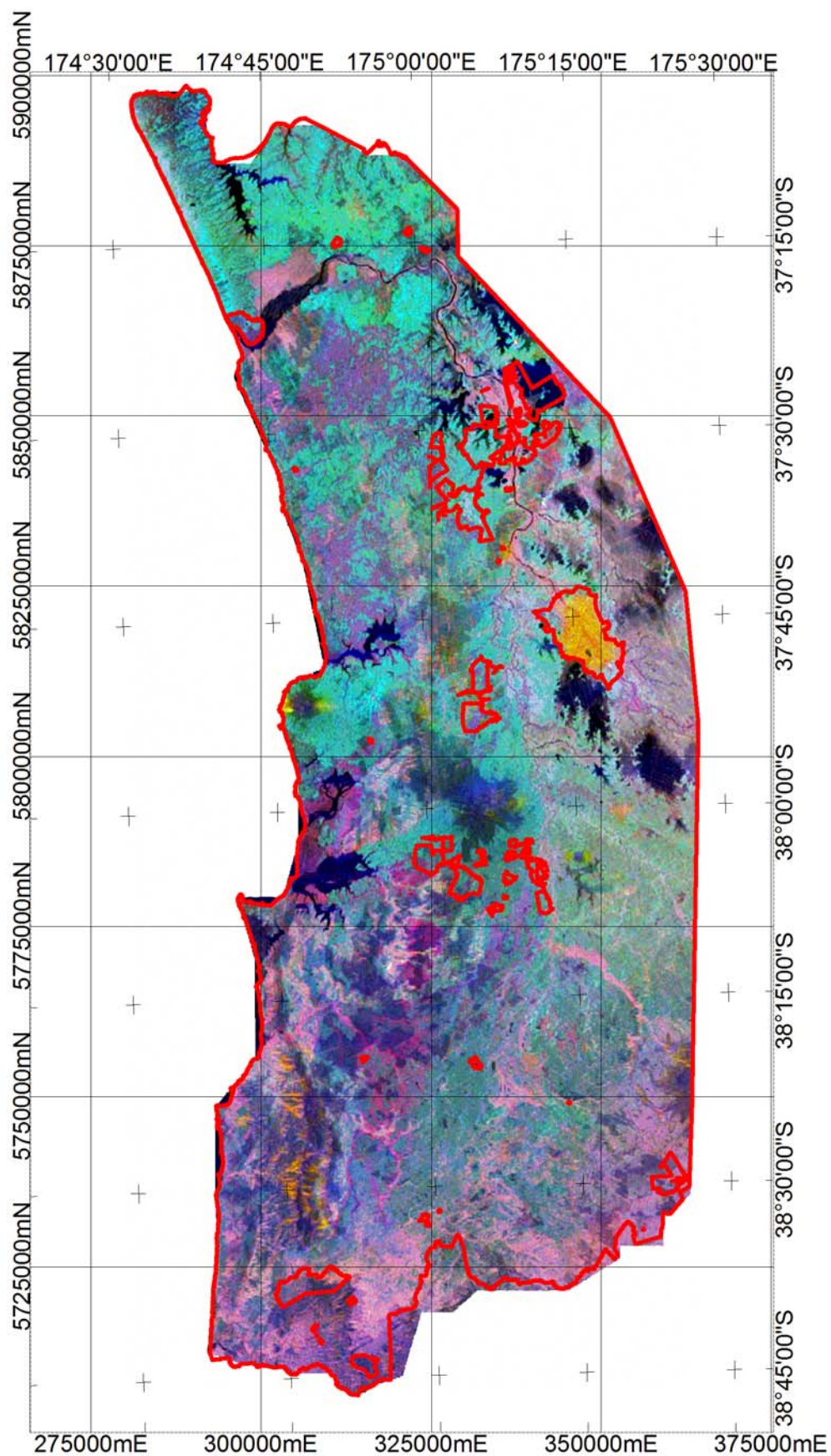
23 targets have been defined that are considered prospective for titano-magnetite mineralisation, and are listed in table 1, and shown on figure 5. Target selection was primarily based on the magnetic signature, then the DTM, radiometrics and 1:250K registered geological maps obtained from the New Zealand Institute of Geological and Nuclear Sciences, were used to prioritise. Any magnetic anomalies that could be explained as outcropping volcanics from the 1:250K geological mapping, were removed prior to generation of the final target file.

Of the 23 targets delineated, 7 are considered to be high priority, and have the potential to represent high tonnage titano-magnetite deposits. Each of the high priority targets are highlighted in figures 6 - 10.

***The targeting has not taken into account any restrictions to mining or exploration activities such as government, native title, environmental or access restrictions.***

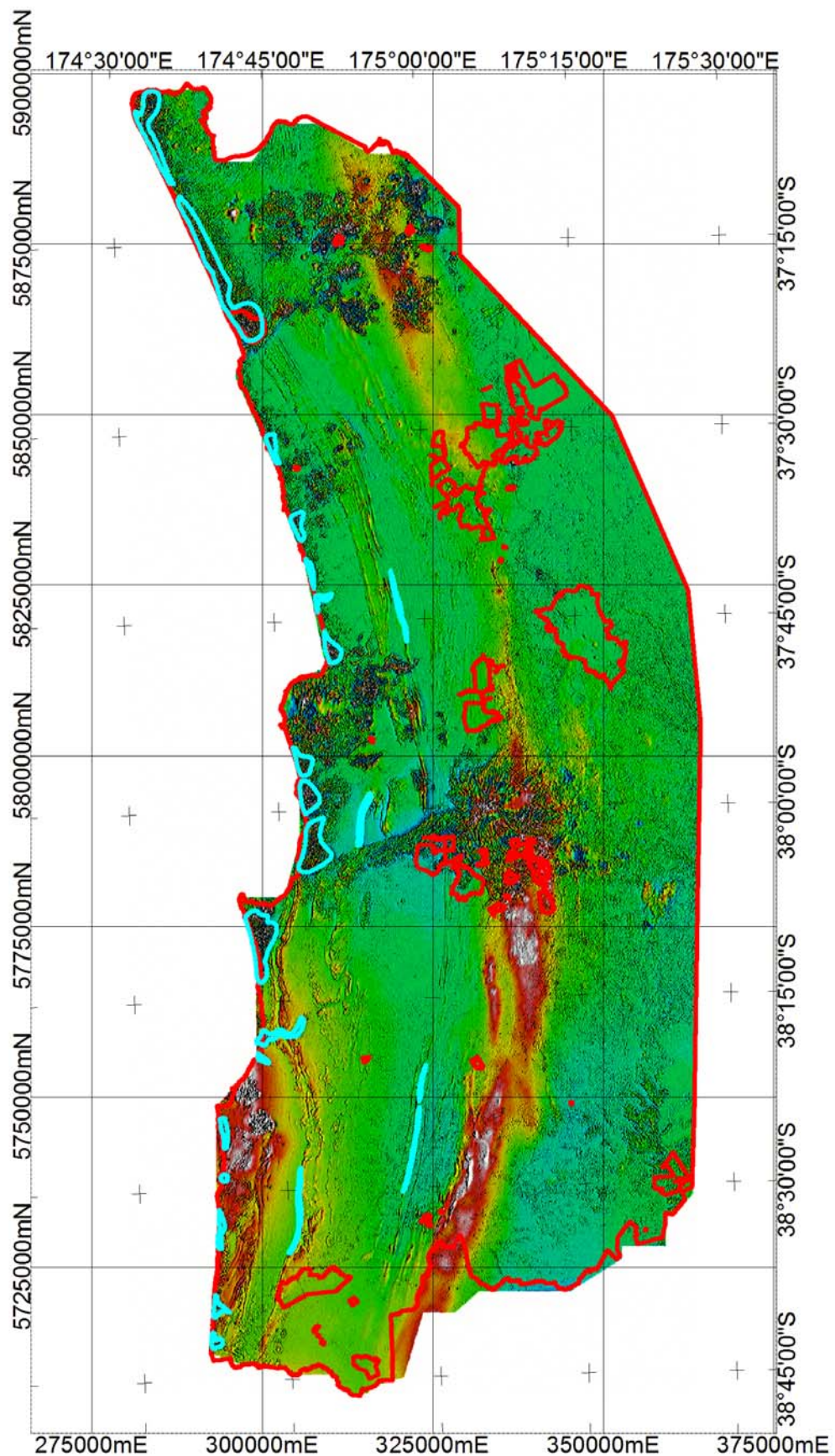
Target No	PRIORITY	DESCRIPTION	Centre Latitude (WGS84)	Centre Longitude (WGS84)	Centre X (SUTM60)	Centre Y (SUTM60)
1	1	14km long cluster of magnetic anomalies, on coast, north of Waikato North	174.56687	-37.09098	283750	5892267
2	1	24km long cluster of magnetic anomalies, on coast, north and inclusive of Waikato North	174.68181	-37.30052	294532	5869274
3	2	4km long cluster of magnetic anomalies, on coast,	174.75400	-37.51756	301509	5845341
4	2	3.5km long cluster of magnetic anomalies, on coast,	174.79357	-37.62183	305278	5833853
5	2	3km long cluster of magnetic anomalies, on coast,	174.81321	-37.68591	307177	5826783
6	2	2km long magnetic anomalies, in drainage, on coast,	174.82999	-37.72122	308748	5822899
7	1	3.5km long cluster of magnetic anomalies, on coast North of Raglan	174.84537	-37.78917	310278	5815390
8	1	3km long cluster of magnetic anomalies, on coast,	174.79281	-37.93667	306036	5798914
9	1	4km long cluster of magnetic anomalies, on coast,	174.80053	-37.98094	306830	5794018
10	1	6km long cluster of magnetic anomalies, on coast,	174.80749	-38.04998	307623	5786371
11	1	10km long cluster of magnetic anomalies, on coast, includes Taharoa	174.71477	-38.16880	299811	5772989
12	2	6km long cluster of magnetic anomalies, along drainage to coast	174.74172	-38.29365	302510	5759190
13	2	1.5km long cluster of magnetic anomalies, on coast	174.71262	-38.32592	300054	5755546
14	2	3.5km long cluster of magnetic anomalies, on coast	174.64568	-38.42088	294471	5744862
15	2	small anomaly on drainage, on coast	174.64355	-38.48192	294458	5738082
16	2	5km long cluster of magnetic anomalies, on coast	174.63533	-38.55115	293939	5730380
17	2	3km long cluster of magnetic anomalies, on coast	174.62804	-38.65363	293597	5718989
18	2	2km long cluster of magnetic anomalies, on coast	174.62266	-38.69834	293258	5714016
19	3	12km long magnetic trend, inland, possible palaeostrandline or volcanics	174.76659	-38.52671	305313	5733380
20	3	12km long magnetic trend, inland, possible palaeostrandline or volcanics	174.96058	-38.45072	322038	5742206
21	3	5km long magnetic trend, inland, possible palaeostrandline or volcanics	174.97772	-38.36267	323319	5752010
22	3	7km long magnetic trend, inland, possible palaeostrandline or volcanics	174.89023	-38.01063	314785	5790905
23	3	10km long magnetic trend, inland, possible palaeostrandline or volcanics	174.95759	-37.73446	320027	5821683

**Table 2: Target locations. Coordinates of the centre of the target area given.**



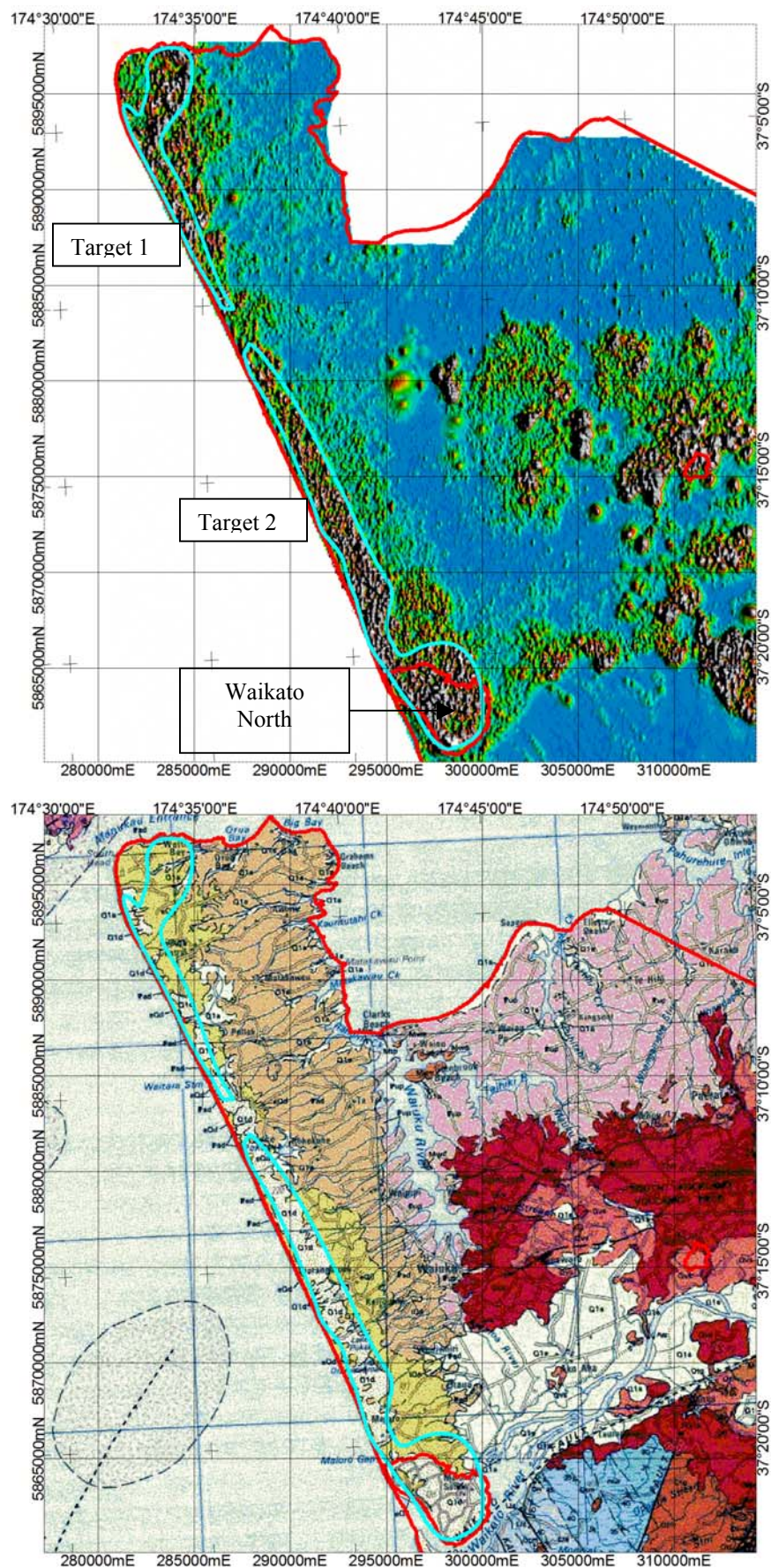
**Figure 4: Ternary radiometric image. Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**





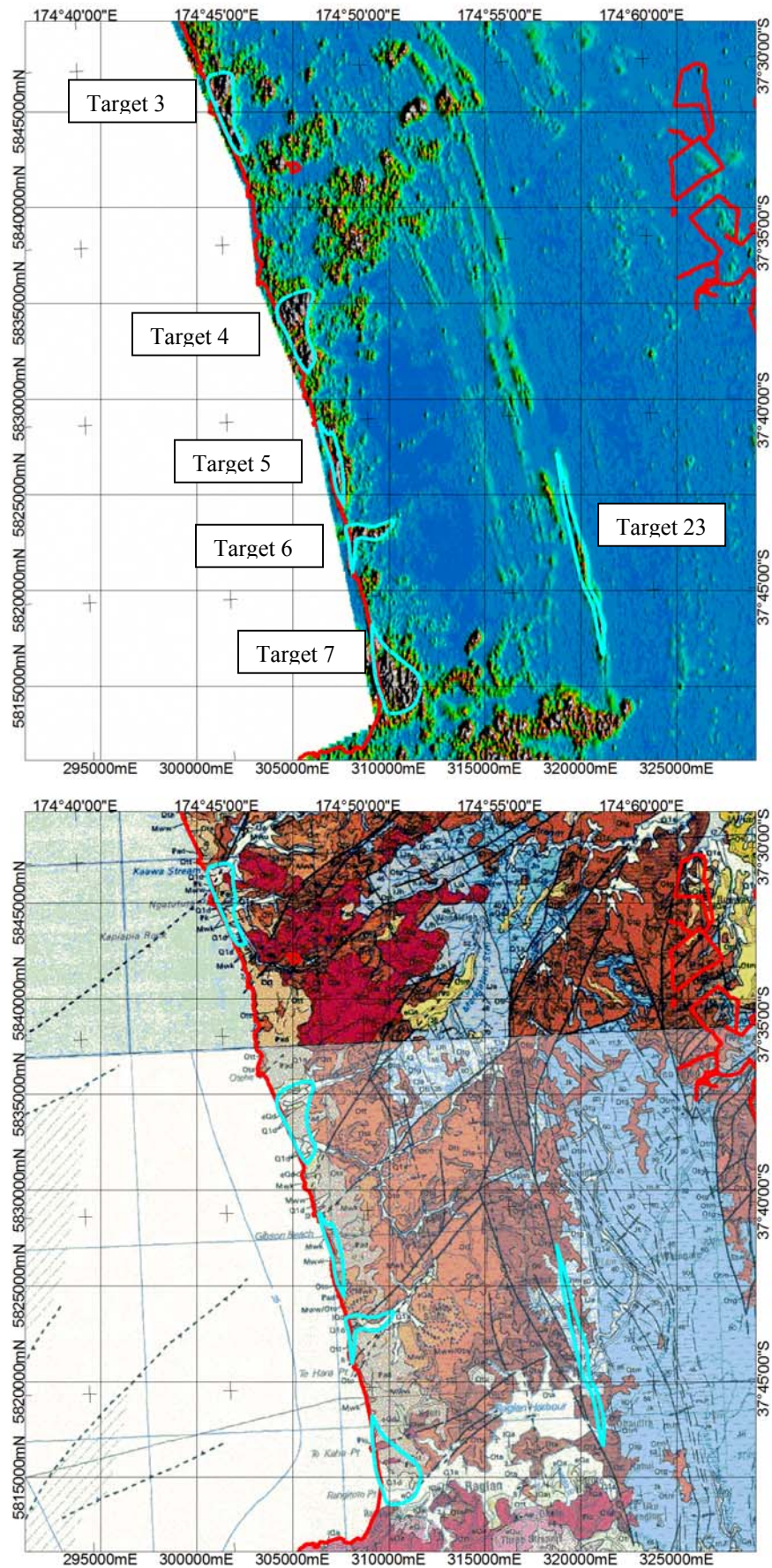
**Figure 5: Target outlines (Blue) TMI image. Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**





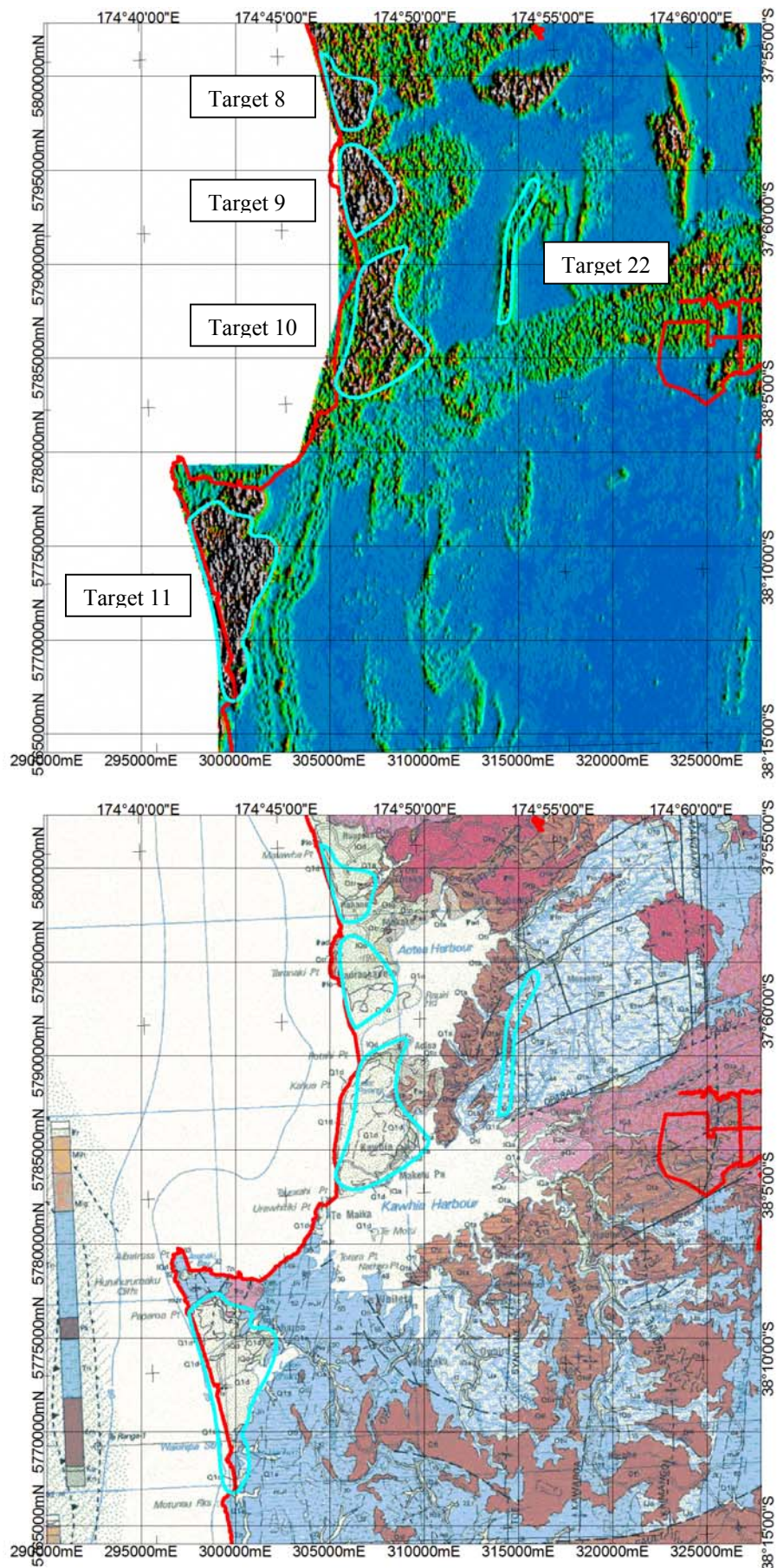
**Figure 6: Target 1 and 2 outlines (Blue) over Analytic Signal TMI image (top) and 1:250K geology (bottom). Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**





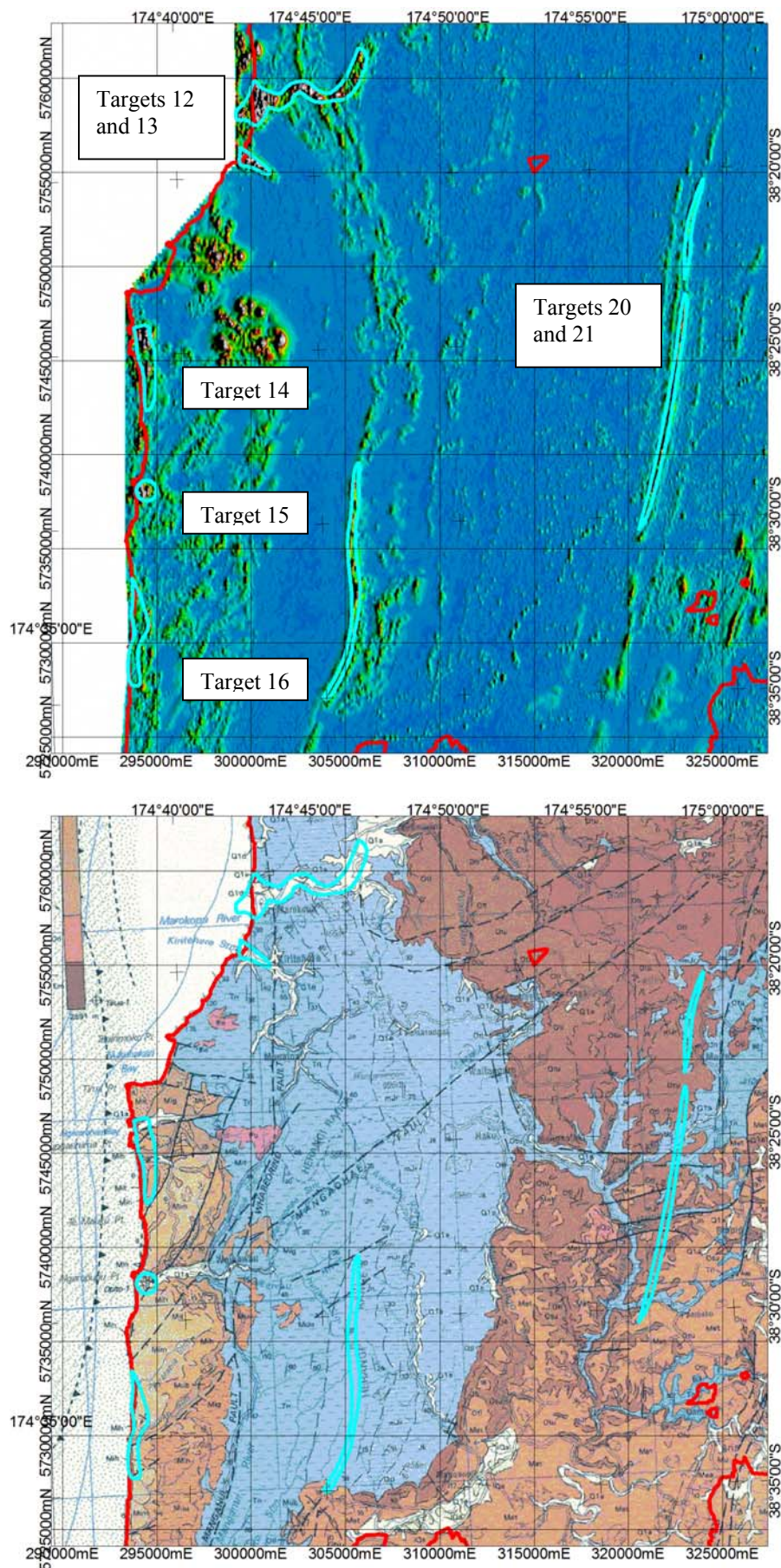
**Figure 7: Targets 3-7 and 23 outlines (Blue) over Analytic Signal TMI image (top) and 1:250K geology (bottom). Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**





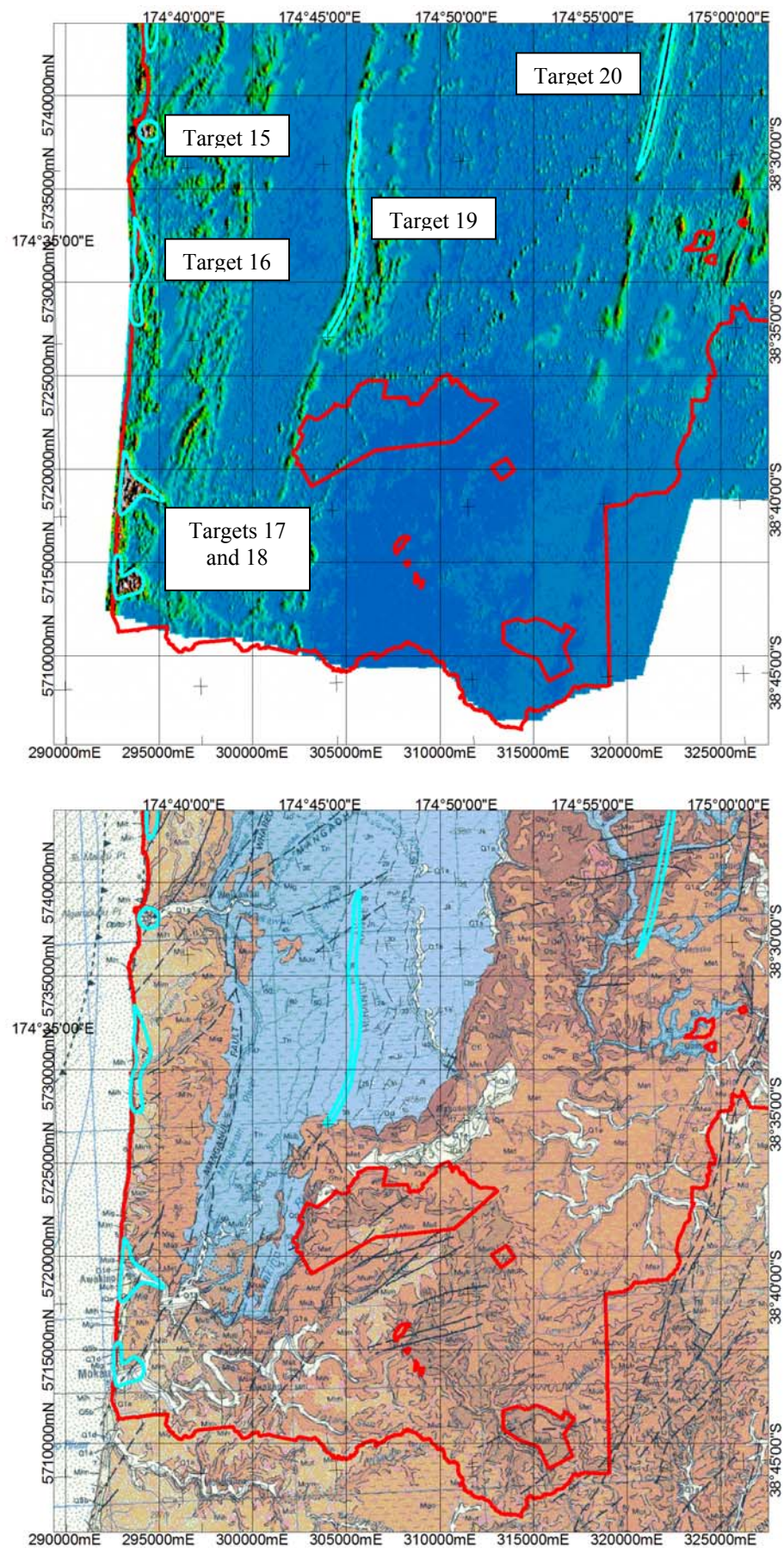
**Figure 8: Targets 8-11 and 22 outlines (Blue) over Analytic Signal TMI image (top) and 1:250K geology (bottom). Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**





**Figure 9: Targets 12-16 and 20-21 outlines (Blue) over Analytic Signal TMI image (top) and 1:250K geology (bottom). Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**





**Figure 10: Targets 15-18 and 19-20 outlines (Blue) over Analytic Signal TMI image (top) and 1:250K geology (bottom). Permit boundary displayed in red. SUTM60 and WGS84 Coordinates.**



## 6 CONCLUSIONS AND RECOMMENDATIONS

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The commissioning of a new aeromagnetic surveys over the New Zealand North Island Iron Sands Project has been successful in providing new, highly detailed magnetic data, which has delineated 23 magnetic targets favourable for titano-magnetite mineralization. Of the 23 targets defined, 7 are considered high priority and could represent potential large tonnage titano-magnetite deposits. Two of these targets are extensions from the Waikato North and Taharoa deposits.

It is recommended that:

- Further investigation and reconciliation of the targets be conducted with respect to possible restrictions on mining or exploration activities e.g. local government, native title, environmental and access.
- Complete open file data search for any previous company exploration data for titano-magnetite mineralization within the permit area.
- After completion of the prior points conduct ground reconnaissance of remaining high priority targets, which should initially include geological mapping, geochemical sampling and geophysical surveying (ground magnetics). The results can then be used to determine if drilling over any target area is warranted.

The information provided in this report should be used as an adjunct to other geoscientific information from the area that may provide further indications of the mineral potential.



# **APPENDIX 1 :**

## **List of Georeferenced Images and Vector Files Supplied**

### **Filenaming Convention**

#### **Image Files**

NZ\_DTM\_nesun\_rbw\_WGS84  
NZ\_DTM\_rbw\_WGS84  
NZ\_DTM\_nesun\_rbw\_WGS84  
NZ\_RAD\_Kpct\_esun\_rbw\_WGS84  
NZ\_RAD\_Kpct\_rbw\_WGS84  
NZ\_RAD\_Thppm\_esun\_rbw\_WGS84  
NZ\_RAD\_Thppm\_rbw\_WGS84  
NZ\_RAD\_Urppm\_esun\_rbw\_WGS84  
NZ\_RAD\_Urppm\_rbw\_WGS84  
NZ\_RAD\_KthUr\_RGB\_WGS84  
NZ\_RAD\_KthUr\_RGB\_he\_WGS84  
NZ\_RAD\_KthUr\_RGB\_over\_DTM\_nesun\_WGS84  
NZ\_RAD\_KthUr\_RGB\_over\_TMI1vdrtp\_esun\_WGS84  
NZ\_tmi\_1vd\_over\_2vdagcrtp\_rbw\_WGS84  
NZ\_tmi\_1vdagcrtp\_g\_WGS84  
NZ\_tmi\_1vdrtp\_esun\_rbw\_WGS84  
NZ\_tmi\_1vdrtp\_nesun\_rbw\_WGS84  
NZ\_tmi\_2vdagcrtp\_he\_g\_WGS84  
NZ\_tmi\_AS\_esun\_rbw\_WGS84  
NZ\_tmi\_tdr\_g\_WGS84  
NZ\_tmi\_tdr\_rbw\_WGS84  
NZ\_tmi\_rtp\_esun\_hsi\_WGS84  
NZ\_tmi\_rtp\_esun\_he\_hsi\_WGS84  
NZ\_tmirtip\_over\_1vdrtp\_esun\_rbw\_WGS84  
NZ\_tmirtip\_over\_DTM\_nesun\_rbw\_WGS84  
NZ\_Geology\_Auckland+Waikato\_WGS84

#### **Vector Files**

NZ\_DTM\_contours\_10m\_WGS84  
NZ\_flightpath\_WGS84  
NZ\_tmirtip\_contours\_10nt\_WGS84  
NZ\_Targets\_WGS84

#### **Processed Imagery Filename Structure:**

tmi = total magnetic intensity  
DTM = digital terrain model  
AHD = Australian Height Datum  
RAD = radiometric image  
K/Th/Ur = Potassium/Thorium/Uranium Image  
Grav/BG267 = Bouguer Gravity 2.67gcc (220 = 2.20 etc)  
SRTM = Shuttle Radar Topography Mission (DTM)

1vd = 1<sup>st</sup> vertical derivative

2vd = 2<sup>nd</sup> vertical derivative  
agc = automatic gain control filter  
rtp = reduced to the magnetic pole  
as = analytic signal  
TD = tilt derivative  
HD\_TD = horizontal derivative of the tilt derivative  
text57 = texture filtered with 5,7 filter variables  
nesun = north east sun angle shading  
esun = east sun angle shading  
resid = residual  
pct = percentage concentration  
ppm = equivalent concentration ppm

RGB = Red, Green, Blue radiometric ternary image (Potassium/Thorium/Uranium)  
lin = linear histogram stretch  
he = histogram equalised  
99clip = histogram 99% clipped  
psc/50 = pseudocolour image/50% transparency  
rbw/50 = rainbow colour image/50% transparency  
g = greyscale image  
wet = wetlook (HSI)

SUTM60 = WGS84 Datum and South Universal Transverse Mercator Zone 60 projection  
WGS84 = WGS84 datum Lat/Long Coordinates

e.g. NZ\_tmi\_1vdagcrtp\_g\_WGS84 = magnetics, 1<sup>st</sup> vertical derivative, agc filtered, reduced to the magnetic pole, grey scale image, WGS84 coordinates

## **APPENDIX 2**

### **UTS Geophysics Survey Logistic Report**



# **Logistics Report**

for a

## **DETAILED AIRBORNE MAGNETIC, RADIOMETRIC AND DIGITAL TERRAIN SURVEY**

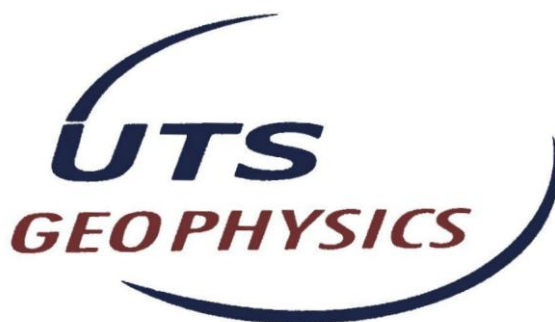
for the

### **NORTH ISLAND PROJECT**

carried out on behalf of

### **SINOSTEEL AUSTRALIAN PTY LTD**

by



(UTS Job #A964)

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## TABLE OF CONTENTS

<b>1</b>	<b>GENERAL SURVEY INFORMATION.....</b>	<b>3</b>
<b>2</b>	<b>SURVEY SPECIFICATIONS .....</b>	<b>3</b>
<b>3</b>	<b>AIRCRAFT AND SURVEY EQUIPMENT.....</b>	<b>4</b>
3.1	SURVEY AIRCRAFT .....	ERROR! BOOKMARK NOT DEFINED.
3.2	DATA POSITIONING AND FLIGHT NAVIGATION .....	ERROR! BOOKMARK NOT DEFINED.
3.3	UTS DATA ACQUISITION SYSTEM AND DIGITAL RECORDING .....	ERROR! BOOKMARK NOT DEFINED.
3.4	ALTITUDE READINGS .....	ERROR! BOOKMARK NOT DEFINED.
3.5	UTS STINGER MOUNTED MAGNETOMETER SYSTEM .....	6
3.6	TOTAL FIELD MAGNETOMETER .....	7
3.7	THREE COMPONENT VECTOR MAGNETOMETER .....	7
3.8	AIRCRAFT MAGNETIC COMPENSATION .....	7
3.9	DIURNAL MONITORING MAGNETOMETER.....	8
3.10	BAROMETRIC ALTITUDE .....	8
3.11	TEMPERATURE AND HUMIDITY .....	9
3.12	RADIOMETRIC DATA ACQUISITION .....	9
<b>4</b>	<b>PROJECT MANAGEMENT .....</b>	<b>10</b>
<b>5</b>	<b>DATA PROCESSING PROCEDURES.....</b>	<b>11</b>
5.1	DATA PRE-PROCESSING .....	11
5.2	MAGNETIC DATA PROCESSING .....	12
5.3	RADIOMETRIC DATA PROCESSING .....	13
5.4	DIGITAL TERRAIN MODEL DATA PROCESSING.....	13
	<b>APPENDIX A - LOCATED DATA FORMATS.....</b>	<b>15</b>
	<b>APPENDIX B - COORDINATE SYSTEM DETAILS.....</b>	<b>17</b>
	<b>APPENDIX C - SURVEY BOUNDARY DETAILS.....</b>	<b>18</b>
	<b>APPENDIX D - PROJECT DATA OVERVIEW .....</b>	<b>19</b>
	<b>APPENDIX E – ACQUISITION AND PROCESSING PARAMETERS .....</b>	<b>20</b>

## 1 GENERAL SURVEY INFORMATION

UTS Geophysics conducted a low level airborne geophysical survey for the following company:

Sinosteel Australia Pty Ltd  
42<sup>nd</sup> Floor, Bank West Tower  
108 St Georges Terrace  
Perth WA 6000

Acquisition for this survey commenced on the 9<sup>th</sup> February 2008 and was completed on the 26<sup>th</sup> March 2008. The base location used for operating the aircraft and performing in-field quality control was Taupo, New Zealand.

## 2 SURVEY SPECIFICATIONS

The area surveyed was located near Taupo, New Zealand. The survey was flown using the WGS84 coordinate system (a Universal Transverse Mercator projection) derived from the World Geodetic System and was contained within zone 60 with a central meridian of 177 degrees. Details of the datum and projection system are provided in Appendix B of this report. Survey boundary coordinates are listed in Appendix C.

The survey data acquisition specifications for each area flown are specified in the following table:

PROJECT NAME	LINE SPACING	LINE DIRECTION	TIE LINE SPACING	TIE LINE DIRECTION	SENSOR HEIGHT	TOTAL LINE KM
North Island	200m	090-270	2000m	000-180	60m	55,050
<b>TOTAL</b>						<b>55,050</b>

The specified sensor height for the magnetic samples is as stated in the above table. This sensor height may be varied where topographic relief or laws pertaining to built up areas do not allow this altitude to be maintained, or where the safety of the aircraft and equipment is endangered.

### 3 AIRCRAFT AND SURVEY EQUIPMENT

The UTS navigation flight control computer, data acquisition system and geophysical sensors were installed into a specialised geophysical survey aircraft.

The list of geophysical and navigation equipment used for the survey is as follows:

#### **General Survey Equipment**

- CRESCO-08-600 fixed wing survey aircraft.
- UTS proprietary flight planning and survey navigation system.
- UTS proprietary high speed digital data acquisition system.
- Novatel 3951R, 12 channel precision navigation GPS.
- OMNILITE 132 real time differential GPS system.
- UTS LCD pilot navigation display and external track guidance display.
- UTS post mission data verification and processing system.
- Bendix King KRA-10 radar altimeter.

#### **Magnetic Data Acquisition Equipment**

- UTS tail stinger magnetometer installation.
- 2 x UTS wingtip magnetometer installation.
- 3 x Geometrics G822A Cesium Vapour total field magnetometers.
- Fluxgate three component vector magnetometer.
- RMS Aeromagnetic Automatic Digital Compensator (ARC500).
- Diurnal monitoring magnetometer (Scintrex Envimag).

#### **Radiometric Data Acquisition Equipment**

- Exploranium GR-820 gamma ray spectrometer.
- Exploranium gamma ray detectors.
- Barometric altimeter (height and pressure measurements).
- Temperature and humidity sensor.

### 3.1 *Survey Aircraft*

The aircraft used for this survey was a CRESCO-08-600 series fixed wing survey aircraft, operated by UTS Geophysics, registration ZK-LTP. The specifications are as follows:

#### **Power Plant**

- Engine Type Pratt and Whitney PT-6-34AG
- Shaft Horse Power 750 eshp
- Fuel Type JET-A1

#### **Performance**

- Cruise speed 155 Kn
- Survey speed 140 Kn
- Stall speed 50 Kn
- Range 2550 Km
- Endurance (no reserves) 10.5 hours
- Fuel tank capacity 1800 litres



### 3.2 *Data Positioning and Flight Navigation*

Survey data positioning and flight line navigation was derived using real-time differential GPS (Global Positioning System).

Navigation was performed using a UTS designed and built electronic pilot navigation system providing computer controlled digital navigation instrumentation mounted in the cockpit as well as an externally mounted track guidance system.

GPS derived positions were used to provide both aircraft navigation and survey data location information.

The GPS systems used for the survey were:

- Aircraft GPS Model Novatel 3951R
- Sample rate 0.5 Seconds (2 Hz)
- GPS satellite tracking channels 12 parallel
- Typical differentially corrected accuracy 1-2 metres (horizontal)  
3-5 metres (vertical)

### **3.3 UTS Data Acquisition System and Digital Recording**

All geophysical sensor data and positional information measured during the survey was recorded using a UTS developed, high speed, precision data acquisition system. Survey data was downloaded onto magnetic tape on completion of each survey flight.

Instrument synchronisation times were measured and removed in real-time by the UTS data acquisition system.

### **3.4 Altitude Readings**

Accurate survey heights above the terrain were measured using a King radar altimeter installed in the aircraft. The height of each survey data point was measured by the radar altimeter and stored by the UTS data acquisition system.

- Radar altimeter models                      King KRA- 10
- Accuracy    0.3 metres
- Resolution    0.1 metres
- Range    0 - 500 metres
- Sample rate    0.1 Seconds (10Hz)

The digital terrain model is calculated by subtracting the terrain clearance (radar altimeter) from the GPS height (interpolated to 0.1 Hz), and as such the accuracy is constrained by the differentially corrected GPS position.

### **3.5 UTS Stinger Mounted Magnetometer System**

The installation platform used for the acquisition of magnetic data was a tail mounted stinger. This proprietary stinger system was constructed of carbon fibre and designed for maximum rigidity and stability.

Both the total field magnetometer and three component vector magnetometer were located within the tail stinger.



### 3.6 *Total Field Magnetometer*

Total field magnetic data readings for the survey were made using a Scintrex Cesium Vapour CS-2 Magnetometer. This precision sensor has the following specifications:



- Model Scintrex Cesium Vapour CS-2 Magnetometer
- Sample Rate 0.1 seconds (10Hz)
- Resolution 0.001nT
- Operating Range 15,000nT to 100,000nT

### 3.7 *Three Component Vector Magnetometer*

Three component vector magnetic data readings for the survey were made using a Develco Fluxgate Magnetometer. This precision sensor has the following specifications:

- Model Develco Fluxgate Magnetometer
- Sample Rate 0.1 seconds (10Hz)
- Resolution 0.1nT
- Operating Range -100,000nT to 100,000nT

### 3.8 *Aircraft Magnetic Compensation*

At the start of the survey, the system was calibrated for reduction of magnetic heading error. The heading and manoeuvre effects of the aircraft on the magnetic data was removed using an RMS Automatic Airborne Digital Compensator (AADC II).

Calibration of the aircraft heading effects were measured by flying a series of pitch, roll and yaw manoeuvres at high altitude while monitoring changes in the three axis magnetometer and the effect on total field readings. A 26 term model of the aircraft magnetic noise covering permanent, induced and eddy current fields was determined. These coefficients were then applied to the data collected during the survey in real-time.

UTS static compensation techniques were also employed to reduce the initial magnetic effects of the aircraft upon the survey data.

### 3.9 *Diurnal Monitoring Magnetometer*

A base station magnetometer was located in a low gradient area beyond the region of influence of any man made interference to monitor diurnal variations during the survey.

The specifications for the magnetometer used are as follows:

- Model Scintrex Envimag
- Resolution 0.1 nT
- Sample interval 5 seconds (0.2 Hz)
- Operating range 20,000nT to 90,000nT
- Temperature -20°C to +50°C



### 3.10 *Barometric Altitude*

An Air DB barometric altimeter was installed in the aircraft so as to record and monitor barometric height and pressure. The data was recorded at 0.10 second intervals and is used for the reduction of the radiometric data.

- Model Air DB barometric altimeter
- Accuracy 2 metres
- Height resolution 0.1 metres
- Height range 0 - 3500 metres
- Maximum operating pressure: 1,300 mb
- Pressure resolution: 0.01 mb
- Sample rate 10 Hz



### **3.11 Temperature and Humidity**

Temperature and humidity measurements were made during the survey at a sample rate of 10Hz. Ambient temperature was measured with a resolution of 0.1 degree Celsius and ambient humidity to a resolution of 0.1 percent.

### **3.12 Radiometric Data Acquisition**

The gamma ray spectrometer used for the survey was capable of recording 256 channels and was self stabilising in order to minimise spectral drift. The detectors used contain thallium activated sodium iodide crystals.

Thorium source measurements were made each survey day to monitor system resolution and sensitivity. A calibration line was also flown at the start and end of each survey day to monitor ground moisture levels and system performance

- Spectrometer model                      Exploranium GR820
- Detector volume                         32 litres
- Sample rate                               1 Hz



## **4 PROJECT MANAGEMENT**

Sinosteel Australia Pty Ltd

Max Nind  
David Sun

UTS Geophysics Perth Office

Nino Tuffilli  
David Abbott  
Cameron Johnston  
Rebecca Steadman

## 5 DATA PROCESSING PROCEDURES

### 5.1 *Data Pre-processing*

The raw survey data was loaded from the field tapes and the recorded data trimmed to the correct survey boundary extents. Any survey lines subsequently re flown were removed from the dataset.

At the commencement of each acquisition flight, all the instrumentation clocks were synchronized to local time, and the error and latency of each instrument in providing its data measurement calculated. The results of these latency measurements were recorded into a synchronisation file, and the results used to assign GPS positions to the magnetic, radiometric and elevation data. As a result of the physical separation of the sensors, a small residual offset still exists between instrument timings.

To compensate for this residual parallax error, an adjustment was made to the instrument clocks. The magnetic and radar altimeter data was adjusted by 0.600 seconds, and the radiometric data was adjusted by 1.375 seconds for each flight.

The synchronized, parallax corrected data was then exported as located ASCII data.

## **5.2    *Magnetic Data Processing***

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 filtered diurnal measurements were subtracted from the diurnal base field and the residual corrections applied to the survey data by synchronising the diurnal data time and the aircraft survey time. The average diurnal base station value was added to the survey 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 updated IGRF 2005 correction was calculated at each data point (taking into account the height above sea level).

This regional magnetic gradient was subtracted from the survey data points.

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.

In order to remove any residual long wavelength variations in the tie line levelled data along the traverse lines, polynomial levelling was then applied.

Final micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensity

Located and gridded data were generated from the final processed magnetic data.

### 5.3 Radiometric Data Processing

Statistical noise reduction of the 256 channel data was performed using the Noise Adjusted Singular Variable Decomposition (NASVD) method described by Hovgaard and Grasty (1997).

Noise-adjusted singular value decomposition is performed, and the number of components to be used is determined by inspection of plots of the spectral components and by a statistical analysis of the contributions of the components. If the spectral shapes show any unusual characteristics, further analysis of the concentrations of the spectral components in the line data is performed in order to identify and eliminate any corrupt spectra. If such spectra were eliminated, the NASVD process is re-performed, in order to obtain spectral components free of any bias from corrupt spectra.

Only the dominant spectral shapes (identified as described above) were used in the spectral reconstruction process. The first 8 NASVD components were used for this process.

Channels 30-250 only are spectrally smoothed, as these contain the regions of interest and are not dominated by the lower end of the Compton continuum. The energy spectrum between the potassium and thorium peaks was recalibrated from the spectrally smoothed 256 channel measurements.

The aircraft background spectrum and the scaled unit cosmic spectrum were then subtracted from the 256 channel data. This 256 channel data was then windowed to the 5 primary channels of total count, potassium, uranium, thorium and low-energy uranium. Dead time corrections were then applied to the data. Radon background removal was performed using the Minty Spectral Ratio method (1992).

The radar altimeter data was corrected to standard temperature and pressure, and height corrected spectral stripping was then applied to the windowed data. Height attenuation corrections based on the STP radar altimeter were then performed to remove any altitude variation effects from the data.

The Uranium and Total Count channels were tie-levelled to remove the effects of residual radon background. The tie-levelling process employed was a least-squares/median filter procedure, which generated a single correction for each line of data. Mis-matches were calculated at each tie-traverse intersection and the median mismatch for each flight line was calculated as the residual levelling error for that line.

Final micro-levelling techniques were then selectively applied to the tie line levelled data to remove minor residual variations in profile intensities, as per the method outlined for magnetic data micro-levelling in 7.2 above. Limits were applied to the radiometric channels in selected areas only during the micro-levelling process are shown in the table below.

#### **5.4    *Digital Terrain Model Data Processing***

The radar altimeter data was subtracted from the GPS altimeter data. The separation distance between the GPS antenna and the radar altimeter of 1.4 metres was subtracted from the digital terrain data.

The digital terrain data thus derived was tie line levelled and gridded. Tie line levelled data was then examined and selectively microlevelled to produce a grid without line dependent artifacts.

**For further information concerning the survey flown, please contact the following office:**

**Head Office Address:**

UTS Geophysics  
Fauntleroy Avenue, Perth Airport  
REDCLIFFE WA 6104

Tel:    +61 8 9479 4232

Fax:    +61 8 9479 7361

**Postal Address:**

UTS Geophysics  
P.O. Box 126  
BELMONT WA 6984

**Quoting reference number: A964**

## APPENDIX A - LOCATED DATA FORMATS

### MAGNETIC LOCATED DATA

FIELD	FORMAT	DESCRIPTION	UNITS
1	I8	LINE NUMBER	
2	I4	FLIGHT/AREA NUMBER	AAFF (Area/Flight)
3	I9	DATE	YYMMDD
4	F10.1	TIME	sec
5	I8	FIDUCIAL NUMBER	
6	I4	UTM ZONE	
7	F12.6	LATITUDE (WGS84)	degrees
8	F12.6	LONGITUDE (WGS84)	degrees
9	F12.2	EASTING (MGA94)	metres
10	F12.2	NORTHING (MGA94)	metres
11	F8.1	RADAR ALTIMETER HEIGHT	metres
12	F8.1	GPS HEIGHT (WGS84)	metres
13	F8.1	TERRAIN HEIGHT (WGS84)	metres
14	F10.2	RAW MAGNETIC INTENSITY	nT
15	F10.2	DIURNAL CORRECTION	nT
16	F10.2	IGRF CORRECTION	nT
17	F10.2	DRN AND IGRF CORRECTED TMI	nT
18	F10.2	FINAL TOTAL MAGNETIC INTENSITY	nT

### RADIOMETRIC LOCATED DATA

FIELD	FORMAT	DESCRIPTION	UNITS
1	I8	LINE NUMBER	
2	I4	FLIGHT/AREA NUMBER	AAFF (Area/Flight)
3	I9	DATE	YYMMDD
4	F10.1	TIME	sec
5	I8	FIDUCIAL NUMBER	
6	I4	UTM ZONE	
7	F12.6	LATITUDE (WGS84)	degrees
8	F12.6	LONGITUDE (WGS84)	degrees
9	F12.2	EASTING (MGA94)	metres
10	F12.2	NORTHING (MGA94)	metres
11	F8.1	RADAR ALTIMETER HEIGHT	metres
12	F8.1	GPS HEIGHT (WGS84)	metres
13	I5	LIVE TIME	milli sec
14	F8.1	PRESSURE	hPa
15	F6.1	TEMPERATURE	Degrees Celcius
16	F6.1	HUMIDITY	percent
17	I6	TOTAL COUNT (RAW)	Counts/sec
18	I6	POTASSIUM (RAW)	Counts/sec
19	I6	URANIUM (RAW)	Counts/sec
20	I6	THORIUM (RAW)	Counts/sec
21	I6	COSMIC (RAW)	Counts/sec
22	F8.1	TOTAL COUNT (CORRECTED)	Counts/sec
23	F8.1	POTASSIUM (CORRECTED)	Counts/sec
24	F8.1	URANIUM (CORRECTED)	Counts/sec
25	F8.1	THORIUM (CORRECTED)	Counts/sec
26	F9.4	DOSE RATE	nGy/hr
27	F9.4	POTASSIUM GRND CONCENTRATION	%
28	F9.4	URANIUM GRND CONCENTRATION	ppm
29	F9.4	THORIUM GRND CONCENTRATION	ppm

## GRIDDED DATASET FORMATS

Gridding was performed using a bicubic spline algorithm.

The following grid formats have been provided:

- ER-Mapper format

## LINE NUMBER FORMATS

Line numbers are identified with a six digit composite line number and have the following format - ALLLLB, where:

A	Survey area number
LLLL	Survey line number
	0001-8999 reserved for traverse lines
	9001-9999 reserved for tie lines
B	Line attempt number, 0 is attempt 1, 1 is attempt 2 etc..

## UTS FILE NAMING FORMATS

Located and gridded data provided by UTS Geophysics uses the following 8 character file naming convention to be compatible with PC DOS based systems.

File names have the following general format - JJJJAABB.EEE, where:

JJJJ	UTS Job number
AA	Area number if the survey is broken into blocks
BB	M     Magnetic data
	R     Radiometric data
	TC    Total count data
	K     Potassium counts
	U     Uranium counts
	Th    Thorium counts
	DT    Digital terrain data
EEE	File name extension
	LDT   Located digital data file
	FMT   Located data format definition file
	ERS   Ermapper gridded data header file
	Ermapper data portion has no extension
	GRD   Geosoft gridded data file



## APPENDIX B - COORDINATE SYSTEM DETAILS

Locations for the survey data are provided in both geographical latitude and longitude and Universal Transverse Mercator metric projection coordinate systems.

### **WGS84**

Coordinate Type  
Semi Major Axis  
Flattening

World Geodetic System 1984  
Geographical  
6378137m  
1/298.257223563

### **MGA94**

Coordinate type  
Geodetic datum  
Semi major axis  
Flattening

Map Grid of Australia 1994  
Universal Transverse Mercator Projection Grid  
Geocentric Datum of Australia  
6378137m  
1/298.257222101

## APPENDIX C - SURVEY BOUNDARY DETAILS

### COORDINATES REPORT

Job ID code: A96401

Client: Sinosteel

Job: North Island

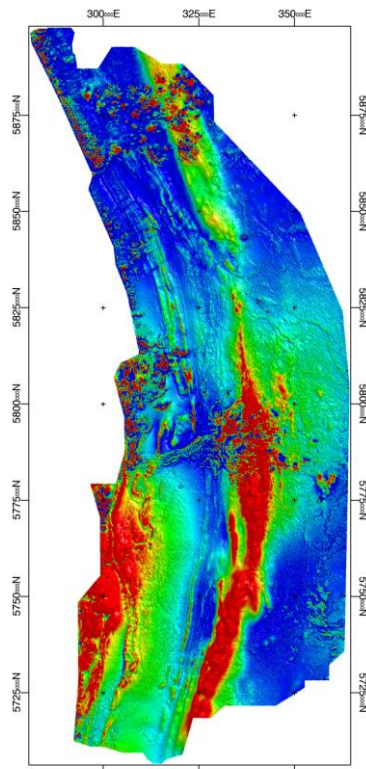
Grid Zone: 60

Surround

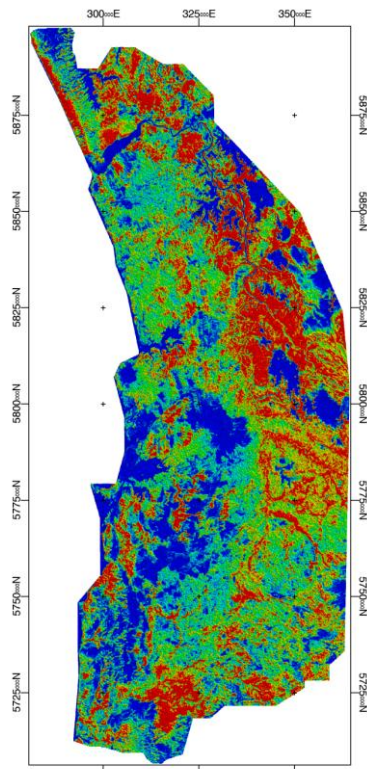
284250.000	5887370.000
298590.000	5887340.000
302210.000	5892970.000
307900.000	5892970.000
315500.000	5888500.000
320750.000	5888500.000
328790.000	5880320.000
328980.000	5873420.000
351400.000	5849900.000
362500.000	5824300.000
364300.000	5804900.000
363900.000	5780700.000
362980.000	5735730.000
359000.000	5732100.000
359000.000	5728200.000
352600.000	5728200.000
352600.000	5726300.000
345100.000	5721600.000
331710.000	5721600.000
327940.000	5718270.000
323390.000	5718270.000
320720.000	5708980.000
316400.000	5707600.000
315190.000	5706490.000
313080.000	5706480.000
311230.000	5707860.000
310370.000	5709410.000
305030.000	5709390.000
300140.000	5710820.000
297000.000	5710820.000
292120.000	5712420.000
293490.000	5729360.000
293320.000	5735460.000
293310.000	5748680.000
299160.000	5755600.000
299100.000	5770300.000
296610.000	5778750.000
296700.000	5779480.000
303250.000	5779480.000
305520.000	5787810.000
305440.000	5796460.000
302630.000	5807000.000
304310.000	5810660.000
309320.000	5813130.000
306090.000	5828710.000
303110.000	5836230.000
302670.000	5840600.000
295990.000	5855750.000
297100.000	5859410.000
288450.000	5878820.000
284250.000	5887370.000

## APPENDIX D - PROJECT DATA OVERVIEW

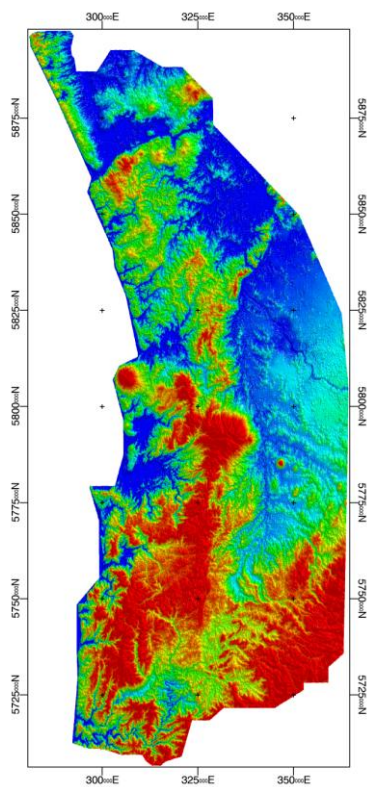
## North Island Project Project



Total Magnetic Intensity



Radiometric Total Count



Digital Terrain Model

## APPENDIX E – ACQUISITION AND PROCESSING PARAMETERS

### Magnetic Processing Parameters

Model	:	IGRF 2008.31
Average Declination	:	19.28 degrees
Average Inclination	:	-62.97 degrees
Average Field strength:		54,307 nT
Average diurnal	:	54,600 nT

### Radiometric Processing Parameters

#### Height Attenuation Coefficients

Total Count:	-0.0074
Potassium:	-0.0094
Uranium:	-0.0084
Thorium:	-0.0074

#### Cosmic Correction Coefficients

Total Count:	1.615
Potassium:	0.092
Uranium:	0.087
Thorium:	0.051

#### Aircraft Background Coefficients

Total Count:	33.69
Potassium:	9.27
Uranium:	0.59
Thorium:	0.05

#### Sensitivity Coefficients

Total Count:	31.5 cps/dose rate
Potassium:	124.6 cps/%k
Uranium:	9.6 cps/ppm
Thorium:	7.4 cps/ppm

**Final Reduction** - All data reduced to STP height datum 60m